ECONOMY-WIDE MODELING OF THE ECONOMIC IMPLICATIONS OF A FTA WITH MEXICO AND A NAFTA WITH CANADA AND MEXICO

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This report was prepared principally by:

Joseph F. Francois and Clinton R. Shiells, Project Leaders

and

Hugh M. Arce, Kyle Johnson, Kenneth A. Reinert, Stephen P. Tokarick

Office of Economics

Address all communications to:

Kenneth R. Mason, Secretary to the Commission
United States International Trade Commission
Washington, DC 20436

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"A SUMMARY OF,
'INDUSTRIAL EFFECTS OF A FREE TRADE AGREEMENT
BETWEEN MEXICO AND THE USA,'
BY THE INTERINDUSTRY ECONOMIC RESEARCH FUND, INC.,"
BY CLINTON R. SHIELLS AND ROBERT C. SHELBURNE
(THE ALMON STUDY)

INDUSTRIAL EFFECTS OF A FREE TRADE AGREEMENT BETWEEN MEXICO AND THE USA

by the Interindustry Economic Research Fund, Inc.
P.O. Box 451, College Park, MD 20740
(301) 405-4609

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Research Summary
prepared by:

Clinton R. Shiells and Robert C. Shelburne
Division of Foreign Economic Research
Bureau of International Labor Affairs
U.S. Department of Labor
(202) 523-7610

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1. Overview

The study of a U.S.-Mexico free trade agreement (FTA) summarized here was conducted jointly by Interindustry Forecasting at the University of Maryland (INFORUM) and the Centro de Investigationes Matematicas at the University of Guanajuato (CIMAT). It is based on linking a 78-sector U.S. model with a 74-sector Mexican model. Each model determines employment, production, prices, exports, and imports in all sectors. Linkage arises from the requirement that the value of U.S. imports from Mexico equals the value of Mexican exports to the United States and vice versa.

U.S. output, exports, and employment all increase modestly from the FTA. Many sectors in the United States experience an increase in employment, while a few suffer employment losses; total U.S. employment increases by 29,300 to 44,500 workers after 5 years. In Mexico, personal consumption, investment, and exports are all stimulated by the FTA. However, imports increase even more strongly so that Mexican gross national product (GNP) falls slightly. This result stems from limiting the scope of the assumed policy changes to removal of tariffs and some non-tariff measures and from some key economic assumptions that underlie the analysis. Notably absent is any consideration of relaxed Mexican restrictions on direct foreign investment.

We first describe the policy experiments conducted in Section 2. Mutual reductions by the United States and Mexico in their tariffs and other trade barriers lead to changes in bilateral trade flows, as shown in Section 3. Changes in both U.S. and Mexican imports and exports result in changes in production and employment in different industrial sectors in each country. To understand the employment results, it is also necessary to understand some of the macroeconomic assumptions embodied in the U.S. and Mexican models. Macro assumptions and results are covered in Section 4. U.S. employment changes by industrial sector, by state, and for different occupational groups are examined in Section 5. Some conclusions of the INFORUM-CIMAT study are provided in Section 6.

2. Assumed Policy Changes

To estimate the economic effects of a U.S.-Mexican FTA, the INFORUM-CIMAT study first forecasts the course of the U.S. and Mexican economies on the assumption that tariffs and other trade barriers remain at their current levels. This serves as a baseline (no policy change) to judge the effects of the FTA. Then the U.S. and Mexican models (called LIFT and MIMEX, respectively) are rerun as before except that tariffs and some important non-tariff barriers to trade between the two countries are eliminated. Comparison of the new forecast with the baseline forecast yields an estimate of the incremental effect of the FTA.

The policy changes analyzed and the range of responses permitted are rather limited in the INFORUM-CIMAT study. Two alternative scenarios are generated in addition to the baseline. First, all tariffs are eliminated on trade between the United States and Mexico, starting in 1990. *It is assumed that there is no phase-in period for the tariff reductions*. This is referred to as the "tariffs only" or "TO" scenario. U.S. and Mexican tariffs as of May 1988 were used as a basis for the INFORUM-CIMAT study. The average tariff is about 3.3 percent for the United States and about 11 percent for Mexico.

The second scenario consists of eliminating all tariffs as before and, in addition, some significant non-tariff trade barriers. Again, no phase-in period is assumed for the tariff reductions, while the non-tariff trade barriers are assumed to be removed gradually. This case is referred to as the "tariffs and barriers" or "TAB" scenario. The four significant non-tariff barriers that are assumed to be removed under the FTA and their severity (based on the INFORUM-CIMAT group's judgmental estimates which are discussed in Chapter V of their Final Report) are presented in the text table below. The figures shown are the assumed increase in trade that would result from the gradual elimination of the non-tariff barrier; INFORUM-CIMAT refer to these as "add factors." These add factors represent a growth of about 10-20 percent a year from the 1989 baseline trade in their respective items.

Estimates of Increased Trade Assumed to Result from the Removal of Non-Tariff Measures
(millions of 1977 dollars)

	1990	1991	1992	2000
U.S. Exports to Mexico				
Agriculture	125	250	375	625
Computers	90	180	270	450
Motor vehicles	180	360	540	900
U.S. Imports from Mexico				
Apparel	100	200	300	500

3. Changes in Bilateral Trade Flows

Elimination of trade barriers between the United States and Mexico lowers the cost of imports to buyers in each country. For the United States, INFORUM-CIMAT compute the effect on overall import prices of the drop in prices of U.S. imports from Mexico. This percent change in the world price of U.S. imports is used to compute the increase in U.S. imports from all sources using the LIFT model. Then, a share of the increase in total U.S. imports is assumed to enter from Mexico based on import share functions, one for each industrial sector, appended to the existing LIFT model.

A similar exercise is conducted using the MIMEX model for Mexico. Reduction in U.S. trade barriers lowers the cost of Mexican imports from the United States and hence reduces the overall price of Mexican imports from all sources. The MIMEX model is used to compute the resulting increase in Mexican imports from all sources. Then import share functions are used in conjunction with results from the MIMEX model to compute the increase in Mexican imports from the United States.

An iterative procedure is employed to solve the LIFT and MIMEX models jointly so that: (1) the value of U.S. imports from Mexico equals the value of Mexican exports to the United States; and (2) the value of U.S. exports to Mexico equals the value of Mexican imports from the United States. Although there is a significant discrepancy between the total value of U.S. exports to Mexico and Mexican imports from the United States, even after attempting to correct for the presence of *maquiladoras* (i.e., in-bond processing firms in Mexico), INFORUM-CIMAT were able to solve for changes in bilateral trade flows. Results after 5 year for U.S. trade with Mexico under the TAB scenario are shown in Table 1. The largest flow changes occur in sectors assumed to be subject to removal of Mexican non-tariff barriers.

4. Aggregate Economic Effects

The INFORUM-CIMAT group's estimates of changes in major economic measures from the baseline attributed to the FTA under both the TO and TAB scenarios are summarized in Tables 2 and 3 for the United States and Mexico, respectively. In the United States, the trade balance rises by 11.3 percent and gross national product (GNP) rises by 0.09 percent after 5 years under the TAB scenario. Accordingly, total U.S. employment rises by 0.03 percent (or 44,500 jobs). Mexico's trade balance falls by 9.8 percent, GNP falls by 0.04 percent, and total employment falls by 0.6 percent after 5 years under the TAB scenario. However, under the TO scenario, the drop in Mexico's GNP narrows over time.

The key assumptions that underlie these results are as follows. First, the dollar-peso exchange rate is assumed not to change as a result of a free trade agreement, although it varies over time. Thus, preferential trade barrier reductions between the United States and Mexico lead to changes in the bilateral trade balance but the exchange rate is assumed not to adjust to eliminate this imbalance.

Second, the United States is assumed to be near full employment and the U.S. money supply is assumed to be invariant to changes in trade policy. Thus, an increase in U.S. net exports represents additional demand for U.S. products. Given the fixed supply of money, U.S. interest rates rise as buyers attempt to acquire more dollars to finance additional purchases of U.S. goods. Increased interest rates cause a drop in aggregate investment and a drop in demand for some interest-sensitive components of personal consumption. Therefore, the stimulus to U.S. net exports brought about by the Mexican FTA raises U.S. interest rates and crowds out interest-sensitive components of U.S. gross national product.

5. Changes in U.S. Employment

By industry. Table 4 presents the changes in U.S. employment by aggregate economic sector after 5 years under both the TO and TAB scenarios. After 5 years, the elimination of trade barriers under either the tariffs only (TO) or tariffs and barriers (TAB) scenarios leads to increases in total U.S. employment of 29,300 and 44,500 jobs, respectively. The estimated aggregate sector U.S. employment effects after 5 years under the TAB scenario are: Agriculture (+10,600 jobs), Crude oil and mining (+300 jobs), Construction (-12,800 jobs), Manufacturing (+48,800 jobs), and Services (-2,300 jobs).

Table 5 presents the top 10 job-gaining and job-losing U.S. sectors under both the TO and TAB scenarios after 5 years. Under the TAB scenario, the largest U.S. employment increases are in Agriculture (+10,600 jobs), Miscellaneous nonelectrical machinery (+7,800 jobs), Communications machinery (+6,300 jobs), and Metal products (+6,100 jobs). Under this TAB scenario, Mexican sectors for which non-tariff barriers are removed (Agriculture, Motor vehicles, and Computers) are in the top 10 employment-gaining sectors, along with many of the leading job-gainers under the TO scenario.

The leading job-losing sectors include traditional import-sensitive sectors such as Apparel as well as an assortment of others. For example, Construction, Medicine, and Hotels rank 1,2, and 4 on both the TO and TAB lists. Bearing in mind the discussion of crowding out in Section 4 above, interest-sensitive sectors such as Construction, Finance, Real Estate, and Lumber are crowded out by higher interest rates and face declines in employment.

By state and occupation. U.S. nonagricultural employment changes by state after 5 years resulting from a U.S.-Mexico FTA under both the TO and TAB scenarios are given in Table 6. Time-series data on state and national nonagricultural employment by industry were used to predict state-level employment changes under the TO and TAB scenarios based on estimated national-level employment changes. Since the U.S. agricultural sector is a major beneficiary under the TAB scenario, employment gains in some states (e.g., California) where agriculture is an important sector will tend to be understated. The top five job-gaining states after 5 years under the TAB scenario were Michigan (+6,300 jobs), Ohio (+5,600 jobs), Oregon (+3,500 jobs), Indiana (+3,300 jobs), and California (+2,600 jobs). The top five job-losing states after 5 years under the TAB scenario were Virginia (-1,100 jobs), Maryland (-800 jobs), New York (-800 jobs), New Jersey (-700 jobs), and Hawaii (-200 jobs).

U.S. employment effects by occupational group after 5 years under the TO and TAB scenarios are summarized in Table 7. The occupational impacts were obtained using an occupation-by-industry matrix prepared by the U.S. Bureau of Labor Statistics. Under the TAB scenario, Operatives, Farmers and farm workers, and Professional and technical occupational groups benefit most from the FTA.

6. Concluding Comments

The INFORUM-CIMAT study of a free trade agreement between the United States and Mexico is one of the first to estimate the aggregate economic effects on the two economies as well as U.S. employment impacts by industrial sector, state, and occupational group. Based on linking econometric models for the United States and Mexico via their trade accounts, the INFORUM-CIMAT study finds that aggregate U.S. output and employment will rise slightly, while Mexican output and employment will fall slightly under either the TO or TAB scenarios. Mexican tariff and other trade barriers are currently higher than U.S. barriers so that U.S. net exports to Mexico increase as a result of the FTA.

The scope of the INFORUM-CIMAT analysis is limited in two respects. First, the scope of policy changes considered is narrow. Only reductions in tariffs and what INFORUM-CIMAT believe to be the major non-tariff barriers to trade are considered. More work is clearly needed to refine the estimates of the trade created by the removal of non-tariff barriers. In addition, they do not consider liberalization of Mexican investment restrictions.

Second, several potentially important effects of a Mexican FTA are not considered. Scale economies and imperfect competition are not considered; these features typically imply much larger aggregate benefits from trade liberalization. In addition, failure to disaggregate labor by skill throughout the calculations may tend to wash out stronger, opposing effects on high-skill and low-skill U.S. labor. Though the study reports changes in the occupational composition of U.S. employment, these changes are calculated by assuming the occupational structure of each industry is unaffected by the FTA; only the change in industry composition affects the occupational composition. In fact, an FTA might result in more low-wage occupations shifting to Mexico within individual industries. Finally, skill requirements are not uniform within individual occupational groups so that the FTA might lower the skill requirements within even narrowly defined occupational categories.

TABLE 1
Projected Increase in U.S. Trade with Mexico by Industrial Sector
After 5 Years Under FTA TAB Scenario
(value in millions of 1977 dollars)

U.S. Export Sectors with the Largest Absolute Increases

Sector	1995 Baseline	Increase Attributed to FTA	
	Export Value	Absolute	Percent
Motor vehicles	1,478.6	797.7	54.0
Computers	673.0	577.8	85.9
Agriculture	801.6	518.7	64.7
Communication equip.	2,073.3	425.7	20.5
Plastic products	676.2	320.0	47.3
Metal Products	811.3	270.2	33.3
Non-elect. machinery	764.1	242.9	31.8
Elect indl apparatus	1,074.1	222.9	20.8
Chemicals, exc agric.	1,290.5	215.6	16.7
Apparel	496.4	209.1	42.1
Top-10 sectors	10,139.1	3,800.6	37.5
Total U.S. exports to Mexico	18,435.0	4,999.0	27.1

U.S. Import Sectors with the Largest Absolute Increases

Sector	1995 Baseline	Increase Attributed to FTA	
	Import Value	Absolute	Percent
Apparel	1,260.4	741.6	58.8
TV sets, radios	2,092.4	233.0	11.1
Motor vehicles	3,612.3	87.4	2.4
Non-ferrous metals	2,321.9	85.7	3.7
Stone & glass	375.5	67.9	18.1
Ferrous metals	328.6	57.7	17.6
Food & tobacco	704.2	51.0	7.2
Elec lighting & eqip.	1,013.0	50.4	5.0
Chemicals, exc agric.	498.0	31.7	6.4
Crude petroleum	2,890.4	23.2	0.8
Top-10 sectors	15,096.7	1,429.6	9.5
Total U.S. imports from Mexico	24,363.0	1,590.0	6.5

TABLE 2
Effects on Major U.S. Economic Measures of a U.S.-Mexico FTA
(percentage change from the baseline)

Item	After 2 Years		After 5 Years		After 10 Years	
	TO Case	TAB Case	TO Case	TAB Case	TO Case	TAB Case
GNP	0.032	0.064	0.057	0.094	0.111	0.166
Personal Consumption	0.000	-0.005	-0.030	-0.046	-0.019	-0.038
Investment	0.064	0.192	-0.077	-0.134	-0.017	0.000
Government	0.000	0.000	0.000	0.000	0.000	0.000
Trade Balance	0.824	1.511	7.368	11.316	12.281	18.421
Total Exports	0.198	0.420	0.695	1.124	0.641	1.019
Exports to Mexico	4.559	9.704	16.659	27.117	17.368	27.424
Total Imports	0.042	0.126	0.114	0.228	-0.052	-0.017
Imports from Mexico	1.384	2.550	4.527	6.526	4.517	6.980
Total Civilian Jobs	0.014	0.026	0.022	0.034	0.032	0.046
GNP Price Deflator	0.000	0.000	0.165	0.247	0.177	0.283
T-Bill Interest Rate	0.000	0.000	1.587	3.175	1.639	1.639

Note: All variables are in real terms except the T-Bill rate.

TABLE 3
Effects on Major Mexican Economic Measures of a U.S.-Mexico FTA
(percentage change from the baseline)

Item	After 2 Years		After 5 Years		After 10 Years	
	TO Case	TAB Case	TO Case	TAB Case	TO Case	TAB Case
GNP	-0.094	-0.817	-0.080	-0.039	0.000	-0.345
Personal Consumption	0.037	-0.104	0.140	0.349	0.209	0.387
Investment	-0.171	-1.921	0.073	1.909	0.470	0.781
Government	0.000	0.000	0.000	0.000	0.000	0.000
Trade Balance	-1.358	-5.375	-2.649	-9.769	-2.865	-9.411
Total Exports	1.096	1.897	3.452	4.817	2.814	4.140
Exports to U.S.	1.384	2.550	4.527	6.526	4.517	6.980
Total Imports	3.122	7.901	9.976	20.415	9.711	20.600
Imports from U.S.	4.559	9.704	16.659	27.117	17.368	27.424
Total Employment	-0.062	-0.750	-0.031	-0.545	-0.006	-0.897
Unemployment Rate	0.000	0.040	0.000	0.000	0.000	0.040

Note: All variables are in real terms.

TABLE 4
Changes in U.S. Employment by Aggregate Sector
After 5 Years Under FTA TO and TAB Scenarios
(employment in thousands)

Sector	1995 Employment Baseline	Absolute Change Under TO Case	Absolute Change Under TAB Case
Agriculture	2,798.0	0.5	10.6
Crude Oil & Mining	808.9	0.2	0.3
Construction	7,976.0	-6.6	-12.8
Manufacturing	20,535.0	40.1	48.8
Non-Durables	8,263.1	6.3	3.2
Durables	12,271.9	33.8	45.6
Services	98,709.4	-2.8	-2.3
Transportation	4,476.2	1.2	1.7
Utilities	2,512.5	0.7	1.0
Wholesale & Retail Trade	30,788.0	-1.0	1.0
Fin.,Insur. & Real Estate	8,075.3	-1.5	-2.1
Services	32,534.0	-2.2	-3.9
Domestic Servants	1,690.0	0.0	0.0
Government	18,633.4	0.0	0.0
Total	130,827.3	29.3	44.5

TABLE 5
Changes in U.S. Employment by Industrial Sector
After 5 Years Under FTA TO and TAB Scenarios
(employment in thousands)

U.S. Industrial Sectors with the Largest Gains in Employment

Sector	1995 Employment Baseline	Gain Attributed to FTA: Absolute	Gain Attributed to FTA: Percent
----------TO Scenario----------			
Misc non-elect machinery	1,045.0	6.9	0.660
Communications machinery	1,108.5	5.8	0.524
Electric appliances	446.1	4.7	1.054
Rubber, plastic products	895.7	4.7	0.525
Metal products	1,843.1	4.6	0.250
Business services	10,852.0	4.0	0.046
Metalworking machinery	438.9	3.3	0.752
Chemicals	1,110.4	2.3	0.207
Non ferrous metal	365.9	1.4	0.383
Computers	371.5	1.4	0.377
----------TAB Scenario----------			
Agriculture	2,798.0	10.6	0.379
Misc non-elect machinery	1,045.0	7.8	0.746
Communications machinery	1,108.5	6.3	0.569
Metal products	1,843.1	6.1	0.331
Rubber, plastic products	895.7	5.3	0.592
Electric appliances	446.1	5.2	1.166
Motor vehicles	786.4	5.0	0.636
Business services	10,852.0	5.0	0.046
Metalworking machinery	438.9	4.0	0.911
Computers	371.5	3.1	0.834

U.S. Industrial Sectors With the Largest Decreases in Employment

Sector	1995 Employment Baseline	Loss Attributed to FTA: Absolute	Loss Attributed to FTA: Percent
----------TO Scenario----------			
Construction	7,976.0	8.6	0.108
Medicine, educ.,npo.	14,341.0	4.0	0.028
Apparel	1,026.9	2.2	0.214
Hotels	4,346.0	1.8	0.041
Wholesale & retail trade	30,788.0	1.0	0.003
Finance, insurance	6,124.3	0.9	0.015
Movies, amusements	1,505.5	0.6	0.040
Real estate	1,951.0	0.6	0.031
Lumber	855.8	0.5	0.058
Furniture	563.6	0.2	0.035
Motor vehicles	786.4	0.2	0.025
----------TAB Scenario----------			
Construction	7,976.0	12.8	0.160
Medicine, educ., npo.	14,341.0	6.0	0.042
Apparel	1,026.9	5.9	0.575
Hotels	4,346.0	2.4	0.055
Finance, insurance	6,124.3	1.5	0.024
Lumber	855.8	1.2	0.140
Movies, amusements	1,505.5	1.0	0.066
Real estate	1,951.0	0.6	0.031
Furniture	563.6	0.4	0.071
Knitting mills	219.6	0.3	0.137
TV, radio, phonograph	49.4	0.1	0.202

TABLE 6
Changes in U.S. Non-Agricultural Private Employment By State
After 5 Years Under Alternative FTA Scenarios
(employment in thousands, ranked by absolute change under TAB scenario)

State	1995 Employment Baseline	TQ Case Percent Change	TQ Case Absolute Change	TAB Case Percent Change	TAB Case Absolute Change
Michigan	3,730.6	0.07	2.611	0.17	6.342
Ohio	4,647.0	0.06	2.788	0.12	5.576
Oregon	1,282.3	0.23	2.949	0.27	3.462
Indiana	2,355.9	0.08	1.885	0.14	3.298
California	13,036.5	0.02	2.607	0.02	2.607
Illinois	4,917.4	0.03	1.475	0.05	2.459
Wisconsin	2,210.6	0.07	1.547	0.10	2.211
Kansas	1,166.4	0.11	1.283	0.17	1.983
Oklahoma	1,060.4	0.12	1.272	0.16	1.697
Washington	2,247.5	0.03	0.674	0.07	1.573
Texas	7,030.9	0.01	0.703	0.02	1.406
Kentucky	1,397.6	0.06	0.839	0.10	1.398
Arizona	1,704.9	0.07	1.193	0.07	1.193
Minnesota	2,056.2	0.03	0.617	0.05	1.028
Missouri	2,216.7	0.02	0.443	0.04	0.887
Alabama	1,520.3	0.06	0.912	0.05	0.760
Utah	764.5	0.06	0.459	0.08	0.612
New Hampshire	605.7	0.09	0.545	0.10	0.606
Florida	5,844.2	0.01	0.584	0.01	0.584
South Dakota	268.4	0.14	0.376	0.19	0.510
Idaho	330.7	0.09	0.298	0.14	0.463
Montana	277.5	0.10	0.278	0.16	0.444
Colorado	1,466.4	0.00	0.000	0.03	0.440
Iowa	1,097.4	0.02	0.219	0.04	0.439
West Virginia	535.0	0.05	0.268	0.07	0.375
Arkansas	865.1	0.03	0.260	0.04	0.346
Mississippi	832.0	0.05	0.416	0.04	0.333
Nebraska	650.9	0.03	0.195	0.05	0.325
South Carolina	1,597.0	0.03	0.479	0.02	0.319
Massachusetts	3,185.5	0.00	0.000	0.01	0.319
North Carolina	3,182.6	0.03	0.955	0.01	0.318
Georgia	3,012.3	0.02	0.602	0.01	0.301
North Dakota	258.2	0.02	0.052	0.11	0.284
Nevada	567.1	0.08	0.454	0.04	0.227
Tennessee	2,028.3	0.01	0.203	0.01	0.203
Connecticut	1,751.9	0.01	0.175	0.01	0.175
Delaware	343.8	0.02	0.069	0.03	0.103
Wyoming	191.1	0.04	0.076	0.04	0.076
Louisiana	1,368.2	0.01	0.137	0.00	0.000
Pennsylvania	4,898.3	0.01	0.490	0.00	0.000
Alaska	219.0	-0.01	-0.022	-0.01	-0.022
New Mexico	543.7	0.00	0.000	-0.01	-0.054
Maine	544.0	-0.01	-0.054	-0.02	-0.109
Vermont	278.8	-0.04	-0.112	-0.06	-0.167
District of Columbia	451.7	-0.04	-0.181	-0.04	-0.181
Rhode Island	450.8	-0.03	-0.135	-0.05	-0.225
Hawaii	467.0	-0.05	-0.234	-0.05	-0.234
New Jersey	3,745.8	-0.02	-0.749	-0.02	-0.749
New York	7,570.7	-0.01	-0.757	-0.01	-0.757
Maryland	2,060.9	-0.03	-0.618	-0.04	-0.824
Virginia	2,870.6	-0.03	-0.861	-0.04	-1.148
Total, non-agricultural	107,706.3	0.026	27.666	0.038	41.212

TABLE 7
Changes in U.S. Employment by Occupation
After 5 Years Under FTA TO and TAB Scenarios
(employment in thousands)

Occupation	TO Case Change from Baseline		TAB Case Change from Baseline	
	Absolute	Percent	Absolute	Percent
Professional, technical	4.73	0.02	6.23	0.03
Managers, proprietors	2.35	0.02	2.88	0.02
Sales workers	0.33	0.00	0.67	0.01
Clerical workers	3.59	0.01	4.34	0.02
Craft workers	3.11	0.02	3.62	0.02
Operatives	14.57	0.10	16.91	0.11
Service workers	-1.46	-0.01	-1.94	-0.01
Laborers, non-farm	1.42	0.02	2.88	0.04
Farmers, farm workers	0.38	0.02	8.10	0.38
Total	29.02	0.02	43.72	0.03

COMMENTS ON PAPER 1

BY RICHARD BOLTUCK

Draft - March 17, 1992

Discussant Comments
prepared by
Richard Boltuck[1]
on

Industrial Effects of a Free Trade Agreement
Between Mexico and the USA

An INFORUM Report

I. Description and Praise

The work of Clopper Almon at the Interindustry Economic Research Fund, Inc. (INFORUM) and his Mexican associates at the University of Guanajuato's Centro de Investigaciones Matimaticas (CIMAT) deserves an A for ambition and speedy availability, but a lower grade in several other important respects. Indeed, Professor Almon's report was fully available in remarkable time, and made a significant contribution to last year's fast track extension debate. This achievement should not be dismissed casually by other researchers who may aspire to policy relevance but who take ultimate comfort in assuring everyone that their approaches use frontier methods.

Unlike other presentations at this conference, Professor Almon did not submit a separate paper addressing the methodological advantages of his modelling technique, and what kinds of questions it is particularly and differentially well-suited to answer. Instead, I have relied on the report INFORUM wrote under

[1] The author is an economist and policy analyst at the Office of Management and Budget (OMB). The views expressed are those of the author alone, and do not necessarily reflect views held by others associated with OMB.

Labor Department contract in September 1990 and have drawn inferences as best I could from what appears to have been done to prepare that report. My comments are mostly limited to methodological concerns and queries, and so do not concentrate on the reported estimates themselves.

The INFORUM analysis was performed by use of the Long-term Interindustry Forecasting Tool (LIFT), a 78-sector model of the U.S. economy, and CIMAT's similarly-structured 74-sector Modelo Interindustrial Mexican (MIMEX) model of the Mexican economy. The authors conducted two experiments: (a) eliminating bilateral tariffs, and (b) eliminating both bilateral tariffs and several major non-tariff barriers. Annual estimates were produced for each of the next five years.

The models were linked through the bilateral trade accounts and solved iteratively until proportional changes in trade were equated in both models. The U.S. results are reported both by industrial sector and geographically by state -- certainly an ambitious and useful effort at disaggregation. In addition to market specification for each sector, the models incorporate macroeconomic effects, including especially the consequences of monetary policy and allowance for business cycles and unemployment. Indeed, in the spirit of large Keynesian models, LIFT and MIMEX are each comprised of hundreds of individually-estimated structural equations. The sector-by-sector market specification requires a full set of estimated import-demand elasticities for each country.

II. The Darker Side of INFORUM's Effort

Although one may appreciate the detailed structure and product of these models, and the attempt to solve for adjustment in Mexico and the United States simultaneously, in an endogenously consistent manner, the end impression is more of Rube Goldberg than of anything more streamlined, internally coherent, and elegant. To a significant extent, this impression of eclecticism results naturally from the long history of methodological accretion dating to 1967 with an earlier generation of model when Professor Almon founded INFORUM at the University of Maryland.

For those who have survived two pages of description and praise, I now offer my bill of major concerns:

(1) *Data Problems*. The report acknowledges serious inconsistencies between the Mexican measures of trade with the United States, and the U.S. measures of trade with Mexico; these inconsistencies could not be reconciled adequately or otherwise explained.

For this reason, the authors chose to equilibrate log changes in trade, rather than levels. This judgment is an understandable accommodation to the data puzzle, but in the end causes considerable alarm. For instance, suppose that Mexican imports fall into two categories: those that are captured in the Mexican trade statistics, and those that are not. On the other hand, the U.S. export statistics do not miss any exports to Mexico. If trade liberalization shifts Mexican imports from the unmeasured import-sector to the measured import-sector, increases in <u>measured</u> Mexican imports would, in true equilibrium exceed increases in <u>measured</u> U.S. exports to Mexico -- and proportional change in measured Mexican imports would be even more accentuated. In this event, equalizing proportional changes between U.S. exports to Mexico and Mexican imports from the United States would understate adjustment in Mexico.

Given the critical role played by the iterative solution technique, which ties U.S. and Mexican adjustment together, one is left wondering how sensitive the reported results are to data measurement errors. This problem obviously concerns the authors greatly, but it also properly leaves the study's users questioning the degree of confidence that should be accorded the report's major conclusions.

(2) *Macroeconomic Channels and Resource Constraints.* The LIFT/MIMEX models have been usefully described as bottom-up macro models. Although great attention is paid to multisectoral presentation, the models also estimate aggregate unemployment and account for the effects of monetary policy on interest rates. Tax policy, government spending, and monetary policy are passive and scenario-independent.

In the estimates generated for the United States, non-trivial contraction of interest sensitive sectors, such as construction, finance, real estate, and lumber, is caused by crowding-out. Mexicans demand more dollar reserves for transaction purposes to purchase U.S. goods, and the Treasury borrows more to cover the increased deficit induced by lower tariff collections. The increased demand for dollars is, by assumption, not accommodated by the Fed, and interest rates rise.

Fascinating, of course, but do the uncertainties of monetary channels enlighten more than they obscure? How much of reported adjustment is due to the ordinary comparative statics of the underlying markets, and how much to monetary adjustment clutter? Is it most plausible to assume no Fed response to increased demand for dollars -- even though accommodation under such circumstances would not be inflationary? How many of the study's readers feel quite sure that changes in demand for money have persistent real effects over five years, and how many suspect that money may instead be neutral, super-neutral, hyper-super-neutral, or whatever? Is the United States "small" in world capital markets, that is, an interest-rate taker? I would think such fundamental questions, much debated among economists every-day, would make the role of money a prime candidate for modelling abstraction in a multisectoral model.

Although interest rates play a prominent, endogenous role in adjustment, exchange rates do not. Since the real exchange rate is a relative price between tradeables and non-tradeables that should be implied as markets reach equilibrium, it is odd that a model that solves for a vector of prices and quantities for each sector would treat exchange rates exogenously.

Another macro-modelling conundrum concerns unemployment. The report's authors regard the treatment of labor hoarding and the estimation of unemployment rates as a clear policy-informing advantage over CGE models. Plainly, however, the existence of unemployment suggests that the model is not imposing a resource constraint to force the solution to respect society's production possibilities. Of course, theories of frictional unemployment accord a productive role to job search time or are characterized by other such stories. In that event, time should be included explicitly as part of the economy's endowment, and allocated among leisure, work, and search. One way or another, Walras should be placated. The trouble with models comprised entirely of estimated structural equations is that one cannot know how Walras really feels about the solution. Moreover, the authors describe the economy as in disequibrium during adjustment. It would be reassuring to believe that some concept of flow equilibrium held over the adjustment period.

I cannot avoid the sense that so much is going on in this pair of linked models that no one really knows what drives the results. The model is run five times sequentially and five solutions are reported, one for each of five years. Is it converging to a steady state? No one knows because the authors do not report the assymptotic behavior of the model, but rather console the reader in the assurance that many of the underlying structural relationships have self-correcting properties.

A final macro issue is the Lucas critique. Is a U.S.-Mexico FTA such a sea change that the consequent stability in the Mexican economy causes basic alterations in behavior by market participants? The coefficients in the structural equations are, in fact, complex functions of underlying behavioral parameters and were estimated under the existing non-FTA regime. Since the relation of the coefficients to the parameters is not modelled, behavioral alterations will not be reflected in the solution and the reported estimates. By contrast, models derived directly from optimizing behavior do not ignore the impact of parametric changes.

(3) *Capital Market Adjustment*. As the authors observe, their models do not consider capital market adjustments, especially in Mexico where the domestic cost of capital greatly exceeds the world cost. Yet most other studies presented at this conference show that the major effects of an FTA are attributable to capital stock and dynamic adjustments. Similarly, the LIFT/MIMEX results are quite small relative to these other estimates. The modelling judgment to abstract from capital stock adjustment is therefore questionable. The authors seem to believe that capital stock adjustment is not a trade issue. But the high cost of capital in Mexico may be attributable chiefly to Mexican barriers against trade in financial services. The Mexican banking oligopoly and other inefficiencies in financial intermediation might well be alleviated by open trade.

(4) *Welfare Implications*. Because the model is not based on the behavior of representative consumers, it does not generate estimated welfare effects. It is difficult to discern, even qualitatively, the welfare effects implicit in the trade experiments conducted. At the end of five years, Mexican GDP is down

slightly, but consumption is up slightly. What happens after five years? Without a notion of the ultimate steady state (if there is one), it is hard to tell. Moreover, one of the most interesting and important sources of potential welfare impact, trade diversion, has been simply assumed away. The avoidance of trade diversion is the criterion used to calibrate bilateral trade shares, one of the key sets of parameters in the models. Unfortunately, a model that cannot summarize the difference between its initial equilibrium and its counterfactual solution in a metric of welfare change has, or should have, limited application in economywide policymaking.

(5) *Sensitivity Testing*. As with many of the models discussed at this conference, the INFORUM exercise cries out for extensive sensitivity testing. What would happen if estimated coefficients on the structural equations are randomly or systematically wrong? How about trade elasticities or trade shares? What difference would it make if Mexican imports are divided into measured and unmeasured categories? It is problematic to make much out of a single reported point estimate with little idea about the quality of the data and parameter estimates, and no idea about how sensitive the results are to such sources of uncertainty.

COMMENTS ON PAPER 1

BY JAIME MARQUEZ

Comments on Clopper Almon,
"Industrial Effects of a Free Trade Agreement
Between Mexico and the United States"

Jaime Marquez[1]
Federal Reserve Board
Washington, DC 20551
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The results shown in this paper are based on a model that Clopper Almon has been developing and improving for the last twenty-five years. This long-term dedication to macroeconometric modeling is rare nowadays and I can think of only a few other instances where models have received as much attention as the one used in this paper. One of the fruits of such dedication is the accumulation of evidence on the functioning of the economies of Mexico and the United States. Specifically, Almon recognizes the interactions between the structure of production and the functioning of the macro economy by combining an input-output matrix with macroeconomic relations into a single model.

This paper uses two such models: one for the United States and one for Mexico. Moreover, the analysis allows for interactions between fiscal and monetary policies, a potentially important consideration. For example, changes in tariffs affect government revenues and, depending on the stance of monetary policy, could influence interest rates. Changes in interest rates have macroeconomic effects of their own which could offset the gains from lowering tariffs. Thus abstracting from the fiscal-monetary policy mix could bias the estimated gains from adopting free trade by these two countries.

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[1] The views expressed in this paper are solely the responsibility of the author and should not be interpreted as reflecting those of the Board of Governors of the Federal Reserve System or other members of its staff.

As originally designed, the U.S. and Mexican models exclude trade between these two countries. To remedy this limitation, Almon includes equations that explain U.S.-Mexico trade in two stages: Stage one determines each country's total imports for a particular product and stage two determines how much of those imports come from the other country. As implemented, however, this linkage has several limitations. First, the price elasticities for U.S. imports from Mexico (second stage) are assumed to be larger than those for multilateral U.S. imports (first stage). Effectively, this assumption makes Mexico the main beneficiary of a reduction in U.S. tariffs and implies an upper bound on the gains of free trade for Mexico.

Second, most of the price elasticities for Mexico's imports are assumed to be greater than one, in absolute value, to satisfy the Marshall-Lerner condition. This condition, however, calls for the sum of the price elasticities for exports and imports to be greater than one. Thus lowering the assumed price elasticities for Mexican imports would violate the Marshall-Lerner condition only if the price elasticities for Mexican exports were very small. Third, price elasticities are treated as invariant to changes in the composition of expenditures. This treatment is both convenient and conventional but inconsistent with both theory and evidence. Finally, the simulations fix the external value of the dollar even though the peso-dollar rate responds endogenously to the removal of tariffs. This situation could arise if changes in the external value of other currencies were to offset exactly movements in the peso-dollar rate, but movements of such precision have a low probability of taking place.

What is the bottom line of Almon's analysis? He finds that the removal of tariffs between Mexico and the United States raises U.S. real GNP by 0.06 percent after five years. Abstracting from issues of computational accuracy, I find this GNP effect to be very small. For example, based on model predictions reported by Hickman et al. (1987), lowering the price of oil by one dollar per barrel raises U.S. real GNP by 0.12 percent after four years.[2] Thus, relative to the effects of ordinary changes in oil prices, the smallness of the GNP effects reported by Almon question the practical significance for the United States of engaging in free trade with Mexico. What is small for the United States as whole, however, might be large for certain industrial sectors and the paper examines the implications for production and employment across several industries.

Finally, one relevant issue, that paper the neglects, is the sensitivity of the results to changes in the maintained assumptions: What would be the effect on U.S. real GNP if the assumed price elasticities were either twice as large or half as large? Addressing these questions isolates which assumptions are crucial to the results and identifies areas for further improvement. In this regard, the U.S. International Trade Commission is developing a procedure to compute confidence intervals for their simulations, a direction of research that I find worth pursuing.

[2] See Hickman, B., H. Huntington, and J. Sweeney, 1987, *Macroeconomic Impacts of Energy Shocks* (North-Holland: Amsterdam), table 5, page 24. These results assume an oil-price increase of 18 dollars per barrel which lowers U.S. real GNP by 2.07 percent after four years.

PAPER 2

"THE ECONOMIC IMPACT OF A FREE TRADE AGREEMENT BETWEEN THE UNITED STATES AND MEXICO: A CGE ANALYSIS," BY CARLOS BACHRACH AND LORRIS MIZRAHI

THE ECONOMIC IMPACT OF A FREE TRADE AGREEMENT BETWEEN THE UNITED STATES AND MEXICO: A CGE ANALYSIS

Carlos Bachrach and Lorris Mizrahi

Policy Economics Group
KPMG Peat Marwick
Washington, D.C.

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INTRODUCTION

The purpose of this paper is to present a detailed technical description of the Computable General Equilibrium (CGE) model developed by the Policy Economics Group of KPMG Peat Marwick to study the economic impact of Free Trade Agreement between the United States and Mexico. Section I presents an overview of the model, followed by a description of the model equations in section II. Section III shows the main issues related to parameter estimation, while section IV describes the main data sources. Section V concludes with a brief description and analysis of the results.

I. OVERVIEW OF THE MODEL

The United States - Mexico CGE model presented here consists of two full-fledged CGE models, one for the United States and one for Mexico, linked by bilateral sectoral trade flows. The two separate models are integrated into a single model, customized to examine the specific issues related to a United States - Mexico FTA. The creation of a single model is essential to ensure a consistent solution and to capture the interactions between the U.S. and Mexican economies. A detailed description of the equations is presented in section III.

For both the United States and Mexico, the foreign account is divided into what we call the "Partner"and the "Rest of the World" (ROW) accounts. In the case of Mexico, the partner is the United States and the ROW includes all other countries, and in the case of the United States, the partner is Mexico and the ROW includes all other countries[1]. This linking enables the simultaneous determination of terms of trade and trade flows between the partners.

By linking the models directly through trade flows, the effects which are unique to the partner countries can be captured. The initial impact of bilateral tariff reductions between partners is to reduce import prices and to divert trade away from the ROW. Overall trade (partner plus ROW) could increase too, but that is a secondary effect resulting from the changes in the economy caused by the tariff reduction. If the country models are not linked directly by trade flows, the initial tariff reductions vis-a-vis the partner translate into lower overall import prices. However, the change in the relative price of partner and ROW imports is not captured. In this case, lower tariffs vis-a-vis the partner result (incorrectly) in higher imports from both the partner and the ROW.

The model distinguishes between "commodities"and "activities". Commodities are the physical units of a product or service consumed in the economy, while activities identify the sectors producing commodities. The main reason for implementing this distinction is

[1] The model is generalized to any number of partners.

secondary production. Production data is usually collected at the establishment level, and classified by the main commodity produced in the establishment (the "activity" of the establishment). On the other hand, consumption data is usually classified at the commodity level. This implies that firms' supply is at the activity level, and consumer demand is at the commodity level. A "Make"matrix is used to maintain a consistent framework, which relates activities' output and prices with commodities' output and prices. Another reason for distinguishing between "commodities"and "activities"is to correctly capture the incidence of various indirect taxes. The distinction between "commodities" and "activities" in the production-consumption sense is implemented only in the U.S. model because Mexican input-output accounts are on a commodity to commodity basis.

Each country model contains forty-four sectors, producing a composite commodity with a constant returns to scale technology. We assume that product differentiation exists on the production side: domestically produced goods sold on the domestic market are imperfect substitutes for goods sold on the export markets. This is captured by a three-level constant elasticity of transformation (CET) function.

On the import side, the specification introduced by Armington (1969) is followed. Imported goods are differentiated by origin, and are imperfect substitutes for domestically produced goods. We employ three-level constant elasticity of substitution (CES) import demand equations to model the substitution between domestic, partner and rest of the world goods.

It follows from the above trade specification that Purchasing Power Parity does not hold, and therefore the domestic prices are partially insulated from changes in foreign prices. This trade specification also accommodates two-way trade, since exports, imports, and domestic goods in the same sector are not identical. The import demand (export supply) equations for each sector are given by the first order conditions of the CES (CET) equations and are a function of the ROW and partner import (export) prices and domestic prices.

For a given sector, the model defines several differentiated goods, all with their own prices: domestic sales (that part of domestic output consumed domestically), two export goods, two import goods and two "composite"goods: output (domestic sales plus exports), and absorption (domestic sales plus imports). Policies such as indirect taxes, subsidies, and tariffs are explicitly incorporated into the relevant price definitions of the appropriate goods.

Given its special position in the Mexican economy, the oil sector is treated differently. It is assumed that the behavior of this sector is determined by government policy and therefore factor use in the Mexican crude oil sector remains constant.

Factor demand equations of different degrees of complexity are estimated. For U.S. manufacturing sectors, a Generalized Leontief specification is used, which differentiates between four different inputs: Capital, labor, materials and energy. This specification is general enough to allow different degrees of substitutability or complementarity among factors of production. For commodities that make up the aggregate materials and energy inputs, we assume the Leontief technology specification. For all Mexican sectors, and non-manufacturing U.S. sectors, the quality and availability of the data did not allow for such generalized specifications. In these sectors, it is assumed that value added and all intermediate good are used in fixed proportions, and that value added itself obeys a Cobb-Douglas specification.

As mentioned above, profit maximization by firms gives rise to factor demand equations, which include demand for labor. A labor-leisure decision is not included in the model, and therefore labor supply is either perfectly elastic (fixed real wage) or perfectly inelastic (fixed employment). The data base is centered around 1988, a year in which unemployment in the United States (5.4 percent) was at its lowest level since 1973, well within the range where the natural rate of unemployment is considered to be. One should not expect an FTA to alter the natural rate of unemployment in the United States. Therefore, it is assumed in the model that full employment (i.e. as observed in 1988) prevails in the United States, and adjustments in the labor market are achieved through changes in the real wage rate. This is a standard assumption in CGE models of the United States (see De Melo and Tarr (1990) and Hanson et. al. (1989)). In Mexico, on the other hand, unemployment is an important phenomena. Therefore, fixed real wages are assumed (as measured against a domestic consumption price index) and adjustments in the labor market are achieved through a change in the employment level (a similar assumption is employed by Kehoe and Serra-Puche (1983)).

Clearly, the correct specification lies somewhere between these two polar assumptions. Given the relative size and trade structure of the two countries, one expects that an FTA will only have a mild effect on the United States Therefore, both assumptions would yield similar overall results for the United States. In the case of Mexico, with a much larger supply of unemployed labor, it is plausible to expect that most effects will indeed be reflected in an increase in employment.

Domestic demand has four components: private consumption, intermediate demand, government, and investment (including inventory accumulation). Private consumption demand follows an Almost Ideal Demand System (AIDS) specification. Under this specification, consumption patterns are affected by both relative prices and household income. The AIDS specification is a general "flexible" function and allows for both complementarity and substitution between goods and services (see Deaton and Muellbauer (1980)). Intermediate demand is calculated from total sectoral outputs, given the above production functions and the Input-Output structure of the economy. The sectoral composition of real investment and government demand is kept fixed and their levels depend on the solution of the model.

All domestic demand is expressed in terms of the composite good which consist of domestic sales, imports from the Partner and imports from the ROW. Similarly, domestic supply has three components: Domestic sales, exports to the partner and exports to the ROW.

Government revenues from net tax collections are proportional to the activity in each sector, whereas transfers are kept constant. Real government savings (i.e. budget deficit or surplus) are also kept constant at their base year level, and thus government spending on goods and services rises or falls roughly proportionally to the overall growth in the economy.

The ratio of net real investment to capital stock is kept fixed in the model. Therefore, unless aggregate capital stock changes, aggregate real net investment is fixed. Inventory demand by sector is a fixed proportion of domestic output. The difference between net aggregate investment and inventory demand represents the total available funds for purchasing new capital goods.

Aggregate savings are given by household, enterprise (including depreciation), government, and foreign savings: they always equal aggregate net investment. Because both aggregate real net investment and real government savings are exogenously determined, the sum of real household, enterprise and foreign savings is also exogenously determined. This implies that a real increase in any one of these components of savings (households, enterprises and foreign) must be offset by one or both of the other two.

Net international transfers are assumed constant; these include debt repayments, labor remittances and profit repatriations. The only exception is when capital is allowed to increase in Mexico, in which case profit repatriations are allowed to change. Given this assumption, all adjustments in foreign savings are achieved through changes in the trade balance.

All trade barriers incorporated in the model are expressed in the form of ad-valorem taxes. In the case of tariffs, this is a straightforward exercise since tariffs are by definition ad-valorem taxes. On the other hand, for quantity restrictions one needs to calculate a "tariff equivalent". A tariff equivalent is the ad-valorem tax required to induce consumers to demand an amount of imports equal to the quota. Finally, the model includes a series of constraints which force the bilateral trade flows, bilateral trade prices and the exchange rates of the United States and Mexico to be consistent.

II. MODEL EQUATIONS

This section provides a detailed description of the model's equations. Several sets and subsets are defined, to index both variables and parameters. To simplify the exposition, Box 1 presents the sets and subsets defined, together with an explanation of the functional notation. The equations, variables and parameters are detailed at the end of this section.

BOX 1

Description of item	Notation	Indices
Countries	k	"us","mx"
Trade partners	wrld, dlrw	"us","rt"for Mexico "mx","rt"for United States
Model sectors	i, j	1 to 44
Non-government ("private")sectors	ipriv	1 to 43
Government sector	igovt	44
Non-oil private sectors	noilpriv	1 to 5, 7 to 43
Oil sector	crude	6
Institutions	inst	"labr","ent"
Factors for Cobb-Douglas	fctr, rtcf	"labor","capital"
Inputs for Generalized Leontief (GL)	input, tupni	"labor", "capital", "matin", "enerin"
Materials commodities for GL	mat	1 to 20, 22 to 38, 40 to 44
Energy commodities for GL	energy	21, 39

Functions

sum(i, f(i)) = summation of f(i) over i

prod(i, f(i)) = multiplication of f(i) over i

log(z) = natural logarithm of z

sqrt(z) = square root of z

The model incorporates three regions: Mexico ("mx"),the United States ("us")and the Rest of the World ("row"). Only Mexico and the United States are fully modeled, while the rest of the world is a passive recipient (and provider) of goods and services. The index **k** denotes the countries actually modeled; for each of these, we divide its trade partners (**wrld** or **dlrw**) between a partner and the rest of the world. For example, Mexico's trade partners are the "us"and the "row".

Forty four sectors are included in the model, indexed by either **i** or **j**. The first 43 are non-government sectors (**ipriv**) and the last one is the government (**igovt**). In the case of Mexico, non-government sectors are further divided into non-oil sectors ("noilpriv")and the oil sector ("crude"). There are two institutions which act as the recipients of Value Added, indexed by **inst**: labor ("labr")and enterprises ("ent").

Two different specifications are used on the supply side (see below for more details): Cobb-Douglas and Generalized Leontief (GL). In the case of the Cobb-Douglas, output follows a Leontief specification between intermediates and value added. Value added, in turn, is produced by two factors following a Cobb-Douglas specification indexed by **fctr**: labor ("labor")and capital ("capital"). In the case of the Generalized Leontief specification, output is produced by means of two factors and two composite intermediates, all of these indexed by **input**: Labor ("labor"), capital ("capital"), materials ("matin") and energy ("enerin"). Each of the intermediates, in turn, is a fixed composite of other intermediates. The sectors included in the materials composite are indexed by **mat**, and those included in the energy composite are indexed by **energy**.

The following rules are used in the model's specification:

(i) Uppercase names denote variables, lowercase names denote either parameters or functions;

(ii) International prices of exports and imports (as seen by country **k**) are stated in the currency of the foreign country (wrld);

(iii) The exchange rate variable, EXR(k,wrld), translates one unit of the currency of country **wrld**, into the currency of country **k**;

(iv) International transfers are denominated in the currency of the country providing the funds.

The equations are organized in blocks; the first block presents the basic price definitions (or nominal identities) of the model. To help interpret the remainder of the model, we will go over the first set of equations in some detail. Equation (1) states that the nominal output of activity **i** in country **k** equals the nominal output of activity **i** marketed domestically, plus the sum (by country of destination) of activity **i**'s nominal exports from country **k** to country **wrld** (in country **k**'s currency); this is the "adding up" condition on the CET function.

The specification of this equation implies that the domestic price of domestic goods marketed within the country need not equal the domestic price of goods exported. This distinction responds to the assumption that goods are differentiated by country of origin and destination. For example, Mexican goods sold in Mexico are imperfect substitutes for imports from the United States or the ROW. They are also imperfect substitutes for Mexican goods exported to the United States or the ROW.

Equation (2) defines the domestic price of commodity **i** exported from country **k** to country **wrld** as its international price denominated in country's **wrld** currency, multiplied by the exchange rate between country **k** and country **wrld**. Equation (3) states that the domestic price of commodity **i** imported in country **k** from country **wrld**, equals its international price (in country **wrld**'s currency) multiplied by the exchange rate between country **k** and country **wrld**, multiplied by its respective tariff and tariff equivalent rates, and divided by additional uniform[2] taxes levied on the domestic sales of these imports. Notice that the tariff equivalent rate is specified as a tax imposed in addition to the tariff.

Sectoral output is the sum of value added, indirect taxes and intermediate inputs (at market prices); this can be seen by multiplying both sides of equation (4) by sectoral output. As seen from this equation, indirect taxes are held proportional to domestic output. Equation (5) states that nominal output by activity **i** equals the sum of nominal commodity output produced by this activity[3]; both magnitudes are measured in producer prices.

Equation (6) translates the domestic producer price of domestic goods into market prices, by adding taxes and subtracting subsidies from the producer price. Equation (7) further defines the price of domestic absorption as the weighted average of the domestic price of domestic goods and imported goods; it is the adding-up or budget constraint condition on the CES function. Equations (8) and (9) define the price indices of capital and consumption.

The second block of equations develops the production side of the model. Equations (10) trough (20) apply to the private sectors (with the exception of the Mexican oil sector). Equation (10) presents a Cobb-Douglas specification for value added in Mexican non-oil sectors, and equation (11) presents the relevant first order conditions for this specification. Equation (12) restates equation (4) in terms of the Generalized Leontief (GL) cost function specification of inputs, while equation (13) lays down the first order condition of the GL cost function[4]. Equations (14) through (19) relate the price and quantity variables of the GL cost function to the variables of the input-output table used in the rest of the model.

Equations (20) to (23) apply to the government sectors and the Mexican oil sector. Equations (20) and (22) define value added for the Mexican oil sector and for the government sector in both countries; equations (21) and (23) determined the use of factors of production in these same sectors. The specification of equation (21) follows the assumption that resource use in the Mexican oil sector is determined by the government and unless this sector is included in the FTA (an unlikely event), one cannot asses whether and to what extent will resource use in this sector change. For the government sector it is assumed that resource use is proportional to total real government spending.

The third block of equations covers the trade relationships. Equation (24) specifies domestic output as a CET composite of exported and domestically consumed goods. The

[2] Uniform in the sense that they do not differentiate between countries of origin.

[3] For Mexico this is a trivial identity since Mexico's Make matrix is diagonal.

[4] The Generalized Leontief specification was used only in U.S. manufacturing sectors; all other sectors follow a Cobb-Douglas specification which was set as a special case of the GL.

first order conditions for optimal allocation of domestic output among domestic and foreign markets are detailed in equation (25). The correspondent CES import specification is outlined in equations (26) and (27).

The fourth block of equations details the Input-Output links within each economy. Equations (28) to (30) determine the intermediate input flows for private sectors; in the U.S. these flows are a function of two main inputs (materials and energy). Equation (31) determines intermediate flows derived from the government sector's output, while Equations (32) and (33) determine the relationship between the domestic output of activities and commodities through the Make matrix. The assumption here is that each activity produces commodities in its own fixed proportions and that the technology is specific to the commodity rather than the activity.

The fifth block covers the allocation of income to different players in the economy. Factors of production are the recipients of value added and net foreign transfers from abroad, including repatriated profits (Equations (34) to (36)). Factors, in turn, pass their income to their respective institutions (labor and enterprises), with labor paying Social Security taxes and enterprises receiving transfers from the government (Equations (37) to (39)). Finally, households collect income from labor, enterprises, the government and abroad (equations (39) to (42)). Notice that while all net labor income is distributed to households, enterprises save part of it and also repatriate profits abroad. Notice that the way the model has been specified, all net profit repatriations in the base year are already included as part of the remittances from capital to the rest of the world. The variable FDIREPAT relates only to incremental repatriations due to changes in the capital stock after the base year.

The sixth block presents the specification of government taxes, subsidies and transfers (Equations (43) through (53)), and the calculation of total government revenues (Equation (54)). Notice that government revenues include net foreign transfers.

The seventh block outlines the specification of savings, investment and depreciation in the model. Household savings are a constant proportion of household income, while real government savings are kept at their base year level. Net enterprise savings are a fixed proportion of net enterprise income. Foreign savings with each trade partner are defined as the current account balance with the partner (in the partner's currency)[5]. Total foreign savings aggregate both partner's foreign savings in domestic currency, while total savings are the sum of enterprise, government, household and foreign savings. Finally, net investment is kept as the same proportion of the capital stock as in the base year. Equation (64) can be regarded as the "foreign market closure" and implies that changes in foreign savings are fully offset by changes in domestic private savings. once corrected for the price level change.

[5] Nominal imports minus nominal exports, minus net transfers from the partner (including profit repatriations), all in the partner's currency.

The eighth block details the sectoral allocation of expenditure items. Private consumptions follows an Almost Ideal Demand System (AIDS) specification and real government consumption keeps the same allocation as in the base year. Nominal investment net of inventory changes, is distributed across sectors by the capital composition vector. Finally, inventory investment is a fixed proportion of sectoral output.

The ninth block fixes net foreign transfers. For the United States, these are fixed in U.S. dollars, while for Mexico these are fixed in the currency of the foreign country. The tenth block ensures consistency between the United States and Mexico real trade flows and between their import and export prices; it also fixes international prices for trade with the rest of the world. The eleventh block ensures consistency between U.S. and Mexico's exchange rates, and sets the rest of the world price as the numeraire.

The twelfth block closes the factor markets. Aggregate labor in the United States remains constant, while in Mexico the real wage is fixed and aggregate labor is endogenously determined[6]. Aggregate capital in both countries is exogenously set[7]. Except for capital in the Mexican oil sectors, the relation of factor returns between sectors remains constant at their base year values. In the Mexican oil sector, capital absorbs all fluctuations in value added. Finally, the last equation ensures that aggregate factor supply equals aggregate factor demand.

The last block states the market clearing conditions. The savings-investment identity should hold by virtue of Walras' law, and it is therefore dropped from the system of equations. An independent consistency check for the model is performed at the end of each run, to ensure that this relationship indeed holds.

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[6] In principle, one could incorporate a more general labor supply schedule. In addition to the specification presented here, we also ran the model under the alternative that the real wage in the United States remains fixed.

[7] In a different version of the model the real return to capital in Mexico was kept fixed, and therefore the aggregate Mexican capital stock was endogenously determined.

EQUATIONS, VARIABLES AND PARAMETERS

I. Price Equations

(1) PX(i,k) * XD(i,k) = PA(i,k) * XXA(i,k) + sum(wrld, PE(i,k,wrld) * E(i,k,wrld))

(2) PE(i,k,wrld) = PWE(i,k,wrld) * EXR(k,wrld)

(3) PM(i,k,wrld) = PWM(i,k,wrld) * EXR(k,wrld) * (1 + tm(i,k,wrld)) * (1 + tmeq(i,k,wrld)) / (1 - itax(i,k))

(4) PVA(i,k) = PX(i,k) * (1 - afee(i,k)) - sum(j, io(j,i,k) * P(j,k))

(5) sum(j, DMAKE(i,j,k) * PD(j,k)) = PA(i,k) * XXA(i,k)

(6) PT(i,k) = ((1 - subr(i,k)) * PD(i,k)) / (1 - dtax(i,k))

(7) P(i,k) * X(i,k) = PT(i,k) * XXD(i,k) + sum(wrld, PM(i,k,wrld) * M(i,k,wrld))

(8) PK(k) = sum(i, iles(i,k) * P(i,k))

(9) PINDEXCON(k) = sum(i, pwtscon(i,k) * P(i,k))

II. Production and Factor Demands

(10) XD(noilpriv,"mx")= ad(noilpriv,"mx")* prod(fctr, FDSC(noilpriv,fctr,"mx")** alpha(noilpriv,fctr,"mx"))

(11) WF(fctr,"mx")* WFDIST(noilpriv,fctr,"mx")* FDSC(noilpriv,fctr,"mx")= alpha(noilpriv,fctr,"mx")
* XD(noilpriv,"mx")* PVA(noilpriv,"mx")

(12) PX(ipriv,"us") * (1 - afee(ipriv,"us")) * XD(ipriv,"us") = sum(input,PINPUT(ipriv,input) * INPDEM(ipriv,input))

(13) INPDEM(ipriv,input) = egl(ipriv,input) + (XD(ipriv,"us")* sum(tupni, bgl(ipriv,input,tupni)
* sqrt(PINPUT(ipriv,tupni)/ pinput0(ipriv,tupni)))/ sqrt(PINPUT(ipriv,input) * pinput0(ipriv,input)))

(14) INPDEM(ipriv,"capital")= FDSC(ipriv,"capital","us")

(15) INPDEM(ipriv,"labor")= FDSC(ipriv,"labor","us")

(16) PINPUT(ipriv,"capital")= WF("capital","us")* WFDIST(ipriv,"capital","us")

(17) PINPUT(ipriv,"labor")= WF("labor","us")* WFDIST(ipriv,"labor","us")

(18) PINPUT(ipriv,"matin")= sum(mat, iomat(mat,ipriv) * P(mat,"us"))

(19) PINPUT(ipriv,"enerin")= sum(energy, ioenergy(energy,ipriv) * P(energy,"us"))

(20) PVA(crude,"mx")* XD(crude,"mx")= sum(fctr, WF(fctr,"mx")* WFDIST(crude,fctr,"mx")
* FDSC(crude,fctr,"mx"))

(21) FDSC(crude,fctr,"mx")=E= fdsc0(crude,fctr,"mx")

(22) PVA(igovt,k) * XD(igovt,k) = sum(fctr, WF(fctr,k) * WFDIST(igovt,fctr,k) * FDSC(igovt,fctr,k))

(23) FDSC(igovt,fctr,k) = fdsc0(igovt,fctr,k) * GTOT(k) / gtot0(k)

III. Trade Equations

(24) XD(i,k) = at(i,k) * (sum(wrld, gamma(i,k,wrld) * E(i,k,wrld) ** (-rhot(i,k)))
+ (1 - sum(wrld,gamma(i,k,wrld))) * XXA(i,k) ** (-rhot(i,k))) ** (-1/rhot(i,k))

(25) E(i,k,wrld) / XXA(i,k) = (PA(i,k) / PE(i,k,wrld) * gamma(i,k,wrld) / (1 - sum(dlrw,gamma(i,k,dlrw))))
** (1 / (1 + rhot(i,k)))

(26) X(i,k) = ac(i,k) * (sum(wrld,delta(i,k,wrld) * M(i,k,wrld) ** (-rhoc(i,k)))
+ (1 - sum(wrld,delta(i,k,wrld))) * XXD(i,k) ** (-rhoc(i,k))) ** (-1/rhoc(i,k))

(27) M(i,k,wrld) / XXD(i,k) = (PT(i,k) / PM(i,k,wrld) * delta(i,k,wrld) / (1 - sum(dlrw, delta(i,k,dlrw))))
** (1/(1 + rhoc(i,k)))

IV. Input - Output Links

(28) ZD(mat,ipriv,"us") = iomat(mat,ipriv) * INPDEM(ipriv,"matin")

(29) ZD(energy,ipriv,"us") = ioenergy(energy,ipriv) * INPDEM(ipriv,"enerin")

(30) ZD(i,ip[illegible] = io(i,ipriv,"mx")* XD(ipriv,"mx")

(31) ZD(i,igovt,k) = io(i,igovt,k) * XD(igovt,k)

(32) DMAKE(i,j,k) = mk(i,j,k) * XXA(i,k)

(33) sum(i, DMAKE(i,j,k)) = XXD(j,k)

V. Income allocation

(34) VALADD(i,fctr,k) = WF(fctr,k) * WFDIST(i,fctr,k) * FDSC(i,fctr,k)

(35) YFCTR(fctr,k) = sum(wrld, (FFAC(fctr,k,wrld) + FDIREPAT(k,wrld) * dum(fctr)) * EXR(k,wrld))
+ sum(i, VALADD(i,fctr,k))

(36) FDIREPAT(wrld,k) = repat(k) * fdishr(k) * dest(k,wrld) * (YINST("ent",k)- ENTTAX(k) - TOTDEP(k))

where: fdishr(k) = (1-domshr(k)) * fdicap(k) / FS("capital",k)

(37) YINST("labr",k)= sum(fctr, YVALINS("labr",fctr,k))

(38) YINST("ent",k)= sum(fctr, YVALINS("ent",fctr,k))+ ENTTRF(k)

(39) YVALINS(ins,fctr,k)= sfctyi(ins,fctr,k) * (YFCTR(fctr,k) - SSTAX(fctr,k))

(40) YH(k) = sum(wrld, FREMIT(k,wrld) * EXR(k,wrld)) + sum(ins, INTYH(ins,k)) + HHTRF(k)

(41) INTYH("labr",k)= sintyh("labr",k) * YINST("labr",k)

(42) INTYH("ent",k)= sintyh("ent",k) * (YINST("ent",k) - ENTTAX(k) - ENTSAV(k)
- TOTDEP(k) - sum(wrld, FDIREPAT(wrld,k)))

VI. Government Accounts

(43) SSTAX(fctr,k) = stax(fctr,k) * YFCTR(fctr,k)

(44) ENTTAX(k) = etax(k) * YINST("ent",k)

(45) HHTAX(k) = htax(k) * YH(k)

(46) TARIFF(i,k,wrld) = tm(i,k,wrld) * M(i,k,wrld) * PWM(i,k,wrld) * EXR(k,wrld)

(47) TAREQV(i,k,wrld) = tmeq(i,k,wrld) * (1 + tm(i,k,wrld)) * M(i,k,wrld) * PWM(i,k,wrld) * EXR(k,wrld)

(48) IMPTAX(i,k) = itax(i,k) * sum(wrld, PM(i,k,wrld) * M(i,k,wrld))

(49) ACTFEE(i,k) = afee(i,k) * PX(i,k) * XD(i,k)

(50) SUBSIDY(i,k) = subr(i,k) * PD(i,k) * XXD(i,k)

(51) DOMTAX(i,k) = dtax(i,k) * PT(i,k) * XXD(i,k)

(52) ENTTRF(k) = enttrf0(k) * GR(k) / gr0(k)

(53) HHTRF(k) = hhtrf0(k) * GR(k) / gr0(k)

(54) GR(k) = sum((i,wrld), TARIFF(i,k,wrld) + TAREQV(i,k,wrld))
+ sum(i, ACTFEE(i,k) - SUBSIDY(i,k) + DOMTAX(i,k) + IMPTAX(i,k))
+ sum(fctr, SSTAX(fctr,k)) + HHTAX(k)) + ENTTAX(k)
+ sum(wrld, FGOV(k,wrld) * EXR(k,wrld))

VII. Savings, Depreciation and Investment

(55) HHSAV(k) = mps(k) * YH(k)

(56) GOVSAV(k)= GR(k) - sum(i, GD(i,k) * P(i,k)) - ENTTRF(k) - HHTRF(k)

(57) GOVSAV(k) / PINDEXCON(k) = govsav0(k) / pindexcon0(k)

(58) ENTSAV(k) = ((1-fdishr(k)) * esr(k) + fdishr(k)) * (1-repat(k)) * (YINST("ent",k)- ENTTAX(k) - TOTDEP(k))

(59) DEPR(i,k) = deprate(i,k) * PK(k) * FDSC(i,"capital",k)

(60) TOTDEP(k) = sum(i, DEPR(i,k))

(61) FSAV(k,wrld) = sum(i, PWM(i,k,wrld) * M(i,k,wrld) - PWE(i,k,wrld)
* E(i,k,wrld)) - sum(ins, FINS(ins,k,wrld)) - sum(fctr, FFAC(fctr,k,wrld))
- FREMIT(k,wrld) - FGOV(k,wrld) + FDIREPAT(k,wrld) / EXR(k,wrld)

(62) FBAL(k) = sum(wrld, FSAV(k,wrld) * EXR(k,wrld))

(63) TOTSAV(k) = ENTSAV(k) + TOTDEP(k) + GOVSAV(k) + HHSAV(k) + FBAL(k)

(64) (TOTSAV(k) - TOTDEP(k)) / (PK(k) * FS("capital",k)) = (totsav0(k) - totdep0(k)) / (pk0(k) * fs0("capital",k))

VIII. <u>Expenditure allocation</u>

(65) P(i,k) * CD(i,k) = (acs(i,k) + sum(j, gcs(i,k,j) * log(P(j,k)))
+ bcs(i,k) * log(sum(j, CD(j,k)))) * (YH(k) - HHTAX(k) - HHSAV(k))

(66) GD(i,k) = gles(i,k) * GTOT(k)

(67) P(i,k) * ID(i,k) = iles(i,k) * (INVEST(k) - sum(j, P(j,k) * VD(j,k)))

(68) VD(i,k) = vdsh(i,k) * XD(i,k)

IX. <u>Net foreign transfers</u>

(69a) FFAC(fctr,"us",wrld)* EXR("us",wrld)= ffac0(fctr,"us",wrld)* exr0("us",wrld)

(69b) FFAC(fctr,"mx",wrld)= ffac0(fctr,"mx",wrld)

(70a) FREMIT(fctr,"us",wrld)* EXR("us",wrld)= fremit0(fctr,"us",wrld)* exr0("us",wrld)

(70b) FREMIT(fctr,"mx",wrld)= fremit0(fctr,"mx",wrld)

(71a) FGOV(fctr,"us",wrld)* EXR("us",wrld)= fgov0(fctr,"us",wrld)* exr0("us",wrld)

(71b) FGOV(fctr,"mx",wrld)= fgov0(fctr,"mx",wrld)

X. <u>Trade consistency and international prices</u>

(72) M(i,"us","mx")= E(i,"mx","us")

(73) E(i,"us","mx")= M(i,"mx","us")

(74) PWM(i,"us","mx")= PWE(i,"mx","us")* EXR("mx","us")

(75) PWE(i,"us","mx")= PWM(i,"mx","us")* EXR("mx","us")

(76) PWM(i,k,"rt")= pwm0(i,k,"rt")

(77) PWE(i,k,"rt")= pwe0(i,k,"rt")

XI. Exchange rates

(78) EXR("us","mx")* EXR("mx","us")= 1

(79) EXR("us","rt")* EXR("mx","us")= EXR("mx","rt")

(80) EXR(k,"rt")= 1

XII. Factor Markets

(81) FS("labor","us")= fs0("labor","us")

(82) WF("labor","mx")/ PINDEXCON("mx")= wf0("labor","mx")/ pindexcon0("mx")

(83) FS("capital",k)= fs0("capital",k)+ fdicap(k)

(84) WFDIST(i,fctr,"us")= wfdist0(i,fctr,"us")

(85) WFDIST(i,"labor","mx")= wfdist0(i,"labor","mx")

(86) WFDIST(igovt,"capital","mx")= wfdist0(igovt,"capital","mx")

(87) WFDIST(noilpriv,"capital","mx")= wfdist0(noilpriv,"capital","mx")

(88) FS(fctr,k) = sum(i, FDSC(i,fctr,k))

XIII. Market clearing conditions

(89) X(i,k) = CD(i,k)) + ID(i,k) + GD(i,k) + VD(i,k) + sum(j, ZD(i,j,k))

VARIABLES

Prices

PX(i,k)	OUTPUT PRICE
PD(i,k)	DOMESTIC PRICE OF OUTPUT WITHOUT COMMODITY TAXES
PT(i,k)	DOMESTIC PRICE OF OUTPUT WITH COMMODITY TAXES
PA(i,k)	DOMESTIC PRICE OF ACTIVITIES
P(i,k)	ABSORPTION PRICE
PK(k)	PRICE OF CAPITAL
PE(i,k,wrld)	PRICE OF EXPORTS IN DOMESTIC CURRENCY
PWE(i,k,wrld)	WORLD PRICE OF EXPORTS - in "wrld"currency units
PM(i,k,wrld)	PRICE OF IMPORTS IN DOMESTIC CURRENCY
PWM(i,k,wrld)	WORLD PRICE OF IMPORTS - in "wrld"currency units
EXR(k,wrld)	EXCHANGE RATE - units of country "k"currency per unit of "wrld"
PINDEXCON(k)	ABSORPTION PRICE INDEX
PINPUT(i,input)	GENERALIZED LEONTIEF PRICE OF INPUTS
PVA(i,k)	PRICE OF VALUE ADDED

Production and trade

X(i,k)	ABSORPTION
XD(i,k)	DOMESTIC OUTPUT
XXD(i,k)	DOMESTIC SALES OF COMMODITIES
XXA(i,k)	DOMESTIC SALES OF ACTIVITIES
E(i,k,wrld)	EXPORTS FROM "k"to "wrld"
M(i,k,wrld)	IMPORTS FROM "wrld"to "k"
ZD(i,j,k)	INTERMEDIATE FLOWS - spending by activity "j"in purchasing commodity "i"
DMAKE(i,j,k)	DOMESTIC MAKE MATRIX - production by activity "i"of commodity "j"

Factors

FS(fctr,k)	AGGREGATE FACTOR SUPPLY
FDSC(i,fctr,k)	FACTOR DEMAND BY SECTOR
INPDEM(i,input)	INPUT DEMAND FOR US GENERALIZED LEONTIEF
WF(fctr,k)	AVERAGE FACTOR PRICE
WFDIST(i,fctr,k)	FACTOR DIFFERENTIAL

Income and expenditure

YFCTR(fctr,k)	TOTAL FACTOR INCOME
YVALINS(ins,fctr,k)	MAPPING OF VALUE ADDED FROM FACTORS TO INSTITUTIONS
YINST(ins,k)	TOTAL INSTITUTIONAL INCOME
INTYH(ins,k)	HOUSEHOLD DISTRIBUTION OF INSTITUTIONAL INCOME
YH(k)	HOUSEHOLD INCOME
VALADD(i,fctr,k)	VALUE ADDED BY FACTOR
FDIREPAT(k,wrld)	REPATRIATED FOREIGN DIRECT INVESTMENT PROFITS FROM COUNTRY wrld TO COUNTRY k - in country wrld's currency
CD(i,k)	SECTORAL PRIVATE REAL CONSUMPTION
GD(i,k)	SECTORAL GOVERNMENT REAL SPENDING
GTOT(k)	TOTAL GOVERNMENT REAL SPENDING

ID(i,k)	INVESTMENT DEMAND
VD(i,k)	INVENTORY DEMAND

Savings, depreciation and investment

HHSAV(k)	HOUSEHOLD SAVINGS
GOVSAV(k)	GOVERNMENT SAVINGS
ENTSAV(k)	ENTERPRISE SAVINGS
DEPR(i,k)	DEPRECIATION BY SECTOR
TOTDEP(k)	TOTAL DEPRECIATION
FSAV(k,wrld)	FOREIGN SAVINGS
TOTSAV(k)	TOTAL SAVINGS
INVEST(k)	TOTAL INVESTMENT

Taxes, subsidies and government transfers

SSTAX(fctr,k)	FACTOR TAXES
ACTFEE(i,k)	INDIRECT TAXES
TARIFF(i,k,wrld)	TARIFF REVENUE
TAREQV(i,k,wrld)	QUOTA RENTS
SUBSIDY(i,k)	SUBSIDIES
DOMTAX(i,k)	DOMESTIC COMMODITY TAXES
IMPTAX(i,k)	IMPORT COMMODITY TAXES
ENTTAX(k)	ENTERPRISE TAX
HHTAX(hh,k)	INCOME TAX
ENTTRF(k)	GOVERNMENT TRANSFERS TO ENTERPRISES
HHTRF(hh,k)	GOVERNMENT TRANSFERS TO HOUSEHOLDS
GR(k)	GOVERNMENT REVENUE

Net International transfers

FFAC(fctr,k,wrld)	WORLD TO FACTORS
FINS(ins,k,wrld)	WORLD TO INSTITUTIONS
FREMIT(k,wrld)	WORLD TO HOUSEHOLDS
FGOV(k,wrld)	WORLD TO GOVERNMENT

PARAMETERS

Some parameters carry the value of variables in the base year. These parameters share the same name as the variable, with the addition of a "0". For example, the parameter "fdsc0"holds the base value of the variable FDSC.

tm(i,k,wrld)	TARIFF RATE ON IMPORTS FROM "wrld"TO COUNTRY "k"
tmeq(i,k,wrld)	TARIFF EQUIVALENT RATES
itax(i,k)	IMPORT TAX
afee(i,k)	AD-VALOREM ACTIVITY FEES
subr(i,k)	AD-VALOREM SUBSIDIES
dtax(i,k)	TAX INCLUSIVE COMMODITY TAX RATES
stax(fctr,k)	TAX RATES ON FACTORS
etax(k)	TAX RATES ON ENTERPRISES
htax(k)	TAX RATES ON HOUSEHOLDS
io(j,i,k)	INPUT-OUTPUT COEFFICIENTS
iles(i,k)	SECTORAL DISTRIBUTION OF FIXED INVESTMENT
vdsh(i,k)	SECTORAL DISTRIBUTION OF CHANGE IN STOCKS
iomat(mat,ipriv)	INPUT-OUTPUT COEFFICIENTS FOR MATERIALS SECTORS
ioenergy(energy,ipriv)	INPUT-OUTPUT COEFFICIENTS FOR ENERGY SECTORS
mk(i,j,k)	COEFFICIENTS OF MAKE MATRIX
pwtscon(i,k)	ABSORPTION INDEX WEIGHTS
ad(ipriv,k)	COBB-DOUGLAS CALIBRATED INTERCEPT
alpha(ipriv,fctr,k)	COBB-DOUGLAS COEFFICIENTS
egl(ipriv,input)	GENERALIZED LEONTIEF CONSTANT TERM
bgl(ipriv,input,tupni)	GENERALIZED LEONTIEF PRICE COEFFICIENTS
at(i,k)	CET FUNCTION CONSTANT TERM
rhot(i,k)	CET FUNCTION SUBSTITUTION COEFFICIENT
gamma(i,k,wrld)	CET FUNCTION SHARE PARAMETERS
ac(i,k)	CES FUNCTION CONSTANT TERM
rhoc(i,k)	CES FUNCTION SUBSTITUTION COEFFICIENT
delta(i,k,wrld)	CES FUNCTION SHARE PARAMETERS
acs(i,k)	AIDS DEMAND SYSTEM - CONSTANT TERM
gcs(i,k,j)	AIDS DEMAND SYSTEM - PRICE COEFFICIENT
bcs(i,k)	AIDS DEMAND SYSTEM - SPENDING COEFFICIENT
gles(i,k)	SECTORAL DISTRIBUTION OF REAL GOVERNMENT SPENDING
sfctyi(ins,fctr,k)	DISTRIBUTION OF FACTOR INCOME TO INSTITUTIONS
sintyh(ins,k)	DISTRIBUTION OF INSTITUTION INCOME TO HOUSEHOLDS
repat(k)	PROPORTION OF NEW FOREIGN OWNED CAPITAL PROFITS REPATRIATED
dum(fctr)	DUMMY EQUAL TO ONE IF fctr EQUALS "capital"
dest(k,wrld)	APPORTIONING OF REPATRIATED PROFITS
fdishr(k)	PROPORTION OF NEW CAPITAL OWNED BY FOREIGNERS
fdicap(k)	INCREASE IN AGGREGATE CAPITAL STOCK
esr(k)	RATIO OF RETAINED EARNINGS TO DIVIDENDS, CALCULATED OVER LOCAL INVESTORS
mps(k)	MARGINAL PROPENSITY TO SAVE
deprate(i,k)	CAPITAL DEPRECIATION RATE

III. PARAMETER ESTIMATION

An effort was made to estimate as many functional relationships as possible from historical data. This task was difficult since it is not always possible to obtain reliable time series data at a sectoral level. When time series data is not available, point estimates were derived from the base year data, or alternatively, a literature search was done to provide reasonable values.

U.S. Manufacturing Production Function

Production behavior in CGE models is traditionally modeled by means of Constant Elasticity of Substitution (CES) production functions. Even though this functional form is very useful when limited data are available or the purpose is to develop simple models, its main disadvantage is that it imposes identical substitutability among any two inputs to be identical.

To avoid imposing this limitation, the behavior of manufacturing industries is derived by means of a Generalized Leontief Cost Function (see Diewert (1971)). This "flexible" functional form allows for arbitrary substitution patterns among inputs.

For estimation, the cost function is restricted to represent a constant returns to scale production technology. The specification differentiates among four factors of production: Capital (k), Labor (l), Energy (e) and Materials (m):

$$COST = Q \cdot e^{-rt} \cdot \sum_i \sum_j B_{ij} \cdot \sqrt{P_i P_j} \tag{1}$$

where:	Q	output
	t	time
	B_{ij}	substitution coefficients
	r	technological change coefficient
	P_i	price of factor i

and: $B_{ij} = B_{ji}$. The coefficient r measures the percent reduction in costs over time, due to disembodied, Hicks-neutral technical change.

Time series data for the period 1949 - 1986 were provided by the Bureau of Labor Statistics, U.S. Department of Labor. The data were classified by two-digit SIC industries. The coefficients were obtained through simultaneous estimation of the system of factor demand equations by Nonlinear Least Squares, imposing the restriction described above and taking into account the contemporaneous correlation of stochastic terms across equations.

Consumption Demand Functions

As with the production side of U.S. manufacturing, we also used a flexible functional form for the consumption side of the model. The "Almost Ideal Demand System" (AIDS) specification, introduced by Deaton and Muellbauer (1980), allows for arbitrary substitution patterns between consumption categories.

Demand for consumption category i is specified in terms of the share of total consumption spent in this category:

$$S_i = \frac{P_i \cdot X_i}{EXP} = A_i + \sum_j G_{ij} \cdot \log P_j + B_i \cdot \log(\frac{EXP}{P}) \qquad (2)$$

where:	EXP	Total consumption expenditure
	X_i	Demand of consumption category i
	P_i	Price of consumption category i
	A_i	Basic share coefficient
	B_i	Expenditure coefficient
	G_{ij}	Substitution coefficients

and the aggregate price index is defined as:

$$\log P = A_0 + \sum_k A_k \cdot \log P_k + \frac{1}{2} \cdot \sum_k \sum_m G_{km} \cdot \log P_k \cdot \log P_m \qquad (3)$$

A set of jointly normal stochastic terms were added to the share equations. The resulting system was estimated by Maximum Likelihood estimation, taking into account the symmetry, adding-up and homogeneity constraints. Since the dependent variable (the shares) add up to one by construction, it is necessary to delete one category from the system when performing Maximum Likelihood (there is no problem in choosing which category to delete, since the estimator is invariant to this choice).

Trade elasticities

Given the frequent changes in trade regulations, the existence of non-tariff barriers and the lack of detailed data, the elasticities of the CES and CET functions were not estimated. For both specifications an elasticity of 2 was assumed for all sectors. This number is within the range used in the literature. Adelman and Robinson's (1988) average elasticity lies between 1.7 and 1.8, while both De Melo and Tarr (1989) and Hanson et. al. (1989) use values equal or greater than 2 for most of their sectors. Assuming an elasticity of 2 is conservative since, as trade barriers are lowered and efforts to penetrate each others markets increase, products will become more substitutable and therefore elasticities would increase.

Tariff equivalents

Non-tariff barriers potentially include many items, most of which are very hard to quantify; we have concentrated on import quotas. The generally accepted procedure to deal with these trade restraints is to convert them into tariff equivalents. A tariff equivalent is the ad-valorem tax required to induce consumers to demand the amount of imports equal to the quota. In the model, tariff equivalents are imposed in addition to existing tariffs. That is, the tariff equivalents are applied to import prices inclusive of tariffs.

Tariff equivalents for the US were obtained from USITC (1989) and USITC (1990). In some cases, the numbers published by the ITC are for specific industries that do not directly match the industry classification used in the model. For these, the ITC calculations are weighted by domestic output.

Tariff equivalents for Mexico are estimated by analyzing sectoral changes in tariffs, licensing restrictions and imports, between May and December 1985. On July 1985 the Mexican government implemented a trade reform, one of whose objectives was to make the system of protection more "transparent". The intention was to raise tariffs and reduce licensing requirements, while keeping the level of protection constant.

Most probably these changes did not exactly offset each other. In some sectors, the reduction in import restrictions was more than compensated by the tariff increase, and vice-versa. Therefore, in comparing the relative change in these two magnitudes, one needs to correct for possible sectoral deviations. In the estimation, we corrected by the difference between a sector's growth rate in imports and the average growth rate in imports. In general, import growth above the average implies that the tariff increase should have been higher to maintain the same level of protection.

The following relationship embodies the properties described above:

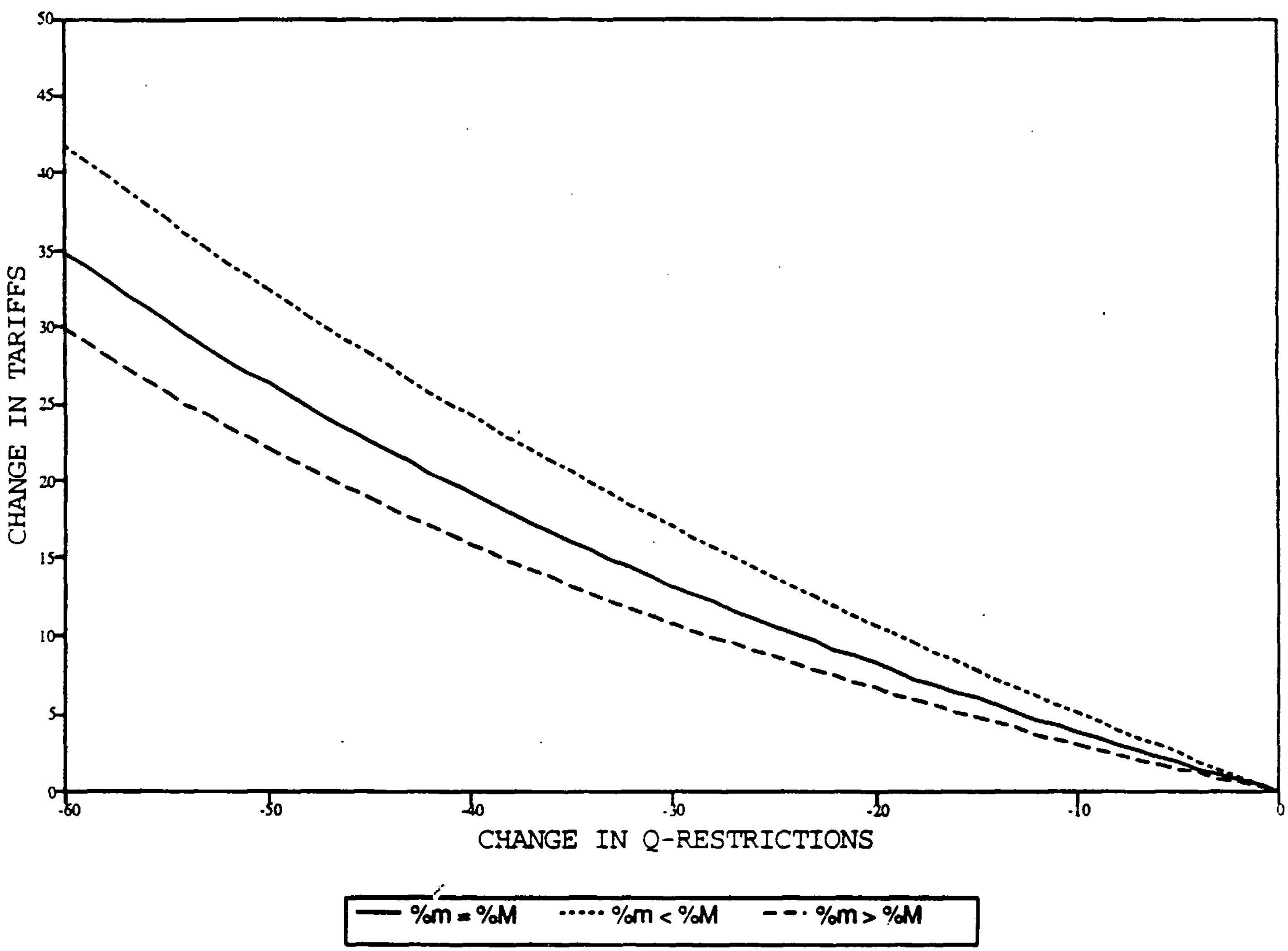
$$t_2 - t_1 = -A \cdot \frac{p_2 - p_1}{100 - B \cdot (1 + \%M - \%m) \cdot (100 + p_2 - p_1)} \tag{4}$$

where:

p_1, p_2	- levels of protection in periods 1 and 2
t_1, t_2	- tariff rates in periods 1 and 2
%M	- growth rate of total imports between 1985 and 1984
%m	- growth rate of sectoral imports between 1985 and 1984
A, B	- parameters

The graph below presents this relationship under three alternative cases. In the central one, the growth in sectoral imports equals the growth in total imports. The top line presents the case in which the growth in sectoral imports is lower than the growth in total imports and therefore the tariff increase more than compensates for the reduction in protection. The lower line presents the case in which the growth in sectoral imports is higher than the growth in total imports and therefore the tariff increase does not compensate for the reduction in protection.

TARIFF EQUIVALENTS FOR MEXICO



The level of protection is measured as the percentage of domestic sectoral production subject to import licensing requirements; it averaged 92.2 percent in May and 47.1 percent in December. Sectoral tariffs are ad-valorem rates, weighted by domestic production; they averaged 23.5 percent in May and 28.5 percent in December.

The above specification is used to simulate the effect of the removal of import licensing. The level of protection in the second period (p_2) becomes zero, and import growth is assumed equal to the overall average. The new level of tariffs becomes:

$$t_2 = t_1 + A \cdot \frac{p_1}{100 - B \cdot (100 - p_1)} \tag{5}$$

Response lags

The Mexican economy has been traditionally more protected than the U.S. economy. However, since 1985 Mexico has made a significant effort in opening its economy to foreign competition, by simplifying the tariff code and lowering tariffs and non-tariff barriers. The most notable change during this period has been the reduction in non-tariff barriers. This was achieved by the almost complete elimination of import licensing requirements in Mexico. Part of the reduction in import licensing requirements was initially compensated by higher tariffs; over time these were also gradually reduced. In the last two years, the tariff code was further simplified to reduce the variability of protection across sectors. This resulted in a slight increase in the average tariff rate, since the new code imposed a ten percent tariff on goods formerly enjoying zero or five percent tariff rate.

The full effect of changes in economic conditions are not instantaneously reflected in an economy. In most cases it is impossible to shorten the time period required to implement economic decisions. For example, if a firm wants to increase production beyond its current capacity, it takes time to order, receive and install new equipment and have it fully operational. Or if export prices become very attractive because of a devaluation, it may still take time to establish marketing networks, and therefore exports do not react immediately to changes in the exchange rate.

These lags are also present in the case of changes in trade barriers. Therefore, the observed trade structure in Mexico and the United States in 1988 is not a reflection of the protection levels in that year, but rather of their protection structure in 1985 or 1986. To evaluate the effects of an FTA one needs first to simulate the structure of the economies as it would look once the effects of the current protection structure are fully accounted for. To carry this simulation, we assume that the trade structure of 1988 reflected the protection in place in 1986, i.e. a lag of two years. We then use the model to simulate the effects of replacing the protection structure as it was in 1986, by the protection structure of the most recent available year. In other words, we create a base line where the lags in trade behavior as well as the latest available protection structure are imposed on our base year. For the case of Mexico, we used the protection structure in place at the end of 1990. For the case of the United States we used the protection structure in place in 1988, the last year for which detailed data is available. The fact that we could not use the protection structure of 1990 for the United States has no impact on the results, since there were no major changes in this period.

IV. DATA SOURCES

Base year data for the U.S. Social Accounting Matrix (SAM) and the model, were gathered from a variety of government sources including the U.S. Department of Commerce, U.S. Department of Labor and U.S. International Trade Commission.

Construction of a 1988 SAM for the United States required reconciling data that differed by source, level of industry detail, and time period. The available data were aggregated or disaggregated, and updated as needed to develop a 1988 44-sector United States SAM. The two main sources of data for the base year SAM are the input-output table and the National Income and Product Accounts (NIPA). A variety of other sources were also consulted for data on capital stock, bilateral trade flows, and tariff and non-tariff trade barriers. The sources of and processing needed for each category of model data are described below.

The Bureau of Economic Analysis (BEA), U.S. Department of Commerce, publishes detailed benchmark input-output tables based mainly on economic census data every five years. Annual tables for intervening years are also published by BEA at a less detailed level and using less reliable data. The 1986 table used in the Policy Economics Group model is an update of the 1982 annual table made by Bureau of Labor Statistics (BLS) for use in modeling projected employment patterns; see BLS (1987) for a description of the methodology. This Input-Output table was later balanced by means of the RAS procedure[8], to be consistent with the rest of the SAM.

The BLS sectors are defined in terms of three or four digit industries of the 1977 Standard Industrial Classification System (SIC). The 44 sectors of the model were also defined by SIC content so each BLS sector could be mapped to a unique model sector. Data for current dollar personal consumption expenditures, investment by type of asset, and government purchases were taken from the Survey of Current Business; see BEA (1990a). These data, however, are not defined in terms of the I-O table commodities, but rather by expenditure categories that are unique to the type of purchaser.

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[8] This procedure modifies the rows and columns of the I-O table proportionally, while keeping their totals constant; see Bacharach (1970) for a description.

To use the NIPA data in the model, therefore, each category of NIPA expenditures is redefined in terms of I-O table goods. The BLS data base provides "bridge"matrices that link the sectoral detail found in the NIPA's to the 226 BLS sectors. The 226 sectors are then aggregated to the 45 model sectors.

Historical data for gross industry output is also available from BLS at the 226 sector level for 1947 through 1988; see BLS (1987) for a description of the methodology. The data is compatible with both the input-output data and national income and product accounts discussed above. For use in the model, these data were also converted from 226 to 45 sectors.

The source for base year value-added data is Gross Product Originating (GPO) by industry published annually as part of the NIPA. BEA publishes data for 14 components of value-added and some 62 industries roughly corresponding to 2-digit SIC categories; see BEA (1990b). In many cases, several GPO industries comprised one model sector. However, in some instances it was necessary to apportion one GPO industry to more than one model sector. The amount of value-added assigned to each model sector from a GPO industry was determined by the industry's share of gross output. GPO data for 1988 was not published in time to be included in the model. Therefore, data for 1987 was inflated by the rate of growth in national income and used as a proxy for actual 1988 data.

Data on U.S. bilateral trade flows with Mexico and the rest of the world were extracted from the Department of Commerce trade data banks; see Bureau of the Census (1990). Data were obtained at the detailed TSUSA commodity level and aggregated to the model's forty four sectors. Capital stock data were obtained from the Wealth Data Tape, produced by the Department of Commerce (see BEA (1990c)). The data were available at a detailed sectoral level, and was aggregated to the model's forty four sectors.

Most data for Mexico were provided by CIMAT - Centro de Investigaciones Matemáticas, in Guanajuato. These data were compiled from Mexican official statistics, including publications by the Instituto Nacional de Estadística, Geografía e Informática (INEGI) and Banco de México.

An aggregated SAM for 1988 was constructed based on data from INEGI (1990) and from the Ministry of Budgeting and Planning (1988). A disaggregation of the SAM (intermediate demands, final demand and its components, and imports) was constructed by CIMAT with the assistance of INEGI. Detailed wage information was obtained from the National Income and Expenditures surveys of 1984 and 1989, and the National Employment Surveys of 1985 and 1989. Net indirect taxes were separated into taxes and subsidies based on direct information processed by INEGI. Investment, depreciation and capital stock data were obtained from the Banco de Mexico. With all the data in place, the 1980 Input-Output matrix was balanced through the RAS procedure to conform with total intermediate cost and demand on the 1988 SAM.

Maquiladora production and gross trade data are not included in the Mexican national accounts. Data on maquiladoras were obtained from INEGI (1989) and incorporated into the SAM[9]. Historical data on output-weighted average statutory tariff rates and licensing requirements were taken from Ten Kate and De Mateo Venturini (1988). Trade-weighted data for more recent years were received from the Division of Foreign Trade Studies at SECOFI[10]. These data are at a more detailed sectoral composition than the model, and had to be aggregated to the model's forty four sectors.

V. RESULTS

The economic effects of an FTA between the United States and Mexico are analyzed under two alternative scenarios. The first analyzes the economic effects assuming that there is no additional capital stock in either Mexico or the United States. Under this condition, the major effect is a shifting of resources between sectors in the two economies. From Mexico's point of view, however, a major incentive to engage in an FTA is the likely increase in foreign investment in Mexico. This leads to the second scenario in which additional capital is invested in Mexico.

Tables 1 through 4 summarize the economic effects on the U.S. economy and on the Mexican economy, under the two scenarios. The tables show the economic effects of the FTA on (i) income, employment and factor prices, (ii) exports, (iii) imports, and (iv) trade balances.

No additional capital in Mexico

Table 1 shows the effects of the FTA on the U.S. economy assuming no additional capital in Mexico. Not surprisingly, the effects on income are very small in the United States. Real income, the real wage rate and the real rate of return on capital all increase, but only by about 0.02 percent. While, by assumption, there is no effect on employment in the United States, the U.S. real wage rate increase indicates higher demand for U.S. labor.

To better assess the impact of an FTA on demand for U.S. labor, each scenario is also simulated under the assumption that the real wage in the United States remains constant. Changes in the demand for labor are then reflected in changes in the overall employment level. Under this alternative assumption, employment in the United States grows by 0.04 percent (40,800 jobs).

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[9] This publication contains data on maquiladora inputs, output and employment by twelve economic sectors of activity.

[10] Secretaría de Comercio y Fomento Industrial

TABLE 1

A SUMMARY OF THE ECONOMIC EFFECTS OF AN FTA WITHOUT ANY ADDITIONAL CAPITAL IN MEXICO
(percent change)

U.S. Economy

Income and Employment		
Real Income	+ 0.02%	
Real Wage Rate	+ 0.02%	
Real Rate of Return	+ 0.03%	
Employment	*	
Exports	Price	Quantity
To Mexico	+ 2.64%	+ 5.39%
To ROW	- 0.04%	+ 0.03%
Imports	Price	Quantity
From Mexico	- 2.20%	+ 4.22%
From ROW	- 0.04%	- 0.00%
Trade Balance		as a percent of total trade
With Mexico	- 1.81%	- 0.24%
With ROW	+ 0.14%	+ 0.02%
Overall Trade Balance	+ 0.03%	+ 0.00%

* No change by assumption

The next section of the table shows the effect on U.S. exports. The price received by U.S. producers for their exports to Mexico increases by 2.6 percent when trade barriers are eliminated. Import duties drive a wedge between the price paid by consumers and the amount received by producers. Eliminating this wedge will tend to raise the price received by producers and lower the price paid by consumers until the two prices are equal. The average combined tariff levied by Mexico on merchandise from the United States is about 8.5 percent; including trade in services, this average becomes 7.1 percent. The average price received by U.S. producers for their exports to Mexico goes up by only 2.6 percent, or about a third of the 7.1 percent combined duty imposed by Mexico.

The price received by U.S. producers for their exports to the ROW decreases slightly, by 0.04 percent. Nevertheless, exports to the ROW increase due to increased competitiveness of the U.S. economy.

The third section of the table shows the effect on U.S. imports. The prices paid by U.S. consumers and producers on imports from Mexico decline by 2.2 percent. The United States imposes a 4.8 percent average combined tariff rate on merchandise from Mexico. When services are included, the average combined tariff rate becomes 3.5 percent. This means that slightly less than two thirds of the U.S. combined tariff rate is reflected in lower prices paid by U.S. consumers and producers.

The prices paid by U.S. consumers and producers on imports from the ROW decline slightly, by 0.04 percent. Nevertheless, there is a minimal decrease in imports from the ROW, because Mexican imports became relatively cheaper than ROW imports. Notice that by assumption, the terms of trade vis-a-vis the ROW are kept constant in the model.

The last section of the table summarizes the effects of the FTA on the U.S. trade balance. In spite of an improvement in the terms of trade vis-a-vis Mexico of around 1.3%, the trade balance with that country deteriorates. This is because the increase in the level of imports motivated by lower import prices is larger than the additional exports generated by higher export prices. That is, even though the percent change in exports is larger than the percent change in imports, the increase in imports is larger than the increase in exports.

While the trade balance with Mexico deteriorates, the improvement in the trade balance with the ROW is larger, resulting in an overall improvement in the United States trade balance. The first category in this section is the trade balance with Mexico, the second the trade balance with the ROW, and the last category is the overall trade balance. Both real exports to and real imports from Mexico increase under an FTA. Real exports to Mexico increase by 5.4 percent whereas real imports from Mexico increase by 4.2 percent. The net effect of increased exports to and imports from Mexico is a slight deterioration in the net export position of the United States with Mexico. Under the current trade regime, the United States is in a trade deficit with Mexico. Under an FTA, the U.S. trade balance with Mexico further deteriorates by 1.8 percent.

The trade balance of the United States with the ROW improves as a result of an FTA. Only part of this improvement is due to trade diversion, the rest being increased competitiveness of the United States. This improvement more than offsets the deterioration of the trade balance with Mexico, resulting in an overall improvement of the U.S. trade balance.

An alternative way to evaluate the change in the trade balance, is to relate it to the total volume of bilateral trade (exports plus imports). This is done in the last column of the table. Even though the trade balance with Mexico deteriorates by 1.8 percent, this amount equals only one quarter of 1 percent of total trade with Mexico.

Table 2 shows the economic effects of the FTA on the Mexican economy under the

TABLE 2

A SUMMARY OF THE ECONOMIC EFFECTS OF AN FTA WITHOUT ANY ADDITIONAL CAPITAL IN MEXICO
(percent change)

Mexican Economy

Income and Employment		
Real Income	+ 0.32%	
Real Wage Rate	*	
Real Rate of Return	+ 0.60%	
Employment	+ 0.85%	
Exports	Price	Quantity
To United States	+ 1.56%	+ 4.22%
To ROW	- 0.22%	- 0.28%
Imports	Price	Quantity
From United States	- 4.30%	+ 5.39%
From ROW	- 0.22%	+ 0.38%
Trade Balance		as a percent of total trade
With United States	+ 1.63%	+ 0.22%
With ROW	- 3.06%	- 0.31%
Overall Trade Balance	+ 1.18%	+ 0.09%

* No change by assumption

first scenario. Real income and the real rate of return on capital increase more significantly than in the United States. For Mexico, in contrast to the United States, it is assumed that increased demand for labor ultimately results in higher employment rather than an increase in the real wage rate. The FTA causes the demand for labor in Mexico to rise, leading to an increase in employment of more than 0.8 percent (188,000 jobs).

The effect on prices received by Mexican producers exporting to the United States and Mexican consumers and producers importing from the United States follows the pattern seen in the United States. Prices in this table are denominated in pesos. The price received by exporters increases, while the price paid for imports declines. In particular, the significant decrease in the price of imports from the United States leads to a sizable increase in imports. In spite of this, the trade balance with the United States improves.

Domestic prices of imports and exports to and from the ROW decrease by a fifth of 1 percent. As with the United States, terms of trade with respect to the ROW are kept constant for Mexico. As a result of this price change, exports to the ROW decrease and imports from the ROW increase. This leads to a significant deterioration of the trade balance with the ROW, dampening the overall improvement in the Mexican trade balance.

Additional capital in Mexico

The first scenario, which does not incorporate the effects of any additional capital entering Mexico, is a useful exercise but probably not realistic. A major thrust of an FTA would be directed toward eliminating or reducing investment restrictions in Mexico. The second scenario allows physical capital in Mexico to increase and looks at the effects of incorporating this additional capital flow on both the United States and Mexican economies.

For purposes of the analysis, it is assumed that additional capital flows into Mexico so as to reduce the real rate of return to capital in Mexico to its pre-FTA level. This is a conservative estimate, since the removal of all investment restrictions in Mexico might well attract even more capital. To force the rate of return down to pre-FTA levels, Mexico needs about twenty five billion dollars worth of additional capital, which is about 7.6 percent of its current capital stock. It is further assumed that 40 percent of the additional capital is owned by foreigners, 60 percent by Mexicans, and that half of the net profits generated by the foreign owned portion of this additional capital will be repatriated. The foreign capital could be owned by U.S. investors or foreign investors, but the main assumption is that it does not on a net basis replace any physical plant and equipment that otherwise would have been located in the United States. As a result of an FTA some plants currently located in the United States may move to Mexico and some plants may move from Mexico to the United States. However, since the rate of return to capital in the United States increases under the first scenario, the United States would also attract capital that otherwise would have been placed somewhere else.

The model solves for the resulting equilibrium once all the additional capital has been installed. Since a large portion of this capital is imported, Mexico's trade balance deteriorates in the transition period. This transitional worsening in Mexico's trade balance is not captured by the model's solution.

Table 3 and Table 4 show the economic effects under the additional capital scenario for the U.S. economy and the Mexican economy respectively. The effects on the U.S. economy are still small but the increases in real income, the wage rate and the rate of return on capital are higher than in the case where no additional capital is allowed in Mexico. Also, the alternative assumption of fixed real wages in the United States leads to a 0.05 percent increase in the demand for U.S. labor (61,000 jobs), which is a larger increase

TABLE 3

A SUMMARY OF THE ECONOMIC EFFECTS OF AN FTA WITH ADDITIONAL CAPITAL IN MEXICO

(percent change)

U.S. Economy

Income and Employment		
Real Income	+ 0.04%	
Real Wage Rate	+ 0.03%	
Real Rate of Return	+ 0.07%	
Employment	*	
Exports	Price	Quantity
To Mexico	+ 2.54%	+ 5.21%
To ROW	+ 0.02%	+ 0.16%
Imports	Price	Quantity
From Mexico	- 6.05%	+ 12.94%
From ROW	+ 0.02%	- 0.20%
Trade Balance		as a percent of total trade
With Mexico	- 20.79%	- 2.80%
With ROW	+ 1.32%	+ 0.18%
Overall Trade Balance	+ 0.07%	+ 0.01%

* No change by assumption

than in the first scenario.

The price received by U.S. producers exporting to Mexico increases by slightly less than in the previous scenario. Real exports to Mexico and the dollars received for those exports both increase relative to the non-FTA case, although somewhat less than under the first scenario. As opposed to the previous scenario, prices received by U.S. producers exporting to the ROW increase slightly, leading to an increase in exports to the ROW. Even though they are small in percent terms, increased exports to the ROW account for more than one third of the overall increase in exports.

There is a significant change in the price paid by U.S. producers and consumers for imports from Mexico. Under the no additional capital scenario, the import price falls by 2.2 percent. Under the additional capital scenario, the price of imports falls by 6.1 percent, leading to a 12.9 percent increase in real imports from Mexico. The dollars paid for those imports, while higher than in the non-FTA case, increase only by about half of the increase in imports. This is due to the 6.1 percent decline in the price of imports. The reason for the larger price reduction is the stronger real devaluation of the Mexican peso relative to the U.S. dollar. In real terms the peso devalues by 5 percent relative to the U.S. dollar.

The relative price paid by U.S. producers and consumers on imports from the ROW increases slightly. This is explained by the decrease in domestic prices caused by lower prices on Mexican imports, while ROW prices remain constant. Real imports from the ROW decrease, offsetting more than twenty five percent of the increase in imports from Mexico.

The U.S. trade balance with Mexico is notably affected, deteriorating significantly more than under the first scenario. As with the previous scenario, this happens in spite of an improvement in the terms of trade vis-a-vis Mexico of around 5.2%. As before, this deterioration is more than offset by an improvement in the trade balance of the United States with the ROW. Overall, the trade balance of the United States improves by more than it does under the first scenario, in which no additional capital is allowed in Mexico.

Table 4 shows the effects on the Mexican economy. Real income in Mexico increases by 4.6 percent and employment increases by 6.6 percent. The real wage rate and the real rate of return on capital remain unchanged by assumption. The real wage rate is unchanged because the demand for additional labor is assumed to result entirely in an increase in employment. The real rate of return is unchanged because, under the simulation, just enough additional capital flows into Mexico to keep the rate of return unchanged.

The real devaluation of the Mexican peso causes all export and import prices to increase. The price received by Mexican producers exporting to the United States increases by more than in the previous scenario, and so do real exports. On the other hand, even though Mexican consumers and producers pay more on imports from the United States, these imports increase as much as in the first scenario. Higher income in Mexico is responsible for this increased demand for U.S. imports.

Changes in trade between Mexico and the ROW follow the same pattern as with the United States. However, the swings in exports and imports are larger since price changes are steeper. Contrary to the first scenario, the trade balance of Mexico with both the United States and the ROW improves, leading to a large overall improvement in its net trade position.

Effects not represented in the model

TABLE 4

A SUMMARY OF THE ECONOMIC EFFECTS OF AN FTA
WITH ADDITIONAL CAPITAL IN MEXICO
(percent change)

Mexican Economy

Income and Employment		
Real Income	+ 4.64%	
Real Wage Rate	*	
Real Rate of Return	*	
Employment	+ 6.60%	
Exports	Price	Quantity
To United States	+ 2.65%	+ 12.94%
To ROW	+ 4.81%	+ 18.06%
Imports	Price	Quantity
From United States	+ 0.61%	+ 5.21%
From ROW	+ 4.81%	+ 0.27%
Trade Balance		as a percent of total trade
With United States	+ 26.88%	+ 3.62%
With ROW	+ 76.39%	+ 7.84%
Overall Trade Balance	+ 59.12%	+ 4.62%

* No change by assumption

It should be emphasized that certain quantity restrictions have not been taken into account in the model. Therefore, the model does not fully capture the effects that an FTA might have on some sectors. For example, imports of some agricultural commodities in Mexico are permitted only after the domestic supply has been consumed; such restriction is not accounted for in the estimated tariff equivalents. In general, there is extensive government intervention in the agricultural sector of both countries.

Another example is import restrictions on motor vehicles in Mexico, which have a unique structure. It is particularly difficult to analyze the impact of the trade balance requirement on this sector. Current regulations in Mexico have induced U.S. producers to maintain an excessive number of production lines in Mexico, producing below efficient levels. An immediate elimination of all restrictions in this sector would lower prices, and induce significant growth in the Mexican market. In the short run, U.S. producers would shift production to the United States where production of certain models is more efficient than in Mexico. One would expect employment in this sector to increase in the United States and to decrease in Mexico, and the trade balance effect to be favorable to the United States in the short run.

This situation would not remain unchanged, however. Over time, U.S. producers would rationalize operations in Mexico, reducing the number of production lines and increasing their volume. As a result, some of the Mexican demand satisfied by foreign (U.S.) production in the short run, subsequently will be provided by production in Mexico.

It is clear that in the long run the Mexican auto market will be larger with an FTA. It is not clear, however, how much of this market will be supplied by production in the United States and how much by production in Mexico. Strategic decisions by U.S. auto makers play an important role in this outcome. Given this uncertainty, no special adjustment for this sector have been made in the model.

Sectoral effects

The major effects of the FTA will be on specific sectors of the economies. Tariffs and non-tariff barriers insulate domestic industries from foreign competition. In general, this protection diminishes the incentive for efficient production and leads to higher domestic prices. In both the United States and Mexico, trade protection is not homogeneous across sectors. Therefore, the elimination of trade barriers between Mexico and the United States will affect different sectors differently. Highly protected sectors will contract relative to other sectors as trade barriers are eliminated.

Sectors that are highly protected in the United States include textiles, apparel and sugar refining. It is not surprising to find them among the contracting sectors in the United States, and with the exception of apparel, among those with the highest growth rates in Mexico under this scenario.

In Mexico, the most protected sectors include apparel, motor vehicles, cleaning and toilet preparations, transportation equipment, machinery and equipment, tobacco manufactures and optical instruments. With the exception of apparel, these sectors are among those with the highest growth rates in the United States and the lowest growth rates in Mexico. Apparel is an exception because it is more protected in the United States than in Mexico (although highly protected in both).

It follows that a significant effect of the FTA will be the reallocation of resources across industries in each country. Table 5 details the sectoral effects of an FTA on U.S. employment and output. Table 6 details the sectoral effects of an FTA on U.S. employment and output.

TABLE 5

ECONOMIC EFFECTS OF AN FTA ALLOWING ADDITIONAL CAPITAL IN MEXICO CHANGE IN U.S. EMPLOYMENT AND OUTPUT

	EMPLOYMENT		OUTPUT	
Sectors	Thousands	Percent	millions 1988 U.S. dollars	Percent
01 Animal Products	0.1	0.01%	-3.5	-0.00%
02 Field crops	-1.4	-0.12	-87.1	-0.13
03 Fruits & vegetables	-2.6	-0.79	-143.4	-0.80
04 Other agriculture	-0.5	-0.05	-22.3	-0.06
05 Mining	-0.0	-0.01	-11.1	-0.02
06 Crude oil & gas	0.2	0.04	6.1	0.01
07 Construction	-1.5	-0.03	-181.8	-0.03
08 Sugar	-1.7	-2.38	-442.1	-3.89
09 Food products	0.6	0.04	197.0	0.06
10 Tobacco manufacturers	-0.0	-0.02	-15.2	-0.05
11 Textiles	-1.0	-0.14	-91.5	-0.13
12 Apparel	-4.4	-0.40	-384.4	-0.62
13 Lumber & wood	-0.2	-0.02	-7.8	-0.01
14 Furniture & fixtures	-0.8	-0.14	-60.1	-0.15
15 Paper	-0.2	-0.03	-3.4	-0.00
16 Printing & publishing	-0.4	-0.03	14.3	0.01
17 Chemicals	0.9	0.13	376.0	0.22
18 Rubber & misc. plastics	0.6	0.07	120.5	0.14
19 Drugs	-0.1	-0.03	-3.8	-0.01
20 Cleaning & toilet prep	-0.1	-0.08	-10.2	-0.03
21 Petroleum refining	0.0	0.02	24.6	0.02
22 Leather	-0.0	-0.00	3.2	0.04
23 Glass	-0.3	-0.19	-25.6	-0.17
24 Stone & clay	-0.5	-0.12	-34.2	-0.08
25 Iron & steel	-0.1	-0.02	25.7	0.03
26 Non-ferrous metals	-0.9	-0.24	-16.0	-0.02
27 Fabricated metal	-0.2	-0.01	32.6	0.02
28 Machinery & equipment	4.5	0.27	856.9	0.48
29 Computing equipment	-2.7	-0.68	-227.8	-0.49
30 Electrical equipment	-0.5	-0.04	-106.5	-0.08

TABLE 5

ECONOMIC EFFECTS OF AN FTA ALLOWING ADDITIONAL CAPITAL IN MEXICO CHANGE IN U.S. EMPLOYMENT AND OUTPUT

(continued)

	EMPLOYMENT		OUTPUT	
Sectors	Thousands	Percent	millions 1988 U.S. dollars	Percent
31 Household appliances	-1.0	-0.46	-157.5	-0.58
32 Electronic components	-4.7	-0.76	-437.9	-0.96
33 Motor vehicles & bodies	2.0	0.45	373.4	0.28
34 Motor vehicle parts	0.2	0.06	26.6	0.05
35 Transportation equipment	0.6	0.05	77.9	0.06
36 Misc. manufacturing	11.4	0.91	1302.9	1.21
37 Transportation	-0.3	-0.01	-46.9	-0.02
38 Communications	-0.1	-0.01	-45.3	-0.03
39 Utilities	0.4	0.04	35.4	0.02
40 Wholesale & retail trade	0.7	0.00	-41.9	-0.01
41 Finance & insurance	1.1	0.02	51.1	0.01
42 Hotels & restaurants	-3.6	-0.03	-177.4	-0.04
43 Other business services	-4.1	-0.03	158.5	0.01
44 Health ed. nonprof & gov	2.3	0.01	156.1	0.01
Total	0	0.00%	1053.7	0.01%

TABLE 6

**ECONOMIC EFFECTS OF AN FTA ALLOWING ADDITIONAL CAPITAL IN MEXICO
CHANGE IN MEXICAN EMPLOYMENT AND OUTPUT**

	EMPLOYMENT		OUTPUT	
Sectors	Thousands	Percent	millions 1988 U.S. dollars	Percent
01 Animal Products	40.4	5.67%	471.0	5.70%
02 Field crops	333.1	10.44	610.9	10.46
03 Fruits & vegetables	113.8	6.08	354.5	6.11
04 Other agriculture	11.7	6.06	127.8	6.09
05 Mining	28.9	13.20	614.1	13.23
06 Crude oil & gas	0.0	0.00	0.0	0.00
07 Construction	141.0	7.39	1351.1	7.41
08 Sugar	24.4	32.07	509.5	32.10
09 Food products	30.1	5.28	1591.9	5.31
10 Tobacco manufacturers	1.1	4.46	46.9	4.49
11 Textiles	22.7	12.67	585.6	12.70
12 Apparel	25.4	18.92	748.7	18.95
13 Lumber & wood	5.7	8.52	134.0	8.55
14 Furniture & fixtures	6.0	7.74	196.7	7.77
15 Paper	4.9	9.64	349.4	9.68
16 Printing & publishing	4.2	6.02	167.3	6.04
17 Chemicals	12.1	11.27	1068.8	11.30
18 Rubber & misc. plastics	6.5	7.38	289.5	7.41
19 Drugs	2.1	5.19	100.2	5.22
20 Cleaning & toilet prep	1.4	4.32	118.3	4.35
21 Petroleum refining	6.2	8.84	500.4	8.87
22 Leather	8.9	7.01	188.7	7.03
23 Glass	3.2	12.35	136.4	12.38
24 Stone & clay	11.0	7.66	357.5	7.69
25 Iron & steel	8.6	12.86	921.3	12.89
26 Non-ferrous metals	3.9	15.67	322.2	15.70
27 Fabricated metal	9.1	9.66	386.7	9.69
28 Machinery & equipment	5.0	8.77	213.9	8.79
29 Computing equipment	2.4	9.14	94.0	9.16
30 Electrical equipment	15.9	12.89	548.6	12.91

TABLE 6

ECONOMIC EFFECTS OF AN FTA ALLOWING ADDITIONAL CAPITAL IN MEXICO CHANGE IN MEXICAN EMPLOYMENT AND OUTPUT

(continued)

Sectors	EMPLOYMENT Thousands	EMPLOYMENT Percent	OUTPUT millions 1988 U.S. dollars	OUTPUT Percent
31 Household appliances	9.9	14.62	311.7	14.64
32 Electronic components	15.1	16.19	439.2	16.21
33 Motor vehicles & bodies	7.1	7.48	579.1	7.50
34 Motor vehicle parts	15.9	14.97	678.0	15.00
35 Transportation equipment	1.8	4.45	27.7	4.46
36 Misc. manufacturing	7.0	9.38	204.8	9.41
37 Transportation	53.6	5.78	1070.3	5.81
38 Communications	7.3	6.03	161.5	6.05
39 Utilities	8.1	7.60	384.2	7.62
40 Wholesale & retail trade	157.8	5.88	2672.7	5.91
41 Finance & insurance	16.5	6.07	473.2	6.08
42 Hotels & restaurants	40.5	6.88	957.3	6.92
43 Other business services	26.0	6.09	917.2	6.13
44 Health ed nonprof & gov	207.4	3.37	1072.9	3.27
Total	1463.6	6.60%	23055.7	7.34%

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COMMENTS ON PAPER 2

BY ROBERT M. FEINBERG

Comments on Bachrach and Mizrahi, "The Economic Impact of a Free Trade Agreement Between the United States and Mexico: A CGE Analysis"

Robert M. Feinberg

While I am not a trade modeller -- I'm not even a trade economist -- my ignorance allows me to be completely objective in analyzing this paper. My comments can be taken to be those of a consumer of these results to use in evaluating the policy issues involved. My concerns fall into three areas: (1) the reliability of the data; (2) the appropriateness of the level of aggregation; and (3) the policy-relevance of the paper (or, how convincing are the results?). I should note that many of my comments would apply equally to most other computable general equilibrium modelling exercises, both those presented at this conference and elsewhere.

On the question of the data and parameters used by Bachrach and Mizrahi, I have strong doubts about the crucial tariff-equivalents and trade substitution elasticities. These are what clearly must drive the results of trade liberalization, yet no attempt at sensitivity analysis seems to have been employed.

Tariff-equivalent estimates can vary quite a bit from year to year, and the authors give no argument for the particular year chosen to be "typical" in terms of world or local market conditions (which would contribute to tariff-equivalents derived from price-wedge calculations). Furthermore, where tariff-equivalents are derived from price wedge comparison (as in the ITC estimates) they should not be added to tariff rates, as done by the authors, to get the total trade-barrier effect; the tariff effect is implicitly included in the price wedge. I must confess that I could not follow the discussion of how Mexican tariff equivalents were calculated. While I see the difficulty in estimating these on limited data, the average tariff equivalent of 0.3 percent (from non-tariff items only) seems so low as to leave one skeptical.

The assumed constant elasticity of substitution of *two* across all sectors may be reasonable as an average, but it makes the analysis of sectoral effects almost meaningless (other than producing the expected result that the relatively most protected sectors have the relatively largest output and employment losses). The true elasticity of substitution between imports and domestic goods in consumption (and between exports and domestic production) is likely to vary quite a bit across sectors and that is where much of the differing sectoral effects of free trade may come from.

Another crucial number in the analysis that seems to come out of thin air is the magnitude of additional capital assumed to be added to the Mexican economy as a result of the NAFTA. How reliable is the $25 billion figure? How realistic is the assumption that it does not displace any investment in the United States? The paper does not discuss the sectoral focus of this additional investment, or how the results would be affected either by a different total amount of investment or a different sectoral distribution within the Mexican economy.

The level of aggregation is another issue that comes to mind to me as an Industrial Organization economist. The sectoral disaggregation employed is to a level of detail somewhere between the 2- and 3-digit Standard Industrial Classification level -- nowhere close to a true economic market. At this level of disaggregation we would expect tremendous intra-sector (as well as inter-sector) variation in tariff and non-tariff barriers, and in demand, production and substitution parameters.

Given this (and the apparent infeasibility of going much beyond 44 sectors in a CGE model of this type), the question arises: are the results more meaningful than those obtained with a CGE model with 22 sectors, or 10 sectors, where parameters can be better tailored to the individual sectors analyzed, or with a partial equilibrium model with 450 sectors? I don't have the answer, but it would be nice to have some feel for whether the level of aggregation imparts any bias to the overall or sectoral results.

Finally, and of course related to the above points, what does the Bachrach and Mizrahi study contribute to the policy debate over the NAFTA? The model's assumptions -- perfectly competitive markets, a precise 2-year lag for the effect of trade barrier removal, ignoring all non-tariff barriers not of the quota variety -- along with the lack of sensitivity analysis on parameters and data, lead me to doubt the reliability of the results.

Adding to my unease is their peculiar argument that the constant trade elasticity of substitution of two is likely to be on the low side. This suggests that the removal of trade barriers would have a larger impact than calculated by the authors (both overall and for each sector). But then the results may be taken to be *minimum* effects (particularly sector-by-sector) where what is likely to be of more interest to workers and firms in affected sectors (especially currently protected sectors) are the *maximum* effects.

In conclusion, while I realize that extensive sensitivity analysis would be quite difficult to do, I think that without such an analysis the results are unconvincing and we have gained little insight into how either the U.S. or Mexican economies would be affected by a NAFTA.

COMMENTS ON PAPER 2

BY KAN H. YOUNG

DRAFT

The Economic Impact of Free Trade Agreement between the United States and Mexico: Comments on A CGE Analysis

by
Kan H. Young*

Comments delivered at the

ITC Conference on Economy-wide Modeling of a NAFTA

February 25, 1992

The Computable General Equilibrium (CGE) Model developed by the Policy Economics Group of KPMG Peat Marwick reflects the state-of-the-art of CGE analysis. The model, as described by the authors "consists of two full-fledged CGE models, one for the United States and one for Mexico, linked by bilateral sectoral trade flows. The two separate models are integrated into a single model, customized to examine the specific issues related to a United State - Mexico FTA." (p.1) As such, strictly speaking, the model is neither a single-country model nor a multi-country model. It is not a single-country model because it includes two countries explicitly; and it is not a multi-country model because the "rest of the world" is not treated fully as if it were a "country."

The model includes 44 production sectors for both the U.S. and

* Business Issues Analysis Division, Office of Business Analysis, Economics and Statistics Administration, U.S. Department of Commerce. These comments represent the opinions of the author, and are not meant to represent, in any way, the views of the Department of Commerce or any of its agencies.

Mexico, and 14 and 4 consumption categories for the U.S. and Mexico, respectively. The traditional assumptions of constant return to scale and perfect competition are retained in the model. Opponents of free trade have frequently asserted that these cornerstones of the traditional "comparative advantage" trade model are unrealistic. Therefore, the same criticism can be expected for the current version of the CGE model. It is not certain how the results will be affected by adopting the alternative assumptions of increasing return to scale and imperfect competition. In addition, whether the criticism could be somewhat lessened by allowing for product differentiation, as is done in the model, is not immediately clear.

In the policy debate, based on national interests, some economists have recognized the arguments, such as strategic considerations and externalities (especially related to R&D) for limited government intervention. Most economists seem to believe that these arguments are not generally persuasive enough to discredit the potential benefits of the free trade policy. However, even when the objective of free trade is agreed upon, the issue remains: whether it can best be achieved by multilateral or unilateral negotiation, or by regional arrangement. The model, as it stands now, appears to be more useful for bilateral negotiation, since it focuses only on the U.S. and Mexico. Each of these countries has only each other as the "partner" besides the "rest of the world." The authors recognized that the model can be generalized to have any numbers of "partners." These partners can be Canada, Japan, Germany or other countries or regions. Alternatively, the "rest of the world" may be treated more fully as if it were a country.

The model is represented by 89 sets of equations, which includes more than 12,600 individual linear and non-linear equations. The large number of equations in the model is a strength as well as a weakness. It is a strength because it provides detailed information; it is a weakness because it is very difficult to comprehend. The results may be very sensitive to the specification of some equations or the values of some parameters. If so, we must be very confident about the appropriateness of the selected specification or parameter values. Therefore, until we know more about the properties of the model, we must consider the results to be very tentative or merely suggestive.

The micro foundation is an important characteristic of the CGE models. However, the macro results are frequently highlighted more than the sectoral results. To the extent that the estimates of aggregate effects are deemed less reliable than those of relative shifts among sectors, this emphasis is misplaced. The paper did not indicate which of its results is more reliable. In view of the many exogenous aggregate constraints imposed, it would not be unreasonable to conjecture that the results on relative sectoral shifts are perhaps more reasonable than those of aggregate effects.

Aggregate capital is assumed fixed in the U.S., and allowed to increase 7.6% to keep the return to capital constant in Mexico in one of the two cases analyzed in the paper. Labor supply is assumed to be fixed (full employment) in the U.S.: and its potential increase is estimated to be only about 40,000 or 60,000 jobs when the perfectly elastic labor supply is assumed. With the same assumption, the estimated job gain for Mexico is about 188,000 or 1,463,600 jobs, depending on whether capital is allowed to increase (capital is mobile or not). In terms of the increase in aggregate real income, the effects are 0.02% for the U.S. and 0.32% for Mexico for the fixed capital case; and 0.04% for the U.S. and 4.46% for Mexico for the case of additional capital for Mexico.

The results on relative shifts among individual sectors are plausible. They show, according to the mobile-capital case, that currently more highly protected sectors tend to contract relative to other sectors, as the tariff and non-tariff trade barriers between the U.S. and Mexico are removed. In the U.S., textiles, apparel and sugar sectors are shown to contract. In Mexico, all sectors will expand, but the more highly protected sectors, such as motor vehicles, cleaning and toilet preparations, transportation equipment, machinery and equipment, tobacco manufactures and optical instrument, will grow more slowly. Notice the results show that real income in Mexico will increase only 4.46%, though total output will increase by 7.34%; and that these increases are obtained by increases of 7.6% of capital and 6.6% of employment under the assumption of constant returns to scale!

There are a number of "convenient" assumptions, such as constant nominal exchange rates or exact offsetting of foreign savings with domestic private savings, that need to be justified more clearly. The parameters of the production and consumption functions are estimated by using advanced econometric techniques, when the data are available. However, some estimated values, such as negative technological progress and positive own price elasticities, are not plausible. In addition, the trade elasticities are not estimated, but simply assumed to be 2 for all sectors. Overall, the analysis represents a technically competent study, but the results should be accepted very cautiously.

PAPER 3

"PROPERTIES OF COMPUTABLE GENERAL EQUILIBRIUM TRADE MODELS WITH MONOPOLISTIC COMPETITION AND FOREIGN DIRECT INVESTMENT," BY DRUSILLA K. BROWN

February 21, 1992

PROPERTIES OF COMPUTABLE GENERAL EQUILIBRIUM TRADE MODELS WITH MONOPOLISTIC COMPETITION AND FOREIGN DIRECT INVESTMENT

by

Drusilla K. Brown
Tufts University

I. Introduction

Economy wide models of the proposed North American Free Trade Area (NAFTA) occasionally seem inscrutable to the outside observer and, in some cases, to the model designers themselves. It is frequently difficult to untangle the economic mechanics underlying some of the counter-intuitive results.

For example, the Michigan Model (see Brown, Deardorff and Stern, 1992 a,b) has been adapted to study North American economic integration. This is a model with 5 country groups, 23 tradable goods sectors, 7 nontradable goods sectors, and two intersectorally mobile primary inputs. Technology in most of the tradable sectors is increasing returns to scale and the market structure is monopolistically competitive. Trade policy is introduced using tariffs and tariff equivalents of nontariff barriers and international capital flows are permitted in some liberalization scenarios.

The model predicts that none of the concerns associated with economic integration are likely to emerge: (1) Welfare rises in all three participating countries (Canada, the United States and Mexico) and the welfare losses by the rest of the world are minuscule, (2) Canada's position in the U.S. market is not noticeably eroded by the addition of Mexico to the U.S.-Canada FTA, (3) trade liberalization narrows the wage-gap between U.S. and Mexican workers, perhaps stemming illegal immigration, but (4) U.S. workers still gain from the agreement, (5) scale effects are positive in nearly all industries in all three countries, with the largest gains emerging in Mexico, (6) despite the fact that Mexico is a labor-abundant country, liberalization raises the return to capital in Mexico relative to other countries in the model, attracting new foreign investment, (7) the scale gains associated with a capital-inflow into Mexico are so strong that the return to capital in Mexico actually rises relative to the return to capital in other countries, (8) the fear that U.S. firms will relocate plants in Mexico seems largely unfounded, (9) adjustment costs associated with intersectoral factor reallocation in the United States will be very small, and (10) pollution problems in Mexico should be somewhat mitigated by a free-trade agreement (see Grossman and Krueger, 1991).

Some of these result could not possibly have emerged in a perfectly competitive homogenous products setting and so must stem from the market structure of the model. The mechanics by which these results emerge, however, are not particularly transparent.

Theoretical models with monopolistically competitive firms have been studied extensively. Some more notable contributions are Brown (1991), Harris (1984), Horstmann and Markusen (1986), Krugman (1980, 1981, 1991), Lancaster (1984), Markusen and Svensson (1985, 1986), and Markusen and Wigle (1989). Our purpose here is to draw on the existing literature dealing with the effects of trade policy on monopolistically competitive firms in order to elucidate some of the less transparent results of the Michigan Model's evaluation of the NAFTA. These points will be illustrated using a simple numeric model broadly similar to the large scale Michigan Model.

II. The Model

The numeric model adopted here is nearly identical in structure to the multi-country multi-sector version of the Michigan Model used to evaluate a North American Free Trade Area. However, here, the dimensions are reduced to two countries (H and F), two sectors (X_1 and X_2), and two factors of production (capital and labor). In addition, the model is not linearized before solution, as is the case with the Michigan Model.

The equations of the model along with variable and parameter definitions are listed in Table 1. A representative agent is taken to maximize a Cobb-Douglas utility function of the two composite goods, as given in equation (1). Each composite good is formed by aggregating over all of the domestically and foreign produced varieties of each good using a CES aggregation function, as in equation (2). Here we allow for the possibility that consumers in each country may have a preference for varieties produced at home relative to those produced abroad. In most cases we will take $\gamma = 0.5$, implying that consumers are indifferent to the location of production. Utility maximization yields national demand for the output of each firm, as given by equation (3). The associated elasticity of demand is given by equation (4).

Monopolistically competitive firms use the elasticity of demand to calculate the optimal mark-up of price over marginal cost as in equation (5), but first elasticity of demand in each of the two markets must be aggregated to form a world market elasticity of demand for the firm. This is the case since we allow for arbitrage between national markets. In equation (5), each firm's perceived elasticity of demand is a sales weighted average over the two national markets.

Although each firm receives the same price for domestic sales and export sales, the price paid by the foreign consumer is adjusted to reflect any ad valorem tariffs that apply. The landed price, then is the world price adjusted for a tariff.

Technology is characterized by increasing returns to scale and is identical across the two countries. Increasing returns is accomplished assuming that firms must first make an initial investment, F, of capital and labor. Variable inputs are then employed in proportion to output. However, the capital-labor ratio for the variable inputs is the same as for fixed inputs, so that technology is homogeneous. Both the fixed and variable input requirements are derived assuming a CES function of capital and labor. Cost minimization yields marginal cost given by equation (8) and firm demand for labor and capital given by equations (10) and (11), respectively. In both sectors the elasticity of substitution between capital and labor, s, is set equal to two (2). Sector 1 is taken to be capital-intensive and sector 2 is labor-intensive.

Factor market clearing conditions are given by equations (11) and (12). In each case factor demand summed over all firms must be equal to an exogenous supply. Labor in each country is assumed to be fixed, but we will allow for the possibility that capital flows from the foreign country to the home country, thus augmenting the capital stock in H and reducing the capital stock in F. Payments to foreign capital installed in H are remitted back to the residents of F.

Equilibrium in the goods markets simply requires that each firm produce enough to satisfy demand by both domestic and foreign consumers, as given by equation (14). The number of firms in each industry is determined by the zero-profits condition, as given by equation (9).

Finally, the model is closed with the income equation. Households in the home country receive payments to factors plus any tariff revenue, as in equation (15). Foreign income is taken to be the numeraire, but implicitly foreign income is composed of payments to factors installed both domestically and in country H.

The numerical model is written in the GAMS (General Algebraic Modelling System) and solved employing Rutherford's (1991) SLCP solver.

III. Results

The model described above was employed to evaluate the effects of tariffs under various endowment and taste configurations. Results are reported in Tables 2 - 12.

Case I. We begin by considering the case in which countries H and F are to be completely identical in terms of factor endowments and preferences. Each country is endowed with 100 units each of capital and labor, consumers are indifferent to the location of firms, and the elasticity of substitution among different varieties of each good, sigma, is taken to be three (3). Free trade equilibrium values for firm sales by market, prices, number of firms, demand elasticity, firm output, and marginal cost are reported in the first two columns of Table 2.

The other four columns of Table 2 report values for these variables under the assumption that country H is imposing a tariff on its imports of good 1 from F. In several respects the model produces the expected results. The tariff raises welfare for country H but lowers welfare for country F up until the tariff reaches around 40 percent at which point home country welfare begins to decline with higher tariffs. Home firm sales of good 1 to the home market rise and imports fall. For example, with a tariff of 10 percent, home demand for good 1 produced by a representative home firm (H.X1 in Table 2) rises from 2.794 to 2.986 and home demand for good 1 produced by a representative foreign firm (F.X1) falls from 2.794 to 2.587. On the other hand, foreign demand for good 1 produced by a representative home firm falls from 2.794 to 2.598 but foreign demand for the a representative foreign firm rises from 2.794 to 2.997. Home country terms of trade for good 1 improve, by about 5 percent in the case of a ten percent tariff. The tariff also has the normal Stolper-Samuelson effects on factor prices. An import tariff on the capital-intensive good lowers the wage-rent ratio at home while the relative return to labor in F rises.

Perhaps a bit surprisingly, the effects of the tariff on sector 2 in H are identical to the effect in F. However, upon reflection, this is a fairly easy result to understand. If we substitute equations (3) and (4) into equation (5) we can find each firm's demand elasticity as a function of prices. That is

$$\eta_H = -\sigma + \frac{(\sigma-1)P_H^{1-\sigma}}{n_H P_H^{1-\sigma} + n_F P_F^{1-\sigma}}$$

$$\eta_F = -\sigma + \frac{(\sigma-1)P_F^{1-\sigma}}{n_H P_H^{1-\sigma} + n_F P_F^{1-\sigma}}$$

where the industry subscripts have been suppressed. Note that in the absence of any tariffs, home firms perceive a more elastic demand curve relative to foreign firms only if the relative price of home goods also rises. That is, if P_H/P_F goes up. This is, of course, the same condition under which total demand for a home country firm falls relative to a foreign firm. Therefore, in the absence of tariffs, the firm that sells a relatively high quantity must also be on a less elastic part of the demand curve.

Turn now to the mark-up and zero profits conditions. We have that

$$\frac{q}{q+F} = \frac{MC}{ATC} = \frac{MC}{P} = \frac{MR}{P} = 1+\frac{1}{\eta}$$

which implies that the firm with the higher sales must be on a <u>more</u> elastic portion of the demand curve.

These two conditions, of course, give use the result that in the absence of a tariff in sector 2, home firm sales, price, elasticity and marginal cost must be equal to those of foreign firms. Equalizing marginal cost for the two different types of firms in sector 2 is accomplished by lowering w/v in country H while raising w/v in country F.

This unequivocal relationship between relative elasticity and quantity is relaxed in sector 1 where the home country is imposing a tariff. The bind that breaks is the relationship between elasticity and demand. The tariff opens up a window in which a Home (Foreign) firm's demand can rise relative to a Foreign (Home) firm even though relative elasticity for the Home (Foreign) firm may be rising. But the tariff does not alter the relationship between elasticity and demand that satisfies the zero-profits and profit-maximization conditions. Consequently, we can conclude that in sector 1 the firm with the higher quantity will also be on a relatively more elastic portion of the demand curve.

The question then is, which firms (Home or Foreign) end up with a relatively more elastic demand and a higher level of output? We might normally expect (see Lancaster, 1984) the tariff, by insulating domestic firms from foreign competition, to cause foreign firms to perceive a less elastic demand curve on their domestic sales. Similarly, the tariff inhibits the ability of foreign firms to compete in the home market (Horstmann and Markusen, 1986). Thus, we expect foreign firms to perceive a more elastic demand curve. Indeed, the home elasticity for home goods does indeed rise from -2.863 to -2.855 in the case of a ten percent tariff. In comparison, home demand elasticity for foreign goods falls to -2.868.

The confounding factor, however, is that the terms of trade change. The rise in the price of the home good relative to the foreign good on the world market is associated with a more elastic foreign demand for home goods (-2.868) as compared to the foreign demand for the foreign good (-2.855).

One might expect that the direct effect of the tariff would dominate the secondary terms-of-trade effect, but that is not the case. When the tariff is set at 10 percent, both home and foreign firms each sell a total of 5.584. But at higher tariff levels home firm output in sector 1 rises relative to foreign firm output and its demand curve is concomitantly more elastic.

It is worth noting at this point, that the results in the previous paragraph will not hold generally. As will be seen below, there are situations in which the tariff will lower home firm output relative to foreign firm output. However, one conclusion does seem to suggest itself throughout the results presented here. The tariff tends to make sector one less competitive for both foreign and domestic firms. That is, elasticity rises and firm output falls for both domestic and foreign producers in a tariffed industry even if the home country alone is imposing the tariff.

Curiously, the opposite occurs in sector 2. The demand curves for both the home and foreign firms become more elastic and firm output rises. This is presumably a consequence of the fact that the tariff shifts world demand toward sector 2. As the industry expands, the market is able to offer more variety and competition intensifies.

Finally, we can also see that the tariff generates inefficient entry into sector 1 in country H. The number of firms rises and each sells less than before the tariff.

We turn now to consider the consequences of a home country tariff imposed on both goods 1 and 2. Results are reported in Table 3. The symmetry of this setting causes the tariff to impact sectors 1 and 2 identically. With the intersectorally distorting effect of the tariff now removed, the optimal tariff nearly doubles to around 75 percent.

Many of the same points above are evidenced here as well, though there is one important difference. Above, as long as sector 2 was not subject to a tariff it was necessary for the real return to labor to fall relative to foreign labor. However, with a uniform tariff, there is no change in relative factor prices within each country, but both home country capital and labor are better off than foreign country labor. The tariff-induced terms-of-trade gain for the home country feeds back onto factor prices, raising the real return to capital and labor.

In differentiated products models there are always two effects exerting competing influences on the return to the factor <u>not</u> used intensively in the tariffed industry. Normally Stolper-Samuelson effects will tend to push the return to this factor down by reducing its marginal product. Opposing the Stolper-Samuelson effect is the positive terms-of-trade effect that pulls up the value of the marginal product on the world market.

In Table 4, we experiment with various combinations of home country tariffs. Not surprisingly, a uniform tariff across both industries yields the highest welfare. This result obviously depends on the symmetry of the two industries. Cross-sectoral differences in demand elasticity or elasticity of substitution between capital and labor could easily reverse this conclusion.

Case II. Our next objective is to verify that the larger the tariff-imposing country relative to its trade partner the larger will be the optimal tariff. The configuration in Case I is maintained with the exception that the home country is now taken to be fifty percent larger than the foreign country. Results are reported in Table 5.

The optimal tariff is now about 85 percent, as compared to 75 percent when the countries were of equal size. This follows from the fact that the terms-of-trade gains from the home country tariff increase with its relative size. See, for example, that here a 70 percent tariff raises factor returns in the home country relative to the foreign country from unity to 1.393. In comparison, international relative factor returns rise to 1.339 when the two countries are of equal size, as can be seen in Table 3.

Case III. In light of the results obtained under Case II, it is interesting to consider the situation in which the tariff-imposing country is also relatively small. Table 6 contains results for the configuration in which the home country imposes a tariff, but the home country is only one-tenth the size of the foreign country.

Not surprisingly, the optimal tariff drops down to 55 percent and terms-of-trade effects are considerably weakened. At the optimal tariff, the return to home country factors relative to foreign factors is only about seven percent higher.

However, the most striking result here is that relative scale effects of the tariff are now reversed. Notice that output per firm in the foreign country remains at 5.922 for all levels of the tariff and perceived elasticity of demand holds constant at -2.974. In contrast, home country firm output falls as the tariff rises. At the optimal tariff rate, home country firm output has fallen to 5.911 from 5.922 under free trade.

A consequence of reducing the size of the home country has been to diminish the role of the terms of trade in determining the demand elasticity, thus enhancing the importance of the tariff. However, the influence of the terms of trade has not been completely eliminated. For if the tariff had been the only force influencing foreign firm perceived elasticity of demand then the foreign demand curve would have become more elastic and foreign firm output would have risen.

Case IV. We turn now to consider configurations that more closely resemble the U.S.-Mexico situation. Mexico is both smaller and more labor abundant. Table 7 reports results for a uniform tariff imposed by the home country for the case in which the foreign country has 25 percent more labor and 75 percent more capital than the home country.

The most interesting points to note in this case concern the implications of protection for the wage and rental rates. Despite the fact that the home country tariff is applied uniformly across both industries, the tariff still lowers the relative return to the home country's abundant factor (labor). The home country wage-rent rate falls from 1.159 under free trade to 1.148 with a tariff of 65 percent. The tariff forces the home country to supply itself with more of the capital-intensive good. As resources shift into this sector the return to capital must rise to clear the factor markets.

We also see again the conflicting Stolper-Samuelson and terms-of-trade effects on factor returns. Although the home wage rate falls relative to the return to capital, home country work workers still earn more than foreign workers.

This result raises interesting implications for the dynamic stability of the model. Suppose, for example, that we were evaluating the case in which the home country imposing the tariff was labor abundant. In this case, as long as the tariff is welfare improving for the home country then labor has an incentive to migrate from F to H. In addition, the terms-of-trade gain also raises the nominal return to capital at home relative to foreign capital. As a result, capital owners in the foreign country also have an incentive to transfer their capital from employment domestically to the home country.

The transfer of both capital and labor to the home country will make the home country larger. Increasing home country size, of course, strengthens the terms-of-trade changes associated with the tariff, thus further raising the return to home capital and labor relative to their foreign counter-parts. One possible force counter-balancing the terms-of-trade effect on the return to factors is the differential scale effects associated with the tariff. We have already discovered that the larger the tariff imposing country the more likely that home firm output falls relative to foreign firm output. However, it is not clear that scale effects could overwhelm terms-of-trade effects in determining relative factor returns. Second, the country importing capital must run a surplus on the merchandise account in order to balance interest payments on imported capital remitted back to the foreign country. Inducing foreigners to absorb the extra production of home varieties of each good tends to worsen the terms of trade of the home country, thus diminishing the normal terms-of-trade gain associated with the tariff.

Case V. The dynamic instability problems discussed under Case IV actually presented itself more forcefully in the NAFTA version of the Michigan Model. In particular, we found that transferring capital from the rest of the world to Mexico actually raised the return to capital in Mexico relative to the rest of the world, although transferring labor to Mexico lowered the Mexican wage relative to the U.S. wage. It seemed to be that the return to capital rose with the capital stock because of very strong positive scale effects on the Mexican economy that fed back onto the return to both capital and labor. In this last case, we attempt to replicate the conditions under which a capital inflow raises the return to capital, though without success.

First, we return to the original symmetric configuration and set the tariff at the optimal level of 75 percent. In the base case, with no capital flows, the return to capital is higher in the home country than the foreign country. Foreign capital is then transferred to the home country, though interest payments are remitted back to the foreign country. Results are reported in Table 8.

Capital flows are welfare improving for the foreign country. For example, with no capital flows, welfare in the foreign country with the tariff is 48.110. A small transfer of one unit of capital raises welfare to 48.177, and foreign welfare rises to 49.192 with a capital flow of 18 units. This occurs, in part, because capital owners are able to earn a higher rate of return abroad than domestically. The home country, however, is losing from the capital flows, though world welfare rises. This is the case since home country terms of trade must deteriorate relative to the no capital case in order to induce foreign consumers to absorb more home produced goods.

The capital flows also tend raise firm output in the industry in each country that uses that country's "newly" abundant factor intensively. That is, firm output in capital-intensive sector 1 in the home country rises from 5.547 with no capital flow to 5.558 with a capital flow of 18 units. Similarly, sector 2 firm output in the foreign country is also rising with greater capital flows. The opposite is occurring in the sector that uses each country's newly scarce factor intensively. As a result, for a capital flow of 18 units, sector 1 firm output at home has risen but foreign firm output has fallen while sector 2 firm output at home has fallen but foreign firm output has risen. The capital flow, then, by fostering greater specialization, generates scale gains for each country that uses its abundant factor intensively.

Various other configurations were tried, attempting to generate a rise in the return to capital due to a capital inflow. These results are presented in Tables 9 - 12. However, in all cases the terms-of-trade deterioration was too large to prevent the relative return to capital from falling.

IV. <u>Conclusions</u>

There are a few lessons for the NAFTA that can be drawn from this exercise. First, it is fairly clear that the determinants of scale effects associated with trade liberalization is complicated and difficult to anticipate. One might have expected that the relatively large tariff reductions in Mexico might actually exert an anti-competitive effect on U.S. firms. However, our results here indicate that a tariff imposed by one country tends to be anti-competitive for both domestic and foreign firms. In light of this result, U.S. scale gains are not surprising even though current U.S. tariffs on Mexico are very low. In addition, the analysis of country size on the likely scale effects across countries creates a strong presumption that the small country will enjoy greater scale gains than larger countries. This result was born out in the large scale NAFTA model.

Second, the results presented here help to understand why the U.S. real wage rate rose with trade liberalization even though labor is the United States's relatively scarce factor. Labor lost relative to capital but still gained absolutely. Mexican liberalization resulted in a terms-of-trade gain for the United States, that pulled up the value of the marginal product of labor. This is the case, even though production in the United States overall became more labor-intensive and the marginal product of labor fell.

Results concerning international capital flows remain a bit of a mystery. In principle it seems as if it might be possible to configure the model in such a way as to minimize the terms-of-trade losses associated with a capital inflow and maximizing the scale gains associated with expanding country size. However, this task remains for the future.

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TABLE 1

EQUATIONS OF THE MODEL

Utility Indicator

$$U_i = D_{i1}^{0.5} D_{i2}^{0.5} \qquad (1)$$

Product Aggregator

$$D_{ij} = \left[\gamma_{ij}^{H} n_{jH} (D_{ij}^{H})^{\rho} + \gamma_{ij}^{F} n_{jF} (D_{ij}^{F})^{\rho}\right]^{1/\rho} \qquad (2)$$

Product Demand

$$D_{ij}^{r} = \frac{0.5 E_i (\gamma_{ij}^{r})^{\sigma} (P_{ij}^{r})^{-\sigma}}{n_{jH} (\gamma_{ij}^{H})^{\sigma} (P_{ij}^{H})^{1-\sigma} + n_{jF} (\gamma_{ij}^{F})^{\sigma} (P_{ij}^{F})^{1-\sigma}} \qquad (3)$$

Elasticity of Demand by Market

$$\eta_{ij}^{r} = -\sigma + (\sigma - 1) \frac{P_{ij}^{r} D_{ij}^{r}}{0.5 E_i} \qquad (4)$$

Aggregate Elasticity of Demand by Firm

$$\eta_{ij} = \eta_{Hj}^{i} \frac{D_{Hj}^{i}}{q_{ij}} + \eta_{Fj}^{i} \frac{D_{Fj}^{i}}{q_{ij}} \qquad (5)$$

Landed Price

$$P_{ij}^{r} = P_{wj}^{r} (1 + t_{ij}) \qquad (6)$$

Mark-up Pricing Rule

$$P_{wj}^{i} = \frac{MC_{ij}}{1 - \frac{1}{\eta_{ij}}} \qquad (7)$$

Marginal Cost

$$MC_{ij} = \left[(a_{ij}^{L})^{s} w_i^{1-s} + (a_{ij}^{K})^{s} v_i^{1-s}\right]^{1/(1-s)} \qquad (8)$$

Zero-Profits Condition

$$P_{wj}^{i} q_{ij} = w_i LD_{ij} + v_i KD_{ij} \tag{9}$$

Labor Demand by Firm

$$LD_{ij} = \frac{(F+q_{ij})(a_{ij}^{L})^{s} w_i^{-s}}{\left[(a_{ij}^{L})^{s} w_i^{1-s} + (a_{ij}^{K})^{s} v_i^{1-s}\right]^{s/(s-1)}} \tag{10}$$

Capital Demand by Firm

$$KD_{ij} = \frac{(F+q_{ij})(a_{ij}^{K})^{s} v_i^{-s}}{\left[(a_{ij}^{L})^{s} w_i^{1-s} + (a_{ij}^{K})^{s} v_i^{1-s}\right]^{s/(s-1)}} \tag{11}$$

Labor Market Clearing Condition

$$L_i = n_{i1} LD_{i1} + n_{i2} LD_{i2} \tag{12}$$

Capital Market Clearing Condition

$$K_i + \delta k_i = n_{i1} KD_{i1} + n_{i2} KD_{i2} \tag{13}$$

Goods Market Clearing Condition

$$q_{ij} = D_{Hj}^{i} + D_{Fj}^{i} \tag{14}$$

Home Country Income

$$E_H = w_H L_H + v_H K_H + \sum_{j=1}^{2} t_{Hj} n_{Fj} P_{wj}^{F} D_{Hj}^{F} \tag{15}$$

VARIABLE DEFINITIONS

U_i *Utility indicator for country i*

D_{ij} *Product aggregator for good j in country i*

D_{ij}^r *Demand in country i for good j produced by a representative firm in country r*

η_{ij}^r *Elasticity of demand in country i for good j produced by a representative firm in country r*

η_{ij} *Elasticity of demand for a representative firm in industry j in country i aggregated over the home and foreign markets*

P_{wj}^i *World price of good j produced in country i*

P_{ij}^r *Price of good j produced by country r paid by consumers in country i*

MC_{ij} *Marginal cost of a representative firm in industry j in country i*

q_{ij} *Firm output in industry j in country i*

w_i *Wage paid to labor in country i*

v_i *Return to capital in country i*

LD_{ij} *Labor demand by a representative firm in industry j in country i*

KD_{ij} *Capital demand by a representative firm in industry j in country i*

n_{ij} *Number of firms in industry j in country i*

E_i *Income in country i*

PARAMETER DEFINITIONS

γ_{ij}^r *Demand parameter determing preference by counsumers in country i for good j produced in country r*

σ *Elasticity of substitution among different varieties of each good*

t_{ij} *Tariff imposed by country i on imports of good j*

a_{ij}^L *Production parameter determining capital or labor intensity*

F *Fixed input requirement of capital and labor*

δk_i *Transfer of capital to country i*

s *Elasticity of substitution between capital and labor*

TABLE 2 HOME COUNTRY TARIFF ON IMPORTS OF GOOD 1

FACTOR ENDOWMENTS: KH = LH = KF = LF = 100
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	tH.1=0		tH.1=10%		tH.1=30%		tH.1=40%		tH.1=50%	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	54.854	54.854	55.409	54.226	55.921	53.250	55.974	52.868	55.938	52.539
Product Demand										
H.X1	2.794	2.794	2.986	2.598	3.288	2.284	3.406	2.159	3.507	2.050
H.X2	2.794	2.794	2.858	2.732	2.953	2.640	2.988	2.606	3.018	2.578
F.X1	2.794	2.794	2.587	2.997	2.205	3.366	2.031	3.532	1.868	3.685
F.X2	2.794	2.794	2.858	2.732	2.953	2.640	2.988	2.606	3.018	2.578
World prices										
X1	2.459	2.459	2.535	2.417	2.671	2.347	2.731	2.318	2.788	2.293
X2	2.459	2.459	2.501	2.501	2.567	2.567	2.594	2.594	2.616	2.616
Number of firms										
X1	7.278	7.278	7.335	7.139	7.447	6.908	7.500	6.812	7.552	6.728
X2	7.278	7.278	7.222	7.416	7.115	7.639	7.065	7.730	7.017	7.810
Elasticity of demand by market										
H.X1	-2.863	-2.863	-2.855	-2.868	-2.843	-2.878	-2.838	-2.882	-2.833	-2.886
H.X2	-2.863	-2.863	-2.863	-2.863	-2.864	-2.864	-2.865	-2.865	-2.865	-2.865
F.X1	-2.863	-2.863	-2.868	-2.855	-2.880	-2.842	-2.885	-2.836	-2.890	-2.831
F.X2	-2.863	-2.863	-2.863	-2.863	-2.864	-2.864	-2.865	-2.865	-2.865	-2.865
Perceived elasticity										
X1	-2.863	-2.863	-2.861	-2.861	-2.857	-2.857	-2.855	-2.854	-2.852	-2.851
X2	-2.863	-2.863	-2.863	-2.863	-2.864	-2.864	-2.865	-2.865	-2.865	-2.865
Wage	1.000	1.000	1.015	1.022	1.039	1.057	1.049	1.071	1.057	1.084
Rent	1.000	1.000	1.032	0.978	1.090	0.943	1.116	0.929	1.141	0.916
Supply by a representative firm										
X1	5.588	5.588	5.584	5.584	5.572	5.571	5.565	5.562	5.557	5.553
X2	5.588	5.588	5.590	5.590	5.593	5.593	5.594	5.594	5.595	5.595
Marginal cost										
X1	1.600	1.600	1.649	1.572	1.736	1.525	1.775	1.506	1.811	1.489
X2	1.600	1.600	1.627	1.627	1.671	1.671	1.688	1.688	1.703	1.703

TABLE 3 HOME COUNTRY TARIFF ON IMPORTS OF GOODS 1 AND 2

FACTOR ENDOWMENTS: KH = LH = KF = LF = 100
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	tH=0		tH=60%		tH=70%		tH=75%		tH=80%	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	54.854	54.854	58.522	49.034	58.606	48.402	58.619	48.110	58.616	47.833
Product Demand										
H.X1	2.794	2.794	3.948	1.610	4.066	1.484	4.120	1.426	4.171	1.372
H.X2	2.794	2.794	3.948	1.610	4.066	1.484	4.120	1.426	4.171	1.372
F.X1	2.794	2.794	2.081	3.476	1.987	3.562	1.942	3.603	1.899	3.642
F.X2	2.794	2.794	2.081	3.476	1.987	3.562	1.942	3.603	1.899	3.642
World prices										
X1	2.459	2.459	3.184	2.464	3.301	2.465	3.358	2.466	3.415	2.466
X2	2.459	2.459	3.184	2.464	3.301	2.465	3.358	2.466	3.415	2.466
Number of firms										
X1	7.278	7.278	7.303	7.304	7.310	7.311	7.313	7.314	7.316	7.317
X2	7.278	7.278	7.303	7.304	7.310	7.311	7.313	7.314	7.316	7.317
Elasticity of demand by market										
H.X1	-2.863	-2.863	-2.834	-2.897	-2.831	-2.902	-2.830	-2.904	-2.828	-2.906
H.X2	-2.863	-2.863	-2.834	-2.897	-2.831	-2.902	-2.830	-2.904	-2.828	-2.906
F.X1	-2.863	-2.863	-2.892	-2.829	-2.895	-2.824	-2.897	-2.822	-2.898	-2.820
F.X2	-2.863	-2.863	-2.892	-2.829	-2.895	-2.824	-2.897	-2.822	-2.898	-2.820
Perceived elasticity										
X1	-2.863	-2.863	-2.853	-2.852	-2.850	-2.850	-2.849	-2.848	-2.848	-2.847
X2	-2.863	-2.863	-2.853	-2.852	-2.850	-2.850	-2.849	-2.848	-2.848	-2.847
Wage	1.000	1.000	1.293	1.000	1.339	1.000	1.362	1.000	1.385	1.000
Rent	1.000	1.000	1.293	1.000	1.339	1.000	1.362	1.000	1.385	1.000
Supply by a representative firm										
X1	5.588	5.588	5.558	5.557	5.550	5.549	5.547	5.545	5.543	5.541
X2	5.588	5.588	5.558	5.557	5.550	5.549	5.547	5.545	5.543	5.541
Marginal cost										
X1	1.600	1.600	2.068	1.600	2.142	1.600	2.179	1.600	2.216	1.600
X2	1.600	1.600	2.068	1.600	2.142	1.600	2.179	1.600	2.216	1.600

TABLE 4 HOME COUNTRY TARIFF ON IMPORTS OF GOODS 1 AND 2

FACTOR ENDOWMENTS: KH = LH = KF = LF = 100
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	tH1=80%, tH2=50%		tH1=80%, tH2=60%		tH1=80%, tH2=70%		tH1=80%, tH2=80%		tH1=80%, tH2=90%	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	58.367	48.822	58.523	48.448	58.600	48.120	58.616	47.833	58.582	47.578
Product Demand										
H.X1	4.067	1.474	4.107	1.435	4.141	1.401	4.171	1.372	4.197	1.346
H.X2	3.906	1.660	4.008	1.551	4.095	1.456	4.171	1.372	4.237	1.298
F.X1	1.778	3.758	1.823	3.715	1.863	3.676	1.899	3.642	1.931	3.611
F.X2	2.287	3.281	2.150	3.409	2.021	3.529	1.899	3.642	1.784	3.748
World prices										
X1	3.279	2.400	3.329	2.424	3.374	2.446	3.415	2.466	3.452	2.484
X2	3.171	2.527	3.257	2.505	3.338	2.485	3.415	2.466	3.488	2.449
Number of firms										
X1	7.448	7.098	7.402	7.178	7.358	7.251	7.316	7.317	7.276	7.378
X2	7.164	7.512	7.216	7.441	7.267	7.376	7.316	7.317	7.363	7.264
Elasticity of demand by market										
H.X1	-2.827	-2.903	-2.827	-2.904	-2.828	-2.905	-2.828	-2.906	-2.829	-2.907
H.X2	-2.839	-2.895	-2.835	-2.899	-2.832	-2.903	-2.828	-2.906	-2.825	-2.909
F.X1	-2.900	-2.820	-2.899	-2.820	-2.899	-2.820	-2.898	-2.820	-2.898	-2.821
F.X2	-2.887	-2.834	-2.891	-2.829	-2.895	-2.825	-2.898	-2.820	-2.902	-2.816
Perceived elasticity										
X1	-2.847	-2.845	-2.847	-2.846	-2.847	-2.847	-2.848	-2.847	-2.848	-2.847
X2	-2.856	-2.856	-2.853	-2.853	-2.850	-2.850	-2.848	-2.847	-2.845	-2.844
Wage	1.283	1.033	1.319	1.021	1.353	1.010	1.385	1.000	1.415	0.991
Rent	1.335	0.967	1.353	0.979	1.370	0.990	1.385	1.000	1.398	1.009
Supply by a representative firm										
X1	5.541	5.536	5.542	5.538	5.542	5.540	5.543	5.541	5.543	5.542
X2	5.567	5.568	5.559	5.559	5.551	5.551	5.543	5.541	5.535	5.532
Marginal cost										
X1	2.127	1.557	2.160	1.572	2.189	1.587	2.216	1.600	2.240	1.612
X2	2.061	1.642	2.115	1.627	2.167	1.613	2.216	1.600	2.262	1.588

TABLE 5 HOME COUNTRY TARIFF ON IMPORTS OF GOODS 1 AND 2

FACTOR ENDOWMENTS: KH = LH = 150 KF = LF = 100
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	tH=0		tH=70%		tH=80%		tH=85%		tH=90%	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	92.021	61.347	98.280	51.649	98.368	50.847	98.376	50.478	98.364	50.128
Product demand										
H.X1	3.400	2.267	4.470	1.178	4.555	1.088	4.594	1.047	4.631	1.008
H.X2	3.400	2.267	4.470	1.178	4.555	1.088	4.594	1.047	4.631	1.008
F.X1	3.400	2.267	2.452	3.173	2.347	3.269	2.297	3.314	2.249	3.357
F.X2	3.400	2.267	2.452	3.173	2.347	3.269	2.297	3.314	2.249	3.357
World prices										
X1	2.447	2.447	3.414	2.453	3.542	2.455	3.606	2.455	3.668	2.456
X2	2.447	2.447	3.414	2.453	3.542	2.455	3.606	2.455	3.668	2.456
Number of firms										
X1	10.817	7.211	10.842	7.246	10.847	7.254	10.849	7.258	10.852	7.262
X2	10.817	7.211	10.842	7.246	10.847	7.254	10.849	7.258	10.852	7.262
Elasticity of demand by market										
H.X1	-2.889	-2.889	-2.873	-2.920	-2.871	-2.923	-2.870	-2.925	-2.870	-2.926
H.X2	-2.889	-2.889	-2.873	-2.920	-2.871	-2.923	-2.870	-2.925	-2.870	-2.926
F.X1	-2.889	-2.889	-2.915	-2.844	-2.917	-2.840	-2.918	-2.837	-2.919	-2.835
F.X2	-2.889	-2.889	-2.915	-2.844	-2.917	-2.840	-2.918	-2.837	-2.919	-2.835
Perceived elasticity										
X1	-2.889	-2.889	-2.882	-2.875	-2.881	-2.872	-2.880	-2.870	-2.880	-2.869
X2	-2.889	-2.889	-2.882	-2.875	-2.881	-2.872	-2.880	-2.870	-2.880	-2.869
Wage	1.000	1.000	1.393	1.000	1.445	1.000	1.471	1.000	1.496	1.000
Rent	1.000	1.000	1.393	1.000	1.445	1.000	1.471	1.000	1.496	1.000
Supply by a representative firm										
X1	5.667	5.667	5.647	5.625	5.643	5.616	5.641	5.611	5.639	5.607
X2	5.667	5.667	5.647	5.625	5.643	5.616	5.641	5.611	5.639	5.607
Marginal cost										
X1	1.600	1.600	2.230	1.600	2.313	1.600	2.354	1.600	2.394	1.600
X2	1.600	1.600	2.230	1.600	2.313	1.600	2.354	1.600	2.394	1.600

TABLE 6 HOME COUNTRY TARIFFS ON IMPORTS OF GOODS 1 AND 2

FACTOR ENDOWMENTS: KH = LH = 100 KF = LF = 1000
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	tH = 0%		tH = 10%		tH = 50%		tH = 55%		tH = 60%	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	128.750	1287.498	129.729	1286.372	131.680	1280.962	131.698	1280.227	131.669	1279.488
Product Demand										
H.X1	0.538	5.384	0.684	5.238	1.364	4.549	1.454	4.457	1.544	4.365
H.X2	0.538	5.384	0.684	5.238	1.364	4.549	1.454	4.457	1.544	4.365
F.X1	0.538	5.384	0.529	5.393	0.483	5.439	0.477	5.445	0.471	5.451
F.X2	0.538	5.384	0.529	5.393	0.483	5.439	0.477	5.445	0.471	5.451
World prices										
X1	2.411	2.411	2.434	2.411	2.558	2.411	2.577	2.411	2.596	2.411
X2	2.411	2.411	2.434	2.411	2.558	2.411	2.577	2.411	2.596	2.411
Number of firms										
X1	7.005	70.051	7.005	70.051	7.012	70.052	7.013	70.052	7.015	70.053
X2	7.005	70.051	7.005	70.051	7.012	70.052	7.013	70.052	7.015	70.053
Elasticity of demand by market										
H.X1	-2.974	-2.974	-2.970	-2.975	-2.952	-2.977	-2.950	-2.977	-2.948	-2.977
H.X2	-2.974	-2.974	-2.970	-2.975	-2.952	-2.977	-2.950	-2.977	-2.948	-2.977
F.X1	-2.974	-2.974	-2.974	-2.974	-2.976	-2.974	-2.976	-2.974	-2.977	-2.974
F.X2	-2.974	-2.974	-2.974	-2.974	-2.976	-2.974	-2.976	-2.974	-2.977	-2.974
Perceived elasticity										
X1	-2.974	-2.974	-2.974	-2.974	-2.971	-2.974	-2.970	-2.974	-2.970	-2.974
X2	-2.974	-2.974	-2.974	-2.974	-2.971	-2.974	-2.970	-2.974	-2.970	-2.974
Wage	1.000	1.000	1.010	1.000	1.061	1.000	1.068	1.000	1.076	1.000
Rent	1.000	1.000	1.010	1.000	1.061	1.000	1.068	1.000	1.076	1.000
Supply by a representative firm										
X1	5.922	5.922	5.922	5.922	5.913	5.922	5.911	5.922	5.909	5.922
X2	5.922	5.922	5.922	5.922	5.913	5.922	5.911	5.922	5.909	5.922
Marginal cost										
X1	1.600	1.600	1.616	1.600	1.697	1.600	1.709	1.600	1.722	1.600
X2	1.600	1.600	1.616	1.600	1.697	1.600	1.709	1.600	1.722	1.600

TABLE 7 HOME COUNTRY TARIFF ON IMPORTS OF GOODS 1 AND 2

FACTOR ENDOWMENTS: KH = 100 LH = 100 KF = 175 LF = 125
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	tH=0		tH=65%		tH=70%		tH=75%		tH=80%	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	61.460	91.060	65.440	83.843	65.456	83.453	65.449	83.082	65.422	82.727
Product Demand										
H.X1	2.291	3.394	3.755	1.888	3.828	1.810	3.896	1.737	3.961	1.668
H.X2	2.275	3.371	3.604	2.007	3.672	1.936	3.736	1.868	3.796	1.803
F.X1	2.291	3.394	1.740	3.929	1.705	3.962	1.672	3.994	1.639	4.025
F.X2	2.275	3.371	1.605	4.016	1.565	4.054	1.526	4.090	1.489	4.124
World prices										
X1	2.324	2.324	1.976	1.547	3.013	2.320	2.041	1.547	2.074	1.546
X2	2.621	2.621	2.212	1.755	3.371	2.634	2.282	1.757	2.317	1.758
Number of firms										
X1	6.701	12.314	6.763	12.301	6.770	12.299	6.777	12.298	6.785	12.296
X2	7.698	9.275	7.703	9.333	7.703	9.340	7.703	9.346	7.704	9.353
Elasticity of demand by market										
H.X1	-2.895	-2.895	-2.858	-2.925	-2.857	-2.927	-2.855	-2.929	-2.853	-2.931
H.X2	-2.882	-2.882	-2.848	-2.911	-2.846	-2.913	-2.844	-2.915	-2.843	-2.916
F.X1	-2.895	-2.895	-2.915	-2.878	-2.916	-2.877	-2.917	-2.876	-2.918	-2.876
F.X2	-2.882	-2.882	-2.911	-2.859	-2.913	-2.858	-2.914	-2.856	-2.916	-2.855
Perceived elasticity										
X1	-2.895	-2.895	-2.881	-2.890	-2.879	-2.889	-2.878	-2.889	-2.876	-2.888
X2	-2.882	-2.882	-2.871	-2.874	-2.869	-2.873	-2.868	-2.872	-2.866	-2.871
Wage	1.087	1.087	0.914	0.727	1.393	1.091	0.943	0.728	0.956	0.728
Rent	0.938	0.938	0.796	0.623	1.213	0.935	0.822	0.623	0.835	0.623
Supply by a representative firm										
X1	5.684	5.684	5.643	5.569	5.638	5.667	5.633	5.666	5.628	5.664
X2	5.647	5.647	5.612	5.522	5.608	5.619	5.603	5.616	5.599	5.613
Marginal cost										
X1	1.522	1.522	1.290	[illegible]	1.966	1.517	1.332	1.011	1.353	1.011
X2	1.712	1.712	1.441	[illegible]	2.196	1.718	1.486	1.145	1.508	1.146

TABLE 8 CAPITAL FLOWS FROM F TO H

TRADE POLICY: H TARIFF ON IMPORTS OF GOODS 1 AND 2 = 75%
FACTOR ENDOWMENTS: KH = 100 LH = 100 KF = 100 LF = 100
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	delta K = 0		delta K = 1		delta K = 5		delta K = 9		delta K = 18	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	58.619	48.110	58.550	48.177	58.286	48.437	58.041	48.683	57.557	49.192
Product Demand										
H.X1	4.120	1.426	4.109	1.438	4.064	1.486	4.019	1.534	3.916	1.642
H.X2	4.120	1.426	4.116	1.430	4.099	1.447	4.083	1.462	4.050	1.495
F.X1	1.942	3.603	1.928	3.616	1.873	3.669	1.819	3.719	1.703	3.827
F.X2	1.942	3.603	1.937	3.608	1.918	3.628	1.900	3.646	1.862	3.685
World prices										
X1	3.358	2.466	3.348	2.462	3.308	2.448	3.271	2.434	3.193	2.408
X2	3.358	2.466	3.349	2.461	3.316	2.441	3.285	2.423	3.220	2.384
Number of firms										
X1	7.313	7.314	7.393	7.234	7.712	6.915	8.031	6.596	8.747	5.876
X2	7.313	7.314	7.306	7.321	7.277	7.350	7.248	7.379	7.185	7.444
Elasticity of demand by market										
H.X1	-2.830	-2.904	-2.830	-2.904	-2.831	-2.902	-2.832	-2.900	-2.835	-2.895
H.X2	-2.830	-2.904	-2.830	-2.904	-2.829	-2.904	-2.829	-2.904	-2.828	-2.904
F.X1	-2.897	-2.822	-2.897	-2.822	-2.899	-2.820	-2.901	-2.819	-2.905	-2.816
F.X2	-2.897	-2.822	-2.897	-2.822	-2.897	-2.823	-2.897	-2.823	-2.897	-2.824
Perceived elasticity										
X1	-2.849	-2.848	-2.849	-2.848	-2.850	-2.847	-2.851	-2.846	-2.853	-2.843
X2	-2.849	-2.848	-2.849	-2.848	-2.849	-2.849	-2.849	-2.849	-2.848	-2.849
Wage	1.362	1.000	1.359	0.998	1.346	0.990	1.333	0.982	1.307	0.966
Rent	1.362	1.000	1.358	0.998	1.342	0.993	1.326	0.987	1.295	0.977
Supply by a representative firm										
X1	5.547	5.545	5.547	5.544	5.550	5.541	5.553	5.538	5.558	5.530
X2	5.547	5.545	5.546	5.545	5.546	5.546	5.546	5.546	5.545	5.547
Marginal cost										
X1	2.179	1.600	2.173	1.597	2.147	1.588	2.123	1.579	2.073	1.561
X2	2.179	1.600	2.174	1.597	2.152	1.584	2.132	1.572	2.090	1.547

TABLE 9 HOME COUNTRY IMPORTS CAPITAL FROM FOREIGN COUNTRY

TRADE POLICY: FREE TRADE
FACTOR ENDOWMENTS: KH = LH = KF = LF = 100
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	delta K = 0		delta K = 5		delta K = 10		delta K = 50	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	54.854	54.854	54.854	54.854	54.854	54.854	54.854	54.854
Product Demand								
H.X1	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794
H.X2	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794
F.X1	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794
F.X2	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794
World prices								
X1	2.459	2.459	2.459	2.459	2.459	2.459	2.459	2.459
X2	2.459	2.459	2.459	2.459	2.459	2.459	2.459	2.459
Number of firms								
X1	7.278	7.278	7.687	6.868	8.097	6.459	11.372	3.184
X2	7.278	7.278	7.232	7.323	7.187	7.369	6.823	7.733
Elasticity of demand by market								
H.X1	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863
H.X2	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863
F.X1	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863
F.X2	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863
Perceived elasticity								
X1	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863
X2	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863	-2.863
Wage	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Rent	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Supply by a representative firm								
X1	5.588	5.588	5.588	5.588	5.588	5.588	5.588	5.588
X2	5.588	5.588	5.588	5.588	5.588	5.588	5.588	5.588
Marginal cost								
X1	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600
X2	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600

TABLE 10 H AND F TARIFFS ON IMPORTS OF GOODS 1 AND 2 PLUS CAPITAL FLOWS FROM F TO H

FACTOR ENDOWMENTS: KH = LH = 100 KF = LF = 1000
DEMAND PARAMETERS: GAMMAH = GAMMAF = 0.5
SIGMAH = SIGMAF = 3

	t = 0%		t = 10%		t = 50%		t = 10% delta K = 20	
	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN	HOME	FOREIGN
Utility	128.750	1287.498	120.120	1295.319	96.859	1304.303	120.184	1295.405
Product Demand								
H.X1	0.538	5.384	0.793	5.128	2.154	3.721	0.786	5.135
H.X2	0.538	5.384	0.793	5.128	2.154	3.721	0.793	5.128
F.X1	0.538	5.384	0.476	5.446	0.286	5.635	0.471	5.451
F.X2	0.538	5.384	0.476	5.446	0.286	5.635	0.476	5.447
World prices								
X1	2.411	2.411	2.218	2.391	1.802	2.354	2.218	2.391
X2	2.411	2.411	2.218	2.391	1.802	2.354	2.218	2.391
Number of firms								
X1	7.005	70.051	7.006	70.051	7.042	70.057	8.582	68.476
X2	7.005	70.051	7.006	70.051	7.042	70.057	6.831	70.224
Elasticity of demand by market								
H.X1	-2.974	-2.974	-2.965	-2.975	-2.921	-2.980	-2.965	-2.975
H.X2	-2.974	-2.974	-2.965	-2.975	-2.921	-2.980	-2.965	-2.975
F.X1	-2.974	-2.974	-2.975	-2.974	-2.979	-2.973	-2.975	-2.974
F.X2	-2.974	-2.974	-2.975	-2.974	-2.979	-2.973	-2.975	-2.974
Perceived elasticity								
X1	-2.974	-2.974	-2.974	-2.974	-2.958	-2.974	-2.974	-2.974
X2	-2.974	-2.974	-2.974	-2.974	-2.958	-2.974	-2.974	-2.974
Wage	1.000	1.000	0.920	0.992	0.746	0.976	0.920	0.992
Rent	1.000	1.000	0.920	0.992	0.746	0.976	0.920	0.992
Supply by a representative firm								
X1	5.922	5.922	5.921	5.922	5.875	5.921	5.921	5.922
X2	5.922	5.922	5.921	5.922	5.875	5.921	5.921	5.922
Marginal cost								
X1	1.600	1.600	1.472	1.587	1.193	1.562	1.472	1.587
X2	1.600	1.600	1.472	1.587	1.193	1.562	1.472	1.587

COMMENTS ON PAPER 3

BY DOUGLAS IRWIN

Comments on Drusilla Brown, "Properties of Computable General Equilibrium Models with Monopolistic Competition and Foreign Direct Investment"

Douglas Irwin

Graduate School of Business
University of Chicago

This paper, unlike several delivered at this conference, is not aimed principally at evaluating the possible effects of a possible North American Free Trade Agreement on production and consumption in the United States, Canada, and Mexico. Instead, this paper aims to help improve understanding of the properties and results of computable general equilibrium models with monopolistic competition.

Brown develops a model with a very stark structure -- straightforward in design yet by no means simple. Two countries consume two composite goods that each have many varieties produced by both domestic and foreign firms. Each firm produces a variety of one good under conditions of increasing returns to scale, but the size of firms is limited by the perceived elasticity of demand which is a function of the degree of competition in the market. This very stark structure is developed to focus solely on the impact of trade in monopolistically-competitive sectors, and thus probably exaggerates those effects to some degree.[1]

The one question I had on the structure of the model has to do with an ambiguity (or

[1] Presumably, to evaluate NAFTA one would like to explore not only this aspect of international competition, but also examine in a more fully specified CGE model (as in the Michigan model Brown refers to) the interaction of various sectors with constant returns or even effectively decreasing returns due to specific factors.

a misunderstanding on my part) about production technology. The assumption is made that a fixed, up-front investment of capital and labor takes on the same factor proportions as the variable use of capital and labor in production, such that technology overall is homogeneous. Yet if factor prices change and the mix of capital and labor in production changes, will the proportions of fixed factors change ex post?

Brown then subjects the model to various simulations. In the first case, the home country puts a 10 percent tariff on imports from country 2 of the sector 1 good. This has the standard effect of increasing the home price of good 1, leading to entry by other firms such that each firm produces a lower level of output -- the derationalization effect as a result of tariffs. A key feature of the model -- and one that comes out time and again -- is the strong terms-of-trade effects of tariffs. Optimal tariffs prove to be very high, 40 percent in this case. I suspect this comes out of the two-country nature of the model and would not carry over to a multicountry setting where competition is greater. It is interesting to note that these effects still arise even though the Armington assumption about national product differentiation is not being made. These terms-of-trade effects sometimes drive the results of the simulations, meaning they should be interpreted with caution. For example, even though the tariff restricts competition in the home market, domestic firms perceive a more elastic demand curve while foreign firms perceive a more inelastic demand curve. As Brown notes, this may not be the standard result in these models. The tariff, curiously, affects sector 2 in both countries symmetrically, a less than intuitive result that can only be explained with reference to the equations of the model.

An across-the-board tariff increase by country 1 has a symmetric effect on each sector, although the optimal tariff increases to 75 percent. Related work by Robert Feenstra (forthcoming in the Journal of Economic Perspectives) provides an interesting contrast to these findings. He shows that in a Krugman-type monopolistically-competitive framework that the welfare costs of excluding all of half the foreign varieties is greater than excluding half of all foreign varieties.

Case II considers the effect of a tariff by a home country that is 50 percent larger than the foreign country. The optimal tariff increases only slightly, suggesting that the optimal tariff is more sensitive to the monopolistic competitive structure than to country size. In considering a home country only a tenth the size of its trading partner the optimal tariff is lower but still quite high at 55 percent.

Case IV considered unequal factor endowments across countries, considering a "Mexico" for example which is a smaller country with a relative abundance of labor. At this stage, factor mobility (foreign investment and labor migration) can be introduced, along with a direct comparison of incomes in the two countries. This is a potentially very rich set-up that has the promise to answer many questions about the possible impact of a NAFTA on a certain sector. A greater discussion of these results and their implications would pave the way for similar experiments within a model more suited to NAFTA-type issues.

This paper has been an effort to explore the properties of CGE models with monopolistically competitive sectors, and thus is not well suited -- because it is not geared -- to generate immediate policy implications. I would like to echo Brown's conclusion that "it is fairly clear that the determinants of scale effects associated with trade liberalization is complicated and difficult to anticipate." Yet over the past decade, work by Brown and others have expanded our theoretical and empirical understanding of international trade under conditions of monopolistic competition. There is no doubt that this has been a beneficial development, but caution is needed as well. The existence of product differentiation is neither necessary nor sufficient to justify use of models of monopolistic competition with economies of scale. A careful look at the production structure underlying various commodities is needed. Many products (textiles, to take one example) can be appear as differentiated products to consumers by trivial production changes within the context of constant returns to scale technology. Indeed, many empirical industrial organization studies find that constant returns is the relevant technology over most ranges of output. I hope that as a profession and as modelers economists have not lost total faith in constant returns to scale even with product differentiation.

In terms of what is to be hoped for in the future, I would express my wish that models be developed where quality is modeled more explicitly. Implicit in monopolistically-competitive models is the notion that there may be gradations in product quality. International trade theorists have recently been working on modeling trade with product quality and these developments may have benefits for empirical researchers. Explicit treatment of quality by making it operational in CGE models would be an important advance, particularly as the quality of intermediate capital goods -- and not just increasing variety -- may be able to account for the economic growth effects of international trade. These growth effects are suspected to be large in the case of Mexico's entry into a North American Free Trade Agreement.

COMMENTS ON PAPER 3

BY JAMES R. MARKUSEN

Comments on

Properties of Computable General-Equilibrium Trade Models with Monopolistic Competition and Foreign Direct Investment

by Drusilla Brown

Comments by

James R. Markusen
Department of Economics
University of Colorado, Boulder

Drusilla's paper is not an empirical paper, but rather uses a simple numerical model to explore the qualitative and quantitative properties of trade with monopolistic competition. Much of our existing knowledge comes from one of two classes of models. First, there are purely analytical models in which we use techniques of comparative statics to understand the relationships among variables. These models are often fairly general in terms of functional forms, but are typically extremely restrictive in terms of dimensionality. When increasing returns and imperfect competitive are introduced, further simplifications to technologies and demand functions must be made in order to get comparative statics results.

A second class of models are applied general-equilibrium models, which often include many sectors. These models numerically compute comparative statics effects corresponding to various policy changes. The difficulty with the large multi-sector empirical models is that they tend to be "black boxes" in that we cannot clearly understand the nature of the complex interactions between the variables. Thus on the one hand we have extremely simple analytical models which bear little relation to actual economies, and on the other hand we have the large black-box numerical models which give us results but little deep understanding.

Drusilla's paper is an attempt to fit between these two extremes. It sets up a model which is likely too complicated to use for analytical comparative statics, but which is nevertheless transparent in that we can clearly trace the line of causality and understand the intuition behind numerical comparative-statics results. I find this to be a worthwhile approach.

Since this is an analytical rather than an empirical paper, my comments will focus on some of the analytics. In particular, I wish to raise several points which I believe are crucial to understanding Drusilla's results, but which are not identified in her paper. My first point relates to the fact that the welfare effects in her experiments are very small. I believe that this is in large part due to the fact that she has (implicitly) assumed a Bertrand pricing rule.

Suppose that consumers spend a constant fraction of their income on a sub-group of goods, and that the sub-utility function is given by

$$(1) \qquad \left[\sum_{i=1}^{n} X_i^{\beta}\right]^{1/\beta} \qquad \sigma \equiv \frac{1}{(1-\beta)} \qquad s \equiv \frac{p_i X_i}{\sum p_i X_i}$$

Where σ is the elasticity of substitution, p_i is the price of X_i and s is the share of group expenditure on one good (assume symmetry such that any good that is produced is produced in the same amount). Assume that one firm calculates how its sales affect its price assuming that the *prices* of the other goods are constant: a Bertrand conjecture. In this case, the firm's perceived demand elasticity is given by

$$(2) \qquad -\eta_b = \sigma - (\sigma - 1)s \qquad \text{(Bertrand conjectures)}$$

which is the formulation found in Drusilla's paper. On the other, suppose that the firm views the *quantities* of the other firms as constant: a Cournot conjecture. Then the firm's perceived demand elasticity is given by

$$(3) \qquad -\eta_c = \frac{\sigma}{1 + (\sigma - 1)s} \qquad \text{(Cournot conjectures)}$$

Now these two lead to rather different pro-competitive effects of trade liberalization. Suppose that, as a result of import penetration, a firm's market share falls from s = .20 to s = .10. Suppose first that σ = 3. We can then calculate the following:

Conjecture	Change in Perceived Elasticity	% change
Bertrand	2.6 to 2.8	7.7%
Cournot	2.143 to 2.5	17.7%

The larger increase in the Cournot case translates into a larger pro-competitive effect. Now consider a second example where the elasticity of substitution is higher, σ = 10.

Conjecture	Change in Perceived Elasticity	% change
Bertrand	8.2 to 9.1	11%
Cournot	5.57 to 5.263	47%

Here we have a far more dramatic difference, with the Cournot behavior likely leading to a much stronger pro-competitive effect. In summary, the manner in which Drusilla chose to model conjectures leads to significantly small pro-competitive and scale effects than an obvious alternative, which is certainly not to suggest that the latter is correct.

My second point concerns expenditure switching between groups of goods. Drusilla gets the result that a small tariff is beneficial to the tariff imposing country because of a positive scale effect in addition to the usual terms-of-trade effect. My point is that this is not necessarily the case as I have shown in Markusen (1989, 1990).

Consider the following nested CES function

$$(4) \qquad U = \left[\left[\sum X_i^{\alpha}\right]^{\beta/\alpha} + Y^{\beta}\right]^{\frac{1}{\beta}} \qquad \alpha, \beta > 0.$$

where Y is a composite competitive good, and where the X_i can be divided into domestic products X_d and foreign products X_f. Consider Case 1 which I will call "substitutability" between the X group and Y.

$$(5) \qquad U = \left[\left[\sum X_i^{\alpha}\right]^{1/\alpha}\right]^{\gamma} Y^{1-\gamma} \qquad \alpha, \gamma > 0.$$

Ignore income effects for sake of argument. In this case, a tariff on X_f leaves expenditure on the X group unaffected (U is Cobb-Douglas between X and Y). But there will be a substitution effect, which shifts expenditure from the X_f goods to the X_d goods. This is beneficial for reasons widely discussed in the trade-industrial-organization literature.

Now consider what I will call "complementarity", which occurs when the X goods are complements. This could occur, for example, with specialized intermediate inputs, where a foreign specialized machine or consultant is a complement to domestic inputs. Suppose for simplicity that there is just a single foreign and domestic X each. Let U be given by

$$(6) \qquad U = \left[\left[X_d^{\gamma} X_f^{1-\gamma}\right]^{\beta} + Y^{\beta}\right]^{\frac{1}{\beta}} \qquad \gamma, \beta > 0.$$

In this case, a tariff on X_f shifts expenditure away from the X group. But the shares of X_d

and X_f within the X group are constant (Cobb-Douglas). Therefore, the tariff shifts expenditure away from *both* X_d and X_f, so that demand for the domestic increasing-returns good falls, which is welfare worsening for the domestic economy (excluding the terms-of-trade effect).

This might indeed be a fairly important point for countries like Mexico. Many foreign inputs ranging from specialized machines, to engineering consultants may be complements for domestic inputs in this sense. Access to those foreign inputs may be crucial for the efficient development of the domestic industry. In this case, protection fails to protect the domestic sector, or "derationalizes" the domestic industry. Thus Drusilla's results may be misleading, in that she implicitly assumes that the differentiated goods are better substitutes for one another than they are for the composite good.

My final point relates to entry and exit. Drusilla assumes free entry and exit, and we know from some theoretical literature that this makes an important difference to the effects of protection and liberalization. My criticism here is simply that there is little discussion of the role of entry and exit in the results. I would be interested in seeing some of that added to the paper.

Markusen, James R., "Trade in Producer Services and in Other Specialized Intermediate Inputs," *American Economic Review* 79 (1989), pp. 85-95.

Markusen, James R., "Derationalizing Tariffs with Specialized Intermediate Inputs and Differentiated Final Goods," *Journal of International Economics* (1990), 28, pp. 375-384.

PAPER 4

"NORTH AMERICAN FREE TRADE AND ITS IMPLICATIONS FOR CANADA: RESULTS FROM A CGE MODEL OF NORTH AMERICAN TRADE," BY DAVID COX AND RICHARD G. HARRIS

NORTH AMERICAN FREE TRADE

AND

ITS IMPLICATIONS FOR CANADA:

Results from a CGE Model of North American Trade*

by

David Cox
Department of Economics
University of Waterloo

Richard G. Harris
Department of Economics
Simon Fraser University

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1. Introduction

The proposed Canada-Mexico-United States North American Free Trade Area (NAFTA) raises a large number of questions regarding its impact on trade flows, incomes, consumer benefits, the pattern of labor adjustment, and aggregate economic benefits by region. Computable General Equilibrium models (CGE's) are the principal tool that economists use to answer such questions. This paper reports on the impact of a NAFTA with a CGE whose focus is primarily directed at the Canadian economy. The GET model[1] provides detailed descriptions of the determination of Canadian trade flows, industry production, and prices at a fairly detailed level of disaggregation. It can be used in conjunction with other models to provide a fairly complete picture as to how a NAFTA would impact on Canada.

The conventional approach to examining the trade impact of reduced trade barriers between countries is to first look at the existing trade flows and levels of trade barriers, and to identify areas where changes in these flows would be likely. There are now a number of studies which document this information regarding Canada, the United States and Mexico.[2] The NAFTA with Mexico has a number of fairly unique problems for analysts because of the relatively small trade flows and trade barriers which exist between Mexico and Canada. In 1989 total Mexican exports to Canada were $1.6 billion and total Canadian exports to Mexico were about $1.0 billion. On the other hand both Canada and Mexico are large traders with the United States. Mexico exports about 65 percent of its total exports to the U.S. and Canada exports in the range of 66 to 70 percent of total exports to the U.S. From the perspective of Canada a central question is the extent to which it will suffer from *trade diversion* in the U.S. market as a

[1]GET stands for "General Equilibrium Trade Model". The model was developed originally by the authors in 1983-84 then was further developed in conjunction with the Department of Finance of the Government of Canada for use in the evaluation of the Canada-U.S. FTA. Technical documentation of GET is available in Harris(1989).

[2]See Investment Canada(1991),Watson(1991) and Waverman(1990).

consequence of the NAFTA. That is how much of the U.S. market will Canadian producers lose to Mexico as a result of the NAFTA. The paper will report on some answers to this question.

There are two other central questions though. First, what are the gains to Canadian consumers as a result of increased access to the Canadian market by Mexican importers, and second, what is the potential for greater Canadian exports to both the United States and Mexico as a consequence of increased economic growth in Mexico. This last question is central to an overall evaluation of the NAFTA. It is a question however the GET model is not capable of addressing. Given that Mexico is a country of 88 million people and an average income level of $2100 US, some have argued there are potentially enormous gains to both Canada and the U.S. if Mexican income levels can start to catch up with those in Canada and the United States.[3] Quantifying these income gains is quite difficult.

The model used in this paper is a 19 industry CGE calibrated to a 1981 data set based on an 88 industry version of the model used originally to examine the 1988 CAFTA.[4] It was desirable to aggregate to a 19 industry level, largely to avoid problems of missing data, and to resolve data inconsistency at the more disaggregated level. Finally the trade flows were adjusted to reflect 1989 market shares in the North American market. Thus the data set is a sort of hybrid reflecting 1981 input-output matrices and industry factor inputs, but 1989 trade flows. Trade barriers listed in Table 0 at the end of the paper in percentage ad valorem form were derived from a number of sources of varying reliability. Since 1981 the most serious data problems in constructing a model with a long run time frame from a Canadian perspective have to do with the substantial real appreciation of the Canadian dollar over the 1980's–about 20 to 25 percent. This appreciation has left the exchange rate substantially above its PPP value, and therefore is not expected to be permanent. 1989 trade shares therefore may not be actually representative of what may occur over the longer term.

[3]See Waverman(1990) for some estimates of how large these gains might be.

[4]See Harris(1984).

More serious however are the relatively small trade flows between Mexico and Canada and the United States. With the recent liberalization within Mexico there are a number of reasons to expect these flows to increase even in the absence of a NAFTA. All CGE models using observed trade flows as there benchmark, are therefore bound to under predict the amount of trade creation which a NAFTA might ultimately lead to. Finally the models are bound to use only existing trade barriers. In the case of Mexico-Canada and Mexico-U.S. these are largely tariff barriers. This leaves two substantive issues of a NAFTA completely out of the analysis. First, the potential for removal of non-tariff barriers to trade in goods and services. Clearly the NAFTA would lead to reductions in non-tariff barriers, but quantification of these barriers remains to be carried out. Second, and probably most importantly, is the liberalization of investment between Mexico and its northern neighbors under a NAFTA. As these barriers are not strictly quantifiable, the CGE models are poorly suited to deal with the investment issue. It is extremely important for the reader to keep this qualification in mind when interpreting the results reported in this paper.

The paper proceeds as follows. In section 2 we report some estimates of what might happen to trade flows between the three countries, as a result of full implementation of the Canada-U.S. FTA, with no change in the trade regime in either country vis-a-vis Mexico. In section 3 the paper reports the impact of A the completion of the NAFTA, on top of the existing Can-US FTA. This section also compares the NAFTA with a Hub-and-Spoke (the HASP) trade arrangement consisting of two separate bilateral agreements; the Can-US FTA and a Mexico-US FTA. Section 3 deals with two important, but unresolved questions. One, how sensitive the results are to assumptions regarding Mexican income creation, and two, sensitivity to productivity changes in Mexican export sectors. Section 4 deal with the issue of NAFTA as a trade bloc-the incentives to raise trade barriers within a North American 'FTA' against non-North American countries. Section 5 considers the potential for Mexican import competition to induce additional rationalization within the Canadian industrial structure. The last section lists the major conclusions.

2. Completion of the Canada-U.S. Free Trade Area (CAFTA)

The first issue addressed is the impact of the completion of the Canada-U.S. Free Trade Agreement. The agreement was implemented in January 1988 with a 10 year phase in period. As of this date (June 1991) most economists would argue we have a considerable amount of adjustment to complete.[5] Table 1 reports estimates on some key aggregates of the effect of the CAFTA on Canada. There is a an estimated terms of trade loss to Canada from the CAFTA, but an real GDP gain of approximately 4.5 percent. Also indicated is a substantial increase in the volume of Canada-U.S. trade-about 25 percent.

In Table 2 the trade patterns between Canada, Mexico and the United States are indicated. The CAFTA raises the Canadian share of the U.S. market from 18 to 23 percent, and the U.S. share of the Canadian market rises from 67.2 to 68.5 percent. These are predicted long run equilibrium changes accounting for adjustments in capital flows and exchange rates to sustain a balance of payments equilibrium on a current account basis. The model is calibrated to a base 1981 year, and the indicated trade volumes are reported. The Canada-Mexico trade volume at 813 million dollars(1981 Canadian dollars) is extremely small. It is interesting that the CAFTA actually creates Canada-Mexico trade by a small amount (1.09 percent.) and leads to a insignificantly small decrease in U.S. Mexico trade. Thus Mexico does not appear to suffer from long run trade diversion as a consequence of the CAFTA. For the non-North American countries the picture is a bit different. In both the U.S. and the Canadian markets the Rest-of-World countries lose market share--3 percentage point in the U.S. and 1.26 percent points in Canada.

Summarizing this section. First, Mexico does not appear to lose much from the completion of the CAFTA relative to the status quo. Second, most of the trade diversion which occurs is against non-North American countries. It is important to remember that in both the BASE and with a CAFTA Mexico's share of the U.S. market

[5]See Harris(1990) for some dynamic estimates on the length of the transition. A substantial part of the productivity gains are expected to come in the last five years of the phase in period.

is about 6 percent and Mexico's share of the Canada market is 0.20 percent.

2. Hub and Spoke versus a NAFTA[6]

From the perspective of Canadian interests the critical issue given the existence of the CAFTA is whether to participate in a North American Free Trade Area (NAFTA) with Mexico and the United States, or to leave matters as is with a CAFTA, but letting the U.S. and Mexico form a separate bilateral free trade area--the Mexico-U.S. FTA. The latter arrangement is referred to as the Hub and Spoke model (HASP) referring to the U.S. as the Hub and Mexico and Canada as the Spoke's. There has been considerable debate within Canada as to the merits of these two arrangements. Opponents of NAFTA point to problems Canadian industry would face from Mexican import competition, and the potential loss of market in the U.S. due to additional Mexican competition there. Proponents of NAFTA point out that the issue of trade diversion within the U.S. market is also a problem with the realistic alternative of a HASP. As to Mexican import competition there are the usual reasons economists offer as to why this might be a good thing. Nobody appears to be certain as to what the terms-of-trade consequences might be, and labour adjustment in the basic industries remains a worry.

In Tables 3 and 4 the model simulations of the HASP versus a NAFTA are presented. The overwhelming feature of these tables is the small impact of either a HASP or NAFTA on Canada. A HASP causes a loss of 2/100 of a percent of GDP while a NAFTA raises GDP by 12/100 of a percent. A HASP causes a small reduction in trade volumes and the NAFTA leads to a small increase in trade volumes. At the aggregate level about the only thing that can be said is that the HASP appears to produce a bunch of small negative numbers and the NAFTA small positive numbers. Obviously from the Canadian point of view the CAFTA is much more important than the choice between the HASP and NAFTA options using conventional economic criteria.

[6]The Hub-and-Spoke versus NAFTA debate was raised and discussed by Hart(1990),Lipsey(1990), and Wonnacott(1990).

In Table 4 the HASP and NAFTA trade patterns are compared to a base CAFTA situation. It is noteworthy that Mexico-U.S. trade volumes increase significantly in percentage terms under both a HASP and a NAFTA, although absolutely the Mexican share of the U.S. market only rises to 6.7 percent from a base of 6.2 percent.

The sectoral results for both a HASP and a NAFTA are given in tables 5 through 8, which report absolute changes in import shares in the U.S. and Canada for each of the importing regions. Under both HASP and NAFTA Mexico gains market share in the U.S. in all sectors, while both Canada and R.O.W. lose. Canadian market share losses are however quite small in virtually all sectors; the largest is Non-metallic minerals in which Canada loses about 0.78 percentage point of the U.S. import market. Mexico's gains are offset by losses from non-North American sources in most sectors. Mexico appears to gain the most in Machinery and Appliances, Non-metallic Minerals, Agriculture, and Textiles. The effect of a HASP on Canadian import shares is remarkable--there is virtually no change(at least up to 3 decimal places) in the import shares of the U.S., Mexico, and R.O.W. from a HASP arrangement. Under the NAFTA in which Canadian tariffs against Mexico are dropped, Mexico's import shares improve by a small amount; in all cases by less than 1/10 of one percentage point.

Not reported are Canada's exports to Mexico. These increase more under NAFTA than under the HASP, but in aggregate terms the amounts are very small. Opening the Mexico market under a NAFTA results in less than a 1/2 percent increase in Canadian exports to Mexico

In general Canada seems to be affected remarkably little by either trade arrangement, given the model and estimated trade barriers between the three countries.

3. Income and Productivity in Mexico

The model was used to ask what would happen to Canadian trade an industry if aggregate real income in Mexico were to rise by some significant amount. In the GET model aggregate real income of Mexico is taken as exogenous, so it might be argued that some of the benefits of a larger North American market to Canada which might ultimately emerge as a consequence of the NAFTA are missing. To check this possibility we explored the consequences on Canada of an assumed increase in Mexican aggregate income of ten percent accompanying a NAFTA. Somewhat to our surprise the effect on economic aggregates was virtually negligible. Exports to Mexico increased but absolutely by very small amounts. We are not very confident of these results because the indirect effects of increased Mexican real income on the U.S. economy are not fully reflected in this model. In particular it is assumed U.S. real income does not respond to changes in Mexican real income--this may be an inappropriate assumption.

Secondly, the model was used to check what would happen if Mexican productivity increases were to occur which resulted in lower real export prices from Mexico. The model was used to check how sensitive the Canadian economy was to a dramatic improvement in relative productivity of the Mexican export sectors. There are three effects at work. Lower real prices on Mexican exports raise consumers real income in Canada through lower import prices; import competition from Mexico however forces some reallocation of resources across industries in Canada. Thirdly, the lower prices on Mexican exports raises both U.S. and Mexican real income. This in turn raises the demand for Canadian exports. The actual simulation looked at a ten percent productivity improvement reflected in a ten percent reduction in real export prices from Mexico. Again the results were surprising in that very little at the aggregate level showed up. Canadian real income was largely unchanged, and the Canadian share of the U.S. import market remained about the same.

4. NAFTA as a Trade Bloc

Considerable comment has been made about the possible consequences of Europe 1992 and NAFTA, together with the demise of the GATT as resulting in large trading blocs. It has been remarked that North America could become a trade bloc, resulting in increased trade barriers against non-North American producers. The peculiar nature of the trade shares of the two spokes makes this an interesting issue. Both Mexico and Canada trade predominantly with the U.S., while the U.S. versus all countries still trades predominantly with non-North American countries--about 75 percent of total U.S. imports come from non-North American sources. It might appear therefore that Canada would benefit, as would Mexico, from higher common trade barriers against R.O.W. suppliers, resulting in an increased share of the U.S. market for both Mexican and Canadian firms.

In Tables 9 and 10 we report the consequences of Mexico, U.S. and Canada raising their ad valorem tariffs against all R.O.W. imports by 10 percent. As shown in Table 10 both Mexico and Canada increase their share of the U.S. market significantly. Canada's share goes from 21 percent to 29 percent and Mexico goes from 6 to 9.3 percent. A protectionist North American trade bloc would be a losing proposition from the point of view of Canadian welfare. Canadian real income falls by 0.10 percent although real GDP rises by 0.18 percent. The net effect of the higher R.O.W. prices is to actually reduce aggregate real income in the region, and thus all parties are made worse off.

We believe this to be an important observation on NAFTA. Should it come about, there is no good economic logic why NAFTA should become a trade bloc, attempting to keep out non-NAFTA member goods through higher trade barriers. This policy is obviously not good for U.S. consumers, and neither is it good for a country such as Canada which stands to gain the most from trade diversion in the U.S. market, as the U.S.'s second largest trading partner.

5. Enhanced Price Competition in the North American Market and NAFTA

The general equilibrium model is incapable of getting much in the way of effects on Canada from a NAFTA because both existing trade barriers between Canada and Mexico are small, and trade flows are also small. There is however a third avenue by which Mexican imports might affect the Canadian economy--through increased price competition within the Canadian market forcing lower prices and thus ultimately lower costs to Canadian producers. The idea is simply that any Canadian producer must match the costs of her cheapest competitor-be that U.S. or Mexican if she is to survive. Thus lowering barriers to Mexican imports can have a strong effect on Canadian costs and pricing, even if Mexican imports are initially small. To put it another way, if Mexico constitutes the important *potential competition* to Canadian firms, rather than U.S. firms, then the NAFTA might have consequences quite different than a bilateral CAFTA.

We admit there is no direct evidence that Mexico would emerge as the important potential competition, rather than the U.S. firms, under a NAFTA, but it is certainly not implausible. To check the consequences of this we re-calculated the HASP-NAFTA simulations we an amended pricing theory, by assuming that Canadian firms in each sector would respond to the lowest price supplier--Mexico or the U.S. These results are reported in Table 11. The important number is in the first row of table. A HASP leads to a virtual zero real income gain, while a NAFTA gives rise to a real income gain of about 1 percent. The reason shows up in the labour productivity row--HASP gives rise to no productivity gains, while NAFTA raises labour productivity by about 2.4 percent above the levels the CAFTA is predicted to yield. What this means is that giving Mexico access to the Canadian market forces some additional rationalization of Canadian industry, that competition from the U.S. alone does not achieve. These rationalization effects show up as increase in productivity, real wages, and real income.

5. Conclusion

This paper has reported some results of an applied general equilibrium modeling of North American trade, with emphasis on the Canadian economy. The results of the study are:

1. In terms of aggregate indicators such as welfare, real wages, trade volumes etc. Canada is indifferent between a Hub and Spoke(HASP) trade arrangement and a North American Free Trade Area (NAFTA).

2. Under either a HASP or a NAFTA Canada would experience little in the way of reduced exports to the U.S. as a consequence of improved tariff free access by Mexico to the U.S. market.

3. To the extent that the creation of a NAFTA would shift the trade patterns in North America it would largely result in increased market shares within the U.S. to Mexico and reduced market shares to non-North American suppliers.

4. Canada would gain nothing in terms of increased real income from a North American trade bloc which raised Canada-Mexico-U.S. trade barriers to non-North American suppliers. This is so even though such actions would raise the Canadian share of the U.S. market significantly. The economic case for NAFTA to become a trade bloc appears to be weak.

5. The largest potential economic gains to Canada from NAFTA appear to be the possibility of further rationalization of Canadian industry induced by opening the Canadian market to price competition from Mexican industry. While not large they could raise real income by about 1 percent, or real wages by 1.3 percent, relative to those levels achievable in the CAFTA.

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Table 1

SUMMARY OF EFFECTS ON THE CANADIAN ECONOMY
THE COMPLETION OF THE CANADA-U.S. FTA

VARIABLE (1)	percentage change
REAL INCOME	3.08508
REAL CONSUMPTION WAGE	5.48700
REAL GDP (AT MARKET PRICE)	4.55654
GROSS OUTPUT	7.80343
LENGTH OF PRODUCTION RUNS	16.29450
LABOUR REALLOCATION INDEX(*)	1.04785
LABOUR PRODUCTIVITY	9.96139
TOTAL FACTOR PRODUCTIVITY	4.27991
TRADE VOLUME (AGG.)	14.76983
TRADE VOLUME (CAN.-U.S.)	25.70117
TERMS OF TRADE (AGG.)	-0.92412

Note: (1) The definition of all variables in Table 1 is contained in Harris(1988). Real Income is a measure of Canadian Welfare using Hicks Compensating Variation. (*)Labour Reallocation Index is percent of labour force which moves intersectorally, and change is measured absolutely.

Table 2

NORTH AMERICAN TRADE PATTERNS AND VOLUMES:
THE COMPLETION OF THE CAFTA

U.S Imports (percent import)	BASE	CAFTA	CHANGE DUE TO CAFTA (absolute change)
Canada	18.07	21.30	+3.23
Mexico	6.22	5.97	-0.25
R.O.W.	75.71	72.73	-2.98
Canada Imports			
U.S.	67.23	68.50	+1.27
Mexico	0.21	0.20	-0.01
R.O.W.	32.56	31.30	-1.26
Trade Volumes (millions 1981 cdn$)			(percentage change)
Canada-U.S.	99901	118145	18.26
U.S.-Mexico	29435	29370	-0.22
Canada-Mexico	813	887	1.09

Note: (1) The Base case is defined as the levels of Canadian, Mexican and U.S. tariffs, and some estimated Canadian and U.S. non-tariff barriers to trade existing prior to 1988 Canada-U.S. FTA.

Table 3

SUMMARY OF EFFECTS ON THE CANADIAN ECONOMY

A HUB AND SPOKE (HASP) ARRANGEMENT VERSUS A NORTH AMERICAN FREE TRADE AREA (NAFTA)

(percentage changes)

VARIABLE (1)	HASP	NAFTA
CANADIAN REAL INCOME	0.00178	0.03121
REAL CONSUMPTION WAGE	-0.00002	0.04481
REAL GDP (AT MARKET PRICES)	-0.01806	0.11794
GROSS OUTPUT	-0.02549	0.16027
LENGTH OF PRODUCTION RUNS	0.34167	0.50684
LABOUR REALLOCATION INDEX	0.00000	0.08721
LABOUR PRODUCTIVITY	0.01182	0.08656
TOTAL FACTOR PRODUCTIVITY	-0.00132	0.04592
TRADE VOLUME (AGG.)	-0.05838	0.30545
TRADE VOLUME (CAN.-U.S.)	-0.07052	-0.10719
TERMS OF TRADE (AGG.)	-0.00005	0.01118

Table 4

TRADE PATTERNS AND VOLUMES: HASP AND NAFTA (2)(3)

U.S. Imports (percent import share)	HASP	NAFTA
Canada	21.22 (-0.08)	21.21 (-0.09)
Mexicc	6.70 (0.73)	6.70 (0.73)
R.O.W.	72.08 (-0.65)	72.09 (-0.64)
Canada Imports		
U.S.	68.42 (-0.08)	68.42 (-0.08)
Mexico	0.20 (0.00)	0.21 (0.01)
R.O.W.	31.38 (0.08)	31.37 (0.07)
Trade Volumes (millions of 1981 Cdn$)		
Canada-U.S.	117943 (-0.18)	118033.05 (-0.09)
U.S-Mexico	40723 (38.65)	40643.42 (38.34)
Canada-Mexico	844 (-4.84)	1397.76 (57.58)

Note: (1) The definition of all variables in Table 3 is contained in Harris(1988). Real income is a measure of Canadian Welfare using Hicks Compensating Variation. Labour Reallocation Index is percent of labour force which moves intersectorally.

(2) The numbers in brackets beside U.S. and Canada imports measure absolute changes from CAFTA values.

(3) The numbers in brackets beside trade volumes represent percentage changes from CAFTA values.

Table 5

Absolute Change in U.S. Import Shares
Relative to a Base CAFTA
with a Hub and Spoke(HASP) Arrangment

	Canada	Mexico	R.O.W.
Food, Bev and Tobacco	-0.18	0.81	-0.63
Rubber&Plastic	-0.01	0.02	-0.02
Textiles&Leather	-0.14	1.65	-1.52
Woods&Paper	-0.34	0.47	-0.14
Steel&Metal Products	-0.27	0.74	-0.48
Transportation Equpt	-0.15	0.4	-0.25
Mach & Appliances	-0.74	2.51	-1.77
Non-metallic minerals	-0.78	2.86	-2.08
Refineries	0	0.01	-0.01
Chemicals-miscmfg	-0.03	0.46	-0.42
Agriculture	-0.2	2.54	-2.34
Forestry	0	0	0
Fishing	0	0	0
Mining	0	0	0

Note: all figures measured as the absolute change in share of imports expressed as percent of total

Table 6

Ab[illegible]te Change in U.S. Import Shares
[illegible]lative to a Base CAFTA
with a NAFTA

	Canada	Mexico	R.O.W.
Food, Bev and Tobacco	-0.18	0.81	-0.63
Rubber&Plastic	-0.01	0.02	-0.01
Textiles&Leather	-0.14	1.65	-1.51
Woods&Paper	-0.35	0.48	-0.13
Steel&Metal Products	-0.28	0.74	-0.47
Transportation Equpt	-0.16	0.41	-0.25
Mach & Appliances	-0.76	2.51	-1.75
Non-metallic minerals	-0.8	2.86	-2.07
Refineries	0	0.01	-0.01
Chemicals-miscmfg	-0.03	0.46	-0.42
Agriculture	-0.2	2.54	-2.34
Forestry	0	0	0
Fishing	-0.02	0.01	0.01
Mining	0	0	0

Note: all figures measured as the absolute change in share of imports expressed as percent of total

Table 7

Absolute Change in Canadian Import Shares
Relative to a Base CAFTA
with a Hub and Spoke Arrangment(HASP)

	U.S.	Mexico	R.O.W.
Food, Bev and Tobacco	0	0	0
Rubber&Plastic	0	0	0
Textiles&Leather	0	0	0
Woods&Paper	0	0	0
Steel&Metal Products	0	0	0
Transportation Equpt	0	0	0
Mach & Appliances	0	0	0
Non-metallic minerals	0	0	0
Refineries	0	0	0
Chemicals-miscmfg	0	0	0
Agriculture	0	0	0
Forestry	0	0	0
Fishing	0	0	0
Mining	0	0	0

Note: all figures measured as the absolute change in share of imports expressed as percent of total

Table 8

Absolute Change in Canadian Import Shares
Relative to a Base CAFTA
with a NAFTA

	U.S.	Mexico	R.O.W.
Food, Bev and Tobacco	-0.01	0.02	-0.01
Rubber&Plastic	-0.01	0	0
Textiles&Leather	-0.02	0.04	-0.02
Woods&Paper	0	0	0
Steel&Metal Products	0	0.01	0
Transportation Equpt	0	0	0
Mach & Appliances	-0.04	0.05	-0.01
Non-metallic minerals	0	0.01	-0.01
Refineries	0	0	0
Chemicals-miscmfg	0	0.01	0
Agriculture	0	0	0
Forestry	0	0	0
Fishing	0	0	0
Mining	0	0	0

Note: all figures measured as the absolute change in share of imports expressed as percent of total

Table 9

SUMMARY OF EFFECTS OF NORTH AMERICAN PROTECTION ON CANADA
A 10% Increase in North Amercican Tariffs Against ROW

VARIABLE	percentage change
REAL INCOME	-0.11691
REAL CONSUMPTION WAGE	-0.02748
REAL GDP (AT MARKET PRICE)	0.18518
GROSS OUTPUT	0.14430
LENGHT OF PROD. RUN (AGG)	6.77313
LABOUR REALLOC.INDX.	0.12215
LABOUR PRODUCTIVITY	2.17974
TOTAL FACTOR PRODUCTIVITY	0.13253
TRADE VOLUME (AGG.)	0.23278
TRADE VOLUME (CAN.-U.S.)	1.42708
TERMS OF TRADE (AGG.)	0.18306

See notes to table 1.

Table 10

NORTH AMERICAN PROTECTION AND TRADE PATTERNS
Impact on NAFTA Trade Shares

U.S. Imports	percent import share
Canada	28.9
Mexico	9.3
R.O.W.	61.8
Canada Imports	
U.S.	70.8
Mexico	00.2
R.O.W.	28.9
Trade Volumes (millions 1981 cdn$)	
Canada-U.S.	121155
U.S.-Mexico	41727
Canada-Mexico	1421

Note. See Table 2 for notes. Simulation assumes NAFTA in place but NAFTA imposes additional 10% tariff against ROW imports.

Table 11

SUMMARY OF EFFECTS ON THE CANADIAN ECONOMY
ENHANCED PRICE COMPETITION WITH MEXICAN IMPORTS IN CANADIAN MARKET
HASP VERSUS NAFTA
(comparison base=CAFTA)

VARIABLE	HASP	NAFTA
REAL INCOME	0.00316	0.93641
REAL CONSUMPTION WAGE	0.00001	1.30383
REAL GDP (AT MARKET PRICE)	-0.01654	1.48482
GROSS OUTPUT	-0.02426	2.19751
LENGHT OF PROD. RUN (AGG)	0.39939	7.28968
LABOUR REALLOC.INDX.	0.00012	0.26441
LABOUR PRODUCTIVITY	0.01333	2.36559
TOTAL FACTOR PRODUCTIVITY	-0.00059	1.09275
TRADE VOLUME (AGG.)	-0.05713	2.62460
TRADE VOLUME (CAN.-U.S.)	-0.06920	3.60723
TERMS OF TRADE (AGG.)	-0.00023	-0.33495

Note: See notes to Table1.

Appendix

In this section the mathematical structure of the model used in the paper will be presented along with a brief discussion of the microconsistent data set assembled to calibrate the model. A detailed description of the basic model is presented in Harris (1984, 1988).

In the version of the model used in the present paper Canada is assumed to trade with three separate regions: Mexico, the United States, and the Rest of World (R.O.W.). The Canadian economy is modelled in detail but the model is less than a "full" general equilibrium model as economic behavior in each of Mexico, the U.S., and R.O.W. is modelled in a reduced form manner. On the supply side own commodity prices are assumed to be exogenous in each of Mexico, the U.S., and R.O.W. as well as national income. On the demand side each foreign region has an import demand function for commodities produced by all regions. Commodities in the model are distinguished not only by their physical characteristics but also by the region in which they are produced.

Industries divide a priori into those which are perfectly competitive constant cost industries (Agriculture, Forestry, Fishing, Mining and five service industries which produce non-traded goods) and those which are imperfectly competitive increasing returns to scale industries (ten manufacturing sectors). There are two primary factors of production in the model: capital and labour. The domestic supply of each factor is fixed. Capital is internationally mobile and in perfectly elastic supply at the world rental rate. Labour is internationally immobile. The domestic wage rate is determined in a competitive labour market. The consumption sector of the model is represented by an aggregate consumer whose income derives from ownership of the economy's resource endowment and net government transfers. Utility maximization generates final demand for commodities produced in all regions.

Equilibrium in the model involves supply equals demand in all domestic commodity markets and the labour market. In addition, in the non-competitive industries firms are earning zero profits.

A. Model Structure

The equations of the model are presented below. In order to avoid introducing very cumbersome notation the model will be presented without reference to taxes, tariffs, or subsidies. In the empirical implementation of the model most of the relevant tax and tariff distortions are present.

1. Notation

Regional Superscripts: c Canada
u United States
m Mexico
r R.O.W.

Commodity Classes: N: index set for noncompetitive industries
C: index set for competitive industries
L: N U C

$p^c = (p^c_i)_{i \epsilon L}$	Canadian commodity prices
$p^u = (p^u_i)_{i \epsilon L}$	U.S. commodity prices
$p^m = (p^m_i)_{i \epsilon L}$	Mexican commodity prices
$P^r = (p^r_i)_{i \epsilon L}$	R.O.W. commodity prices
w	domestic wage
r	world rental on capital
P =	$(p^c, p^u, p^m, p^r, w, r)$ price system

2. Domestic Final Demand

The consumer's utility function over commodity aggregates is given by the log-linear (Cobb-Douglas) form

$$\log U = \log \mu_0 + \sum_{i \epsilon L} \mu_i \log C_i \tag{A1}$$

C_i is the CES aggregator over domestic, U.S., Mexican and R.O.W. goods

$$C_i = \left[\gamma_i^c D_i^{c\,\rho_i} + \gamma_i^u D_i^{u\,\rho_i} + \gamma_i^m D_i^{m\,\rho_i} + \gamma_i^r D_i^{r\,\rho_i}\right]^{\frac{1}{\rho i}} \tag{A2}$$

with the elasticity of substitution between goods in category i given $\sigma_i = 1/1\text{-pi}$.
Given income I and the price vector P, the demand for domestic good D^C_i is given by

$$D_i^C = \frac{\mu_i I \gamma_i^{c^{\sigma_i}} p_i^{c^{-\sigma_i}}}{\gamma_i^{c\sigma_i} p_i^{c(1-\sigma_i)} + \gamma_i^{u\sigma_i} p_i^{u(1-\sigma_i)} + \gamma_i^{m\sigma_i} p_i^{m(1-\sigma_i)} + \gamma_i^{r\sigma_i} p_i^{r(1-\sigma_i)}} \tag{A3}$$

Final import demands D^u_i, D^m_i and D^r_i have similar functional forms.

3. Export Demand

(i) U.S. demand for Canadian goods

The U.S. consumer has a utility function over the 19 commodity aggregates which is assumed to have the Cobb-Douglas form. Within each commodity class i the utility function has CES sub-aggregators of the Armington form, aggregating utility from Canadian, U.S., Mexican and R.O.W. goods. Given the assumption of exogenous income, I^u, utility maximization will yield a demand function for Canadian exports to the U.S. of the form

$$E_i^u = \frac{\mu_i^u I^u \gamma_i^{uc\sigma_i} p_i^{c-\sigma_i}}{\gamma_i^{uc\sigma_i} p_i^{c(1-\sigma_i)} + \gamma^{uu\sigma_i} p_i^{u(1-\sigma_i)} + \gamma_i^{um\sigma_i} p_i^{m(1-\sigma_i)} + \gamma_i^{ur\sigma_i} \rho_i^{r(1-\sigma_i)}} \tag{A4}$$

(ii) Mexican and R.O.W. demand for Canadian goods

Demand for Canadian goods by these two regions is assumed to arise in the exact same manner as in the U.S. This will lead to export demand functions E^m_i and E^r_i which will have the same form as given by (A4).

4. Technology

All firms have a variable unit cost function $V^i(P)$, assumed independent of the level of output, of the form

$$\log V^i(P) = \gamma_{\alpha i} + \sum_{i \in L} \alpha_{ij} \log \Gamma_{ij} + \alpha_{iw} \log w + \alpha_{ir} \log r \tag{A5}$$

Γ_{ij} is the price index of a composite input used by industry i, a composite of both domestic and foreign varieties of commodity j.

Assuming price-taking behavior in input markets, the input-output matrices for the economy are derived from the unit cost functions by applying Shepard's lemma. The domestic Leontief matrix $A^c(P) = [a^c_{ij}(P)]$ is defined by

$$a^c_{ij}(P) = \frac{\alpha_{ij}\beta_{ij}V^i(P)}{p_j} \tag{A6}$$

where a^c_{ij} is the demand for domestic good j, per unit of output of good i. The Leontief matrices $A^u(P)$, $A^m(P)$ and $A^r(P)$ for the U.S., Mexico, and the R.O.W. are derived in a similar manner.

The fixed costs of each representative firm in each noncompetitive industry, $i \varepsilon N$, are given by the function

$$F_i(r,w) = rf^i_k + wf^i_L \tag{A7}$$

where f^i_k and f^i_L are the minimum amounts of capital and labour, respectively, needed to setup a plant. In the noncompetitive industries the total cost function of a representative firm is given by

$$TC_i\ (P,y_i) = F_i\ (r,w) + V^i\ (P)y_i \tag{A8}$$

5. Short-Run Equilibrium

The industrial structure variables held constant in the short-run are markups on unit variable costs by firms, $i \varepsilon N$, $(m^i) = m$; number of firms in each industry, $i \varepsilon N$, $(Fm_i) = Fm$. Let $S = (m, Fm)$ be the vector of structural variables. Aggregate consumer income is given by

$$I = wL + rK_D + \psi \sum_{i \in N} \Pi_i \tag{A9}$$

where L is the aggregate labour endowment, K^D is the domestic capital endowment, Π_i the short-run profits or losses in industry $i \varepsilon N$, and ψ is the share of domestic ownership in industry $(0 < \psi < 1)$.

Equilibrium commodity prices are determined by the equations

$$p_i = m_i \, V^i(P) \qquad i \epsilon N$$

$$p_i = V^i(P) \qquad i \epsilon C \tag{A10}$$

Letting X(P,I,S) represent domestic final demand and E(P) representing total export demand by all regions, commodity market clearing implies that the vector of gross outputs Z must satisfy

$$Z = (I - A(P)^T)^{-1} \, (X \, (P, \, I, \, S) + E(P)) \tag{A11}$$

Given the vector of domestic gross output, labour market equilibrium requires

$$L = \sum_{i \epsilon L} a_{iw}(P) \, . \, Z_i + \sum_{i \epsilon N} Fm_i \, . \, f_L^i \tag{A12}$$

where a_{iw} is the labour requirements co-efficient in industry i. Industry profits Π_i are

$$\pi_i = Fm_i \left[(p_i - V^i) \left(\frac{Z_i}{Fm_i} \right) - F_i(r,w) \right] \tag{A13}$$

A short-run equilibrium for a given S is a wage (S), domestic commodity price vector p (s), income I(S), and vector of gross outputs Z (S) satisfying (A10) - (A12).

6. Firm Behavior

(i) Under the monopolistically competitive pricing hypothesis (MCPH), the market demand curve of industry iεN is assumed to have a constant elasticity form

$$Z_i = k_i \, p_i^{-\epsilon_i} \tag{A14}$$

Under the assumption that individual firms view their own demand as proportional to market demand, the optimal pricing rule is given by

$$\frac{p_i - V^i}{p_i} = \frac{1}{\epsilon_i} \tag{A15}$$

In the long-run the perceived elasticity is equated to the elasticity of the "true" demand curve, which is given by share weighted market elasticities of final, export, and intermediate demand

$$\epsilon_i = \epsilon_i^C \, . \, \frac{D_i^C}{Z_i} + \epsilon_i^U \, . \, \frac{E_i^U}{Z_i} + \epsilon_i^M \, . \, \frac{E_i^M}{Z_i} + \epsilon_i^R \, \frac{E_i^R}{Z_i} + \sum_{j \epsilon L} \frac{a_{ji} Z_j}{Z_i} \, \epsilon_{ij}^I \tag{A16}$$

where ε^C_i is the elasticity of domestic final demand, ε^U_i is the elasticity of U.S. export demand, ε^M_i is the elasticity of Mexican export demand, ε^R_i is the elasticity of R.O.W. export and ε^I_{ij} is the elasticity of intermediate demand, and $a_{ji} \, Z_j$ is the intermediate use of commodity i by industry j.

(ii) Under the Eastman-Stykolt pricing hypothesis

$$p_i^C = p_i^U (1+t_i) \qquad \text{(A17)}$$

where t_i is the domestic tariff.

7. Long Run Equilibrium

To close the model it is assumed that firms enter and exit in response to the presence of pure profits and losses as in the classic Marshallian adjustment process. A long-run equilibrium is a short-run equilibrium with two additional conditions.

(i) All industries are in (approximately) a zero profit condition.

(ii) Under the MCPH, the perceived elasticity is the "true" elasticity.

B. Calibration

In order to make the model outlined above operational numerical values must be assigned to all of the parameters. The starting point for our calibration exercise was the microconsistent data set which was assembled for the 88 industry model which we used to examine the Canada-U.S. FTA (see Harris (1988) for details). This data set was assembled for the base year 1981. The model used in the present paper differs from that model in two respects. First, the model has been aggregated from 88 to 19 sectors. The reason for this was the difficulty in getting comparable trade data across all regions. The second difference is that Mexico was added as a separate trading region.

In order to incorporate Mexico into the model our benchmark data set was augmented to include data on Mexican commodity trade with the three other regions. We obtained Mexican trade data from the Mexican government, Secretaria de Comerico y Formento Industrial, for the year 1989. Additional information on North American trade flows was obtained from the studies by Investment Canada (1991), Watson (1991), and Waverman (1990). We then apportioned the trade flows in our 1981 data set to be consistent with trade shares as they existed in 1989. Data on tariff rates for Mexico and the other regions were obtained from a variety of services. The tariff rates used reflect levels of protection as they existed in the late 1980's. Thus our benchmark data set is a sort of hybrid which utilizes 1981 production data but reflects 1989 trade flows and tariff rates.

COMMENTS ON PAPER 4

BY MORRIS MORKRE

COMMENTS ON

"NORTH AMERICAN FREE TRADE AND ITS IMPLICATIONS FOR CANADA"[1]

at Symposium on Econony-Wide Modeling of the Economic Implications of a FTA with Mexico and a NAFTA with Canada and Mexico, U.S. International Trade Commission

February 24, 1992

by

Morris E. Morkre
Bureau of Economics
Federal Trade Commission

Introduction

Fortunately for trade policy analysts there are instances of sharp rationality: where a country moribund with a maze of restraints that limit international trade and investment suddenly and dramatically opens its doors to trade and investment. One such instance is Mexico under the regime of former President Miguel de la Madrid (December 1, 1982 to December 1, 1988). Moreover, barely two years ago the thought of Mexico joining with the United States in a free trade arrangement was regarded as highly premature.[2] This view was obviously mistaken. As events have unfolded Mexico has joined with the United States and also Canada in working to form a North America Free Trade Arrangement (NAFTA).

The three country NAFTA now under negotiation, involving Canada, Mexico, and the United States, promises to join one very large economy with two smaller ones where the two smaller countries share several similar features with respect to the U.S. For both Canada and Mexico, the United States is the major export

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[1] by David Cox and Richard G. Harris.

[2] Sidney Weintrub (1990), "The Impact of the Agreement on Mexico," in P. Morici (ed.), Making Free Trade Work: The Canada-U.S. Agreement, Council on Foreign Relations, pp. 110, 120.

market, taking about two-thirds of their exports, and source of foreign investment. Several major U.S companies, including the big three auto companies, have investments in either Canada or Mexico, or in both. Furthermore, Canada and Mexico have relatively little trade or investment between them.

In view of this latter point, one may question why Canada is that interested in joining a free trade area with its two southern neighbors. It appears that an important part of the answer deals with autos and foreign investment. Both Canada and Mexico are reportedly seeking to attract foreign investment with the lure that output would gain free entry to the U.S. market. Canada is afraid that if it stays out of the talks it may lose an advantage to Mexico.

With this background, I turn to the paper by Cox and Harris. Cox and Harris provide a valuable contribution to our understanding of the likely effects of a possible NAFTA. The paper focusses on the effects on Canada of different events that may occur if Mexico joins the U.S. in a free trade area. They ask several important policy questions and obtain some interesting answers. Cox and Harris use a CGE model that builds on a well-known model developed in the mid 1980s. I divide my comments on the paper into three main parts: (1) the basic model, (2) issues related to the use of the model in this paper, and (3) results.

Basic Model

The structure of the basic model has been presented in an earlier paper by Harris.[3] The model incorporates many of the features commonly found in single country, neoclassical, CGE models constructed for trade policy analysis. For example, the model examines a representative consumer who acts rationally to maximize real income by consuming domestic and imported products, where domestic and imported products are differentiated products (the Armington assumption). It examines full employment, long-run equilibrium states and assumes there is a balance of payments constraint. When shocks occur to the model, it is assumed that prices adjust to clear all markets. The rental rate of capital services is fixed at the world level and capital is perfectly mobile.

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[3] Richard Harris (1984), "Applied General Equilibrium Analysis of Small Open Economies with Scale Economies and Imperfect Competition," American Economic Review, Vol. 74, No. 5, pp. 1016-1032.

A important feature of the model is the treatment of scale economies and market structure.[4] The sectors/industries of the economy are divided into two groups. One group consists of perfectly competitive industries, which have constant returns to scale. This group includes all service industries, agriculture, and natural resource industries. The second group consists of imperfectly competitive industries, which have increasing returns to scale (that are internal to the firms). This group includes all the manufacturing industries.

The presumption that all manufacturing industries have increasing returns to scale may be overreaching. For example, textiles, apparel, and leather sector, typically has a relatively large number of producers and empirical evidence suggests that constant returns to scale is appropriate.

Increasing returns to scale are inconsistent with perfect competition and it necessary to specify how firms behave under imperfect competition. Note that each firm's total are assumed to be the sum of a fixed cost component (set up cost) and a constant unit variable cost. Thus marginal cost is constant.

Harris and Cox propose two hypotheses to explain how imperfect competitors set prices. Under the first hypothesis, called monopolistic competitive pricing (MCPH), all firm's are assumed to be identical and act like a mini-monopolist, in which case the profit maximizing price is obtained from the Lerner formula. Under the second hypothesis, called Eastman-Stykolt pricing, firms set price equal to price of the imported product times one plus the tariff rate. Under either hypothesis, long run equilibrium involves entry or exit until excess profits are zero. One suggestion for the paper is that it is not clear when each hypothesis is used.

Application of Model to NAFTA

To study the NAFTA, trade with Mexico and the United States are broken out. Furthermore, for each of the three foreign areas examined -- Mexico, the United States, and a catchall rest of world -- national income and supply prices are fixed exogenously. Thus, it is not possible to consider the effect of changes in Canada's production and trade on foreign income and subsequent feedback effects.

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[4] Another feature of the model is that each sector produces one product that is sold at home or exported. There is no differentiation between domestic and exported products, as is the case in other CGE models. These other models use a CET function to aggregate products produced for the home market and for exports.

Finally, the model assumes there is a <u>symmetry</u> between all products in a sector. Thus, from the standpoint of Canadian consumers, the degree of substitution between the home product and the competing U.S. product is the same as that between the home product and Mexican product. The expectation is that Canadian and U.S. goods are closer substitutes than Canadian and Mexican goods.[5] Presumably the symmetry assumption is invoked due to paucity of relevant data. If the presumption is correct, the model will overstate the effect on Canada of changes in prices for exports from Mexico.

<u>Overview of Results</u>

Cox and Harris use their model to examine five issues: (1) what are the effects of completing the Canada-U.S. FTA? (2) what difference does the NAFTA make to Canada, beyond the Canada-U.S. FTA? (3) what happens to Canada if the NAFTA increases Mexico's income substantially, i.e.., by 10 percent? (4) what happens to Canada if the NAFTA becomes a protectionist block vis-a-vis the rest of the world, i.e., increases tariffs on rest of world by 10 percent? and (5) what is the effect on Canada of a NAFTA if Mexican producers as well as U.S. producers were the effective competitors (i.e., price constraining) to Canadian producer?

Regarding the first issue, the estimated effects for completion of the Canada-U.S. FTA highlight the workings of the Cox-Harris model. The terms of trade are estimated to <u>fall</u> by nearly 1 percent, yet there is an <u>improvement</u> in national welfare (measured by Hicksian compensating variation) by 4.5 percent. The role played by economies to scale in Canadian manufacturing industries is very strong. These results are anticipated given the results reported in Harris (1984). Liberalization cuts import prices and forces the Canadian firms that survive to expand in order to compete and by expanding they achieve greater economies of scale. With greater economies to scale, prices of domestic products are reduced which provide gains to Canadian consumers and, since Canadian producers sell the same product at home and abroad, there is also a fall in the terms of trade. The result for Canadian national welfare is somewhat surprising given that trade in autos and auto parts is already free under the 1965 U.S.-Canada auto pact. A large share of bilateral trade between the U.S. and Canada, reportedly 30 percent, is in autos and auto parts.

Regarding the second issue, the results suggest that Canada is little affected by either a NAFTA added to the Canada-U.S. FTA or a free trade arrangement between Mexico and the U.S. excluding

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[5] This is suggested, for example, by the empirical results reported by Gene Grossman (1982), "Import Competition from Developed and Developing Countries," <u>Review of Economics and Statistics</u>, Vol. 64, No. 2, pp. 271-281.

Canada but maintaining the Canada-U.S. FTA. Canada's real income changes by about one tenth of a percent or less. The reason appears to be the small trade volume between Canada and Mexico. However, it should also be noted that the authors examine the effects of removing tariff barriers. No data was obtained about nontariff barriers. Finally, the model does not address one of the policy issues regarded as very important to Canada and a key reason for Canada to join the NAFTA talks. This is the fear by Canada that under a Mexico-U.S. FTA the U.S. would grant greater benefits to Mexico in trade in autos and auto parts. As the authors state, their model does not address the effects of the liberalization of investment between Mexico and the U.S. (and Canada).

Regarding the third issue, an assumed exogenous increase in Mexico's income by 10 percent consequent to the NAFTA is estimated to have very small effect on Canada. Similarly, an assumed exogenous improvement in Mexico's productivity (reflected in a 10 percent decline in Mexico's supply prices) also had small effects. Presumably this is also due to the small bilateral trade between Canada and Mexico plus the model's assumption that national income in the U.S. was fixed.

Regarding the fourth issue, Cox and Harris explore the interesting question of how a protectionist NAFTA trade block, protectionist against third countries, would affect Canada. They find that while an increase by 10 in tariffs against third countries would cause trade diversion in the U.S. market in Canada's favor, i.e., increase substantially Canadian exports to the United States at the expense of third countries, Canada's national welfare would fall slightly (by 0.1 percent). This result is puzzling. Given that two-thirds of Canada exports/imports go/come to/from the United States I would have expected a significant expansion of Canada's national welfare. This surprising result, if it stands, highly important for the Uruguay Round since it suggests that beyond the regional trade area, even a small country stands to gain further (and not lose) from multilateral trade liberalization.

Regarding the fifth issue, Cox and Harris find that under the NAFTA if Canadian producers regard Mexico's exporters (as well as U.S. exporters) as potential competitors then Canada's real income increases by 1 percent. This is an odd experiment because one wonders why Mexico's producers should not have been considered competing with U.S. producers all along (in earlier simulations).

Final Remarks

This is a useful paper and raises important questions. It would be helpful if in the introductory section there were a little more discussion about the model (e.g., from bottom of p. 8) and a clarification about when each pricing rule is used (in appendix, sec. 6). Finally, no sensitivity results are reported. It would be helpful, even in footnotes, to discuss how the results reported in the text are affected by changing parameters.

COMMENTS ON PAPER 4

BY ELISABET RUTSTROM

Discussion of "North American Free Trade and its Implications for Canada"

by

E.E. Rutström
Department of Economics
University of South Carolina

The Cox and Harris model, the General Equilibrium Trade model (GET), was originally developed to evaluate the effects on Canada from the Canada - US Free Trade Agreement (CAFTA). At the time it was something of a revolution in the CGE modelling literature as it was the first model to seriously consider non-competitive industry behavior. It provided important insights into how important considerations of industry structure can be when estimating welfare effects of trade protection.

The model has been extended with a very simple closure of trade with Mexico, in order to make some inferences regarding possible Free Trade Agreements with Mexico. They consider both a full trilateral agreement - the North-American Free Trade Agreement (NAFTA) - and a hub-and-spoke system with two bilateral agreement with the US as the hub (HASP). Two basic results are presented in the paper. First, the effects on Canada of a NAFTA agreement are virtually identical to the effects of a HASP agreement. Second, all effects are very small and often negligible.

The first result does not strike one as very surprising. The model is static, and the benchmark trade flows between Canada and Mexico are of the second order of smalls. There is no reason to expect that direct free trade between Canada and Mexico should have any considerable effect on the Canadian economy in such a static structure.

Somewhat surprising, however, is the result that the Free-Trade Agreement between Mexico and the US has virtually no effect on Canada. There is almost no trade diversion from Canadian imports to the US as a result of the increased Mexico trade. Most trade diversion that is created is with respect to US imports from ROW. As the Armington elasticity for US imports by source is the same across sources, the most likely explanatory candidate is then the structure of trade. It must be the case that Canadian exports to the US are in altogether different goods categories than Mexican exports to the US. The paper would greatly benefit from a simple comparison of the characteristics of the trade flows in the model.

The large welfare results in the CAFTA that arose from the non-competitive industry assumptions have already been realized as most of Canada's trade in manufactures is with the US. No more gains from further rationalizations were realized in a NAFTA or a HASP. Again a simple discussion of which industries are assumed to price according to what pricing hypothesis and the existing trade flows for these goods would have been very enlightening. The paper would also have benefited from a more technical analysis of the importance of the exogenous world commodity expenditures and the assumption of contestable markets for exports.

Sensitivity analysis

It is important in all CGE exercises to get some information on how sensitive the qualitative results are to variations in key parameter values. There has been considerable debate regarding the reliability of literature estimates of price and substitution elasticities. Despite this debate all too many CGE exercises still are content to rely on finding equilibria conditional on using only point estimates of elasticities, whether these point estimates are generated by empirical studies or are merely reflections of the modellers own priors on such values. We do not want to imply that one or the other method is preferred over the other, but rather that whichever method is chosen it should be accompanied by a measure of the robustness of the model to choices of these values.

The field of CGE currently lacks a broad literature of methods for sensitivity analysis. However, some methods exist, and have been used with some success. In particular, Harrison and Vinod [1992] have developed a method that is both reliable and cost efficient. It is based on a random sampling method and allows the researcher to decide on the sampling size. In problems where the variance of the posterior distribution of reported variables is low, it is possible to draw inferences on fairly small sample sizes. If, however, there is a robustness problem with the CGE model, much larger sample sizes might be necessary. Because of the cost effectiveness of this approach it is possible to vary a large number of parameters unconditionally. Moreover, it can be used to examine non-local perturbations of elasticities, which is desirable given the scope of our uncertainty over their exact values.

In terms of the Cox and Harris paper a sensitivity analysis could serve to determine the robustness of the qualitative result that the HASP results in negative welfare effects and the NAFTA in positive welfare effects. The question of what is needed in terms of elasticity values to produce significant results, seems relevant as well.

Industry structure

We also want to take this opportunity to comment, briefly, on the industrial structure in the GET. One of the basic pricing assumptions in the oligopolistic industries is based on the Eastman - Stykolt hypothesis. This hypothesis states that the domestic industry structure is collusive, but that foreign firms introduce an element of competition and therefore provide a ceiling on domestic prices by offering to sell the same product as the domestic firm at the world price. The foreign price, inclusive of the domestic tariff, becomes a focal price for a perfectly collusive domestic oligopoly. This is a pricing assumption that will have the effect of biasing all welfare results from liberalization exercises upward. It is not at all clear why domestic pricing should be collusive rather than competitive. If an aggressive environment was assumed we would expect a Ramsey price outcome of zero profits and much smaller welfare effects.

We do not intend to say that the Eastman-Stykolt pricing assumption is erroneous. On the contrary we believe it provides an important upper bound on welfare effects. We only want to caution readers not to interpret large welfare effects arising out of such assumptions as anything but an upper bound. Therefore it is also important to realize that the real GDP effect reported for the CAFTA of about 4.5% is an upper bound result. In light of this realization the smaller results reported for the NAFTA and the HASP do not appear to be out of order, given that these simulations provide no further cost rationalizations.

In general, exercises including alternative industry structures and imperfect competition are much better if included as complements to competitive exercises. The results are very sensitive to the choice of pricing assumption (Harris [1986]) and are therefore better suited as qualifications to and upper and lower bounds on effects than as reasonable expectations.

A final question

The final question we want to address in this discussion is the purpose of the extension of the model to include trade with Mexico. If the purpose is to provide Canadian policy makers with an informative tool upon which decisions regarding membership in NAFTA could be based, we think much is lacking. Indeed, the authors themselves point to several such shortcomings. The most important one is probably the static nature of the model. A more growth oriented approach would provide much more interesting and informative results. Would growth in Mexico be beneficial to Canadian industry as new export markets develop, or would the increased competition for US market shares more than outweigh these benefits? The paper makes a very crude attempt at evaluating the effects of a Mexico growth scenario by simply increasing the exogenously determined national income in Mexico. Again, the small effects could probably be explained by the static nature of the model as well as the exogenous nature of export demand patterns. More interesting scenarios would include studying effects of different demand assumptions (such as demand systems under different homotheticity assumptions) and different assumptions regarding industrial structural change.

A possible and less ambitious purpose of the simulation exercise might be to simply infer some direction of change and possible ranking of sectoral effects. The model is much better suited for this type of analysis, but is still unreliable due to the lack of a test for robustness. A sensitivity analysis is crucial in order to infer anything from the qualitative effects of the NAFTA and the HASP.

Final remarks

In general the paper needs much better documentation of the data and more discussion around model driven results. It is always worrying when authors treat their own models as black boxes, commenting on the surprising results with no further attempt at relating these results to key assumptions in the model. This, in combination with a sensitivity analysis, would give the study a better focus. However, a much more useful model would be one investigating impacts of alternative growth scenarios, emphasizing demand effects and structural change.

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PAPER 5

"TRADE LIBERALIZATION IN A MULTINATIONAL-DOMINATED INDUSTRY: A THEORETICAL AND APPLIED GENERAL EQUILIBRIUM ANALYSIS," BY LINDA HUNTER, JAMES R. MARKUSEN, AND THOMAS F. RUTHERFORD

Trade Liberalization in a Multinational-Dominated Industry:

A Theoretical and Applied General Equilibrium Analysis

Linda Hunter
Department of Economics
San Diego State University

James R. Markusen†
University of Colorado, Boulder and
National Bureau of Economic Research

Thomas F. Rutherford‡
Department of Economics
University of Western Ontario

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Trade Liberalization in a Multinational-Dominated Industry:

A Theoretical and Applied General Equilibrium Analysis

Abstract

Existing theoretical models in the trade-industrial-organization literature assume almost exclusively that firms are "national enterprises", so that there is no international coordination by multinational firms. To the best of our knowledge, this assumption is exclusively used in relate applied general-equilibrium models. Yet industries with increasing returns and imperfect competition, which form the subject matter of these literatures, are often precisely the industries that are dominated by multinationals. This paper develops a model in which multinationals compete among themselves but coordinate production, pricing, and sales decisions across multiple plants and markets. Free entry and exit is assumed, and cases in which the multinationals can and cannot segment markets are considered. The model is then applied to the North American auto industry, motivated by the possibility of North American free trade. Results are compared to a counter-factual model, calibrated to the same data, which assumes strictly national ownership of firms.

1 Introduction

International trade theory now includes, as one of its principal positive and normative branches, a substantial theoretical literature on trade and trade policy under conditions of increasing returns to scale and imperfect competition. Several of the many possible approaches to modelling increasing-returns technologies and imperfectly competitive behavior have in turn been embedded in applied general equilibrium models (*e.g.*, Harris (1984), Harris and Cox (1984), Smith and Venables (1988), Brown (1989), Brown and Stern (1989), Markusen and Wigle (1989), and Wigle (1988)). A cynical view of both the theoretical and the applied literature is that "anything can happen" depending on the assumptions one chooses. A more constructive statement is that we must be careful to choose the empirically-relevant assumptions if we are to get the policy conclusions correct. Among these choices are the nature of conjectures (Eaton and Grossman (1985)), free entry versus fixed numbers of firms (Venables (1985) and Horstmann and Markusen (1986)), and segmented versus integrated markets (Markusen and Venables (1988)).

One key feature of increasing-returns, imperfectly-competitive industries that has received little attention is the joint ownership of production plants in different countries by multinational firms (the Canadian manufacturing sector is about 60% foreign owned). Models have been constructed to endogenize the existence of multinationals (*e.g.*, Markusen (1984)), but little is known about how multinational ownership affects trade liberalization scenarios. To the best of our knowledge, this issue has not been touched in applied GE analysis.

The purpose of this paper is to develop an analysis of trade liberalization in the presence of trans-border price and output coordination by multinational firms. This analysis is then embedded in an applied general equilibrium model of the North American auto industry, motivated by the possible reorganization that US-Mexican free trade might bring to that industry. The model will attempt to capture key industrial-organization and institutional features of that industry, and will numerically solve for the impact of alternative trade-liberalization schemes on the pattern of production and trade within North American, and between North America and the rest of the world (ROW).

Our modelling efforts focus on capturing multinationality as just noted. Both the theoretical model and the applied general-equilibrium model are therefore aggregated to two goods (autos and a composite) and two factors ("labor" used in both sectors and "resources", a specific factor in the composite sector). The composite is produced with constant returns by a competitive industry and is homogeneous across countries. Autos are a homogeneous good produced with increasing returns (decreasing average cost) at the plant level. Within the region of trade liberalization, an auto firm initially maintains plants in all countries, and in addition there are imports from outside the region. The auto firms compete with one another, but coordinate their outputs, prices, and sales across the national markets. We assume free entry and exit of firms, and assume initially (*i.e.*, before liberalization) that the firms can segment markets. Policy experiments include liberalizing trade for producers only (allowing continued market segmentation), and free trade for consumers (imposing arbitrage constraints, market integration). This comparison is motivated in particular by the original US-Canada Auto Pact which explicitly permitted free trade for producers only.

Theoretical results suggest the possibility of weaker pro-competitive effects from trade liberalization that have been discussed elsewhere in the trade-industrial-organization literature. With multinationals, increased import penetration due to liberalization does not constitute an erosion of market share and an increased perceived demand elasticity for the domestic firm as it does in the standard national-firm model. Nevertheless, substantial benefits can still be captured through increased scale, particularly in small markets. The theoretical results also suggest that the difference between free trade for producers and free trade for consumers may be substantially different with multinational firms from the national enterprise models. In particular, the multinational firms do not want cars arbitraged from high-production-cost locations to low-cost locations, an irrelevant issue with strictly national firms. Optimal pricing to prevent arbitrage may thus lead to substantial deviations from the segmented-markets equilibrium, if the low cost location (*e.g.*, Mexico) is the high consumer-price location under segmentation.

The general-equilibrium model is then applied to the North American auto market (Mexico, Canada, USA) with rest-of-world (ROW) supply explicitly modelled and endogenous. As we shall show, calibration of the model is a tricky exercise in its own right, and we believe that the paper contribute some modelling innovations in this regard. Data on production costs, consumer prices, and the assumption of free entry and exit (zero economic profits) are not mutually consistent with particular forms of oligopolistic behavior such as Cournot. Our modelling choice is to accept the data and the free entry assumption, and then calibrate a "conjecture parameter" which is basically a multiplier on the standard Cournot formula in order to make the model consistent. We find that the value of this parameter falls with market size, indicating that smaller markets are inherently more collusive.

In addition to calibrating the data to the theoretical multinational model, we calibrate the same data to a model which assumes strictly national ownership of firms. This national enterprise model thus corresponds conceptually to the other applied general-equilibrium papers referenced in the introduction. Computation of the national enterprise model and the integrated markets solution requires the explicit introduction of inequality constraints (*e.g.*, certain trade links switch from inactive to active), a feature ruled out in other modelling efforts.

Results from the trade liberalization experiments correspond closely to insights obtained from the theory. The national enterprise model does overestimate the welfare effects of trade liberalization, and market integration generates far larger welfare effects than free trade for producers alone. The low-cost producer (Mexico) is the high-price market under segmentation, so the arbitrage constraint forces a significant change on multinational behavior.

We caution care in taking the results of the model as reliable empirical estimates because of the many modelling simplifications (*e.g.*, in factor markets). To the extent that the results are suggestive, they show that North American free trade in autos is basically a Mexican issue, with very large benefits to Mexico (especially with market integration) and very small costs to the US and Canada. Despite the weaker pro-competitive effects with multinationals just noted, the large gains to Mexico are nevertheless due to strong industrial-organization effects: longer production runs (lower average costs) and the exit of firms. The weak welfare and production effects on the

US and Canada are partly due to the diversion of auto imports from ROW to Mexico.

2 The General Equilibrium Model

The Y sector in each of the four regions (CAN, USA, MEX, and ROW) produces a composite commodity, homogenous across regions, from "labor" (L) and a sector-specific factor "resources" (R). Both factors bear no relationship to empirical entities of the same name. Y is specified as Cobb-Douglas, but calibration of the factor shares permits us to specify any arbitrary (local) elasticity of factor supply to X. In any of the four regions we have:[1]

$$Y = G(L_y, R) = L_y^{\alpha} R^{1-\alpha} \tag{1}$$

Production of X in the auto sector, requires a fixed cost in units of labor F and a constant marginal cost in units of labor c. The labor required by the kth firm in the X sector is given by

$$L_{kx} = cX_k + F \tag{2}$$

Let n denote the number of firms active in a country, and assume identical cost functions across firms. Total labor requirements for the X sector are simply:

$$L_x = n(cX_k + F) \tag{3}$$

Equation (4) gives the labor supply adding up constraint in which L_t denotes the labor used in transportation services (discussed below) and $\bar{L}$ is the aggregate endowment:

[1] In order to simplify notation, the region subscript j is suppressed.

$$\bar{L} = L_y + L_x + L_t \qquad (4)$$

Consumers in each region have utility functions defined over consumption of autos and the composite commodity. p_i denotes the price of autos in terms of the composite good in region i. No auto producer accounts for more than 0.6% of GDP in any region, and so we make two simplifying assumptions about producer behavior. First, auto producers maximize profits in terms of the composite commodity (over 99% of GDP). Second, auto producers view total income as fixed. Both assumptions are standard in the literature, which is not to argue that they are always appropriate. We can then view producers as facing an inverse demand function $p_i(C_i)$ where C is consumption of autos and where income is perceived as parametric in this function. We also assume that the auto producers do not perceive market power in factor markets.

Let superscript N denote a North American owned firm and let R denote a ROW firm, the latter assumed to have no plants in the three North American regions while the former is assumed to have plants in all three North American regions. Let subscripts c, u, m, and r denote the four regions. Let t_{ij} denote the tariff rate on exports from region i to region j and let r_{ij} denote the transport cost from region i to region j. t is ad valorem while r is specific (in units of labor from the exporting region). Consider for example the profits earned by a North American firm in the US market. C_u denotes the total sales (not production) by all firms in the US, while C_u^N and C_u^R denote the sales by NA and ROW firms respectively in the US market ($C_u = C_u^N + C_u^R$). X_u^N denotes the sales (*i.e.*, production plus imports from affiliated plants) in the US by an individual NA firm. Finally, X_{ij}^N will denote the shipments of an individual NA firm from region i to region j ($\Sigma_i X_{ij}^N = X_j^N$). "Profits" (revenue net of marginal cost) for a NA firm derived from US sales are then given by

$$\Pi_u^N = p_u(C_u)X_u^N - \sum_{i\in c,u,m} (1+t_{iu})(c_i+r_{iu})X_{iu}^N \tag{5}$$

The firm's optimal markup rule for production in the US and sold in the US is given by the partial derivative of (5) with respect to X_{uu}^N. We assume $t_{ii} = r_{ii} = 0$, so

$$\frac{\partial \Pi_u^N}{\partial X_{uu}^N} = p_u + X_u^N \frac{\partial p_u}{\partial C_u}\frac{\partial C_u}{\partial X_{uu}^N} - c_u = 0 \tag{6}$$

Multiplying and dividing by $p_u\ C_u^N\ C_u$ we can transform (6) as follows:

$$p_u + p_u \frac{X_u^N}{C_u^N}\ \frac{C_u^N}{C_u}\left[\frac{C_u}{p_u}\frac{\partial p_u}{\partial C_u}\right]\frac{\partial C_u}{\partial X_{uu}^N} = p_u\left(1 + \Omega_u \frac{(s_u^N/n_u^N)}{\sigma_u}\right) = c_u \tag{7}$$

where $\Omega_u = \dfrac{\partial C_u}{\partial X_{uu}^N}$, $\sigma_u = \dfrac{p_u}{C_u}\ \dfrac{\partial C_u}{\partial p_u}$, $s_u^N = \dfrac{C_u^N}{C_u}$, and $n_u^N = \dfrac{C_u^N}{X_u^N}$. Ω_u gives the NA firm's "conjecture" as to how much total supply in the US will change in response to its own change in supply. σ is the Marshallian market price elasticity of demand (a negative number). s_u^N is the share of NA firms in the total sales in the US, and n_u^N is the number of NA firms producing in the US. The markup formula given in equation (7) is equivalent to Cournot if $\Omega = 1$. Larger values of Ω indicate a market that is more collusive than Cournot.

The form of the markup in equation (7) takes the usual form of a quantity subtracted off of the consumer price. For computational purposes, it is more convenient for us to specify the markup as an *ad valorem* addition to marginal cost. We will denote such markups as m_i^N for NA firms and m_i^R for ROW firms selling in market i. These markups thus take the form $p_i = (1 + m_i^N)\ c_i$. Our programming converts the price-based markup formulas of equation (7) to these cost-based markups.

Consider serving one market from multiple plants under the ownership of a single firm. The first-order conditions for (6) with respect to X^N_{iu} (i=c,m) simply replace c_u with $(1+t_{iu})(c_i + r_{iu})$. We assume that Ω_u is the same regardless of the source of the firm's supply. The present equivalents of (6) and (7) then show that the optimal plan involves equating the marginal cost in region j to the "CIF" delivered marginal cost from i, so:

$$p_j = (1+m^N_j)(1+t_{ij})(c_i+r_{ij}) = (1+m^N_j)c_j \tag{8}$$

Hence, any NA firm's imports from Canada or Mexico into the USA receive the same markup as US production sold in the US. In addition to the markup rules, free entry (zero profit) conditions are added to the model to determine the number of firms (plants) active in each country. A discussion of these equations is postponed to the section on calibration.

The MNE and NE models differ principally in the response of a firm's market share to trade liberalization. In the case of the MNE model, a car imported from Mexico to the US does not constitute a reduction in the combined market share of US firms because the Mexican exporter is US owned. In the NE model, that same import reduces the market share of the US firms because it comes from an independent firm. We see from equation (6) that a US firm's perceived elasticity of demand increases and its market decreases, *ceteris paribus*, in the NE but not in the MNE model. Four hypotheses follow. In comparing trade liberalization under the NE model to the MNE model, we expect (A) higher welfare (although not necessarily in all countries), (B) higher auto production in NA, (C) higher output per NA firm, and (D) fewer numbers of surviving firms in the NE relative to the MNE case.

This completes the discussion of the theory for calculating a world general equilibrium solution when firms can price discriminate among markets.

But whether or not this is the proper approach depends on the nature of a free-trade agreement as discussed in the introduction. It may be that in a free-trade solution, some arbitrage constraint is not satisfied, and thus genuinely free trade for consumers will lead to a different outcome. This is precisely the case in our empirical work developed below, in that Mexico, in spite of being an exporter of cars, actually has a relatively high consumer price for cars in (discriminating) free trade.

There exists some theoretical uncertainty or rather arbitrariness as to how we should model market integration (arbitrage constraints), a problem that confronted Horstmann and Markusen (1986) and Markusen and Venables (1988). In our case it is more difficult with firms jointly optimizing across plants. For example, if firms "correctly" endogenize the effect of arbitrage on price, they will be contradicting the assumption of Nash behavior used in other aspects of the model.

In this paper, we will take an approach similar to Horstmann and Markusen (1986) and Markusen and Venables (1988), described in the context of US-Mexican trade when the arbitrage constraint from the US to Mexico is binding. We assume that a firm operating a Mexican plant views the responses of the outputs of other firms according to the parameter Ω_m, but correctly endogenizes arbitrage by consumers: *i.e.*, if the plant reduces Mexican sales by one unit, consumers will import from the US until the arbitrage constraint is again satisfied. The key result is intuitive: the multinational firm does not want US production supplied to Mexico, because that results in some of the Mexican sales originating from high cost US production rather than from low cost Mexican production. It is optimal to expand Mexican output and sales (and/or reduce US output and sales) up to the point where the arbitrage constraint is just binding and no imports from the US occur.

For clarity, assume that tariffs are zero and that a firm has plants only in the US and Mexico. Assume also that an arbitrage constraint is binding: $p_u + \tau_{um} = p_m$. Using the notation developed above, the firm's programming problem is given by[2]

$$\begin{aligned} \max \Pi^N = {} & p_u(C_u)X_u^N + p_m(C_m)X_m^N - \sum_{i \in m,u} (c_i + \tau_{iu})X_{iu}^N \\ & - \sum_{i \in m,u} (c_i + \tau_{im})X_{im}^N - (F_u + F_m) + \lambda(p_u - \tau_{um} - p_m) \end{aligned} \tag{9}$$

in which λ is the non-negative Lagrange multiplier on the arbitrage constraint. The first order conditions for this problem are as follows:

$$p_u + X_u^N p_u' \Omega_u - c_u + \lambda p_u' \Omega_u \leq 0 \quad \text{for } X_{uu}^N \geq 0 \tag{10}$$

$$p_m + X_m^N p_m' \Omega_m - c_u - \tau_{um} - \lambda p_m' \Omega_m \leq 0 \quad \text{for } X_{um}^N \geq 0 \tag{11}$$

$$p_m + X_m^N p_m' \Omega_m - c_m - \lambda p_m' \Omega_m \leq 0 \quad \text{for } X_{mm}^N \geq 0 \tag{12}$$

$$p_u + X_u^N p_u' \Omega_u - c_m - \tau_{mu} + \lambda p_u' \Omega_u \leq 0 \quad \text{for } X_{mu}^N \geq 0 \tag{13}$$

From equations (11) and (12) we see the result just asserted: $X_{um}^N = 0$ given that $c_m < c_u$ at the equilibrium. The firm does not want to supply Mexico from the US. From equations (10) and (11) we again get the result that $c_u = c_m + \tau_{mu}$, or alternatively that Mexican exports to the US market carry the US markup. Multiply (12) through by $\frac{p_u' \Omega_u}{p_m' \Omega_m}$ to obtain:

[2] In (9) and subsequent equations, we use c_i and τ_i to represent the marginal cost of supply and transport. In our computations, these should both be multiplied by w_i, the labor wage, maintaining homogeneity of the price system. We omit the wage variable in this presentation in order to simplify notation.

$$\left[p_m + X_m^N p_m' \Omega_m - c_m\right] \beta - \lambda p_u' c_u = 0 \tag{14}$$

where $\beta = \frac{p_u' \Omega_u}{p_m' \Omega_m} = \frac{\Omega_u p_u C_m \sigma_m}{\Omega_m p_m C_u \sigma_u} = \frac{\Omega_u p_u C_m}{\Omega_m p_m C_u}$. β may be interpreted as the increase in X_{mm}^N necessary following a unit increase in X_{uu}^N in order to prevent arbitrage: d $X_{mm}^N = \beta$ d X_{uu}^N. The final equation of (14) exploits Cobb-Douglas demand ($\sigma = -1$), giving a very simple formula for computing β.

Denote the quantity in brackets times β in (14) as γ, and note from our previous definition of m^N in (7) and (6) that we can write this as:

$$\gamma = \left(p_m + X_m^N p_m' \Omega_m - c_m\right) \beta = \left[\frac{p_m}{1+m_m^N} - c_m\right] \beta \tag{15}$$

Equation (15) is interpreted as the change in profits from the Mexican operation, following a unit change in supply to the US market (since Mexican supply must increase to preserve zero arbitrage). The firm's optimal US supply must take this change into account. Note that we expect γ to be negative. With Mexican supply increased to prevent arbitrage, marginal revenue (with zero imports) is less than marginal cost. Now substitute (14) into (10):

$$p_u + X_u^N p_u' \Omega_u + \gamma - c_u = 0 \tag{16}$$

With $\gamma < 0$, the US markup will be larger, *ceteris paribus*, than when the firm can discriminate. The burden of preventing arbitrage is shared between a US price increase and a Mexican price decrease (*i.e.*, the negative effect of increased US output on Mexican profits is endogenized). Note from the formula for β in (14) that γ becomes small as the size of the Mexican market becomes small relative to the US market.

Using the notation of (7) and (6), (16) gives us the new US markup equation.

$$1 + \frac{\Omega_u \left(s_u^N/n_u^N\right)}{\sigma_u} + \frac{\gamma}{p_u} = \frac{1}{1+m_u^N} \tag{17}$$

To compute the integrated markets solution, five equations are solved simultaneously with the rest of the general equilibrium system. Two equations are added for β defined in (14) and γ in (15) while (7) and (6) are retained for defining m_m^N, the latter used in computing γ in (15). Benchmark values of Ω_m and Ω_u are also retained. A fourth equation (17) gives the US markup rule as just noted. The final additional equation (inequality) bounds the markup of NA firms in Mexico such that the Mexican price does not exceed the US price plus the transport cost. Letting m_m^k represent the actual Mexican markup, this constraint is given by

$$(1+m_m^k)c_m \le (1+m_u^N)c_u + \tau_{um} \tag{18}$$

If this constraint is not binding, then the markup m_m^N continues to be calculated from (7). Regardless of whether or not the arbitrage constraint in (9) is binding, the markup rule ensures that no US cars are arbitraged to Mexico. Note that this is intuitively optimal for the firm because, as noted above, arbitrage would imply that the Mexican market was being supplied by costly US production rather than by inexpensive Mexican production. The intuition behind the increased (ceritis paribus) US markup is that part of the optimal response to the "threat" of arbitrage from the US to Mexico is to raise the US price as well as to lower the Mexican price.

3 The Applied General Equilibrium Model

This sections presents three aspects of the numerical model which we have constructed. It begins with a discussion of the basic modelling format and summary of the computational issues. It then returns to the theoretical model structure from the previous section to describe how the model is calibrated. Finally, it discusses the sources and magnitudes of base year values used for model specfication.

The Modelling Format

The theoretical model of the previous section appears to be very simple, with two homogeneous goods, four countries, two factors, no taxes other than tariffs on cars, and a single consumer in each country. In fact, the industrial-organization aspects of the model make its specification considerably more complicated than a simple counting of these dimensions would suggest. A second problem relates to the need for a robust solution algorithm in light of the many side constraints, including both equations and inequalities. Some activities such as certain trade links are slack in the benchmark, but may not be in the counterfactual experiments, so we need to be able to calculate corner solutions for some variables. This latter set of difficulties is easily handled by using a non-linear complementarity (NLCP) modelling format (Rutherford (1989), Harker and Pang (1990)) which handles the side constraints, inequalities, and corner solutions.

The dimensionality of the model is much greater than it appears at first glance for several reasons. First, the NLCP format is most natural with constant returns in all activities, so the production of cars in each region requires two activities: one produces fixed costs, and the other produces actual output. Second, two side constraints are needed in each country to determine the markup rule, and there are different markups for NA and ROW firms. We then compute equilibria for a "generic" tax-distorted Arrow-Debreu economy. In modelling free entry imperfect competition with increasing returns, the markup on marginal cost is then specified as an endogenous "tax" on inputs (marginal cost). Third, a "dummy" consumer is specified in each country; this consumer receives the markup revenues and "demands" fixed costs. The level of the fixed-cost activity corresponds to the number of firms in free-entry equilibrium. Fourth, since sales to different countries carry different markups, different trade activities to each country must be specified from a given country. While in a competitive, constant-returns model we might specify a sector by a single variable, here a sector is specified by two activities, two side constraints, an endogenous tax rate, an additional consumer, and up to three additional trade activities. Three more inequality side constraints are needed to compute the integrated markets solution. All together, the model has 32 sectors, 25 commodities, 15 side constraints, and 8 consumers. The fully calibrated model thus specifies 32 activity levels, 25 commodity prices, the values of 15 constraint variables, and 8 income levels: 80 separate non-linear inequalities constitute the model.[3]

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[3] This equation count alone does not pose particular difficulty for computations. The NLCP format has addressed equilibria in constant returns to scale models with over 300 dimensions (see Harrison, Rutherford and Wooton (1989)). Certain aspects of the imperfect competition formulation can, however, pose difficulties. In particular, we found that the pricing equations are not well defined over the full price simplex, so convergence problems can arise.

Calibration of the Model

Let w denote the wage rate in terms of the composite good Y. The elasticity of scale (ε) is given by the ratio of the average to the marginal cost of producing X. ε decreases with plant scale.

$$\varepsilon = \frac{AC}{MC} = \frac{w(c + F/X_k)}{wc} = 1 + \frac{F}{cX_k} \tag{19}$$

Good engineering estimates, along with data on outputs by model type and by firm, allow us to estimate ε for the three North American regions. We also have reasonably good data giving the relative price of cars to the composite price index in the three North American countries. We unfortunately do not have data on marginal cost. The procedure that we follow is to arbitrarily set marginal cost for the US (and ROW), make guesses as to the marginal cost in Mexico and Canada, and then proceed according to the following steps. When we get to equation (8), (30) below, we will see that consumer price ratios for Mexico and Canada are implied. The initial estimates of marginal cost are then adjusted until the resulting domestic price ratios in (8), (30) match the price data. Given ε, estimates of marginal cost, and data on outputs, we then calibrate back to solve for the level of fixed costs, F.

$$F = (\varepsilon - 1)cX_k \tag{20}$$

The wage rate in terms of Y in a country is given by the marginal product of labor in the production of Y.

$$w = \alpha \left(\frac{R}{L_y}\right)^{1-\alpha} \tag{21}$$

Using (1) and (21), the elasticity of the wage rate with respect to labor demand in the X sector (holding transport demand constant) is then given by

$$\frac{L_x}{w}\frac{\partial w}{\partial L_x} = -\frac{L_x}{L_y}\frac{L_y}{w}\frac{\partial w}{\partial L_y}$$
$$= \frac{L_x}{L_y}\frac{\alpha(1-\alpha)L_y^{\alpha-2}R^{1-\alpha}}{\alpha L_y^{\alpha-2}R^{1-\alpha}} \tag{22}$$

This simplifies to

$$\frac{L_x}{w}\frac{\partial w}{\partial L_x} = \frac{L_x}{L_y}(1-\alpha) = \frac{L_x}{L_y}\theta = \omega \tag{23}$$

where θ is the value share of resources in Y output, and ω denotes the wage elasticity of X sector labor demand. ω is a general equilibrium elasticity, that tells how much the "wage" or more appropriately marginal cost (wc) in the X sector, must rise as output expands. A higher value of ω will tend to choke off expansion of the X sector (or reduce contraction) in a country following trade liberalization. ω is unfortunately a major empirical unknown. This parameter depends in part on the time-frame of the analysis as well as on the structural characteristics of the individual national economies. In a more detailed model, such as that of Kehoe and Serra-Puche (1983), labor market imperfections might be taken into account in order to produce a consistent representation of this elasticity.

We choose units so that $w = 1$ in the benchmark. Using (3) and recalling that Y is Cobb-Douglas, (23) can be rewritten as

$$\omega = \theta\ \frac{(cX_i+F)n}{(1-\theta)Y} \tag{24}$$

which gives us θ as a function of the other variables:

$$\theta = \frac{\omega Y}{(cX_i+F)n+\omega Y} \tag{25}$$

In our calibrating procedure, Y, X_i, c, ω, ε and n are given in the benchmark data set. F is then calculated from equation (20). Equation (25) then allows us to infer θ which is then used to calibrate the Y sector production function and the region's factor endowments.

Our model assumes free entry of firms or plants until profits are zero, both in the benchmark and counterfactual equilibria. For the NA firms (possibly) operating plants in all three NA regions, the sum of markup revenues must then be equal to fixed costs. Because NA sales to ROW are zero, this benchmark condition is given in matrix form by

$$\left[(1+t_{ij})(c_i+\tau_{ij})X_{ij}^N\right]\begin{bmatrix} m_c^N \\ m_u^N \\ m_m^N \end{bmatrix} = \begin{bmatrix} F_c \\ F_u \\ F_m \end{bmatrix} \qquad (i,j)\in c,u,m \tag{26}$$

But the joint maximization by plants across NA borders (equation (6)) implies that (26) simplifies to

$$\left[c_j X_{ij}^N\right]\begin{bmatrix} m_c^N \\ m_u^N \\ m_m^N \end{bmatrix} = \begin{bmatrix} F_c \\ F_u \\ F_m \end{bmatrix} \tag{27}$$

Our preliminary program that calibrates the model solves this system of three simultaneous equations in order to obtain the values of m_i^N consistent with the benchmark data. Since it is difficult to say how many ROW firms are relevant, ROW firms are simply assumed to be Cournot ($\Omega = 1$) and fixed costs in ROW are inferred from this markup rule. Given that we have solve for m_i^N for the NA firms from the cost and output data, we then work backwards using the markup formula in (7) to calibrate Ω. From (7) and the definition of m_i^N we have

$$1 + \Omega_i \frac{s_i^N/n_i^N}{\sigma_i} = \frac{1}{1+m_i^N} \tag{28}$$

Cobb-Douglas utility functions give us $\sigma = -1$, and all the other variable in (28) are known at this point. The conjecture parameter is thus calculated by rearranging (28):

$$\Omega_i = -\frac{\sigma_i (n_i^N/s_i^N) m_i^N}{1+m_i^N} \tag{29}$$

Given that we have the marginal costs in each region and the markups by both ROW and NA firm in all regions where they are active, consumer prices in each region are given simply as

$$p_i = (1+m_i^N) c_i \tag{30}$$

At this point, the relative consumer prices in the US, Mexico, and Canada are compared to our data on these prices. The initial marginal costs in Canada an Mexico are then adjusted, the entire model recalibrated, and a new set of consumer prices generated until the data and the values obtained by the benchmarking procedure converge. Once these informal iterations are completed, (6) allows us to calculate transport costs on the active trade links.[4]

$$\tau_{ij} = \frac{p_j}{(1+t_{ij})(1+m_j^N)} - c_i \tag{31}$$

[4] We set trade costs τ_{ij} using (31) for all North-American trade links, including those which are inactive in the benchmark, setting $\tau_{ij} = 0$ if the values from (31) is negative. In the counterfactual calculations, these activities may operate at positve levels.

In order to calibrate the model with national rather than multinational firms, we follow a somewhat different procedure. In the NE model, we take as given prices, marginal costs and fixed costs which arise from the MNE calibration. We then recalibrate conjectures in order to satisfy the free entry zero profit condition. This results in slightly different values off Ω_u and transport cost margins.

The Benchmark Data

All data required to generate our results are displayed in Tables 1 and 2. Table 1 gives the protection levels in the four regions. Cases BILAT and TRILAT liberalize US-Mexico, and US-Canada-Mexico trade respectively for producers only (consumers could be thought of as facing an infinite tariff). All data are 1988 values. The integrated markets scenarios use the same protection as TRILAT except that arbitrage constraints are imposed. The US protection level is a weighted average of the tariff on cars and light trucks which are substitutes in production. The Mexican tariff was 20%, but non-tariff barriers discriminated against imports by non-NA producers, so we have rather arbitrarily set the Mexican tariff against ROW at 33%. ROW tariffs are arbitrary but immaterial since they are not being adjusted (*i.e.*, lower ROW tariffs would just raise calibrated transport costs by the same amount).

Table 2 gives some of the key data for the four regions. The model is calibrated so that all producer prices are one initially. The level of Y is then inferred from the percentage share of passenger cars in GNP in each region. ω is unfortunately quite arbitrary: the 20% values implies that a doubling of the auto sector in a given country raises the "wage" (marginal cost of production) in terms of good Y by 20%. ε is calculated from

Table 1: Protection Levels in Alternative Scenarios (%)

	CAN	USA	MEX	ROW
Benchmark Equilibrium (BENCH)				
CAN	0	0	20	33.3
USA	0	0	20	33.3
MEX	9.5	3.8	0	33.3
ROW	9.5	3.8	33.3	0
Bilateral Free Trade (BILAT)				
	CAN	USA	MEX	ROW
CAN	0	0	20	33.3
USA	0	0	0	33.3
MEX	9.5	0	0	33.3
ROW	9.5	3.8	33.3	0
Trilateral Free Trade (TRILAT and INTEG)				
	CAN	USA	MEX	ROW
CAN	0	0	0	33.3
USA	0	0	0	33.3
MEX	0	0	0	33.3
ROW	9.5	3.8	33.3	0

engineering studies together with the outputs per firm and model line in each country for the three North American regions. ϵ for ROW is set equal to that

Table 2: Benchmark Parameters

Benchmark Input Data

	Y	ω	c	ε	n	P_{xi}/P_{xu}
CAN	44.3	0.2	0.95	1.2	5	1.1
USA	470.9	0.2	1.00	1.10	8	1.0
MEX	12.8	0.2	0.70	1.75	5	1.4
ROW	1152.7	0.2	0.90	1.10	10	-

Benchmark Net Trade Pattern for Autos (millions of cars)

	CAN	USA	MEX	ROW
CAN	0.632	0.573	0	0
USA	0	7.113	0	0
MEX	0	0.148	0.206	0
ROW	0.359	3.111	0	22.281

Calibrated Parameters

	CAN	USA	MEX	ROW
Ω	1.74	1.02	2.71	1.00
θ	0.87	0.92	0.86	0.90
m_j^N (%)	28.6	10.0	118.6	

for the US. n denotes the number of auto producers in each country.[5] P_{xi}/P_{xu}

[5] Mexican firms: GM, Ford, Chrysler, Nissan, Volkswagen. US firms: GM, Ford, Chrysler, Nissan, Toyota, Honda, Mazda and Volkswagen (since closed in the US). Canadian firms: GM, Ford, Chrysler, Honda and Volvo. The model's assumption that each NA firm produces in all three countries is clearly an approximation. A rigorous treatment would add five more firm "types" (defined by number and location of plants to our two, greatly increasing the complexity and dimensionality of the model. However, we believe our approximation captures the critical feature of the data: with the single minor exception of Volvo in Canada, all of the exports from Canada and Mexico to the US are intra-firm rather than arms-length transactions.

denotes the approximate relative consumer prices (each in terms of Y) in country i relative to the US. As described in the previous section, these data are then used to infer a marginal cost (c) in the three North American regions which is consistent with ε and the consumer price ratio. Marginal cost for ROW is set rather arbitrarily between that of Canada and that of Mexico. Sensitivity analysis suggests that this is of little importance to the experiments conducted.

4 Results and Interpretations

Tables 3, 4 and 5 give results for five experiments. Case BENCH contains benchmark equilibrium values. Cases BILAT and TRILAT are as described above, computed with both the MNE and NE models. Case INTEG, computed only for the MNE model, assumes that US cars can be supplied (arbitraged) to Mexico at the US consumer price plus a transport cost of 5%.

The first set of results are for changes in welfare, measured as a percentage of the value of auto production at factor cost (average cost per car). We see that the effects on Canada and the US are almost negligible, never reaching even one percent of production, although the integrated markets cases produce changes that are about triple those of BILAT and TRILAT. The latter two scenarios are identical because Canadian protection on Mexican autos is nonbinding. The effects on ROW in all scenarios are negligible.

The effects on Mexico are non-trivial relative to the size of the sector and protection level in the first two scenarios. The welfare effects in the integrated markets scenarios are extremely large for this type of analysis. The contrast between these results and those of liberalization retaining market segmentation is equally dramatic. The two differ by a factor of six. We

Table 3: Welfare Results

Welfare Index I: Change as % of Auto Production Cost

	Multinatinal			National	
	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	-0.07	-0.07	-0.25	-0.04	0.42
MEX	2.81	2.81	22.34	2.83	5.92
USA	-0.10	-0.10	-0.33	0.14	0.06

Welfare Index II: Change as % of GDP

	Multinational			National	
	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	-0.002	-0.002	-0.008	-0.001	0.01
MEX	0.09	0.09	0.73	0.09	0.19
USA	-0.002	-0.002	-0.005	0.002	0.001

will see the explanation for this difference shortly. The second set of numbers in Table 3 express the welfare changes as a percentage of GNP.

Percentage changes in auto production are shown in Table 4. Losses to the US and Canada under BILAT and TRILAT are very small, with increased Mexican production and sales in the US coming more at the expense of ROW imports than US or Canadian production. This last result reverses in the integrated scenarios. We believe this is due to the way the North American firms coordinate their markups to prevent arbitrage. As shown in the theory section above, the NA firms raise their US markups, *ceteris paribus*, to prevent arbitrage, and thus the ROW firms capture more sales (*i.e.*, are hurt less) than when markets are segmented. The most interesting result here is the strong boost in production that Mexico gets from market integration, about double what they get if markets remain segmented. Yet from this alone it is not clear why we get the dramatic welfare effect from market integration.

Table 4: Production and Pricing Effects

Auto Production (% change)

	Multinational			National	
	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	-0.6	-0.6	-1.8	-0.5	-0.7
MEX	21.9	21.9	42.5	26.6	28.1
ROW	-0.1	-0.1	-0.04	-0.2	-0.2
USA	-0.5	-0.5	-1.7	-0.07	-0.07

Number of Firms

		Multinational			National	
	BENCH	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	5	5.01	5.01	5.06	5.01	4.93
MEX	5	5.07	5.07	3.09	2.50	2.05
ROW	10	10.00	10.00	10.00	9.99	9.99
USA	8	8.00	8.00	8.10	8.02	7.99

Domestic Markups by NA Firms (% over marginal cost)

		Multinational			National	
	BENCH	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	28.6	28.7	28.7	28.8	28.6	27.6
MEX	118.6	115.3	115.3	58.7	114.0	105.1
USA	10.0	10.0	10.0	10.3	9.8	9.9

Output per Firm (thousands of cars)

		Multinational			National	
	BENCH	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	241	239	239	234	239	243
MEX	71	85	85	164	180	222
USA	889	885	885	863	886	890

The first part of the answer is given by the data on the number of firms in Table 4. Reading across the rows we see that BILAT and TRILAT have a negligible influence on rationalizing the number of firms. There is essentially no exit from the US or Mexico, and we actually have a small increase in Canada. There is little effect on ROW since in the data NA sales are only about 12% of its production. The big effect comes with market integration, which forces a large price decrease in Mexico. This in turn forces a large rationalization in Mexico and exit from the industry.

This is also seen in the results on domestic markups of NA firms. The alternative scenarios make almost no difference for the markups in the US and Canada, and the fall in the Mexican markup is small under BILAT and TRILAT. But with market integration, the Mexican markup falls by over half as the NA firms price to prevent arbitrage.

Finally, the effect of market integration is seen equally clearly in the data on output per firm. Liberalization while maintaining market segmentation has a significant effect on output per firm in Mexico, but the effect of market integration is to more than double the level under BILAT and TRILAT, increasing output per firm by 154% over the benchmark level. The markup levels and the output per firm reveal why an industry expansion of 45% translates into such a large welfare gain. First, there is a large consumer surplus gain in Mexico as the consumer price falls significantly (the relative price of autos is 40% higher in the benchmark than in INTEG). Second, there is a large efficiency gain with firms increasing outputs by 154%, moving down a steep average cost curve.

These data in Table 4 also reveal that there is very little rationalization in the US or Canada. As just noted, Canadian and US production, markups, and output per firm move very little. We believe that this is in large part due to the multinational nature of the industry. Refer back to equations (6) and (7), and note that the perceived demand elasticity

Table 5: AUTO TRADE EFFECTS

Imports (millions of cars)

	Multinational				National	
	BENCH	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	0.36	0.36	0.36	0.35	0.36	0.39
MEX					0.10	0.13
USA	3.83	3.87	3.87	3.95	3.95	3.93

Exports (millions of cars)

	Multinational				National	
	BENCH	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	0.57	0.56	0.56	0.54	0.56	0.59
MEX	0.15	0.23	0.23	0.30	0.35	0.37
USA					0.10	0.08
ROW	3.47	3.44	3.44	3.46	3.40	3.41

In the national firms model, we observe reciprocal dumping between Canada and and the U.S. and Mexico:

	BILAT	TRILAT
CAN to MEX	0.002	0.050
MEX to CAN		0.068
USA to MEX	0.103	0.081
MEX to USA	0.347	0.302

North American Firms' Market Share (%)

	Multinational				National	
	BENCH	BILAT	TRILAT	INTEG	BILAT	TRILAT
CAN	63.8	64.0	64.0	64.9	74.0	77.7
MEX	100.0	100.0	100.0	100.0	100.0	100.0
USA	71.6	71.9	71.9	71.6	72.2	71.8

and therefore the US markup of a NA firm depends not on just its US production, but on its combined supply to the US market from its plants in the US, Canada, and Mexico. Thus if the firm imports one more car from Mexico and produces one less car in the US, the firm's perceived market share, perceived demand elasticity, and markup (*ceteris paribus*) are unchanged.

Turn now to the results for the NE model in Tables 4 and 5, and compare the TRILAT scenario under the NE assumption to the corresponding TRILAT results under the MNE assumption. In this comparison we find results consistent with our earlier hypothesis of larger pro-competitive gains with national firms. In Table 4, all three NA countries gain in trilateral free trade under the NE assumption, and Mexico's gains are double those found in the MNE calculations. Losses for the US and Canada under the latter assumption turn into gains in the NE model. Second, Table 4 shows large production gains for Mexico and a much smaller loss for the US in NE relative to MNE in trilateral free trade. Canada shows a slightly larger loss in the NE model, but the combined output of NA firms rises by about 72,000 cars. Third, Table 4 shows that the number of firms is lower for all four countries under the NE assumption than under the MNE assumption. The rationalization effect on Mexico is very strong. Fourth, Table 4 shows that the markups in all three NA countries are lower under the NE assumption. And finally, Table 4 shows that output per firm is higher in all three NA countries under the NE assumption in trilateral free trade. Decreases in output per firm in the US and Canada in the MNE model switch to increases in the NE model. Some of the numbers are quantitatively small, but it must be remembered that the initial protection levels are very small, at least the key tariff: the US tariff against Mexico (3.8%). We view our earlier hypotheses as receiving strong confirmation.

Table 5 lists changes in imports and exports of cars. In BILAT and TRILAT in the MNE model, Mexico increases its exports to the US by 92 thousand cars. Net imports in the US increase by 43 thousand cars. The difference is composed of a reduction of 11 thousand from Canada and 38 thousand from ROW. Diversion from ROW is thus three times larger than the diversion from Canada. In the scenario INTEG, Mexican exports to the US are 157 thousand units above the benchmark. Canada's exports fall by 37 thousand units, while ROW's exports to the US actually grow by 3 thousand units. As suggested above, this seems due to the fact that, with integrated markets, NA firms raise their US markup to prevent arbitrage to Mexico.

The conjecture parameter Ω listed in Table 2 is based on equation (29). The value for ROW is set equal to 1, indicating Cournot conjectures. The calibrated value for the US turns out to be very close to the Cournot value. Canada's value is significantly higher at 1.74, indicating a more collusive market. Mexico's is much higher yet at 2.71, indicating that, *ceteris paribus*, the Mexican domestic markup is 171% higher than the Cournot value. Again, this high value of non-competitive behavior helps explain the high initial consumer price in Mexico despite the low production cost, and it helps explain the powerful rationalization effect of market integration.

The resource shares in sector Y (θ) presented in Table 2 are calibrated using equation (25). These values are quite similar across regions, reflecting the fact that the same values of ω is assumed for each country and the fact that auto production is a roughly similar share of national output in all three regions.

5 Summary and Conclusions

The purpose of this paper is to present an analysis of trade liberalization with multinational firms and (initial) market segmentation, motivated by and applied to the effects of US-Mexico free trade on the North

American auto industry. The theoretical approach follows the free-entry tradition of Venables (1985), Horstmann and Markusen (1986), and Markusen and Venables (1988) rather than alternative approaches with fixed number of plants because the former seems far more consistent with historical experience in this industry. Both segmented markets (Venables) and integrated markets (Horstmann and Markusen) approaches are jointly considered, and indeed one of the most interesting results is the possible change in regime from the former to the latter as a consequence of trade liberalization. An important theoretical development of the present paper is to add joint decision making (multinational ownership) across plants to the elements of increasing returns and imperfect competition.

The applied general equilibrium model follows the traditions of Harris (1984), Harris and Cox (1984), Smith and Venables (1988), Wigle (1988), and Markusen and Wigle (1989) in assuming free entry and technologies with fixed costs and constant marginal cost. The model differs from these by adding the elements of multinational decision making and assuming homogeneous products (*e.g.*, consumers cannot tell whether a North American car is made in the US, Canada, or Mexico). We believe that these assumptions are vital to getting the story right for the auto industry. The important role of trade liberalization in possibly breaking market segmentation has been examined by Smith and Venables (1988), Norman (1989), and Venables (1990a), and this paper adds the further element of multinational decision making to that analysis.

The results have been highlighted in the introduction and in the previous section, so we can be brief here. First, trade liberalization that maintains market segmentation has a significant effect on Mexican production and welfare given the initially low level of protection, and almost zero effects on the US and Canada. We argued that the effect of multinational decision making contributes to the lack of rationalization in the US and Canada following increased Mexican imports. This is clearly one point where the explicit treatment of multinationals leads to different results from those predicted by theory which assumes national ownership of all production (*e.g.*, Markusen and Venables) and corresponding numerical results (*e.g.*, Harris and Cox).

Our results indicate that free trade for producers only (market segmentation) leaves the Mexican consumer price of autos significantly higher than in the US despite the fact that Mexico is the low cost producer. Permitting free trade for consumers (market integration) leads to double the effect on Mexican production and increases Mexican welfare by six times the effect when free trade is permitted for producers alone. Arbitrage possibilities force the rationalization of the Mexican industry, leading to exit of firms, but also producing a very large increase in output per firm such that total industry output rises sharply.

No imports to Mexico actual occur after market integration because the multinationals do not want Mexico supplied by high cost US production. The multinationals follow a combined policy of raising the US markup and lowering the Mexican markup (*ceteris paribus*) to prevent arbitrage. But this reinforces the effect just noted: trade liberalization does not force the rationalization of production in the US or Canada because of the markup coordination of the multinational firms. Output per firm in the US falls by about 3% following trade liberalization and market integration.

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COMMENTS ON PAPER 5

BY JOSEPH F. FRANCOIS

Trade Liberalization in a Multinational-Dominated Industry: Comments

by
Joseph F. Francois*

I. Introduction

In this paper, the authors construct an applied general-equilibrium model of the North American auto industry. They make a number of important contributions, both in the development of the techniques employed and in the applied analysis of a very topical trade policy issue. Their greatest contributions in this regard relate to methodological development and exposition. While the authors are motivated, in part, by the possibility of U.S.-Mexico free trade, their contributions to our understanding of the actual implications of a NAFTA are somewhat limited. The focus of the model is on the production of finished autos, and on how a free trade agreement (FTA) might reallocate production among the United States, Canada, and Mexico. The authors also examine to what extent increased Mexican production might divert imports from outside North America as opposed to displacing U.S. and Canadian production.

The authors find that free trade for producers results in significant gains for Mexico (2.8 percent of auto production costs or 0.09 percent of gross domestic product) and virtually no production or welfare effects on the United States and Canada. Free trade for consumers (full market integration) results in very large welfare gains to Mexico (22.3 percent of auto production cost or 0.73 percent of GDP) as its very collusive industry is forced to rationalize. However, effects on the United States and Canada remain small.

I have organized my comments along two basic themes. One concerns the theoretical structure of the model, and the other the data employed in the application of the model.

II. Theoretical Issues

The authors are to be commended for their innovations regarding the treatment of market structure and increasing returns in CGE modeling. The incorporation of multinational behavior in an applied GE framework is an important contribution to the field. Yet, while the paper is technically innovative, this was not the authors' only or even primary objective. They set out

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* Research Division, U.S. International Trade Commission. These comments represent the opinions of the author, and are not meant to represent, in any way, the views of the International Trade Commission or of any individual Commissioner.

a goal for themselves, in the beginning of their paper, of developing a model that captured "key industrial-organization and institutional features of that industry." In this regard, it appears the paper is missing a basic characteristic of the industry, namely two-way trade in intermediate components and related specialization within the North American market at the intermediate product level.

The authors devote their modeling efforts to capturing scale economies, imperfect competition, and especially trans-border price and output coordination activities of multinational firms at the final product level. The rationalization of parts production is not considered. Yet the current structure of North American auto trade suggests, rather strongly, the importance of international returns to scale due to specialization at the intermediate product level.

To illustrate the importance of intermediate trade, Table 1 presents U.S. imports for 1990 under HTS tariff headings 9802.00.60 and 9802.00.80, which provide for production sharing. Canadian imports would enter duty free anyway under the Automotive Products Trade Act (APTA). However, the extension of a Customs user fee, first imposed in 1986, motivates the importers of duty-free vehicles from Canada to declare eligibility under 9802.00.80. According to Customs data, $19.5 billion dollars worth of automobiles and parts entered the United States from Canada in 1990 under the production sharing headings. The U.S. value shares are represented graphically in Figure 1. Of the imports from Canada, $7.2 billion represented U.S. components, a 36 percent value share. In the case of Mexico, $3.9 billion was imported, with a U.S. components value share of 47 percent.

What should be done by the authors in this regard? I realize that it is quite easy to suggest an extension or elaboration that appears theoretically simple but that proves rather unpleasant to actually implement. Since I have the luxury of being a discussant, and do not have to worry about actual implementation, I am going to make what I suspect is just such a suggestion. Currently, the authors incorporate engineering data into their analysis regarding realized and potential scale economies at the final assembly plant level. They assume cost functions that include both fixed and constant marginal costs. This framework should be expanded to incorporate increasing returns due to specialization at the intermediate product level. If, in the future, the model assumes product differentiation at the final product level, I suggest incorporating firm level returns due to specialization along the lines of Francois (1990). In its current form, with homogenous autos, I suggest incorporating returns to specialization along the lines of Ethier (1982), Markusen (1986) and Francois (1992a,b).

Without substantive changes to the structure of their model, the current simplification of a single mobile factor can be generalized by adopting a cost function that is homothetic, with a composite set of factor service inputs that are implicitly drawn from the rest of the economy and produced subject to constant returns to scale. Equation (2) in their paper than becomes

$$Cost(X_K) = [cX_K + F]P_Z \tag{1}$$

where P_Z is the cost of the input Z. Z can be interpretted as one "package" of the inputs necessary for production of an automobile, with final assembly having the cost function represented by equation (1) above. The production of Z can then be modelled as being subject to increasing returns due to specialization.

Formally, assume that there are a large number of production techniques available for producing Z. Different techniques involve different levels of specialization of the production process. The specialized intermediate inputs or activities that result from each stage of production are provided by intermediate producers. Index each technique by n, where n can be though of as the number of distinct direct production stages or processes into which production at the component level has been divided. If we assume the different production techniques are CES, we have:

$$Z_n = \left(\sum_{i=1}^{n} \phi_i^{\rho} \right)^{1/\rho} \tag{2}$$

where $1>\rho>0$, and ϕ_i is the intermediate input or activity provided by intermediate firm i. With equation (2), any member of the set of available production techniques exhibits constant returns in direct production activities. However, there are increasing returns with higher degrees of specialization, as measured by increases in n.

Following the usual approach in this literature, specialized intermediate producers can be modeled as monopolists, with the intermediate sector itself subject to free entry and average cost pricing. The cost function of these intermediate firms can be specified in the same manner as the authors specify costs for final auto production. Intermediate good or activity ϕ_i is thus produced by firm i subject to the total cost function

$$C(\phi_i) = [\alpha_1 + \alpha_2(\phi_i)]\ f(\omega) \tag{3}$$

where the term $f(\omega)$ represents the price of a unit of composite factor services F, ω represents the vector of factor prices, and the function $f(\omega)$ is homogeneous of degree 1. The coefficients α_1 and α_2 reflect fixed and variable production costs. From the assumptions regarding free entry, monopoly pricing, and average cost pricing, it can be shown that

$$\Phi = (\alpha_1/\alpha_2)\ ((\sigma-1)/1) \tag{4}$$

where Φ is the level of output for individual intermediate firms. If we define a composite intermediate ζ_i produced by each intermediate firm i as $\zeta_i=\Phi^\rho$, so that

$$\zeta = \sum_{i=1}^{n} \zeta_i = n\Phi^\rho \tag{5}$$

then it follows from equations (3), (4) and (5) that the unit cost of producing ζ is

$$C(\omega) = \left[(\alpha_1\sigma)\ f(\omega)\right] \tag{6}$$

From equation (6), in reduced form the model collapses to a common specification of external scale economies. In particular, equation (2) can be rewritten as:

$$Z = n^{1/\rho}\Phi = \zeta^{1/\rho} \tag{7}$$

Many of the most interesting implications for a NAFTA in autos relate to local/NAFTA content requirements and rationalization at the intermediate product level. Other adjustments will likely occur as the number of product types adjusts at the final product level. Yet rationalization of parts production and the number of models per plant are not considered. At a minimum, product differentiation at the final product level and explicit treatment of international returns to scale are needed to account for these effects. With the model in its present form, reported welfare gains should be viewed as minimums, since they miss additional gains from rationalization due to these factors.

III. Some Empirical Issues

I have a few concerns regarding the empirical underpinnings of the model. Protection is only assumed for assembled autos. Yet, the agreement being contemplated in the NAFTA negotiations is economy-wide, and would imply that (a) barriers exist in other sectors as well, and (b) these barriers are also going to be changed. Introducing and then removing protection from the background Y sector in the model would likely imply greater welfare gains and a further expansion of the auto sector relative to current solution values. I suspect that insight into the effective level of protection for this sector can be gleaned from other papers included in this conference.

The measures of potential scale economies, while based on engineering data, appear to be somewhat high when viewed in the context of econometric studies of the elasticity of scale.

This is particularly true for Mexico. I am referring in particular to Table A4.2 of the Roland-Holst, Reinert, and Shiells (1992) paper presented at this conference, as well as to Harris' (1986) discussion of the subject. I suggest taking an average, as well as assessing the sensitivity of the simulation results to these values.

Finally, returning to the theme of the institutional features of the industry, the assumption that non-North American (primarily Japanese) firms do not have plants in North America strikes me as a bit too unrealistic. However, the proper treatment of the "transplants" should probably be linked to an assessment of the effect of potential NAFTA content rules on the product and content mix of autos sold in an integrated market. Without expanding the current model to included trade in parts as discussed above, I doubt that much would change in the results by dropping this simplification. The content issue and international returns to scale (in this context meaning NAFTA-wide scale economies) are potentially some of the most interesting issues in this regard. However, I suspect that they are also some of the most difficult to actually assess empirically.

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TABLE 1

Imports of Parts Under HTS Subheadings 9802.00.60 & 9802.00.80
1990, in thousands of dollars

	Total value	Duty-free value	Dutiable value
CANADA			
9802.00.80			
internal combustion engines and parts*	964,292	97,488	866,804
motor vehicles	17,275,016	6,739,643	10,535,374
motor vehicle parts	1,270,130	330,826	939,304
9820.00.60			
internal combustion engines and parts	3,860	1,910	1,950
motor vehicle parts	1,219	564	655
TOTAL	**19,514,517**	**7,170,431**	**12,344,087**
MEXICO			
9802.00.80			
internal combustion engines and parts*	279,137	97,268	181,869
motor vehicles	2,602,160	1,061,650	1,540,510
motor vehicle parts	1,049,637	677,692	371,946
9820.00.60			
internal combustion engines and parts	9,312	7,333	1,979
motor vehicle parts	21,828	17,345	4,483
TOTAL	**3,962,074**	**1,861,288**	**2,100,787**

Source: *Product Sharing: U.S. Imports Under Harmonized Tariff Schedule Subheadings 9802.60 and 9802.80, 1987-1990*, USITC publication 2469, December 1991.

COMMENTS ON PAPER 5

BY FLORENCIO LOPEZ-DE-SILANES

Comments: Trade Liberalization in a Multinational-Dominated Industry

Florencio Lopez-de-Silanes
Harvard University

Hunter, Markusen and Rutherford (HMR) address what may be one of the most crucial and difficult aspects of the transition to a free trade area in a multinational-dominated industry, in this case the Automobile sector. This paper makes two main contributions in my perspective. On theoretical grounds, their model introduces the key difference between a multinational and a domestic company. In the context of free trade import penetration leads to less erosion of market share of the multinational enterprise thus diminishing the normally associated increase in perceived demand elasticity for the "national" firm framework. Additionally, the above distinction between types of firms results in optimal pricing strategies by the multinational company leading to significantly different welfare results when free trade is confined to producers rather than to both producers and consumers.

On the empirical ground, the analysis of the Automobile Industry in US, Canada and Mexico when applied to their model confirms the two main theoretical issues that the paper explores. Applied General Equilibrium exercises which do not introduce the Multinational distinction when appropriate, overestimate welfare effects of trade liberalization. Secondly, "Market Integration", which HMR define as free trade for consumers and producers, creates higher welfare effects than partial free trade for producers only. This is an important issue in the context of the 1965 Auto Pact between Canada and the U.S. and will certainly be in the considerations for the North American Free Trade Agreement (NAFTA). The empirical estimates of welfare gains under different scenarios in the paper could be summarized by the large efficiency gains on the Mexican side of the industry and the small- to no-loss outcome in the US-Canada side in terms of production and welfare. HMR's results suggest that Mexican autos will be substituting imports from the rest of the world.

The authors warn us about the "cynical" view of Applied General Equilibrium Models which suggests that anything can happen. I will therefore try to jump to the "constructive" side of the spectrum if we are to use this model for policy implications. The introduction of the multinational character of the industry moves us in the right direction of choosing the empirically-relevant assumptions for modelling. Nonetheless, there are still several important limitations of the model itself and some assumptions embedded in it which are important in qualifying the Automobile industry and drive the results of the paper. I will therefore try to address my comments to some modifications of the model which would capture the real character of the industry, affect the empirical results, and contribute to policy implications. I will divide the points looking at the structure of the supply and the demand sides of the HMR model.

Supply Side.

1. Two Factors.

While the composite good is produced by both factors, labor and a composite specific resource, automobiles only include labor in their production process. There is clearly an immediate bias of the results in gains towards the relatively labor-abundant economy and against the high-wage countries.

The introduction of a second factor in the production of cars, mobile capital for example, would alter the results. A close look at plant location decisions of the industry in the last ten years confirms the wide spread view among insiders that labor costs alone in the context of "just-in-time" technology are not enough to account for the decisions to move production plants across countries. The remarkable fact that the Japanese Auto Assembly Industry is still today almost completely retrenched inside Japan, with the sole significant exception of the transplants in North America, seems to suggest that wages could be significantly lower in neighboring countries but this is not enough. A second example, and extremely relevant to the NAFTA issue, is the behavior of the industry in Mexico in the 1980's. The last decade showed not only a significant wage differential between Mexico and the rest of the OECD economies but also important policy incentives in the form of investment subsidies, higher domestic content rules and Balance-of-Payments restrictions that auto assemblers had to meet in order to remain in the market. Nevertheless, although the sector's production facilities have increased, there has not been a massive movement of investment of assemblers towards Mexico.

Although it is true that variables such as risk cannot be taken out of the picture, there seems to be important factors in the cost structure of the industry (maintenance of machinery, access to market, reliable suppliers, infrastructure, etc,..) which are not captured by the present formulation and could be conveyed by introducing another factor in the production function. Alternatively, another possibility could be another input namely "auto components". This takes us to another assumption of the HMR world; two goods.

2. Two goods.

The composite good in this model is produced in a perfectly competitive sector while auto production faces increasing returns to scale. Although this is certainly on the right track, the limits of a two-sector framework where the good with scale economies has only one input is a misleading representation of the auto industry. At the extreme end this could imply that autos are only assembled in the relatively low-wage economy, which acts like an in-bond industry. The obvious question is: An in-bond industry of what ? If we now assumed that components were relatively capital or technology intensive, then labor abundant economy imports components from the high-wage countries which supply the intermediate input market. At this point, the existence of another input becomes essential to the issues raised by the model. In order to get a real picture of this industry we need the Auto parts sector. One country of the new larger integrated market could end up producing more autos than before free trade, but it is certainly true that trade of the intermediate input can alter total trade flows in the opposite direction. I will try to illustrate this point with two examples.

(a) U.S.-Canada Automobile Trade Balance after the Auto-Pact:

In 1964, the Canadian Automobile industry looked very similar to Mexico's before the 1989 Auto Decree. The similarities involve scale, pricing behavior, trade flows, regulation, etc,.. A year later, the Auto-Pact allowing free trade of new motor vehicles and parts across the U.S.-Canadian border set the North American Auto industry in a new development stage characterized by constant growth of trade flows between the two countries. If we only look at Figure 1, which reports trade in motor vehicles between the two economies, we get an impression similar to what HMR seem to convey with their results. In the first 13 years after the Auto Pact, the U.S. surplus in vehicles not only disappeared but turned into an increasing deficit. We could then say that the HMR prediction takes place with the relatively low-wage economy producing the cars for the market. But this model does not seem to explain the data not only because it does not capture the two-way trade in the motor vehicles' sector itself (which I will address later), but more importantly because it completely ignores parts two and three of the story. A glimpse at Figure 2 suggests that although Canada is making cars for the U.S. market, it is really assembling "U.S. cars" in the sense that its increasing imports of U.S. made components nothing but widens its initial Auto parts deficit. Figure 3 finally shows that in the first decade of the experiment it is not clear cut who is running the overall trade deficit in the sector. What we can safely conclude is that the explosion of trade flows in the industry has led to high integration and, under the increasing returns to scale assumption and rationalization of production processes observed, this has been reflected in net gains. Let me give you another example to illustrate the need of a third good in this model.

(b) U.S.-Mexican Automobile Trade Balance.

We might think the above story happened twenty years ago in a very different world-wide industry environment and between two countries similar in many aspects thus facilitating this integration. But the case of Mexico is very different, we could continue, and assembling on one side of the border and producing the auto parts on the other side is not likely to occur. I will try to argue that not only it could happen but that it is actually already happening.

If we had to describe the automobile industry in Mexico in the last three decades we would have to mention the permanent trade deficit in auto components leading to an overwhelming deficit for the sector as a whole in 24 out of these 30 years, as illustrated in Figure 4. This fact has been at the origin of the different industrial and trade policy measures that government regulation has imposed since 1962.[1] After 20 years of regulation targeting the development of the sector in the country and its trade deficit, the direction of trade flows was finally reversed during 1983-88. The above was the result of stricter government regulation (which included higher domestic content and a zero-deficit Balance-of-payments scheme), the collapse of the domestic market, and the increased competition in the international arena. The combination of these three factors led to large exports of engines, in a first stage, and passenger cars in a second moment. Nevertheless the artificial trade surplus did not endure the partial deregulation of the industry and increased openness of the sector with the 1989 Automotive Decree. The new decree, still in effect today, reduced the domestic content rule from 60 to 35 percent, incorporated a less stringent Trade-Balance

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[1] For a detailed analysis of the past Automotive Decrees in Mexico, their effects on the Mexican Industry and relation to the U.S. see Lopez-de-Silanes (1991), "Automobiles; Mexican Perspective" in "U.S.-Mexican Industrial Integration; The Road to Free Trade" edited by Sidney Weintraub.

mechanism, and allowed imports of motor vehicles tied to certain rules. Imports of components exploded jumping from 1.7 billion US$ to almost 4.6 billion in 1990 as shown in Figure 5. The data seems to suggest that although Mexico has recently increased its exports of vehicles it has also significantly augmented its imports of components in a higher percentage.

A final point to the argument against integration we sketched above could go along the lines that most of these imports should be coming from Germany and Japan since the multinational firms of these countries located in Mexico have increased their production, exports and domestic market share in the last five years. Berry, Grilli and Lopez-de-Silanes (1991)[2] looked at Mexican imports of the automobile industry at the product level. The main findings are summarized in Table 1 which shows that the United States have been and still are the main source of imports for the industry in all its levels. The composition of imports finds all U.S. participation above 70 percent, which again illustrates the high degree of dependence of intermediate components from North America in the Mexican industry.

Demand Side.

The main contributions of HMR fall on the supply side of the model while the demand specification involves strong assumptions. This in turn reflects the inability of the model to capture the dynamics of the growth of the new market.

Their results, as mentioned above, imply large gains for Mexico in the form of rationalization and consumer welfare through price discipline, while the US and Canada are left practically indifferent. Part of this result is driven by the two-goods and two-factors assumptions, which if altered would reflect gains on the US-Canadian side. Additionally, a further explanation of these results could be found in the assumption of automobiles as an homogenous good which limits the ability of the model to explain the large two-way trade that we observe among integrated nations, as we will show below.

Another important part of the "indifference" result seems to follow from a combination of elasticity assumptions. The HMR formulation implicitly assumes constant demand elasticity equal to one. This parameter in turn feeds back in the process and affects the final estimates. The opposite approach adopted by Berry et.al., trying to enrich the demand side of the model,

[2] Berry, S., V. Grilli & F. Lopez-de-Silanes (1991), "The Automobile Industry and The Mexico - U.S. Free Trade Agreement" (forthcoming in M.I.T. Press).

estimated own-price elasticities for the different types of cars significantly larger than one for Mexico. These parameters would reflect larger quantity demanded on the Mexican side, especially if price discipline is brought by an FTA. The larger-than-unity demand elasticities will also reduce the power of producers to price discriminate across markets in the HMR framework since it limits the size of producer markups making price reductions more likely to occur in the Multinational version of the model.

Income elasticity is practically out of the picture in this paper. Again, our estimates find a large number for this parameter in the case of Mexico. Under growth scenarios of the economy, possibly triggered by NAFTA itself, this would account for large increases in the Mexican market in the next 5 to 10 years. This "new market" will undoubtedly be partially supplied through production located in Mexico, but contrary to the results in the paper, two similar experiences in Canada and Spain seem to suggest a large import component in the final supply for the new growing market.

I have already suggested the increased integration of the US-Canada Auto Industry after the Auto Pact. Figures 6-9 show part of this phenomenon with increased production in Canada and the growth of Canadian exports to the United States reaching levels around 80 percent of total production. But this movement was accompanied by a large increase in imports of vehicles from the U.S. to supply Canadian demand. Today, over 50 percent of the Canadian market is supplied by imports from the United States, which account for close to 7 percent of U.S. total production.

The integration of Spain to the European Economic Community (EEC) has resulted in a similar pattern. Before 1982, the Spanish Automobile Industry faced restrictions which resulted in production tied to domestic sales and virtually no imports of motor vehicles. In the last decade reform to the regulation affecting the industry resulted in increased production and exports. Nevertheless, it is the integration to the EEC in 1986 which clearly defines a new path for the industry as illustrated in Figures 10 and 11. Although exports as a percentage of domestic production followed a growing trend throughout the decade, 1986 does not seem to have triggered a higher growth rate of this ratio. Meanwhile, integration to the EEC meant a large jump in imports as a percentage of production and of registrations. In 1985, imports accounted for 83,000 units and only four years later they were above 508,000 units representing close to 40 percent of registrations that year.

These two examples point at the growth potential of the Mexican market under NAFTA and the increasing importance of imports to supply the growing demand. The rationalization of production and the growth of the market as a whole is not completely captured in the HMR model but is clearly an important issue that needs to be addressed enriching its demand side. It would have been interesting to see what the model would have predicted for Spain and Canada.

Some of the possible extensions and modifications of the model suggested above, would certainly complicate its solution and require even more computational work, but are probably worth exploring since they would enhance the framework and arrive at different empirical results. The approach of Hunter, Markusen and Rutherford certainly points in the direction of capturing the empirically relevant characteristics of the industry modelling part of its strategic behavior through the introduction of the multinational character of the firm and thus enriching Applied General Equilibrium exercises. Further work along these lines seems fruitful and suggestive.

Figure 1

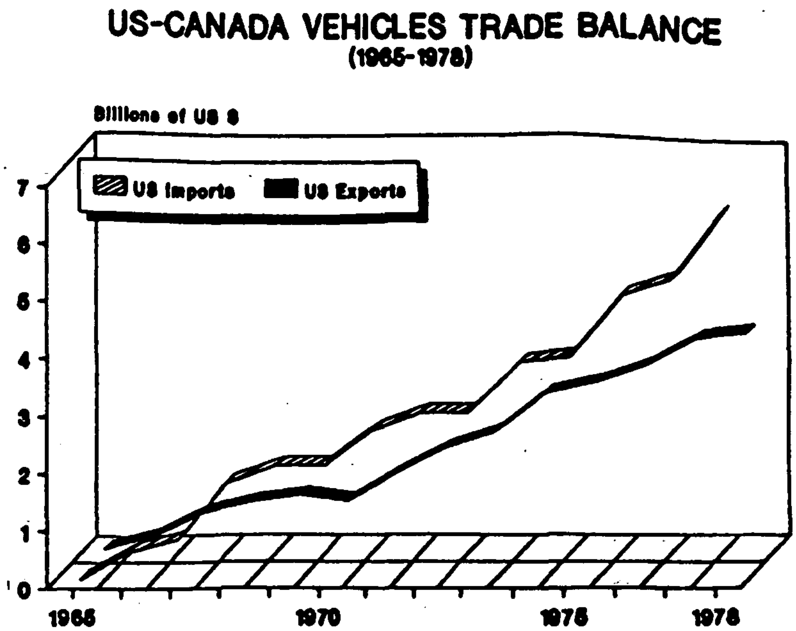


Figure 2

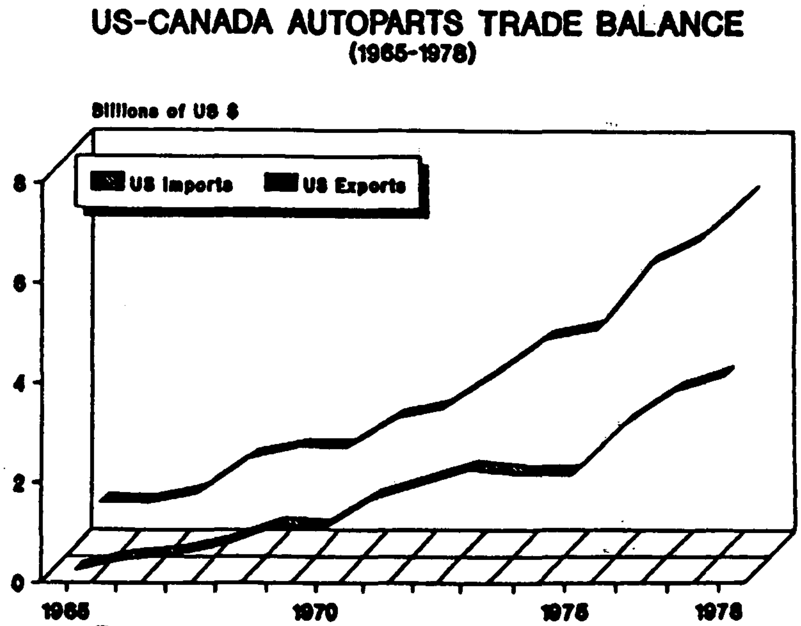
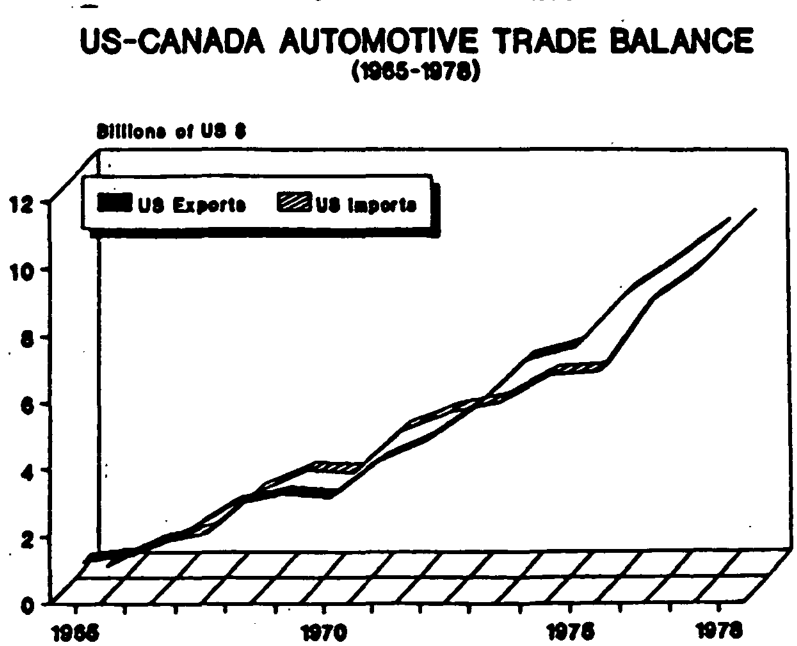
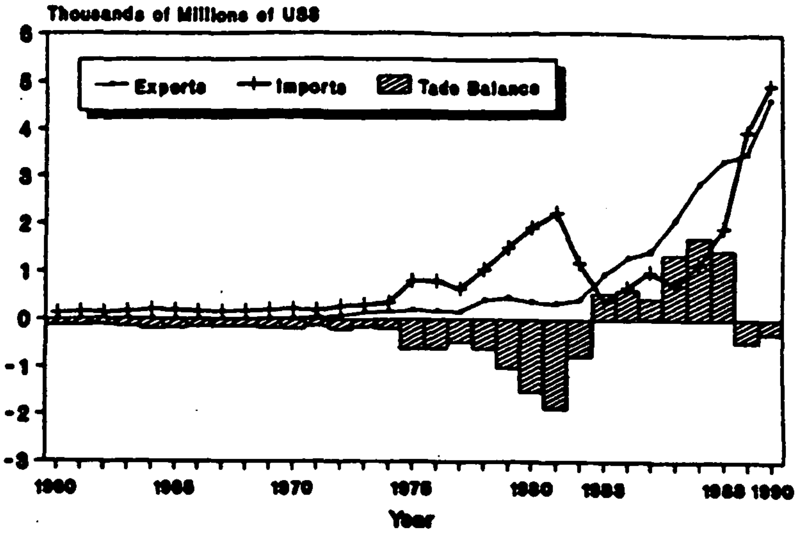


Figure 3



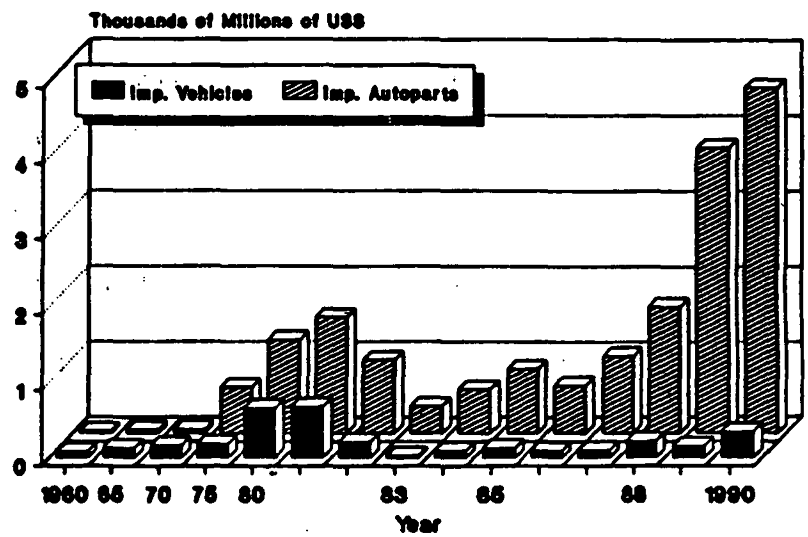
MEXICAN AUTOMOTIVE TRADE
(1960-1990)

Figure 4



MEXICAN AUTOMOTIVE IMPORTS
(1960-1990)

Figure 5



Source:Calculated with data from
INEGI, Banco de Mexico and SECOFI.

TABLE 1

MEXICAN AUTOMOBILE IMPORT STRUCTURE

IMPORTS	1982 U.S./TOTAL (%)	1990 U.S./TOTAL (%)
COMPONENTS USED IN PARTS PRODUCTION	71.6%	73.0%
ENGINE COMPONENTS & PARTS	82.3%	83.7%
AUTOPARTS	76.0%	73.6%
CHASIS & BODIES	98.5%	88.9%
VEHICLES	96.4%	86.1%

SOURCE: Berry, Grilly & Lopez-de-Silanes (1991).

Figure 6

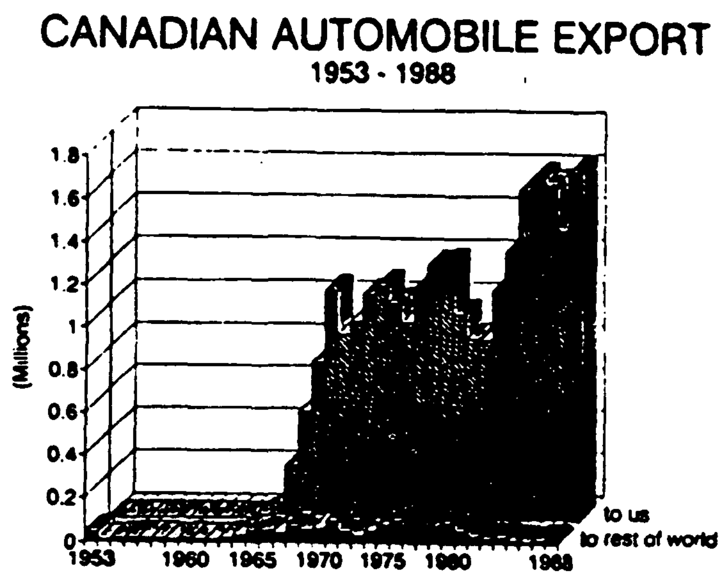


Figure 7

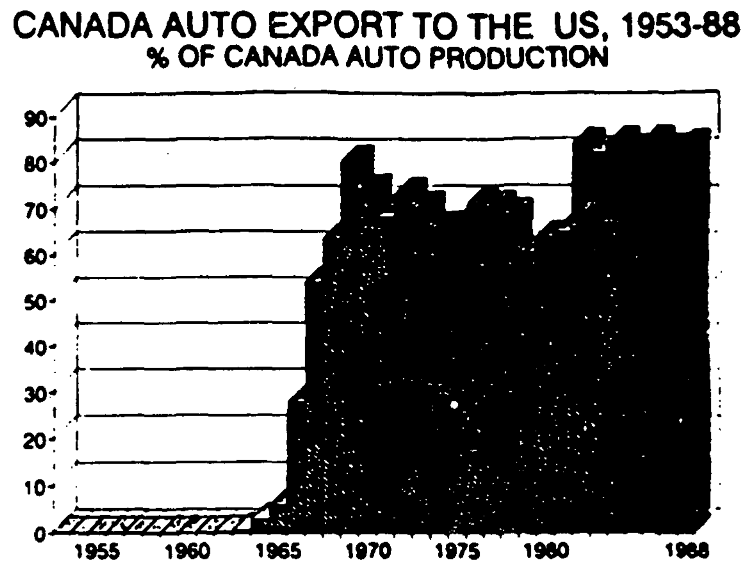


Figure 8

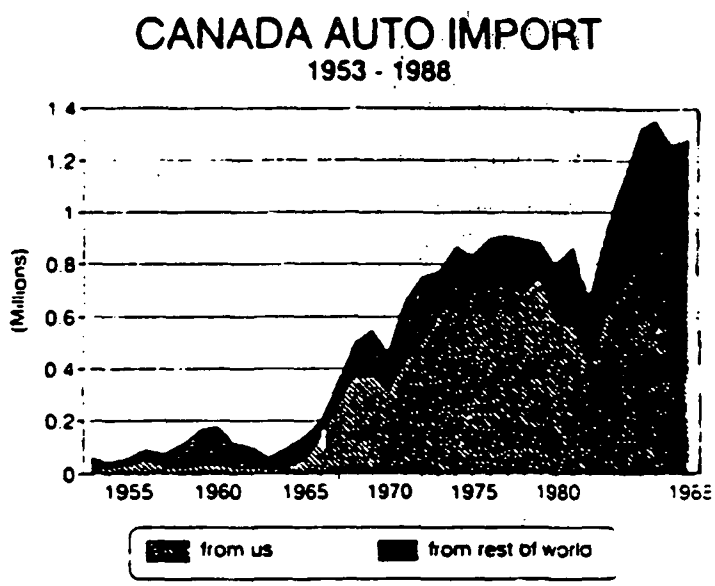
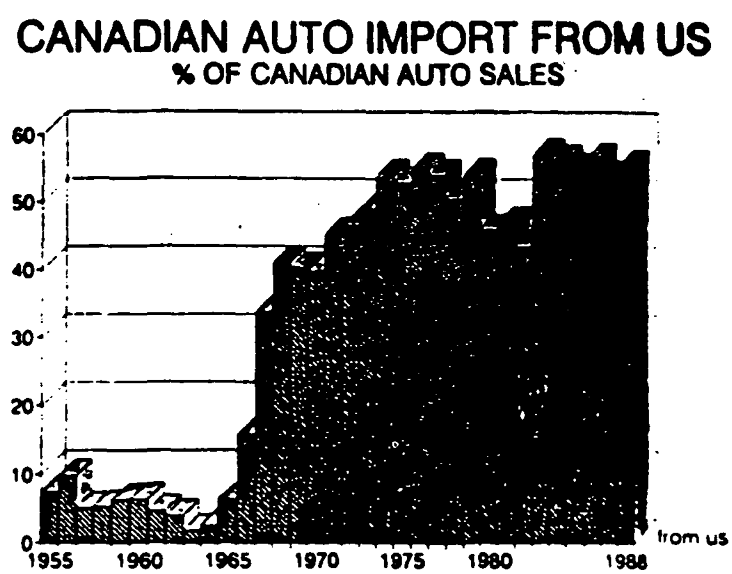
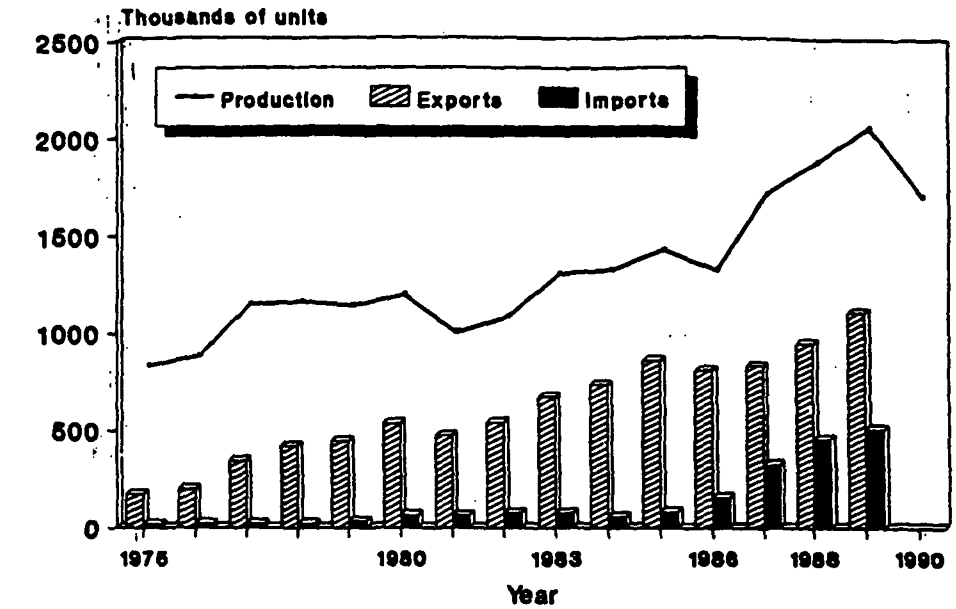


Figure 9



SPAIN'S AUTOMOBILE SECTOR
(1975-1990)

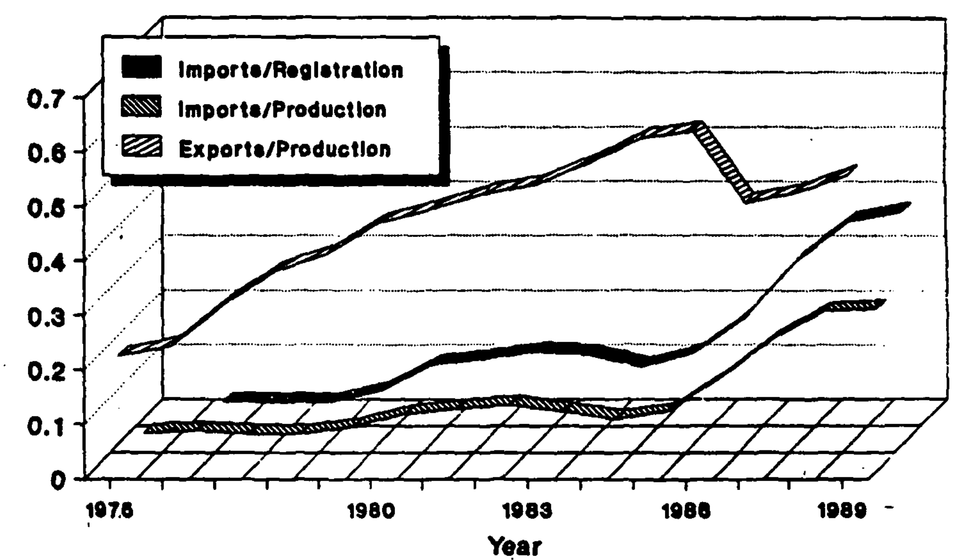
Figure 10



Source:Calculated with data from
WARDS and AMIA.

SPAIN's AUTOMOBILE SECTOR
(1975-1989)
Total Motor Vehicle Units

Figure 11



Source:Calculated with data from
WARD's.

PAPER 6

"MODELING THE DYNAMIC IMPACT OF NORTH AMERICAN FREE TRADE,"
BY TIMOTHY J. KEHOE

Federal Reserve Bank of Minneapolis
Research Department

MODELING THE DYNAMIC IMPACT OF NORTH AMERICAN FREE TRADE

Timothy J. Kehoe*

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ABSTRACT

The current tool of choice for analyzing the impact of a potential North American Free Trade Agreement on the economies of Canada, Mexico, and the United States is the static applied general equilibrium model. Although this type of model can do a good job in analyzing, and even in predicting, the impact of trade liberalization or tax reform on relative prices and resource allocation over a short time horizon, it does not attempt to capture the impact of government policy on growth rates. For this we need a dynamic model. This paper outlines some of the issues that confront a researcher interested in building a dynamic general equilibrium model to assess the potential economic impact of a NAFTA, including the impact on growth rates. Simple calculations based on preliminary empirical work indicate that the dynamic benefits of increased openness could dwarf the static benefits found by more conventional applied general equilibrium models.

*University of Minnesota and Federal Reserve Bank of Minneapolis. I am grateful to Karine Moe for diligent and energetic research assistance.

1. Introduction

The current tool of choice for analyzing the impact of a potential North American Free Trade Agreement on the economies of Canada, Mexico, and the United States is the static applied general equilibrium model. Examples of such analyses include Brown, Deardorff, and Stern (1991); Cox and Harris (1991); Hinojasa-Ojeda and Robinson (1991); KPMG Peat-Marwick (1991); Sobarzo (1991); and Yúnez-Naude (1991). They all tend to find small, but favorable impacts of such an agreement.

Static applied general equilibrium models can do a good job in analyzing, and even in predicting, the impact of trade liberalization or tax reform on relative prices and resource allocation over a short time horizon. Kehoe, Polo, and Sancho (1991), for example, assess the performance of a static general equilibrium model of the Spanish economy that had been constructed to analyze the impact of the tax reform that accompanied Spain's 1986 entry into the European Community. They find that the model was able to account for more than two thirds of the variation of relative prices that occurred between 1985 and 1987. (It would be interesting to do similar *ex post* performance evaluations of the analyses of the NAFTA.)

Typically, however, this sort of model predicts small changes in economic welfare (see Shoven and Whalley 1984 and Whalley 1989). One reason for this is that these models do not attempt to capture the impact of government policy on growth rates. For this we need a dynamic model. Anything that can affect the growth rate of a variable like income per capita or output per worker, if only slightly, can have a tremendous impact over time.

Currently, there is no model that analyzes the impact of a NAFTA on growth rates. This paper outlines some of the issues that confront a researcher interested in building a dynamic applied general model to assess the potential economic impact of a NAFTA, including the impact on growth rates. A dynamic model can capture the effect of government policy on capital flows, and these are very important. Yet, as we argue in the next section, a low capital-labor ratio cannot be the only, or even the most important, factor in explaining the low level of output per worker in Mexico compared to that in a country like the United States. We must look elsewhere for explanations for the differences in levels of output per worker. It is here that the new, endogenous growth literature, which follows Romer (1987) and Lucas (1988) and focuses on endogenous technical change, is able to provide potential answers. This literature is still at a tentative, mostly theoretical level. This paper uses preliminary empirical work at an aggregate level to estimate the impact of free trade on growth rates in Mexico.

Although our calculations are fairly crude, they suggest that the dynamic impact of a NAFTA could dwarf the static effects found by more conventional applied general equilibrium models. Similar kinds of suggestive calculations are done to estimate the dynamic gains from the European Community's 1992 Program by Baldwin (1992). Unlike Baldwin's analysis, however, the results presented here are based on theories and empirical estimates that deal with trade directly. Baldwin obtains his numbers by multiplying estimates of static gains from trade obtained by other researchers by a multiplier derived from a highly aggregated growth model with dynamic increasing returns but without any explicit role for trade. It is worth pointing out that the analysis in this paper does not take into account phenomena like unemployment or underutilization of capacity. It is possible that a free trade agreement would provide dynamic gains based on a more traditional macroeconomic analysis; see Fischer (1992) for some suggestive results in this direction.

Although endogenous growth literature is still at a tentative stage, the intuition behind it is fairly simple. Increased openness can alter the growth rate in clear ways: Economic growth is spurred by the development of new products. New product development is the result of learning by doing, where experience in one product line makes it easier to develop the next product in the line, and of direct research and development. On the final product side, increased openness allows a

Direction Of Trade 1989

(Millions of 1989 U.S. Dollars)

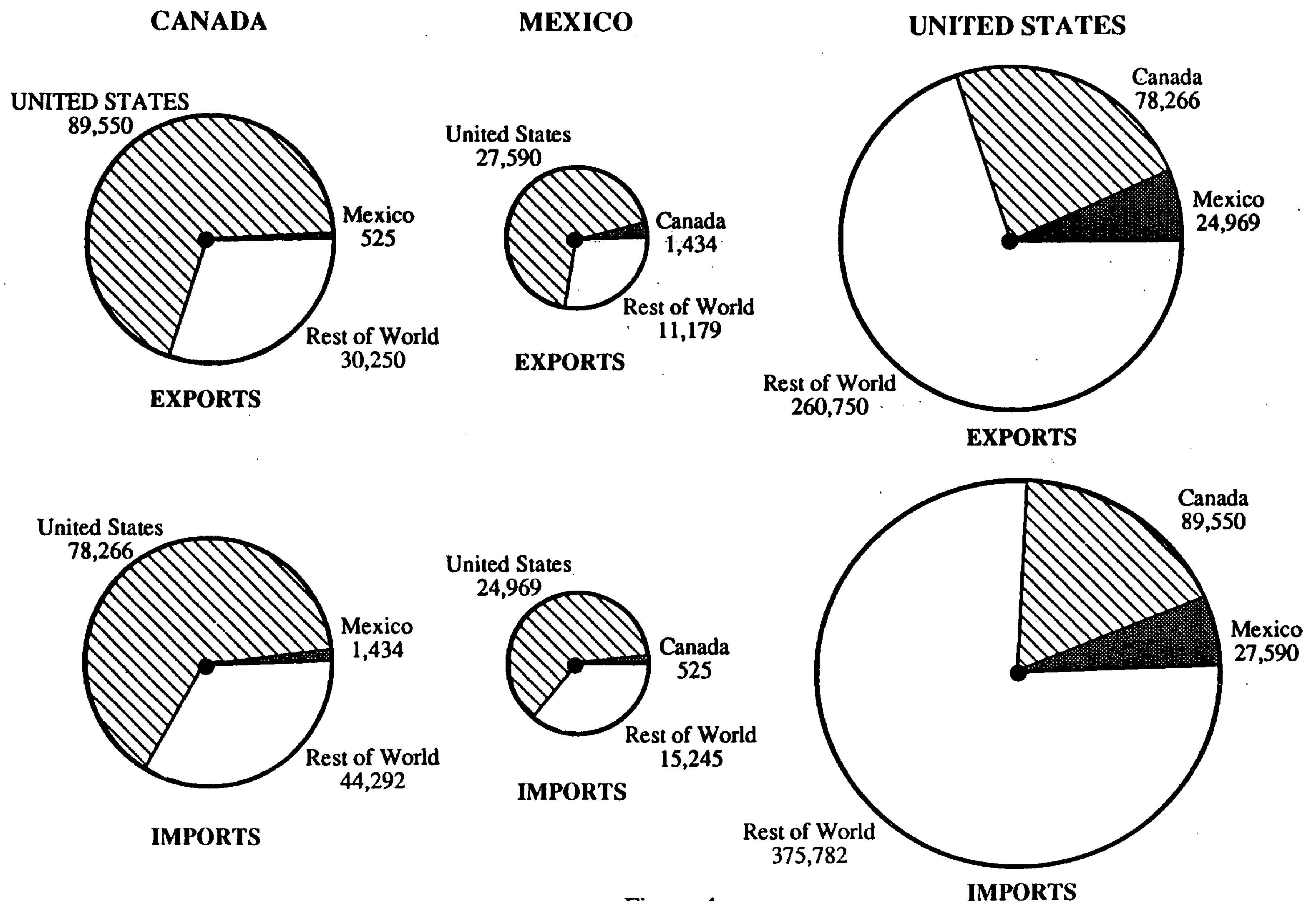

Figure 1

Source: IMF, Direction of Trade Statistics Yearbook, 1990.

country to specialize more, achieving a larger scale of operations in those industries in which it has a comparative advantage. On the input side, increased openness allows a country to import many technologically specialized inputs to the production process without needing to develop them itself.

It is worth noting that the analysis in this paper pertains to the benefits of free trade in general, not just the NAFTA. Because of their relative sizes and geographical locations, Canada and Mexico do most of their trading with the United States; see Figure 1. For them the concepts of free trade and the NAFTA are inextricably connected. Although Canada is the United States' largest trading partner and Mexico its third largest, about three quarters of U.S. trade is with countries outside North America. Nonetheless, the NAFTA represents an opportunity of the U.S. to commit itself to a free trade policy, and for this reason the progress on the NAFTA is being closely monitored throughout the world.

2. Capital Flows

A major impact of NAFTA would be on capital flows. One would expect capital to flow from relatively capital rich Canada and the U.S. to relatively capital poor Mexico. Indeed, it is by exogenously imposing a substantial capital flow of this sort that static models such as that of KPMG Peat-Marwick (1991) are able to show a significant welfare gain to Mexico. It is worth stressing two points about capital flows, however: First, differences in capital-labor ratios between Mexico and its northern neighbors cannot be the sole explanation of the large differences in output per worker between these countries. (See Lucas 1989 for a discussion and calculations similar to those below.) Consequently, simply equalizing capital-labor ratios cannot be the solution to the problem of eliminating income differences. Second, when modeling the savings and investment decisions that determine capital flows, we need to take into account the significant differences in age profiles of the population between Mexico and its neighbors.

To illustrate the point that differences in capital-labor ratios cannot explain the differences in output per worker, suppose that each economy has the production function

$$Y_j = \gamma N_j^{1-\alpha} K_j^{\alpha}$$

where Y_j is GDP, N_j is the size of the work force, and K_j is capital. In per capita terms, where $y_j = Y_j/N_j$ and $k_j = K_j/N_j$, this becomes $y_j = \gamma k_j^{\alpha}$. The net return of capital is

$$r_j = \alpha\gamma k_j^{\alpha-1} - \delta$$

where δ is the depreciation rate. In 1988, according to Summers and Heston (1991), real GDP per worker was \$14,581 in Mexico and \$37,608 in the U.S. Suppose that $\alpha = 0.3$, which is roughly the capital share of income in the U.S. Then to explain this difference in output per worker, we need capital per worker to be larger than that in Mexico by a factor of 23.5,

$$\frac{k_{us}}{k_{mex}} = \left[\frac{y_{us}}{y_{mex}}\right]^{1/\alpha} = \left[\frac{37{,}608}{14{,}581}\right]^{1/0.3} = 23.5.$$

Suppose that $\delta = 0.05$ and $r_{us} = 0.05$, which are roughly the numbers obtained from calibration. Then the net interest rate in Mexico should be 17.2 times that in the U.S.,

$$r_{mex} = (r_{us}+\delta)\left[\frac{k_{us}}{k_{mex}}\right]^{1-\alpha} - \delta = 0.10(23.5)^{0.7} - 0.05 = 0.86.$$

During the period 1988–90 the real return on bank equity in Mexico (and banks are the major source of private capital in Mexico) averaged 28.2 percent per year, as compared to 4.7 percent in the U.S. (see Garber and Weisbrod 1991). Since 28 percent is far less than the 86 percent that we would expect if differences in capital-labor ratios were the principal determinant of the differences in output per worker between Mexico and its neighbors, we must look elsewhere for this determinant.

There are at least two objections that can be raised to the above calculations: First, a comparison based on per capita GDP in U.S. dollars using the exchange rate to convert pesos into dollars would suggest that y_{us}/y_{mex} is much larger, about 7.9. Second, calibrating the capital share parameter α using Mexican GDP data would yield a larger value, about 0.5. These two objections work in opposite directions, however, and our calculations can be defended as being in a sensible middle ground: income comparisons based on exchange rate conversions neglect purchasing power parity differentials; per capital comparisons rather than per worker comparisons neglect demographic differences; much of what is classified as net business income in Mexico is actually returns to labor; and so on.

Moreover, that differences in capital per worker cannot be the sole explanation of differences in output per worker across countries is a more general point. It is supported both by historical evidence, such as that of Clark (1987), and by even more extreme examples of differences in output per worker: According to Summers and Heston (1991), real GDP per worker in Haiti in 1988 was 4.9 percent of that in the U.S. The same sort of calculations as those above would suggest that interest rates in Haiti should be over 11,000 percent per year if differences in the capital-labor ratio were the sole explanation of the differences in output per worker. Furthermore, historical evidence does not indicate that Mexico has always been starved of funds for investment. The problem has often been that investments abroad, particularly in the U.S., have been more attractive. Between 1977 and 1982, for example, \$17.8 billion of private investment flowed into Mexico while \$18.7 billion flowed out (Garcia-Alba and Serra-Puche 1983, p. 45).

Although capital flows cannot provide all of the answers to Mexico's problems, they are important. If capital flows could lower the net interest rate in Mexico from 28 percent per year to

5 percent, we would estimate that the capital labor ratio in Mexico would increase by a factor of about 5.5

$$\frac{k'_{mex}}{k_{mex}} = \left[\frac{0.28 + \delta}{0.05 + \delta}\right]^{1/(1-\alpha)} = 5.5.$$

This would increase Mexican output per worker to about $24,300, which would close the current gap with the U.S. level by about 42 percent.

Some of the current high return on capital in Mexico can be accounted for by an inefficient and oligopolistic financial services sector. A NAFTA might increase the efficiency of this sector. An even more significant impact of a NAFTA would be to create a stable economic environment that would encourage private investment in Mexico. It was do to this in at least two ways: First, it would lock the Mexican government into the free trade policy and the liberal policy towards foreign direct investment that it is currently pursuing unilaterally. Second, it would protect Mexican producers from protectionist tendencies in the U.S., which fluctuate with the business cycle and are sensitive to a variety of special interest groups. Direct foreign investment in Mexico has increased dramatically in recent years, as seen in Figure 2. Some of this increase has been due to the liberalization of Mexican laws regarding such investments, and some has undoubtedly been due to improvements in expectations about Mexico's economic future.

A sensible analysis of capital flows must model consumer's savings decisions. In modeling savings decisions in North America, we must take into account demographic differences among these countries. To illustrate the importance of demographic differences, we note that currently half of the population of Mexico is under the age of seventeen, while the populations of Canada and the U.S. are currently aging as the postwar baby boom generation reaches middle age. These differences would be very important in an overlapping generations context in which life-cycle consumers dissave when young and build up human capital, save during the middle of their lives,

Book Value of Direct Foreign Investment in Mexico

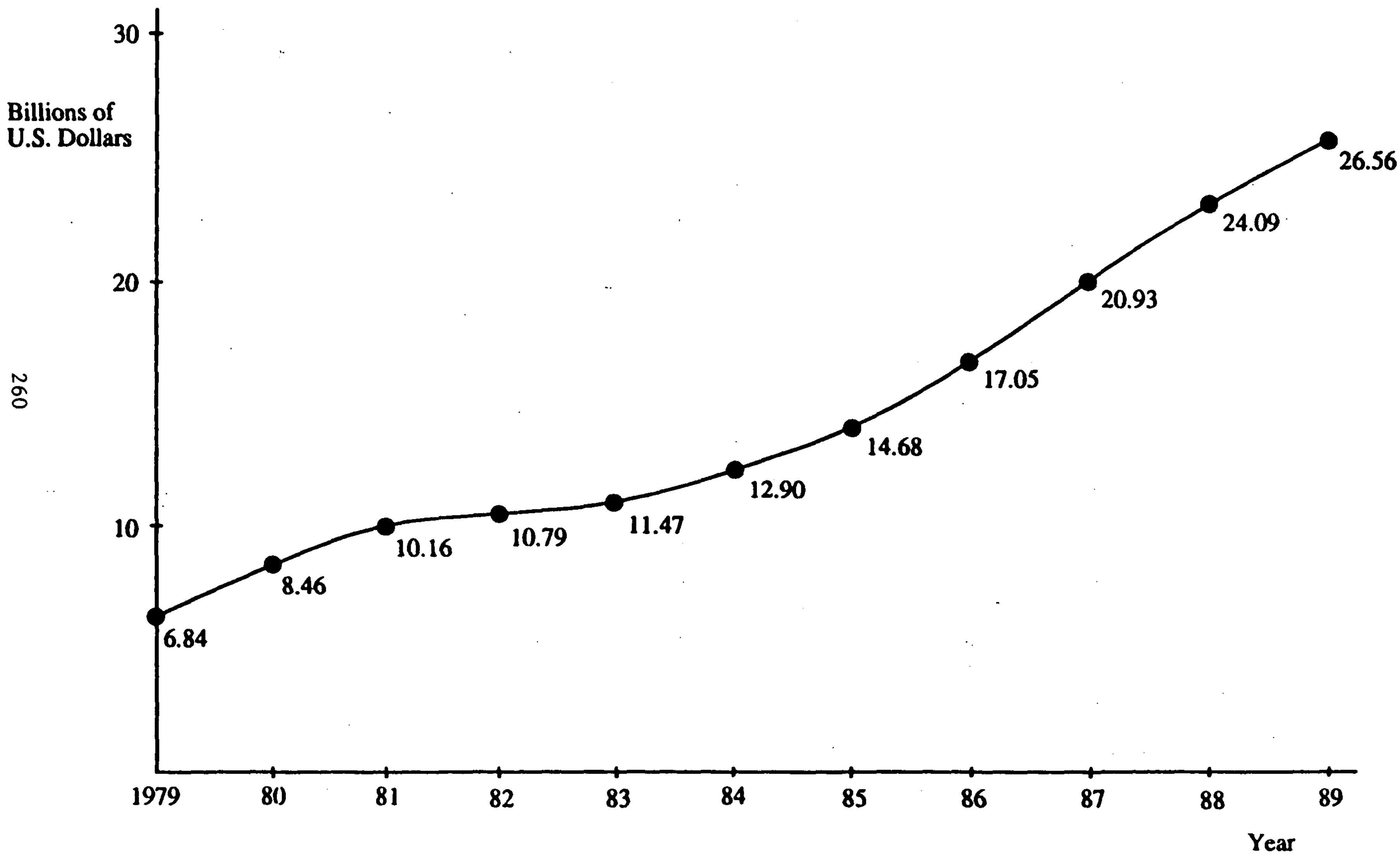

Figure 2

Source: Secretaría de Comercio y Fomento Industrial and dissave again when old during retirement. An example of an applied general equilibrium model with overlapping generations is Auerbach and Kotlikoff (1987). Modeling demographic differences in an overlapping generations framework would be especially important in a model in which the accumulation of human capital, as well as that of physical capital, plays an important role.

3. Specialization in Final Products

The potential of learning by doing to account for economic growth has been recognized since the pioneering work of Arrow (1962). The micro evidence has a long history going back to Wright (1936), who found that productivity in airframe manufacturing increased with cumulative output at the firm level. Later studies have confirmed this relationship at the firm level and industry level. Recent research that incorporate learning by doing into models of trade and growth include Stokey (1988) and Young (1991).

Consider the following simple framework, as presented by Backus, Kehoe, and Kehoe (1991): Output in an industry in some country depends on inputs of labor and capital, country and industry specific factors, and an experience factor that depends, in turn, on previous experience and output of that industry in the previous period. Keeping constant the rates of growth of inputs, the crucial factor in determining the rate of growth of output per worker is the rate of growth of the experience factor. Output per worker grows faster in industries in which this experience factor is higher. The level of growth of output per worker nationwide is a weighted average of the rates of growth across industries. One way increased openness promotes growth is that it allows a country to specialize in certain product lines and attain more experience in these industries.

Modeling dynamic increasing returns as the result of learning by doing is a reduced form specification for a very complex microeconomic process. It captures the effects of the learning curve documented by industrial engineers. It also captures, to some extent, the adoption of more efficient production techniques from abroad and from other domestic industry. The learning that takes place is not solely related to physical production techniques, but also to the development of complex financial and economic arrangements between producers of primary and intermediate goods and producers of final goods. The ability of a country to benefit from learning by doing depends on the educational level of the work force. It also depends on whether a country is at the frontier of development of new products and production techniques or if it can import these from abroad: it is easier to play catch-up than to be the technological leader.

Consider a model in which value added in industry i, i = 1, ..., I, is produced according to the function

$$Y_{it} = \gamma_i A_{it} N_{it}^{1-\alpha_i} K_{it}^{\alpha_i}.$$

Here Y_{it} is real value added of industry i in period t, N_{it} is labor input, and K_{it} is capital services. The variable A_{it} measures the external effects of learning by doing. We assume that

$$A_{it+1} = A_{it}(1+\beta_i Y_{it})^{\eta},$$

where β_i and ρ are positive constants. Thus, the rate of increase in learning is proportional to total output. This is slightly different from the standard experience curve, in which productivity is an increasing function of cumulative output, but has the same flavor: current production raises future productivity. Defining $y_{it} = Y_{it}/N_t$ to be real output per capita and similarly defining n_{it} and k_{it}, we obtain

$$y_{it} = \gamma_i A_{it} n_{it}^{1-\alpha_i} k_{it}^{\alpha_i},$$

which implies that the growth rate in per capita output is

$$g(y_{it}) = \frac{y_{it+1}}{y_{it}} - 1 = (1+\beta_i Y_{it})^{\eta} \left[\frac{n_{it+1}}{n_{it}}\right]^{1-\alpha_i} \left[\frac{k_{it+1}}{k_{it}}\right]^{\alpha_i} - 1.$$

If we consider a balanced growth path in which the capital stock in each industry grows at the same rate as output and the fraction of the labor force in each industry is constant, then we can calculate

$$g(y_{it}) = (1+\beta_i Y_{it})^{\delta_i} - 1$$

where $\delta_i = \eta/(1-\alpha_i)$.

The aggregate growth rate is the weighted average of growth rates of individual industries, with weights given by shares in aggregate output:

$$1 + g(y_t) = \sum_{i=1}^{I} (Y_{it}/Y_t)[1 + g(y_{it})] = \sum_{i=1}^{I} (Y_{it}/Y_t)(1+\beta_i Y_{it})^{\delta_i}.$$

If, in addition, $\beta_i = \beta$ and $\delta_i = 1$ for all i, aggregate growth is

$$g(y_t) = \beta Y_t \sum_{i=1}^{I} (Y_{it}/Y_t)^2.$$

We refer to the summation in the above expression, a number between zero and one, as a *specialization index*. Its product with aggregate output operates as a scale effect on growth. In general, that is, with $\delta_i \neq 1$, the appropriate specialization index is based on other powers of the output shares Y_{it}/Y_t, but this simple measure captures the dispersion of production across industries that the theory suggest is important.

4. Imports of Specialized Inputs

Increased openness allows a country to import more specialized inputs to the production process. Stokey (1988) and Young (1991) have proposed models in which new product development is still the result of learning by doing, but where the primary impact of learning by doing is in the development of new, more specialized inputs. Trade allows a country to import these inputs without developing them itself. Aghion and Howitt (1989), Grossman and Helpman (1989), Rivera-Batiz and Romer (1989), and others have proposed similar models where it is research and development that leads to the development of new products. (Here, of course, the relationship of trade and growth is more complicated if one country can reap the benefits of technological progress in another country by importing the technology itself without importing the products that embody it.)

Suppose, as in Stokey (1988) and Young (1991), that learning by doing leads to the development of new or improved products. Final output is produced according to the production function

$$Y_t = \gamma N_t^{1-\alpha} \left[\int_0^\infty X_t(i)^\rho di \right]^{\alpha/\rho} .$$

There is a continuum of differentiated capital goods (or intermediate goods), with $X_t(i)$ denoting the quantity of capital goods of type i, $0 \leq i \leq \infty$. The parameter ρ is positive, allowing output even if there is no input of some capital goods. This type of production function embodies the idea that an increase in the variety of inputs leads to an increase in measured output.

Growth arises from an increase in the number of available capital goods. In period t, only capital goods in the interval $0 \leq i \leq A_t$ can be produced. Production experience results in the expansion of the interval, the development of new products,

$$A_{t+1} = A_t(1+\beta Y_t).$$

The resource constraint on capital goods is

$$\int_0^{A_t} X_t(i)di = K_t.$$

If the production functions for capital goods are identical, then the most efficient allocation of resources results in equal production of all goods that are actually produced. Let us assume that all goods in the interval $0 \leq i \leq A_t$ are produced in equal amounts. Under suitable assumptions, this is the equilibrium outcome (see, for example, Romer 1990). Letting $X_t(i) = \bar{X}_t$, $0 \leq i \leq A_t$, we obtain

$$\bar{X}_t = K_t/A_t,$$

which implies

$$Y_t = \gamma N_t^{1-\alpha} K_t^{\alpha} A_t^{\alpha(1-\rho)/\rho}.$$

The growth rate of output per worker is

$$g(y_t) = (1+\beta Y_t)^{\alpha(1-\rho)/\rho} \left[\frac{k_{t+1}}{k_t}\right]^{\alpha} - 1.$$

If we assume, in addition, that the capital stock grows at the same rate as output, then growth is simply a function of the scale of production:

$$g(y_t) = (1+\beta Y_t)^{\delta} - 1,$$

where $\delta = \alpha(1-\rho)/[\rho(1-\alpha)]$. Again there is a scale effect at the country level: countries with larger outputs grow faster.

The most interesting aspect of this theory is the perspective it gives us on trade and growth. In the previous section the natural interpretation is that technology is embodied in people and is not tradeable. Trade may influence the pattern of production, including both the scale of production and the pattern of specialization, and in this way affect growth. In this model, technology is embodied in product variety, and there is a more subtle interaction between trade and growth. Recall that increases in the number of varieties of intermediate goods raise output. If these varieties are freely traded, a country can either produce them itself or purchase them from other countries. By importing these products a small country can grow as fast as a large one. When there is less than perfectly free trade in differentiated products, we might expect to find that both scale and trade in differentiated products are positively related to growth.

A commonly used measure of the extent to which a country engages in trade of specialized products in the Grubel-Lloyd (1975) index. The Grubel-Lloyd index for country j is

$$GL^j = \frac{\sum_{i=1}^{I}\left(X_i^j + M_i^j - |X_i^j - M_i^j|\right)}{X^j + M^j}.$$

Here X_i^j is exports of industry i; M_i^j is imports of industry i; X^j is total exports; and M^j is total imports. Backus, Kehoe, and Kehoe (1991) find a strong positive relation between the Grubel-Lloyd index for all products at the three-digit S.I.T.C. level and growth in GDP per capita for a large sample of countries. They also find a strong positive relationship between the Grubel-Lloyd index for manufactured products and growth in manufacturing output per worker. Trade in category 711, nonelectrical machinery, might consist of imports of steam engines (7113) and exports of domestically produced jet engines (7114). Simultaneous imports and exports of these goods provide the country with both, and leads to more efficient production.

5. Some Empirical Estimates and Illustrative Calculations

Using cross-country data from a large number of countries over the period 1970–85, Backus, Kehoe, and Kehoe (1991) analyze the determinants of growth. Various other researchers have used similar cross-country data sets to estimate the parameters of endogenous growth models; see Levine and Renelt (1990) for a survey. Typically, researchers in this area find that their results are very sensitive to the exact specification of the model and the inclusion or exclusion of seemingly irrelevant variables. Backus *et al.* find, however, that, in explaining rates of growth of output per worker in manufacturing, results related to the theory sketched out in the previous two sections are remarkably robust. Using their methodology we can estimate some parameters for a model in which both specialization in final output and the ability to import specialized inputs foster growth. Details concerning the data sources and methodology can be found in Backus *et al.*

Consider a relationship of the form

$$g(\bar{y}^j) = \alpha + \beta_1 \log \bar{Y}^j + \beta_2 \log \sum_{i=1}^{I} (\bar{X}_i^j/\bar{Y}^j)^2 + \beta_3 \log \overline{GL}^j + \beta_4 \log y^j + \beta_5 \, PRIM^j + \epsilon^j.$$

Here $g(\bar{y}^j)$ is average yearly growth of manufacturing output per worker in percent form from 1970–85; $\bar{Y}^j$ is 1970 manufacturing output; $\Sigma_{i=1}^{I}(\bar{X}_i^j/\bar{Y}^j)^2$ is a specialization index based on exports at the three digit S.I.T.C. level; $\overline{GL}^j$ is the 1970 Grubel-Lloyd index of intra-industry trade; y^j is 1970 per capita income; and $PRIM^j$ is 1970 primary school enrollment rate. Bars above the variables indicate that the variable deals with the manufacturing sector only; the specialization index and the Grubel-Lloyd index, for example, are computed for manufacturing industries only.

We include total manufacturing output and the specialization index to account for the impact of specialization in production of final goods. One motivation for using export data is that specialization is most important in the export sector. Another motivation is purely practical: the trade data permits a more detailed breakdown of commodities, and the export specialization index can be thought of as a proxy for the total production specialization index: if exports are proportional to outputs, then $\bar{X}_i^j = \epsilon \bar{Y}_i^j$ and $\Sigma_{i=1}^{I}(\bar{X}_i^j/\bar{Y}^j)^2 = \epsilon^2 \Sigma_{i=1}^{I}(\bar{Y}_i^j/\bar{Y}^j)^2$ and the two indices are proportional. The Grubel-Lloyd index is included, as we have explained, because it captures, in a loose way, the ability of a country to trade in finely differentiated products, which our theory implies is important for growth. We include initial per capita income and the primary enrollment rate partly because they are widely used by other researchers in this area, such as Barro (1991), and partly because they may be relevant to our theory: The inclusion of per capita income allows for less developed countries, which are playing catch-up, to face different technological constraints. The inclusion of the enrollment rate allows for differences in countries' ability to profit from learning by doing because of differences in levels of basic education.

A regression of the above relationship yields

$$g(y^j) = \underset{(5.761)}{3.151} + \underset{(0.255)}{0.729} \log \bar{Y}^j + \underset{(0.119)}{0.359} \log \sum_{i=1}^{I} (\bar{X}_i^j/\bar{Y}^j)^2 + \underset{(0.416)}{1.018} \log \overline{GL}^j - \underset{(0.785)}{0.468} \log y^j + \underset{(2.187)}{2.064} \, PRIM^j$$

NOBS = 45 $\qquad$ $R^2 = 0.478.$

(The numbers in parentheses are heteroskedasticity-consistent standard errors.) Notice that in this regression the coefficients all have the expected signs, and that the first three variables, total manufacturing output, the specialization index, and the Grubel-Lloyd index, are all statistically significant.

To illustrate the dramatic impact of trade liberalization possible in a dynamic model that contains the endogenous growth features discussed in the previous two sections, let us suppose that NAFTA allowed Mexico to increase its level of specialization in production of final manufactured goods and imports of specialized inputs. The average values over 1970–85 of the specialization indices and Grubel-Lloyd indices for the three North American countries are listed below. The values of the same indices for South Korea, a country with about the same output per worker as Mexico, are also included for comparison.

	$\Sigma_{i=1}^{I}(\bar{X}_i^j/\bar{Y}^j)^2$	$\overline{GL}^j$
Canada	7.10×10^{-2}	0.642
Mexico	5.93×10^{-4}	0.323
U.S.	1.92×10^{-3}	0.597
Korea	5.43×10^{-2}	0.363

Suppose that free trade allows Mexico to increase its specialization index to 0.1×10^{-2} and its Grubel-Lloyd index to 0.6. Dramatic increases of this sort are possible: In 1970, for example, Ireland had a Grubel-Lloyd index for manufactured goods of 0.150; in 1980, after having joined the European Economic Community in 1973, this index was 0.642.

Using the above regression results, we would estimate the increase in the growth rate of manufacturing output per worker of 1.645 percent per year

$$1.645 = 0.359 \log\left[\frac{1.00 \times 10^{-2}}{5.93 \times 10^{-4}}\right] + 1.018 \log\left[\frac{0.600}{0.323}\right]$$
$$= 1.014 + 0.545.$$

It is clear that much is at stake in the issues discussed here. Suppose that Mexico is able to increase its growth rate of output per worker by an additional 1.656 percent per year by taking advantage of both specialization and increased imports of specialized intermediate and capital goods. Then, after 25 years, its level of output per worker would be more than 50 percent higher than it would have otherwise been. By way of comparison, if Mexico's output per worker were 50 percent higher in 1988 than it was, then output per worker in Mexico would be about the same as that in Spain (again, this comparison uses Summer's and Heston's 1991 data). Our earlier calculations suggested that Mexico could increase its output per worker by about 66 percent by increasing its capital per worker until the rate of return on capital is equal to that in the U.S. Admittedly, these calculations are very crude, but they suggest that there is a significant impact of increased openness on growth through dynamic increasing returns. Furthermore, the dynamic benefits of increased openness dwarf the static benefits found by more conventional applied general equilibrium models.

Obviously, this is an area that requires more research, and even a crude disaggregated dynamic general equilibrium model of North American economic integration would make a substantial contribution. More empirical work also needs to be done. Notice, for example, that the Grubel-Lloyd indices reported above fail to capture the observation that Korea is fairly closed in final goods markets but open to imports of intermediate and capital goods.

Our analysis suggests that Mexico has more to gain from free trade than do Canada or the U.S. Both are already fairly open economies, and the U.S. is big enough to exploit its dynamic scale economies. Mexico, however, has a smaller internal market. To follow an export-led growth strategy, Mexico must look to the U.S., as the trade statistics in Figure 1 indicate.

Endogenous growth theories can be used to support industrial policies that target investment towards certain industries and trade policies that protect some final goods industries. At the level of aggregation used here, our results have little to say directly about such policies. Two warnings about such policies are worth making, however: First, with regard to industrial policies, the learning by doing process discussed in this paper, and innovation in general, is something that needs to be modeled at a more micro level. Whether the government can do a better job than market forces in directing investment in the presence of this kind of external effect is an important question that is left open by our analysis. Second, with regard to trade policies, open access to U.S. markets for Mexico mean open access to Mexican markets for the U.S. in the context of the NAFTA. It would be difficult, if not impossible, politically for Mexico to pursue selective protectionist policies like those of Korea.

6. Aggregation Issues

One problem that confronts a researcher interested in constructing a dynamic general equilibrium model to analyze the impact of NAFTA is what level of aggregation to use. There is evidence that some disaggregation is necessary: Echevarria (1991), for example, finds that, while changes in total factor productivity in the OECD has been negligible in recent decades in agriculture, it has been significantly positive in services, although less than in manufacturing. Simple regressions of growth in income per capita on the initial composition of output, that is, on percentages of output in industry, agriculture, and services, account for more than 22 percent of the variation in growth rates. Furthermore, differences in total factor productivity between Mexico and the U.S. differ substantially across industries. The growth effects of a NAFTA are, therefore, apt to vary across industries. The empirical results of Backus, Kehoe, and Kehoe (1991), which finds that the simple endogenous growth models presented in this paper do well in explaining productivity growth in manufacturing but not growth in total output per capita further suggests that disaggregation is needed.

Obviously, much depends on the level of disaggregation of goods in the model. The costs of computing an intertemporal equilibrium, for example, go up very quickly with the number of sectors, at least if adding new sectors adds new state variables. The more sectors that we add, however, the more that we are able to capture gains from trade.

A further problem in applied modeling of trade and growth at a disaggregate level is that the objects in theoretical models that stress the development of new products do not have obvious empirical counterparts in the data. (We should note that work such as that of Brown (1987) and Watson (1991) indicate that the disaggregation of goods typically used in static trade models has problems in terms of capturing the degree of substitutability between imports and domestically produced goods.) Various approaches have been used to reinterpret trade data disaggregated using the S.I.T.C. in terms of these sorts of themes, for example, Feenstra (1990), Havrylyshyn and Civan

(1985), and this paper. This is obviously an area that needs more research, particularly research with a high imagination component.

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COMMENTS ON PAPER 6

BY JOHN W. SUOMELA

Comments on **Modeling the Dynamic Impact of North American Free Trade** by Timothy J. Kehoe

By John W. Suomela

Analyses of potential effects of a North American Free Trade Area (NAFTA) generally rely on comparative static models and show only a modest potential for gain. Kehoe claims that such comparative static models understate the true gains from a NAFTA because the greatest gains would be from increased growth rates. Unfortunately, none of the comparative static models that were presented at the USITC symposium addresses the question of the effect of a NAFTA on growth. Neither does Kehoe's paper. His modest goal is to provide some clues to how we might begin to analyze the potential dynamic effects of a NAFTA on Mexico's growth rate.

The potential effect of a NAFTA on growth of per capita income in Mexico depends on its effects on the accumulation of capital and on the productivity of capital and labor. While Kehoe states that "A major impact of NAFTA would be on capital flows," he also points out that it would be a gross oversimplification to look only at the capital flows into Mexico that might result from a NAFTA. It is equally important to look at consequent changes in the productivity of capital and labor within Mexico.

In particular, Kehoe suggests that it is important to consider the effects of learning by doing. All of the anecdotal and statistical evidence seems to support the view that learning by doing is important. But, most of the evidence of learning by doing has been gathered using cross-country analysis or is based on firm- or industry-specific case studies. There is little evidence that a free trade area enhances learning by doing.

Although removing restrictions on trade and investment generally encourages economic growth, and presumably learning by doing accompanies growth, countries can remove their restrictions unilaterally. "It is worth noting that the analysis in [Kehoe's] paper pertains to the benefits of free trade in general, not just the NAFTA." Therefore, the argument for a free trade area becomes a political argument, not an economic argument: *Mexico would gain from a NAFTA because a NAFTA would oblige Mexico to continue the economic reforms it has already instituted.*

ANALYZING PRODUCTIVITY GROWTH

I was drawn in as a discussant of Kehoe's paper at the USITC symposium because I was chairing the session, and the scheduled discussants did not show up. I cannot claim a familiarity with current literature on economic growth, so I will cover only those aspects of the paper that caught my interest.

The first thing that caught my interest was Kehoe's "learning by doing" equation:

$$\frac{y_{it+1}}{y_{it}}-1=(1+\beta_i Y_{it})^{\eta}\left[\frac{n_{it+1}}{n_{it}}\right]^{1-\alpha_i}\left[\frac{k_{it+1}}{k_{it}}\right]^{\alpha_i}-1.$$

where β, η, and α are positive constants, Y_{it} is real value added of industry i in period t, and y_{it} is the real output per capita. Even if per capita labor and capital were not to grow over time (i.e. by holding both per capita labor and capital (n_{it}, k_{it}) constant) and taking the natural log of both sides, we get

$$Dy_{it}=\eta\ln(1+\beta_i Y_{it})$$

where **D** is a log change operator.

Therefore, according to Kehoe's equation, the rate of growth in industry i would increase with its size, even if there were no addition to labor or capital.[1] The growth rate continues to accelerate forever, no matter how high it already is. But it is obvious that rapid growth eventually slows, even with the addition of labor and capital. Engineering studies and economic theory indicate that growth would be expected to follow an **S**-shaped curve. As the industry begins to import technology and as workers begin to become more productive by acquiring human capital, the growth rate accelerates. The greatest contribution of learning by doing occurs at the beginning of the **S**-curve. Growth begins to slow when the the industry approaches the technology frontier, which is the limit on output per worker given the present state of technology.

Figure 1 is drawn to illustrate typical industry growth paths (labeled y_1 through y_4). The steeper the growth path the higher the rate of growth. Line $y^*(t)$ is a stylized depiction of

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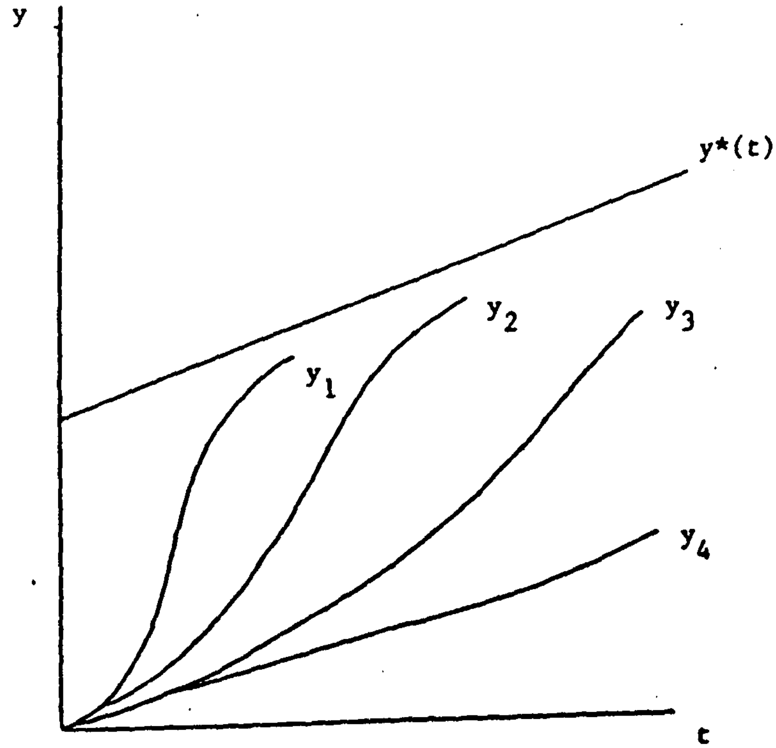
[1] The error is already obvious when Kehoe first introduces his learning by doing equation: $A_{(it+1)} = A_{it}(1+\beta_i Y_{it})^{\eta}$, where β_i and η are positive constants. A_{it} measures the external effects of learning by doing and is replaced by capital and labor in the above equation. Note that lower case characters are used to designate per capita values.

Figure 1



the technology frontier and is shown as an increasing function of time.[2]

One would expect that government policies exist that could set its industries on higher growth paths. Any gain from such a government policy would be related to the area between the higher growth path and the previous growth path. The present value of the benefits of such government policy are normally finite because, although more rapid growth will get the industry to the technology frontier faster, the two growth paths should eventually converge.[3]

One alternative specification for an S-curve (for fitting data to a growth path that starts slowly, accelerates with learning, and then decelerates as the technology frontier is

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[2] Actually, technology breakthroughs tend to occur in spurts, so the technology frontier should probably follow a step pattern.
[3] Unless, of course, the industry would not grow more rapidly than the technology frontier without a change in government policy.

approached) would be[4]

$$Dy = A + \alpha \ln y + \beta \ln(y^{*} - y).$$

Both α and β would be expected to be positive coefficients. Looking at Kehoe's empirical results, it appears that his variable $\mathbf{Y}^{j}$ (manufacturing output) could be positively correlated with $\mathbf{y}$ in this equation[5] and $\mathbf{y}^{j}$ in Kehoe's paper would be negatively correlated with the $\mathbf{y}^{*}-\mathbf{y}$ because $\mathbf{y}^{*}$ is a constant in cross country analysis. Therefore, Kehoe's empirical results tend to confirm this specification. But I wouldn't want to presume too much. I have not carried out the necessary empirical tests. But I have examined some data that were readily available.

Figure 2 shows a plot of some raw data from the International Monetary Fund's **International Financial Statistics**. After adjusting growth in GDP per capita for inflation and plotting all the available data for which the OECD has measures of per capita GDP purchasing power parity we get figure 3. As you can see, the data in figure 3 are consistent with figure 1. Countries whose industries are closest to the technology frontier (highest real GDP per capita) would not be expected to have the

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[4] This equation is used for illustrative purposes only. A more familiar form of this equation would be

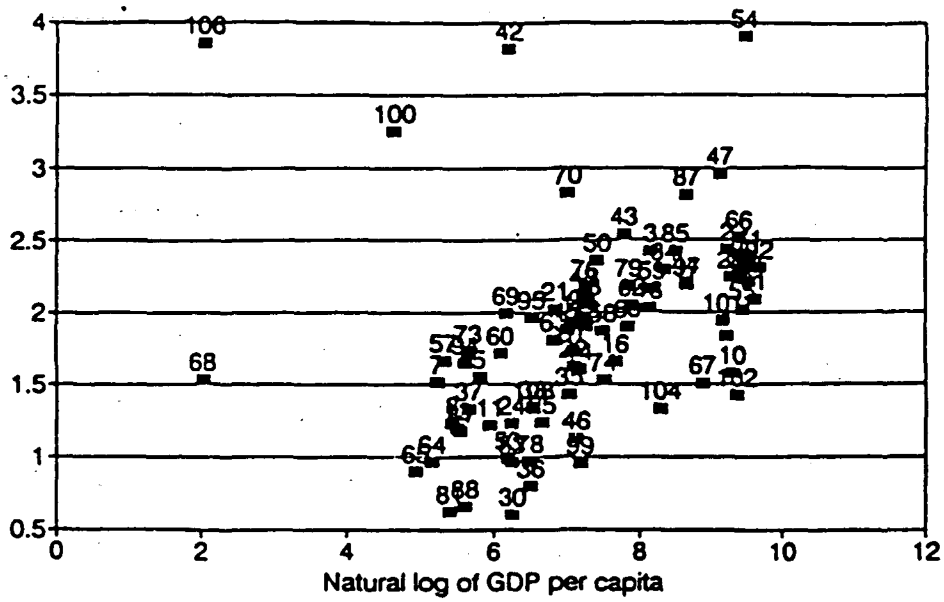
$$\ln(y_{t+1}) = \ln(A' y_t^{\alpha'} / (y^{*} - y_t)^{\beta'}),$$

where $A' = e^{A}$, $\alpha' = \alpha+1$, and $\beta' = -\beta$, which can be recognized as a generalization of a logit function. Note that with a logit function growth asymptotically approaches 0 rather than Dy^{*} as y goes to y^{*}.

[5] In Backus, et al, the correlation between the log of GDP per capita and the log of manufacturing per worker is .772.

Figure 2

Log Change in per capita GDP
from 1960 to 1980 (nominal prices)



highest rates of growth. Neither would the lowest per-capita GDP countries. Among the middle-income countries we would expect both the highest growth rates and the most variability in growth rates. Thus the data support the engineer's model. Furthermore, we would expect to find that growth rates slow as countries converge on the technology frontier. A comparison of figure 3, which shows growth from 1960 to 1980, with figure 4, which shows growth from 1970 to 1980, seems to bear this out. It appears that growth rates among the most advanced countries are converging on the rate for the United States.[6]

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[6] My armchair empiricism is backed up by a recent article in the first quarter 1992 **Economic Review** of the Dallas Federal Reserve: "The Comparative Growth Performance of the U.S. Economy in the Postwar Period," by Mark A. Wynne. Wynne compared growth among the G-7 countries and found convincing evidence that from 1950 to 1988 real per capita GDP and growth rates of real per capita GDP are converging on the U.S. rate for all of the G-7 countries.

Figure 3

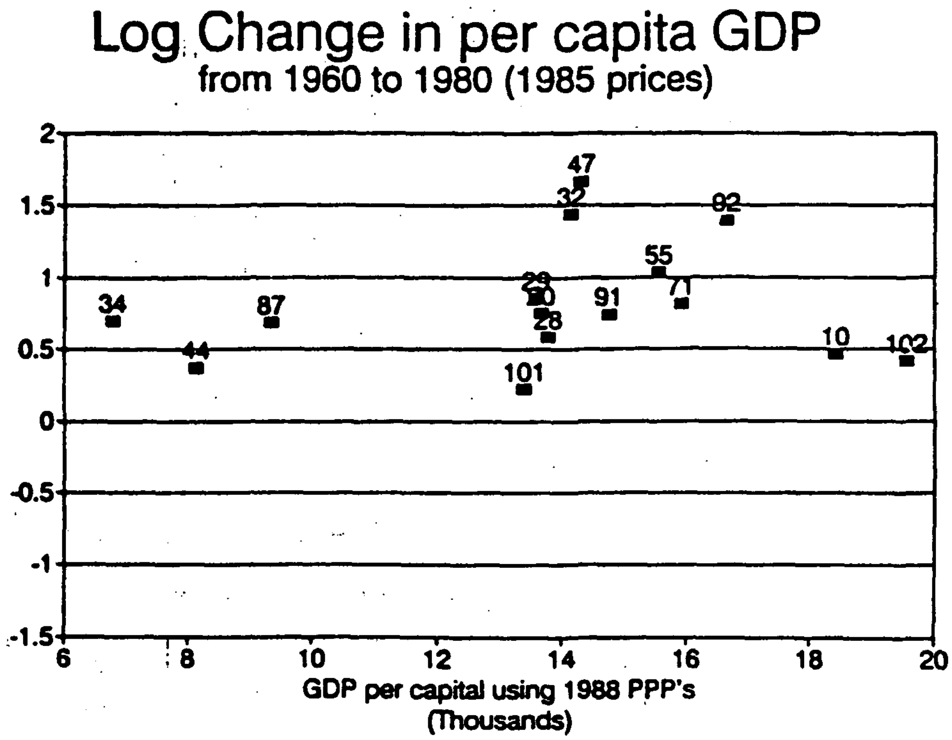
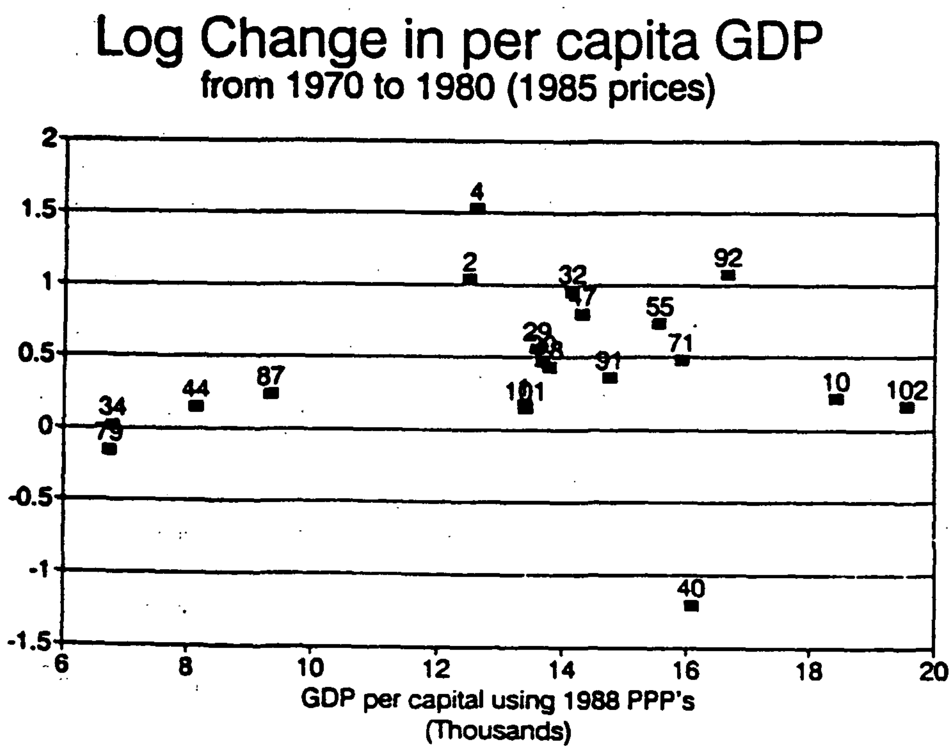


Figure 4



The distribution of growth rates predicted in figure 1 and depicted in figures 3 and 4 indicate that there is a problem with heteroscedasticity: the variation of growth rates is greatest for middle-income countries. Because there are plenty of observations, and because we are interested in policies that could affect Mexico's growth rate, the cross-sectional analysis should probably be confined to middle-income countries, thus eliminating income as an independent variable. By finding determinants of growth for countries at approximately the same stage of development as Mexico the results would be more applicabile to the case of Mexico, and there would be an improvement in the statistical properties of the data.

There are two other variables for which Kehoe found significant relationships with the rate of growth: the specialization index and the Grubel-Lloyd index. Both of these are specialization indexes: the first in an inter-industry specialization index and the second is an intra-industry specialization index. Both of these appear to be indicators of the openness of an economy. These should be important because a NAFTA should leave the economies of Mexico, Canada, and the United States more open to each other and thus should allow a greater degree of specialization, at least in the case of Mexico.

CONCLUSIONS

While Kehoe's evidence is compelling, it is not convincing. A NAFTA should be good for Mexico because the combined market of the United States, Canada, and Mexico is greater then Mexico's protected market. But Mexico has protected itself from the world market, not just the North American market, and Mexico has already increased its growth rate by unilaterally reducing trade and investment restrictions against the world and by reforming its domestic economy. How much more can Mexico's already high growth rate be increased by the further liberalization that would occur with a NAFTA? Given Kehoe's paper, should we presume that the comparative static models that were presented underestimate the benefits of a NAFTA? If so, by how much?

Country codes

1 Australia
2 Austria
3 Barbados
4 Belgium
5 Benin
6 Botswana
7 Burkina F
8 Burundi
9 Cameroon
10 Canada
11 Central A
12 Chile
13 China (PR
14 Columbia
15 Congo
16 Costa Ric
17 Cote D Iv
18 Cyprus
19 Czechoslo
20 Denmark
21 Djibouti
22 Dominican
23 Ecuador
24 Egypt
25 El Salvad
26 Ethiopia
27 Fiji
28 Finland
29 France
30 Gabon
31 Gambia
32 Germany
33 Ghana
34 Greece
35 Guatemala
36 Guyana
37 Haiti
38 Honduras
39 Hungary
40 Iceland
41 India
42 Indonesia
43 Iran
44 Ireland
45 Israel
46 Jamaica
47 Japan
48 Jordan
49 Kenya
50 Korea
51 Kuwait
52 Lesotho
53 Liberia
54 Libya
55 Luxembour
56 Madagasca
57 Malawi
58 Malaysia
59 Malta
60 Mauritani
61 Mauritius
62 Mexico
63 Morocco
64 Myanmar
65 Nepal
66 Netherlan
67 New Zeala
68 Nicaragua
69 Niger
70 Nigeria
71 Norway
72 Oman
73 Pakistan
74 Panama
75 Papua NG
76 Paraguay
77 Peru
78 Philippin
79 Portugal
80 Qatar
81 Rwanda
82 Saudia Ar
83 Senegal
84 Sierra Le
85 Singapore
86 Solomon I
87 Spain
88 Sri Lanka
89 Sudan
90 Swaziland
91 Sweden
92 Switzerla
93 Syria
94 Tanzania
95 Thailand
96 Togo
97 Trin & To
98 Tunisia
99 Turkey
100 Uganda
101 UK
102 US
103 Uruguay
104 Venezuela
105 Yemen
106 Yugoslavi
107 Zaire
108 Zambia
109 Zimbabwe

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COMMENTS ON PAPER 6

BY LANCE TAYLOR

Lance Taylor
February 1992

Comments of "Modeling the Dynamic Impact of North American Free Trade"

by Timothy J. Kehoe

This paper restates the familiar points that neither resource reallocation due to getting prices more "right" nor physical capital accumulation is a good explanation for productivity growth. It also proposes channels via which a North American Free Trade Agreement (NAFTA) might raise the growth rate of Mexican labor productivity, viz

(1) Although capital flows to Mexico will not have a decisive effect on the growth rate, they may help speed it up. Kehoe thinks that national savings differentials due to differing U.S./Canadian and Mexican age structures in overlapping generations growth models may have some influence (via international capital movements) in this context. The assertion seems empirically improbable, but even more striking is the fact that nowhere does Kehoe discuss investment behavior. His approach is thoroughly neoclassical in the sense that his growth models are based on hitchless transformation of saving into capital stock with all resources fully utilized and no independent investment demand. As discussed below, this view is a poor representation of Mexico in the 1980s and early 1990s, and may well be a poor way to discuss growth prospects for the future as well.

(2) Increasing returns due to learning may be important sources of higher productivity. If the economy is opened, it may specialize in certain product lines, and increase learning. After a bit of manipulation, a specialization index based on the sum of squares of sectoral shares in total output is proposed.

(3) On the input side, access to a variety of intermediate and capital goods may raise productivity. A Grubel-Lloyd trade diversity index is proposed

to quantify this possibility.

(4) When a base level of manufacturing output (as a proxy for accumulated learning) and these measures of export specialization and trade diversification are put into a cross-country regression equation for the growth rate of manufacturing output per worker (from a paper by Kehoe and other authors), they get positive coefficients, although strictly speaking the one for specialization is not significantly different from zero. Hypothetical increases in the export specialization and Grubel-Lloyd indexes for Mexico after NAFTA are plugged into the equation: voila, productivity growth would rise by 1.656% per year.

These ideas are entertaining as far as they go, but fail to recognize the real constraints NAFTA may put on the Mexican economy. We can briefly mention a couple of possibilities:

(1) Throughout the past decade, Mexican growth has been triply limited by foreign exchange, saving, and investment constraints, which can be formalized in a "three-gap" model (Taylor, 1991). In Figure 1, we plot these restrictions as they relate capacity utilization (or the level of output) and the growth rate of capacity (or investment). Both variables of course took low levels in Mexico after 1982.

Since in fact intermediate and capital goods imports trade off inversely as users of foreign exchange (for given exports and capital inflows, if one goes up the other must go down) and are essential inputs into domestic production and capital formation respectively, there is a negatively sloped foreign exchange constraint FF. Both saving (SS) and investment (II) have positive slopes.

The solid lines represent the slow growth/low output equilibrium of the 1980s -- no capital inflows and an enforced trade surplus. The dashed lines show an early 1990s form of disequilibrium. Capital inflows (direct investment and repatriation of capital flight) have raised the saving and foreign restrictions but physical investment (as opposed to financial speculation on the stock market) has not fully responded and is the limiting factor now.

Upward and downward movements in these schedules will heavily influence growth in the future. For example, if NAFTA is put off for political reasons, financial capital may well flow back from Mexico to the U.S. as confidence lapses, shifting the external and saving limits back down and restoring the stagnant equilibrium of the 1980s. Even if this glum prospect is avoided, the rate of capital formation in Mexico will have to rise if growth is to be resumed. Even successful establishment of NAFTA may not give animal spirits a sufficient boost.

(2) Investment is also important as a bearer of technical change -- the notion that productivity-enhancing technology is built into new capital formation is at least as convincing as the theories proposed by Kehoe. Figure 2 illustrates one implication.

Suppose that there are two sectors in the economy, and capital cannot be moved between them once installed. However, over time the ratio of sector 1's capital stock to sector 2's can change as investment occurs. Under standard assumptions, sector 1's profit rate will then fall and sector 2's rise. If capital stock growth rates respond to profit rates (a standard investment theory), we get the two solid growth curves that are are illustrated. They intersect at a steady state where both sectors' capital stocks (and thereby productive capacities, under more assumptions) expand at the same rate.

Suppose further, in a specific case, that sector 1 produces intermediate goods under a policy of import substitution, and that sector 2 is a home goods user industry. Increasing protection will raise profitability in sector 1 and cut it in sector 2. The investment curves will shift to the dashed positions, with the outcomes being an increase in the ratio of intermediate to home goods capital stocks, and an ambiguous change in the steady state growth rate.

The moral is that by removing protection, NAFTA could destimulate investment in some sectors and raise it in others, with an unclear effect on the steady state capital stock growth rate. If productivity growth is strongly responsive to investment in the sectors that are hurt, it could slow down overall.

From the angle of both macroeconomic and sectoral investment behavior, potential effects of NAFTA on Mexico are not clear. Investigating them would be just as important as looking at the potential linkages that Kehoe points out.

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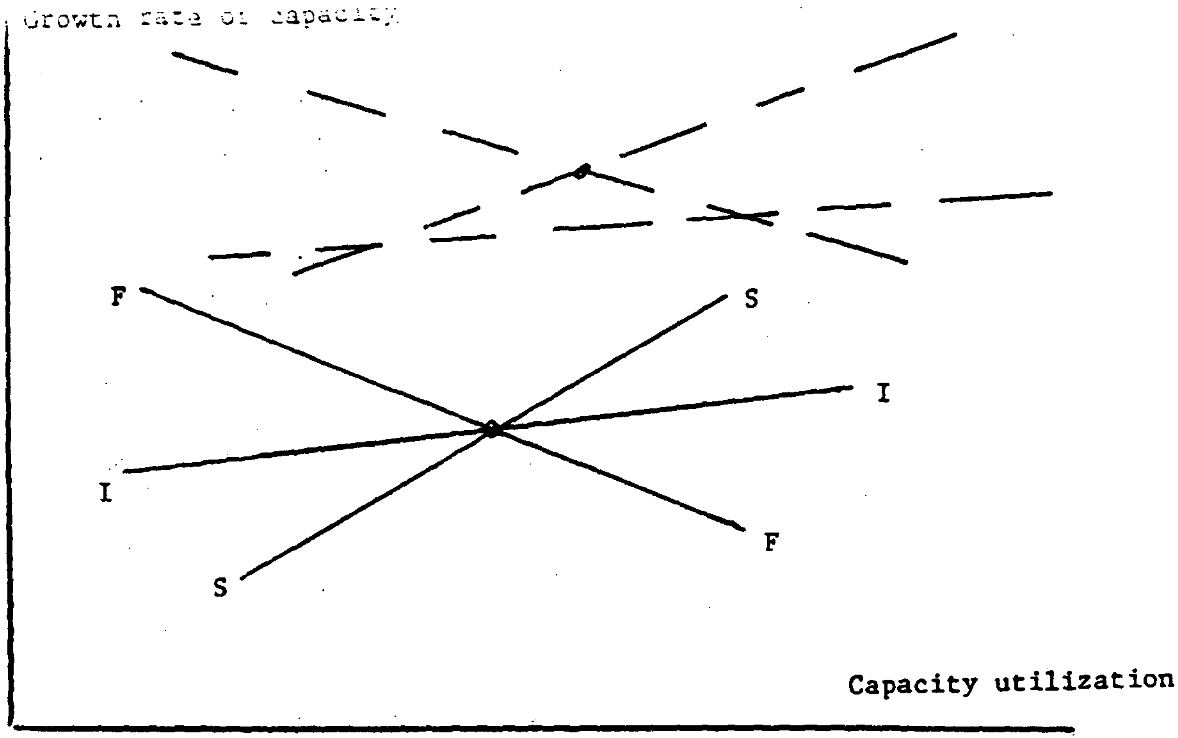

Figure 1: Three-Gap restrictions

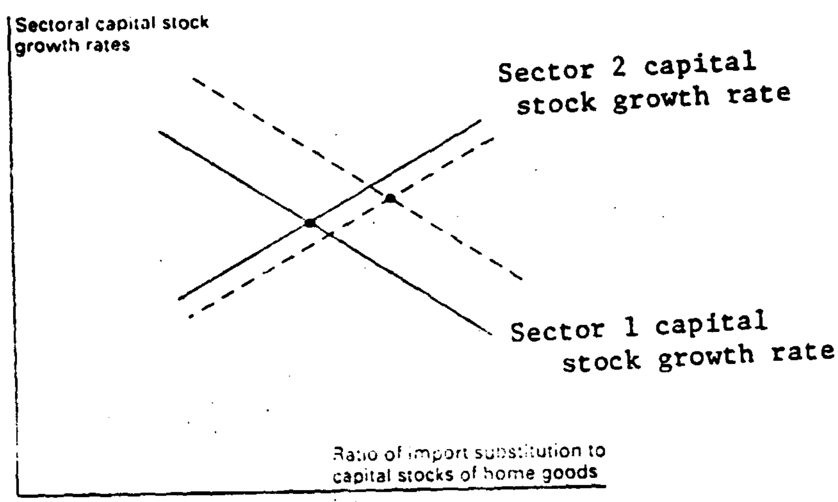

Figure 2: A two-sector growth model

PAPER 7

"TRANSITION PROBLEMS IN ECONOMIC REFORM: AGRICULTURE IN THE MEXICO-U.S. FREE TRADE AGREEMENT," BY SANTIAGO LEVY AND SWEDER VAN WIJNBERGEN

December 1991.

TRANSITION PROBLEMS IN ECONOMIC REFORM: AGRICULTURE IN THE MEXICO-US FREE TRADE AGREEMENT*

Santiago Levy and Sweder van Wijnbergen
Boston University | World Bank and CEPR

Abstract

How fast should Mexican agriculture be incorporated into the North-American FTA? What policies should characterize the transition? We use Mexican agriculture as a case study to analyze the transition problems that arise in most major economic reforms. We focus on the implications for policy design of the absence of efficient capital markets; on the welfare costs of reforming only gradually; on incentive problems created by trade adjustment policies; and on the redistributive aspects of policy reform in the presence of realistic limits on available intervention instruments. Our key point is that adjustment should focus on increasing the value of the assets owned by the groups affected, and not on direct income transfers or programs targeted on output or other characteristics controlled by the beneficiaries. We target adjustment on what people have, as opposed to what people do.

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1. Introduction

Agriculture contributes less than 8% of Mexico's GDP. Nevertheless, when in June 1990 Presidents Salinas and Bush announced negotiations on a Free Trade Agreement (FTA) between Mexico and the US, it was clear that agriculture would be a major stumbling block. At stake is much more than the efficiency gains that liberalizing agriculture, and particularly maize, would bring to Mexico, substantial as we find them to be. Maize protection is Mexico's de facto rural employment and anti-poverty program, so distributional concerns complicate the liberalization process. Further complications arise because, while high maize prices almost certainly contribute to rather than alleviate poverty, rapid liberalization would increase poverty on the transition path.

This paper focuses on the distributional effects of liberalizing maize in Mexico, the policies that can be put in place to alleviate them, and the incentive problems such policies in turn lead to. Our results, however, are of much wider interest than the FTA negotiations themselves. Agriculture has been a major stumbling block in trade negotiations everywhere. Agriculture has always been excluded from GATT negotiations until the recent Uruguay round, which almost collapsed because of it. In many cases the reasons are similar to the ones discussed in this paper.

Transition problems like the ones analyzed in this paper are likely to arise in most major economic reforms. In particular, we focus on the implications for policy design of the absence of well functioning capital markets; on the welfare costs of reforming only gradually; on the incentive problems created by trade adjustment policies; and on the redistributive aspects of policy reform in the presence of realistic limits on the array of intervention instruments available to the Government.

Maize is Mexico's key crop and main rural employer; it occupies the largest acreage, it is the most costly in terms of fiscal subsidies, and it is the most protected[1/]. It is grown by subsistence farmers, mostly in rain-fed lands; it is also grown by medium and large scale farmers in rain-fed and irrigated lands. Since irrigated lands have higher yields, the latter groups, who are not among the poor, receive large infra-marginal rents. Only 0.32 of every peso of subsidy reaches subsistence farmers (Levy and van Wijnbergen (1991)).

Tortillas, Mexico's main staple food, are mainly made from maize. The government subsidizes tortillas, but the subsidies fail to fully offset the effects of maize protection; thus the rural poor are taxed on their main consumption good. For landless workers and the 65% of maize producers whose land is so marginal that they are actually net maize buyers, this tax exceeds the subsidy they receive as producers.[2/]

We show that liberalization lowers the value of rain-fed land, thus hurting the sub-set of the rural poor who own land by reducing the rents derived from this asset. This would lower the value of the main asset farmers can collateralize, reducing their access to credit at the very moment when such access is needed most. Liberalization also lowers the demand for rural labor. And since migration links rural and urban labor markets,

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1/ Import controls support a price 70% above the world price (allowing for transport costs and quality differentials); 42% of the total arable land is allocated to this crop, which employs one out of three rural workers; subsidies to maize and tortillas cost about US$ 1 billion in 1991.

2/ In urban areas the tax is partly offset by deliveries of tortillas through the 'tortivale' program. Under this program each urban family earning less than two minimum wages receives one kilo of tortillas per day free. This is less than daily family consumption, so the program is infra-marginal.

liberalization of maize lowers wage rates across the board. The effects of liberalization thus spill-over to the urban poor.

Lump-sum transfers are not a feasible option in Mexico, so other policies to protect the poor are needed. Moreover, Mexico's poor have limited access to capital markets, access which may in fact be reduced by the liberalization because it lowers land prices. Hence, these policies must not only focus on steady-state welfare, but also on the transition period. And because the FTA is a permanent shock, these policies should also facilitate change towards other activities.

In section 2 we sketch an inter-temporal model to trace the impact on households' welfare of Mexico-US free trade in agriculture, and of different adjustment policies. In section 3 we quantify the trade-offs between the speed of liberalization and the size of the efficiency gains; we also study the impact on labor and land markets. Section 4 designs a program to facilitate adjustment towards free trade in maize that protects the rural poor during the transition. Political economy considerations that bear on the design of this program are addressed in section 5. Section 6 concludes.

2. Model Structure

2.1 Static Relationships

The economy is divided into an urban and a rural sector. The urban sector produces only a tradeable industrial good and a non-tradeable services good. Each of these goods is produced with fixed intermediate inputs and a Cobb-Douglas technology for urban labor and sector-specific capital.

Land and rural labor produce five tradeable goods in the rural sector: maize, other basic grains, fruits and vegetables, other agricultural goods, and livestock. We distinguish between rain-fed (T1) and irrigated (T2) land, because yields and land/labor ratios for the same crop differ between types of land. We include tortillas as a pure consumption good. Tortillas are non-traded, but by assumption perfectly elastically supplied at the zero-profit, tax/subsidy inclusive price; their price depends only on the producer price of maize and any taxes or subsidies.

We distinguish six types of households, classified by ownership of factors of production. Four are in rural areas: landless rural workers, whose only asset is labor; subsistence farmers, who on average own two hectares of rain-fed land, work their own land and participate in the rural labor market; rain-fed farmers, who own the remainder of the rain-fed land and half of the land used for livestock; and owners of irrigated land, who own the irrigated land, and the other half of livestock land. Neither rain-fed nor irrigated farmers supply labor. Urban workers supply all urban labor, and urban capitalists own the urban capital stock.

~~Urban workers, landless rural~~ workers and subsistence farmers all have the same preferences, as do rain-fed and irrigated land owners and urban capitalists. The first group allocates a much larger share of expenditure to rural goods than the second, so changes in food prices have a much larger impact on the first group[3/].

Migration plays an important role in determining the incidence of changes in agricultural protection. While migration to the US has attracted most international attention, rural-urban migration inside Mexico is quantitatively more important. Mexico's rapid urban growth has been largely

3/ Preferences are given by a nested Cobb-Douglas/CES/CES utility function. The outer nest CD allocates expenditures between a composite rural good, industry and services. The next CES nest aggregates the five rural goods into a composite rural good. The last CES nest distributes maize consumption between raw maize and tortillas.

by such migration, and involves numbers in excess of any available estimate of the number of Mexican migrants currently in the US (Garcia y Griego (1989)).

We therefore focus on internal migration, and assume that migration flows keep the ratio of per-capita utility differentials between landless rural workers (the most likely migrants) and urban workers (the most likely target group) constant. We use utility differentials rather than wage differences (as in the Harris-Todaro model) because urban transfers like the tortivale program also affect migration choices. We capture all such effects by focusing on total utility. With L^{ru} the stock of migrants from rural to urban areas, U_r and U_u per capita utility of a worker in the rural and urban areas, respectively, and the superscript 0 an initial equilibrium, we get:

$$L^{ru} = k[(U_u/U_r)/(U_u^0/U_r^0)]^{\eta} - k \quad ; \quad k > 0 \quad \eta \geq 0 \tag{1}$$

where η is the elasticity of migration to urban-rural utility differentials. Keeping utility differentials constant is achieved by setting η very high.

We distinguish <u>physical</u> (the actual physical hectares of land allocated to a particular crop) from <u>effective</u> land (the amount actually usable). The relationship between them is:

$$\tilde{T}_j = \tau_j . T_j^{\phi_j} \quad ; \quad \tau_j > 0, \quad 0 < \phi_j < 1 \tag{2}$$

where ~ denotes effective land; the subscript j refers to the four agricultural goods. Equation (2) is intended to capture incentives for crop rotation and other practices that preclude allocating all land to a single crop. Irrigated land is assumed to be better than rain-fed in that $\phi1_j \leq \phi2_j$, so that diminishing returns set in more slowly than in rain-fed lands. Hence, for the same price change, the supply response in irrigated lands is stronger.

Agricultural production functions exhibit constant returns to scale to labor and <u>effective</u> land; thus value added in maize, m, in rain-fed lands is:

$$VA1_m = LR1_m^{1-\alpha 1_m} \tilde{T}1_m^{\alpha 1_m} = LR1_m^{1-\alpha 1_m} \tau 1_m^{\alpha 1_m} T1_m^{\phi 1_m \alpha 1_m}$$
$$= \rho 1_m LR1_m^{1-\alpha 1_m} T1_m^{\lambda 1_m} \quad (3)$$

$LR1_m$, $T1_m$ are rural labor and rain-fed lands allocated to maize; $\rho 1_m = \tau 1_m^{\alpha 1m}$ and $\lambda 1_m = \phi 1_m . \alpha 1_m$. Similar functions apply to the other agricultural products in both types of land. Since $0 < \lambda < \alpha < 1$, there are diminishing returns to <u>physical</u> land for given labor intensity. Thus, for a wide range of prices there need not be full specialization in agriculture.

Trade interventions are modelled as combinations of production and consumption taxes/subsidies. We also model direct lump-sum transfers to urban workers through the tortivale program. Such tortilla deliveries are infra-marginal, and thus equivalent to a direct income transfer. For given taxes and subsidies, domestic prices for tradeable goods follow world prices, as we assume domestic goods to be perfect substitutes for world goods, and take world prices to be exogenous. But services are non-traded, so this market, like the markets for rural and urban labor, and rain-fed and irrigated land, is cleared by prices. Our model thus determines, via the excess demand functions in (4), factor prices and the real exchange rate:

$$\begin{aligned} LR^D(P) + L^{ru}(P) - LR^0 &= 0 \\ LU^D(P) - L^{ru}(P) - LU^0 &= 0 \\ T1^D(P) - T1 &= 0 \\ T2^D(P) - T2 &= 0 \\ qs_s(P) - qd_s(P) &= 0 \end{aligned} \quad (4)$$

P contains the rural and urban wage rates, the rental rates on rain-fed and irrigated land, and the price of services (the real exchange rate). The vectors of goods' supply and demand are, respectively, qs and qd, the subscript s refers to services, and the superscript D denotes the market demand for a particular type of labor or land. LR^0 and LU^0 are the initial distribution of the total labor force so that in the base case $L^{ru} = 0$.

2.2 Inter-Temporal Relationships

At each period the economy is described by the excess demand functions in (4). But from one time period to the next the economy changes as a result of exogenous and policy-induced changes. The exogenous changes are: (i) growth of labor and population[4/], (ii) Hicks-neutral technical change, (iii) growth of the urban capital stock[5/], (iv) government spending in non-agriculture items, and (v) the path of world prices. Importantly for our results, we assume that the rate of growth of productivity in rain-fed agriculture is lower than in irrigated agriculture. This reflects the fact that high yielding varieties, pesticides, fertilizers and other innovations are easier to implement in irrigated lands.

We model two policy-induced changes to alter the economy's growth path: trade policy and agriculture investments. Within trade policy, attention focuses on the sectors where liberalization occurs, on the date at which changes start, and on the speed at which they take place. Within agriculture investments, we focus on the size and time-profile of irrigation investments.

Investments in irrigation infrastructure change the endowments of irrigated and rain-fed land with a 1-period gestation lag:

4/ To reflect Mexico's demographic transition, the rate of growth of labor, 3%, is set higher than the rate of growth of population, 2%. During the transition period, see below, the rate of growth of labor slowly declines until in the steady-state it equals that of population. Thus, households who own labor initially grow faster than households who own only land or capital.

5/ In a fuller model of the impact of the FTA, investment rates in industry and services would clearly be endogenous. Here, however, we are interested in the effects of changes in agricultural liberalization only.

$$T1_t = T1_{t-1} - RI_{t-1} \quad ; \quad T2_t = T2_{t-1} + RI_{t-1} \tag{5}$$

RI is the number of hectares of rain-fed land transformed to irrigated land. Owners of rain-fed land (subsistence peasants and rain-fed farmers) are assumed to benefit from irrigation investments in proportion to the initial share of rain-fed land held by each group. The investments are paid for by the government. The real resource costs of irrigation are an increasing function of the stock of irrigated land, reflecting the fact that as these investments increase, lands of poorer-quality are encountered (greater distance from water resources, etc.). We capture this by:

$$Q_t = q\left(\frac{\sum_{i=0}^{t-1} T2_i}{T2_0}\right)^{\gamma}; \quad q>0;\ \gamma>1 \tag{6}$$

where Q_t is an index of marginal costs of irrigation investments.

The rates of growth of labor in each period, gl_t, are exogenous, but migration responds to endogenously determined utility differentials, implying in turn that the urban and rural labor force are determined endogenously by:

$$LR_t = (LR_{t-1} - L^{ru}_{t-1})(1 + gl_{t-1}) \quad ; \quad LU_t = (LU_{t-1} + L^{ru}_{t-1})(1 + gl_{t-1}) \tag{7}$$

2.3 The Transition Path and the Steady-State

We divide the future into a transition path and a steady-state. The transition path lasts T-1 years; the steady-state obtains from period T onwards, going out to infinity. All policy-induced changes take place during the transition period. During this period the rate of growth of labor also converges to that of the population. In the steady-state, on the other hand, all households grow at the same rate, and the rate of growth of aggregate output, which equals the rate of growth of the capital stock, is given by the sum of labor and productivity growth.

Hence, by assumption, static and intertemporal relative prices remain unchanged over the interval $[T,\infty)$. This allows us to Hicks-aggregate the steady-state path of the economy. It suffices to simply calculate period T values, since all future periods will be identical up to a uniform scale factor (growth rate) for all quantities. The aggregation process therefore only affects discount factors between T-1 and T; these are larger than those between earlier periods because this 'period' is replicated an infinite number of times (again, up to a uniform scale factor for all quantities).

Let the common and constant post-T growth rate be g and the real world interest rate r^w. Define $\delta=1/(1+r^w)$ and $\delta_a=(1+g)/(1+r^w)$, where δ_a is the period-to-period growth-adjusted discount factor. Then the following expressions obtain for discount factors from year i back-to-period-1, $\delta(i)$:

$$\begin{aligned} \delta(i) &= \delta^{i-1} && \textit{for } i < T \\ &= \sum_T^\infty \delta^{i-1} = \frac{\delta^{T-1}}{1-\delta} && \textit{for all } i > T \textit{ combined} \end{aligned} \tag{8}$$

Consider now the Net Present Value, NPV_y, of $\{y_t\}$, where $y_t=y_{t-1}(1+g)$ for all t > T:

$$\begin{aligned} NPV_y &= \sum_1^\infty y_t.\delta^{t-1} = \sum_1^{T-1} y_t.\delta^{t-1} + \delta^{T-1}.\sum_T^\infty y_T.(1+g)^{t-T}\delta^{t-T} \\ &= \sum_1^{T-1} y_t.\delta^{t-1} + \delta^{T-1}\sum_T^\infty y_T.\delta_a^{t-T} = \sum_1^{T-1} y_t.\delta^{t-1} + \frac{\delta^{T-1}}{1-\delta_a}.y_T \end{aligned} \tag{9}$$

Thus the infinite horizon is captured by calculating period T only (out of all $[T,\infty)$ periods), but adjusting the period T discount factor to equal:

$$\delta(T) = \frac{\delta^{T-1}}{1-\delta_a} \tag{10}$$

2.4 Budget Constraints and Welfare Measures

Only urban capitalists save and invest. Private investment is driven by the exogenously given growth of the capital stock. Private savings is a constant proportion of urban capitalist's income. This proportion is exogenous during the transition period, but is endogenized in the steady-state to satisfy their inter-temporal budget constraint. Thus, if during the transition period they accumulated debt (assets), the steady-state savings rate is increased (decreased) so that the discounted value at time T of future savings over investment equals the value of the debt (assets) accumulated up through period T-1; see the appendix for details.

Household's welfare is the present discounted value of the time-paths of utility $(U^h_0 \ldots U^h_{T-1}; U^h_T)$. Let the rate of time-preference, ρ, be constant and equal for all households, and use a CRRA utility function to aggregate utility over time. If σ is the inter-temporal elasticity of substitution, we calculate welfare of household h as:

$$W_h = \sum_1^{\infty} \frac{u_h(c_t)}{(1+\rho)^t} = \sum_1^{T-1} u_h(c_t) \cdot \delta^t_{pref} + \frac{u_h(c_T)}{(1+\rho)^T} \sum_T^{\infty} \frac{(1+\sigma^{-1} \cdot gc)^{t-T}}{(1+\rho)^{t-T}}$$

$$= \sum_1^{T-1} u_h(c_t) \cdot \delta^t_{pref} + \frac{u_h(c_T) \cdot \delta^T_{pref}}{1-\delta_{prefA}} \qquad (11)$$

$$\text{where } \delta_{pref} = \frac{1}{1+\rho} \quad \text{and} \quad \delta_{prefA} = \frac{1+\sigma^{-1} \cdot gc}{1+\rho}$$

where gc is the steady-state rate of growth of per-household consumption.

Because all private households satisfy their inter-temporal budget constraint, the present discounted value (PDV) of the government deficit (surplus), equals the PDV of the trade deficit (surplus), B. We do not impose the condition that B = 0. Rather, we measure the difference between the PDV of the government deficit in the base path, denoted by B^o, and any B generated by an alternative path, and interpret the difference as the change in resources generated by the policy change. For each path we calculate the lump-sum transfers (taxes) required so that each household in each period has the same current utility as in the base path. When the value of these income compensations are included as part of government's expenditures, as if in fact these compensations had been given, the difference between B^o and B is the aggregate efficiency gain of any policy change.

3. The Impact of Free Trade in Maize

We study the implications of liberalizing maize by comparing a reference path for the economy that leaves maize and tortilla policies at their present levels with various alternatives where maize and tortilla prices are freed-up; on the reference path there is no irrigation investment[6], and US protection of its Fruits & Vegetables (F&V) sector stays at its present level.[7]

Table 1 shows the efficiency gains and distributional impact of eliminating all taxes and subsidies to maize and tortillas. The efficiency gains measure the increase in national income assuming the government delivers lump-sum transfers (or levies) so that every household has always the same utility as in the reference path. The welfare changes measure the impact of various alternative adjustments, but exclude the effects of such transfers.

In this section we only focus on the first two columns, where we evaluate the effects of liberalization without any adjustment policies. The first column shows the impact of an immediate elimination of all maize and

6/ Also, on the reference path real government spending and the capital stock in industry and services grow at 4% annually. Productivity in the urban sector grows at 2%, and in rain-fed (irrigated) agriculture at 0.5 (1.5%).

7/ We assume that protection to other agricultural sectors, basic grains in particular, is removed over a 5 year horizon. This allows sharper focus on whether to include maize in the FTA, and what kind of supporting policies are advisable. Because liberalization of grains is already incorporated in the base scenario, these results only provide measures of the efficiency gains (costs) from including (excluding) maize in the FTA.

tortilla taxes and subsidies; the second column shows the effects of a gradual change where maize moves linearly to world prices over 5 years (so that in the sixth year domestic and world prices are equal).

Table 1: Welfare and Efficiency Effects						
	Maize 1Y no CNA no F&V	Maize 5Y no CNA no F&V	Maize 1Y CNA no F&V	Maize 5Y CNA no F&V	Maize 5Y CNA F&V	Maize 6Y CNA early F&V
Subsistence Farmer[a]	0.967	0.971	1.007	1.011	1.013	1.015
Landless Rural Worker[a]	0.984	0.985	0.993	0.995	1.000	1.001
Rain-Fed Farmer[a]	0.943	0.949	0.996	1.001	1.000	1.003
Irrigated Farmer[a]	1.028	1.024	1.019	1.015	1.028	1.025
Urban Worker[a]	0.984	0.986	0.993	0.995	1.000	1.001
Urban Capitalist[a]	1.018	1.017	1.013	1.012	1.007	1.006
Efficiency Gains[b]	42.44	40.08	51.96	49.57	44.81	43.18
Cumulated Fiscal Gain[b]	23.17	21.94	18.04	16.76	13.64	12.50

a/Measured as a percentage of the reference case.

b/1989 US$ billion; Mexico's GDP was 207 billion in 1989.

Instantaneous liberalization leads to very large efficiency gains. The PDV of these gains is US$ 42.4 billion. With a growth-adjusted discount rate of about 3%[8/], these efficiency gains translate into US$ 1.22 billion of

8/ We assume a (risk-adjusted) world real interest rate of 7%, and long term rates of technical progress and population growth such that steady-state growth is 4%. The growth-adjusted discount rate thus is 2.9% (=(1.07/1.04-1)*100), implying a growth-adjusted discount factor of 0.972.

additional consumption per annum, or 0.6% of 1989 GDP. This is a very significant number for gains from removing taxes and subsidies to only two commodites: maize and tortillas. The efficiency gains of gradual liberalization are less, at US$ 40.1 billion, but actually not by very much. Distributing the adjustment over a five year period reduces the net discounted value of the efficiency gains by only 5.5%. Thus the efficiency costs of a more gradual approach do not seem large when compared to the benefits that maize liberalization eventually leads to.

But the aggregate efficiency gains have substantial distributional effects. To understand how different groups are affected by the policy change, first look at what happens to the prices of the factors of production. The more straightforward one is labor. As Figure 1 shows, rural product wages are adversely affected by the cut in maize prices. While maize is less labor-intensive than fruits and vegetables, it is more labor-intensive than all other activities in agriculture, hence rural product wages fall once maize prices go down.

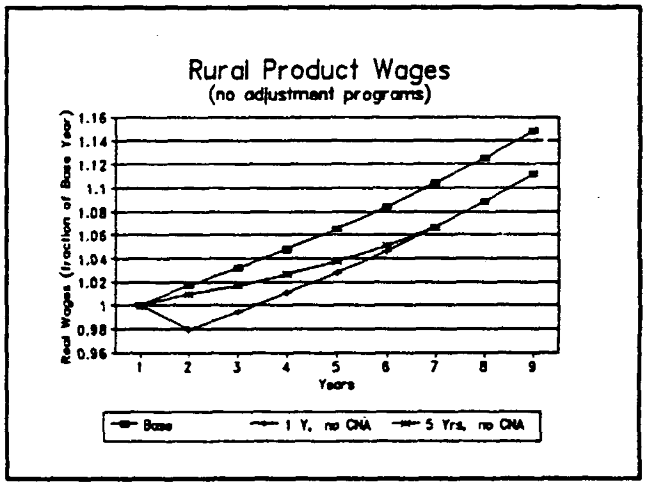

Figure 1

Table 2 shows the discounted value of all current and future rental income for both types of land. Column 1 indicates that the value of rain-fed land drops by almost 25% under immediate liberalization, clearly a very significant capital loss. This is because most maize is grown in rain-fed lands, where substitution possibilities towards other crops are much more limited than on irrigated land. The value of irrigated land actually goes up.

Because both substitution possibilities and labor-intensity are higher in irrigated lands, the positive effect of lower rural product wages offsets the negative impact of lower maize prices.

Table 2: Land Values and Land-Holdings[a/]

	Rain-fed Land	Irrigated Land	Land-holdings of Subsistence and Rain-fed farmers	Land-holdings of Irrigated farmers
Base Case	12.065	40.169	12.065	40.169
Case 1: 0 year adjustment, no CNA Program	9.231	40.800	9.231	40.800
Case 2: 5 year adjustment, no CNA program	9.443	40.725	9.443	40.725
Case 3: 0 year adjustment, with CNA program	9.180	40.668	11.499	40.668
case 4: 5 year adjustment, with CNA program	9.390	40.597	11.703	40.597
case 5: 5 year adjustment, with CNA program, access to US F&V market	9.608	42.175	12.030	42.175
case 6:as 5, but maize price cuts take last 6 years & start one year after CNA program	9.726	42.137	12.141	42.137

a/ million pesos of 1989 per hectare.

Contrasting the fall in land values with the reduction in rural product wages, it is clear that a larger part of the adjustment falls on land. The reason for this is that labor is more mobile than land. Labor can be re-allocated within agriculture towards other crops with much more ease than rain-fed land, and in addition some of the impact on labor is shifted to urban workers through rural-to-urban migration.

Figure 2 shows the migration response. Note first that under the reference case migration is substantial. Long-term productivity trends do not favor agriculture, particularly not rain-fed agriculture. This, together with the exhaustion of land on the extensive margin, makes it clear that even with current maize policies future migration will be substantial. The model predicts a cumulative migration of almost 1.2 million workers over the next decade. Such large migration suggests that maize protection as a rural

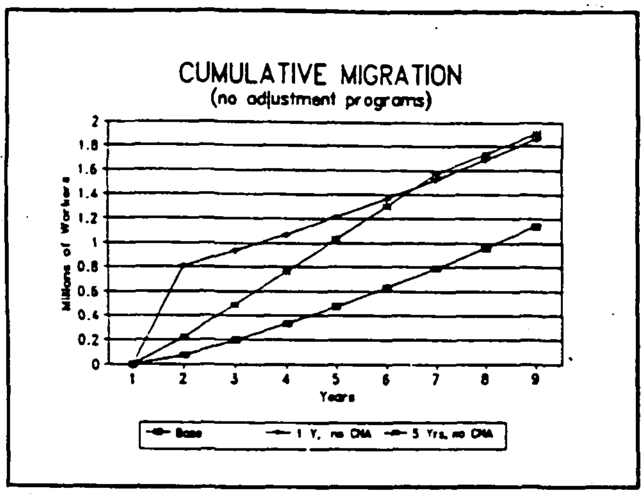

Figure 2

employment policy is likely to fail increasingly or, alternatively, become much more expensive than it already is.

Immediate liberalization has a large impact on migration, adding 700,00 workers in a single year (Figure 2). Gradual liberalization also increases migration over the reference case, but does so at a slower pace. However, after the adjustment is over, the cumulative amount of migration is the same. Table 1 shows what these factor price developments imply for households' welfare. Rural landless workers lose out as rural wage rates fall. But their welfare drops less in percentage terms than rural product wages do, because they are also consumers of maize and profit from lower maize prices. As Figure 3 shows, the drop in the rural consumption wage is less than the fall in the rural product wage.

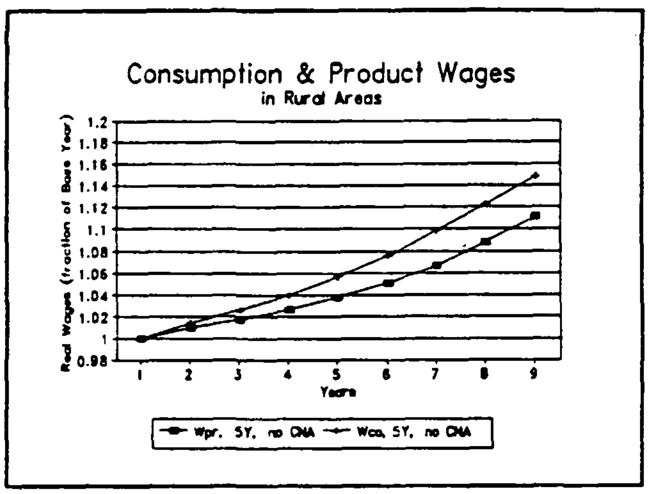

Figure 3

Subsistence farmers own rain-fed land and hire out as day laborers to other farmers; they are thus doubly hit as both the value of their land drops by 25%, and their labor income declines in line with the drop in rural wages (though they also benefit from lower consumer prices). The situation is more complex for rain-fed and irrigated farmers. They both lose because of lower maize prices, but they gain because of lower rural wages (since they are both net users of labor). These two factors are capitalized in land prices, and the balance is clear from table 2: rain-fed farmers lose substantially, while irrigated farmers experience a small gain. Note that under gradual liberalization values of rain-fed land fall less than under immediate, since protection-induced rents can be reaped for five additional years.

Figure 4 illustrates how this affects rain-fed farmers. The shaded area measures the differences in utility between immediate ('cold turkey') and gradual liberalization. The gradual path gives them additional rents during the transition (although at declining rates), but it produces no further gain once the transition is over.

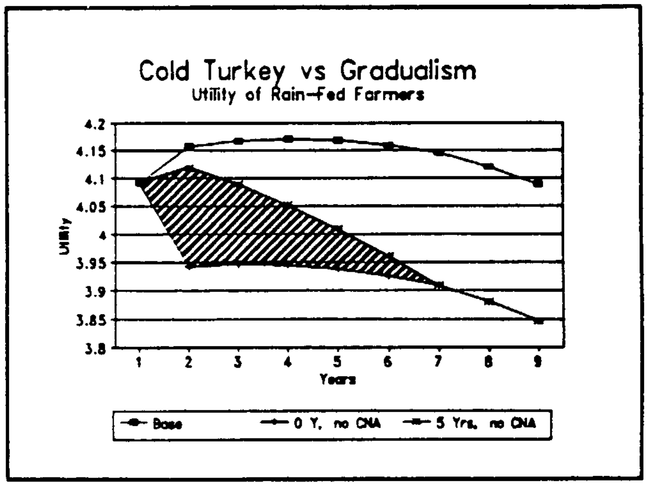

Figure 4

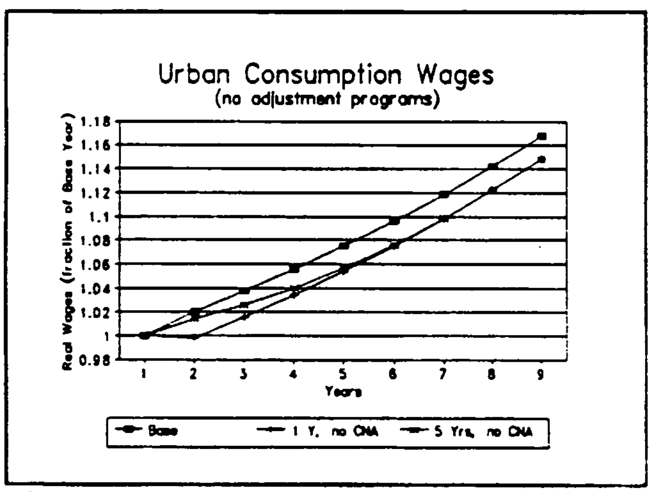

Figure 5

Migration slows the drop in rural wages at the cost of increased downward pressure on urban wages. Figure 5 shows that despite lower consumer prices for maize, urban worker's real consumption wages fall relative to the base case. And with the marginal product of capital increasing as a result of higher urban employment, capitalists are better off.

To sum up: the efficiency gains of liberalization in the absence of adjustment policies are substantial, but unevenly distributed. Immediate liberalization produces larger gains, but gradualism is not very costly; the aggregate efficiency gains foregone during the five year transition are small. But the converse of this is that gradualism barely mitigates the welfare loss for the groups affected. Of course, prolonging the liberalization over more than five years further insulates the groups concerned from welfare losses, but also further reduces the aggregate efficiency gains. The issue is therefore not only how fast to liberalize, but also what measures are taken during the transition to transfer some of the efficiency gains to the groups most affected by it. How this can be done is the subject of the next section.

4. What Type of Trade Adjustment?

The inclusion of Mexican agriculture into the FTA is a permanent change. A poverty-minded adjustment program for such a change should therefore have two objectives: first, transfer income to those among the poor that are adversely affected. Second, facilitate their finding alternative sources of income. The major problem in the design of such a program is that the first objective usually conflicts with the second.[9/]

A program designed to help maize producers would provide incentives to increase, or at least maintain, maize production, because benefits would decrease with lower output; such a program would discourage farmers from searching for alternative activities. Moreover, if the benefits are significant, the program would also provide incentives for rent-seeking and

9/ cf Diamond (1982) for this point.

graft; the number of 'registered' maize producers would soon exceed the rural population. This is particularly important in Mexico, where administrative capacity is weak, as are records of farm size and output. But, more fundamentally, a program focused on transfering income to maize producers fails to alter underlying conditions in agriculture. For the adjustment program to be transitory, it must increase the productivity of the factors owned by the groups affected by the policy change, so that after the program ends these groups do not need further assistance. Section 3 indicates that in Mexico's case this translates into programs that can increase land values and stimulate the permanent demand for rural labor.

Table 2 indicates that at free trade prices the average rental rate on irrigated land is four times that of rain-fed land. Thus a program of investments in land improvements has a substantial potential for increasing land productivity.[10/] Such a program is particularly promising because private irrigation investment has been discouraged by land tenure problems and explicit regulation, while public investment has been curtailed for budgetary reasons.[11/] As a consequence, the return on such a program is likely to be high.

A public investment program focused on land improvements generates transitory demand for rural labor. By supporting the rural wage rate during the construction period it eases the transition towards free trade for landless rural workers and subsistence farmers; and by slowing down migration

10/ We refer to a program of 'land improvements' to emphasize that it involves not only irrigation infrastructure, but also investments in drainage, land levelling, ditch-clearing, etc.

11/ See Sanchez Ugarte (1991) for a description of water's regulatory regime in Mexico.

it helps insulate urban workers from the policy change. And because irrigated land is about 2.4 times more labor-intensive than rain-fed (at the free trade crop composition), the program stimulates the permanent demand for rural labor. Thus, once the program is finished it continues to provide employment opportunities in the rural areas.

But the program also helps to increase the value of the land owned by subsistence and rain-fed farmers. As some of their land is improved with irrigation and drainage, the capital loss suffered due to removal of protection is reduced. This in turn restores the value of their main collateral and enhances their access to credit. In addition, transforming land from rain-fed to irrigated lowers risks faced by farmers and augments crop choice. This facilitates a permanent adjustment away from maize cultivation.

Simulations three and four explore such a program. In both simulations we assume that a total of 1.1 million hectares of land are transformed from rain-fed to irrigation, with investments beginning in the second year and lasting a total of five years[12/]; in simulation three maize and tortilla prices are liberalized immediately, while simulation four assumes a pari-passu five year adjustment path for price liberalization and irrigation investments.

Table 1 shows that the efficiency gains of maize liberalization accompanied by irrigation investments are over 20% higher than in the absence of irrigation (with slightly larger gains when liberalization is immediate). Moreover, the efficiency gains when gradual liberalization is accompanied by the irrigation program exceed by almost 17% the gains from immediate

12/ The program is assumed to irrigate 0.25 million hectares in each of the first three years, 0.20 in the fourth and 0.15 in the fifth. This program is feasible given Mexico's previous experience in this area. We refer to the program as the 'CNA program' because it would be implemented by the Comision Nacional del Agua, Mexico's agency in charge of irrigation construction.

liberalization without adjustment program. Clearly, the potential gains from irrigation investments are large. This increased efficiency has two sources: one, the four-to-one difference in the level of productivity of irrigated vs. rain-fed land. Two, an increase in the average rate of technical change in agriculture: technical change is faster in irrigated land, and the program increases the share of total arable land that is irrigated.

Equally interesting are the distributive effects of the program. Column 4 of table 1 indicates that the two groups directly dependent on the value of rain-fed land are both better off when gradual liberalization is accompanied by the irrigation program. The reason for this is shown in table 2: although land prices are almost the same as in simulations 1 and 2 (the differences resulting from different behavior of wage rates), the value of the land holdings of these two groups is almost restored to the pre-liberalization levels, as now these groups hold a mix of rain-fed and irrigated land.

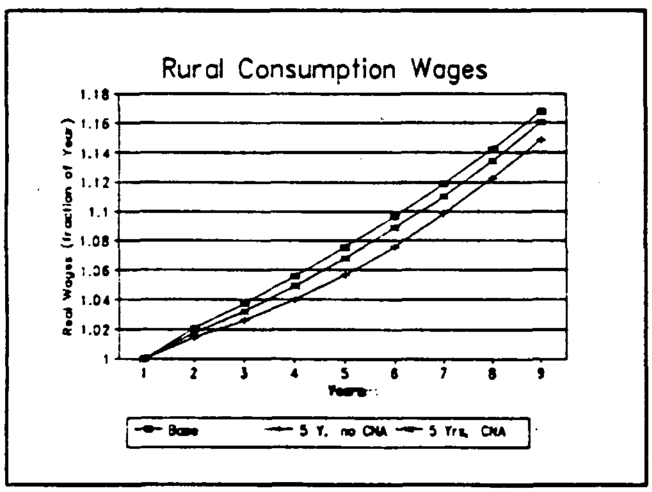

Figure 6

Figure 6 shows that rural wage rates are also higher when liberalization is accompanied by the irrigation program, generating benefits for landless rural workers and subsistence farmers and, by further slowing migration, for urban workers as well. As a consequence, the welfare of landless rural workers and urban workers is almost restored to the protection level (cf. table 1). The converse of this tightening in the labor market is reflected in urban capitalists and irrigated farmers' welfare, which is correspondingly diminished (though still higher than under protection).

Figure 7 depicts the time-path of utility for rain-fed farmers for the five year liberalization paths with and without the CNA program. With the CNA program rain-fed farmers are initially worse-off, reflecting the interaction between the rural labor market and the gestation period of irrigation investments. For them, the initial impact of the CNA program is a tightening of the rural labor market, with negative implications for second-period utility. It is only after the third year, when the irrigation works come on stream, that the benefits of land improvements out-weigh the costs of higher rural wages. And though their welfare is higher than on the reference path, it takes five years for current-period utility to be higher. This interaction between the path of price declines on the one hand, and the timing of irrigation investments, on the other, determines <u>when</u> the different groups receive the benefits of the adjustment program. All this is masked by the discounted value of utility, but such timing issues can be very important for the political economy aspects of the reform (cf the next section).

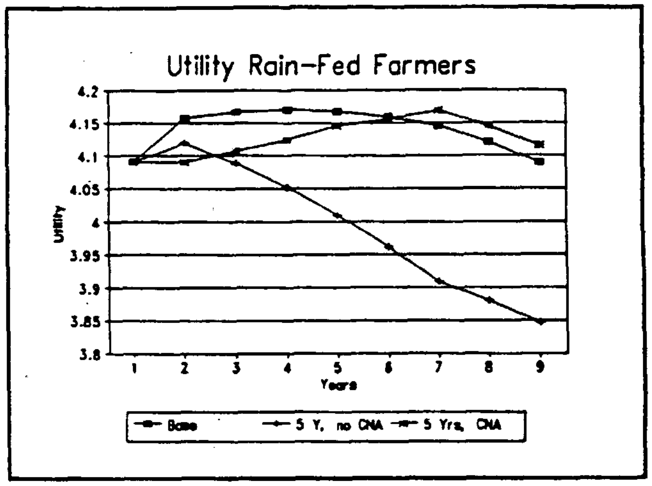

Figure 7

The scenarios presented so far have ignored any change in US protection towards Mexico's export crops. Simulation five considers a scenario where the gradual liberalization of the Mexican maize market is accompanied by a gradual liberalization over the same five year period of the US market for fruit &

vegetables, the sector with the most significant agricultural trade barriers in the US[13]. We assume that this simultaneous trade liberalization is accompanied by the same five year CNA program considered before.

Consider first the distributional effects of improved market access to the US fruit & vegetable market. This policy combination generates a Pareto improvement vis-a-vis the reference case: the welfare of all households is at least equal to the protection situation, and for some there is a gain.

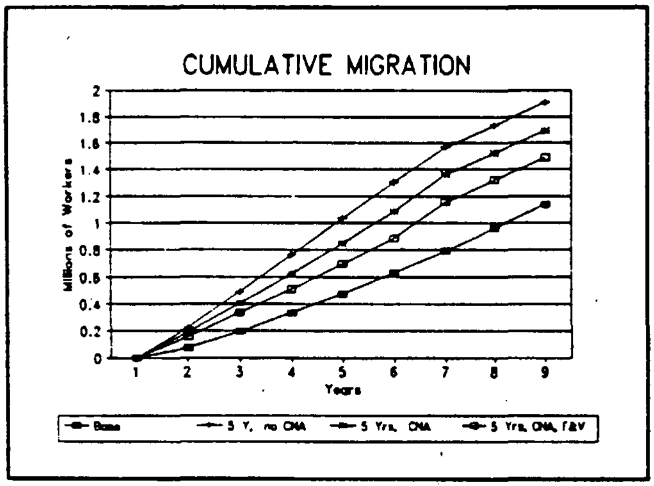

Figure 8

Because fruits and vegetables is the most labor-intensive crop, a price increase shifts out the demand for rural labor, which translates into higher rural wages, reduced migration (Figure 8), and higher urban wages. Thus, the opening of the US market has a positive distributional effect via higher wage rates. By reducing labor displacement, it facilitates the transition towards free trade in maize.

Irrigated farmers are more than compensated for the higher rural wages by higher prices for fruits & vegetables: their welfare increases (table 1). But rain-fed farmers profit little from improved export prices for fruits and vegetables, but must pay higher wages; thus, they constitute the only group in the rural areas who do not benefit directly from a comprehensive FTA.

13/ These barriers are equivalent to a 20% tariff (Feenstra and Rose (1991)). But because the sector labelled here 'fuits and vegetables' includes other crops (cf the data appendix) the tariff is scaled back to 5%. Thus prices faced by Mexican fruit and vegetable exporters increase by 1% during each of the five years of adjustment, and then stay constant at the higher level.

Next, consider the effects of the US liberalization on aggregate efficiency. Table 1 shows that the aggregate efficiency gains in simulation five are slightly lower than in four, which has the same path for maize prices and irrigation investments. This seemingly paradoxical result follows from second-best effects. Because of the urban-rural wage differential, re-allocating labor from rural to urban areas gives, ceteris paribus, efficiency gains. By slowing down migration, the gradual liberalization of the US market diminishes the size of the gains from labor re-allocation into urban areas.

Consider next the fiscal impact of the adjustment program. We focus on the trade-off between fiscal savings from the reduction in maize and tortilla subsidies vs. the fiscal cost of the CNA irrigation program. Figure 9 plots the fiscal impact of maize and tortilla subsidies: (i) the cost of maize production subsidies, (ii) the revenue from tortilla taxes, (iii) the cost of the tortivale program; and, for simulations 3 and 4, (iv) the cost of irrigation investments[14].

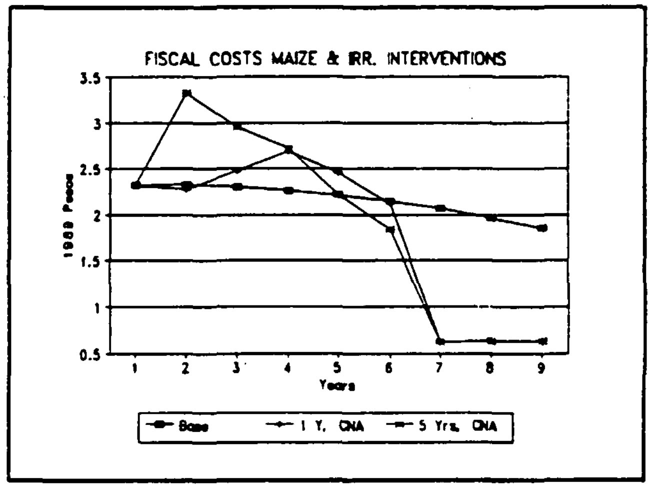

Figure 9

On the reference path the fiscal costs of maize interventions actually decline through time. This is because tortilla consumption, which under current policies is taxed, grows faster than subsidized maize production. When irrigation investments are undertaken, the fiscal position initially deteriorates, but then improves after the fifth or sixth year. With gradual

14/ Investment costs reflect the time-profile of the CNA program and the increased marginal costs of irrigating lower quality lands. The last 150,000 hectares are, on average, 49% more expensive than the first 250,000.

liberalization, this deterioration is initially quite sharp, because only small savings are made each year on the costs of maize interventions. With immediate liberalization, the savings from maize interventions actually dominate the costs of irrigation investments in the first year, and the fiscal costs over the next four years are smaller than in the case of gradual liberalization. After the sixth year, when the irrigation program is complete, both alternatives generate lower costs than current policies[15].

Table 1 indicates the net fiscal impact of each alternative: the net present value of the fiscal surplus in simulation three (four) is 3.5% (3.2%) higher than on the reference path. Current maize policies cost more than the adjustment programs proposed to ease the transition to free trade.

5. On the Pace of Adjustment

Much of the economic literature, and in fact Mexico's own experience, argues for fast-paced reforms. But in this case several points argue for a more gradual approach. First, the impact of speed of reform on labor markets and migration. As shown in figure 2, if maize prices are liberalized instantaneously, around 700,000 workers are predicted to move almost straight away. This implies a migration of between 1 and 5 million people (average family size in rural areas is 7). This would put demands on urban infrastructure and labor markets that would be almost impossible to meet. A more gradual reform leads to the same migration, but spreads it out over most of the coming decade, buying time to set up the infrastructure and training facilities needed to accommodate such a large group of migrants.

15/ The fiscal costs of intervention do not fall to zero because the costs of the tortivale program still have to be covered (though the tortivale program is cheaper because of the lower producer price of maize).

The second problem stems from the political dimensions of such a large reform effort. A reform that inflicts substantial losses on particular groups in society may be more difficult to implement, even if the majority benefits. In section 4 we argued that a program focused on improving currently rain-fed land by irrigation and other productivity enhancements intervenes at the right margin; it makes subsistence and rain-fed farmers better off since the value of their land holdings recovers, and also benefits landless rural workers through the labor market impact. But to fully restore land values to pre-liberalization levels requires at least five years, because of technical and engineering constraints on construction. Immediate liberalization of maize, even if accompanied by the irrigation program, would therefore still impose substantial transitory losses: cf Figure 10 for the case of rain-fed farmers.

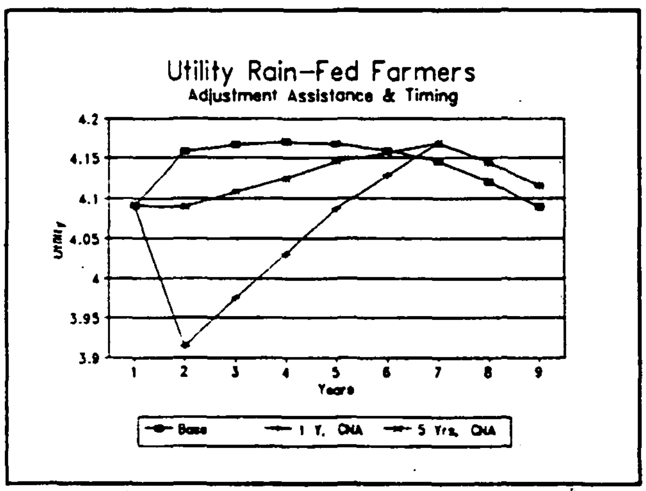

Figure 10

A gradual phasing-out of maize price supports mitigates this problem, although a relative decline (compared to the base case) is difficult to avoid for this group. But note that an absolute drop in utility is avoided if the CNA program is accompanied by gradual phasing-out of maize price supports.

A final argument concerns period-to-period losses. The rural poor have little access to capital markets to help them smooth consumption. Many live in extreme poverty, and may have higher discount rates than assumed here, as survival is at stake. This implies that initial losses, even if the net change in discounted welfare is positive at the discount rate used here, may be particularly costly. But if the adjustment program was such that at no point during the transition utility was less than on the reference path, the reforms would not hurt the rural poor for any discount rate. The government can then argue that they are being made better-off, or at least not losing out, without asking them to wait five years before benefits materialize. Because it is administratively impossible for the government to reach the rural poor directly, and because gradualism may avoid initial losses, this too calls for gradualism as a second best solution.

Simulation 6 explores these issues. We consider the same liberalization of the US market for fruits & vegetables and the same irrigation program, but assume that the liberalization of maize and tortilla prices is spread over six years. Further, we assume that the change in maize and tortilla prices begins one-year after the irrigation program starts. This 'irrigation first' scenario could be interpreted as a signal from the government to farmers of its intentions to help them adjust to free trade in maize: the government invests in productivity improvements before any sacrifice is asked for. This policy insures that all households see their welfare increase vis-a vis the reference path though this comes at an efficiency cost. But this cost is not very large: total efficiency gains are only 4% smaller than the case where maize prices move pari-passu with the irrigation program.

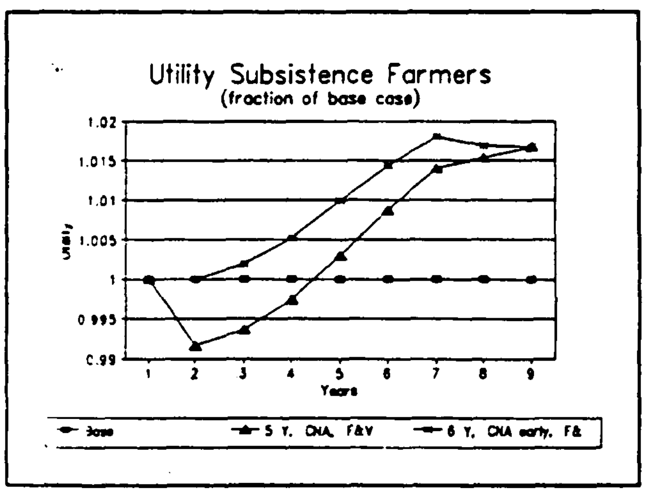

Figure 11

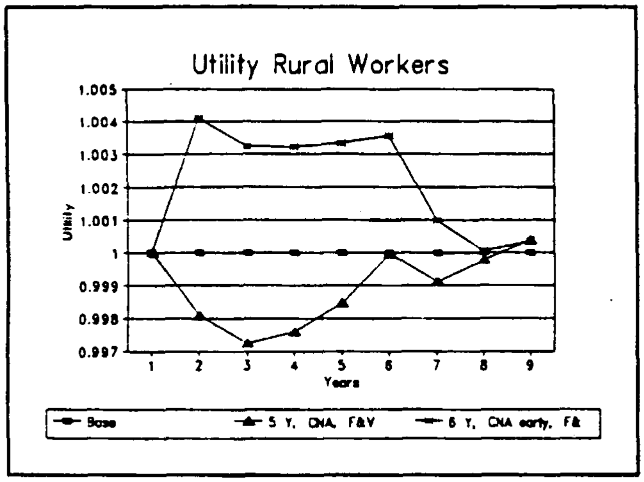

Figure 12

The pay-off to this efficiency cost is shown in Figure 11 and Figure 12: landless rural workers and subsistence farmers are better off at every point in time than under protection. And because spreading the maize pricing over a longer horizon also slows down migration, urban workers also have higher utility at each point in time. Thus, if price reforms and adjustment programs are timed carefully, <u>incorporating maize into the FTA can strengthen poverty alleviation efforts</u>.

Consider now farmers on rain-fed lands. Despite the timing changes in the irrigation and liberalization program, their utility is still less than the reference case for three years (Figure 13). As discussed, the CNA program tightens the rural labor market. And while higher rural wages improve initial utility of subsistence farmers and landless workers, they also raise wage costs for rain-fed farmers. Thus, because the government can only help the first two groups via higher rural wages, it cannot simultaneously help rain-

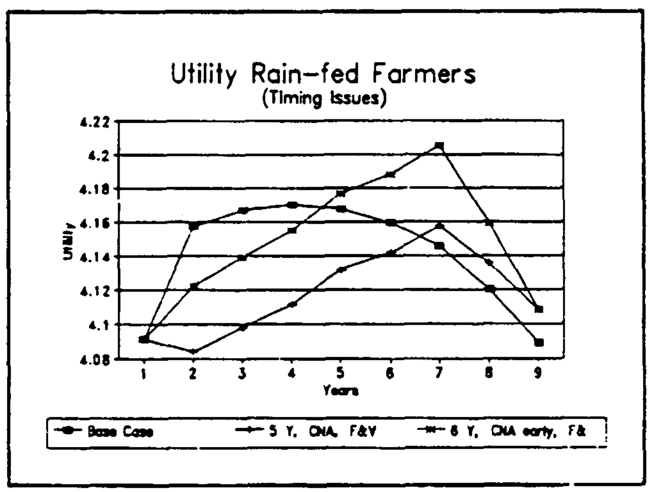

Figure 13

fed farmers in the initial phase of the reforms. This may call for other instruments to provide transitory support to this group (see below).

Figure 14 shows the fiscal impact of these timing changes. Initially fiscal expenditures increase substantially because there are no savings from reduced maize subsidies while outlays for irrigation are made. But though it takes 5 years for the fiscal costs of interventions to fall below those under protection, table 1 shows that in present value terms this policy is still cheaper than continuing protection forever. The fiscal issue associated with the adjustment program is thus not one of overall costs, but one of transitory financing.

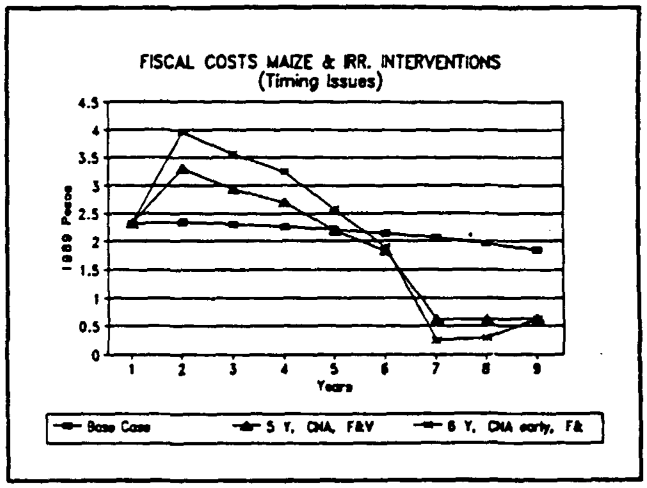

Figure 14

But to label an issue as 'transitory' is not to dismiss it as irrelevant. Fiscal authorities will want to insure that if resources are commited to irrigation investments, maize prices will indeed be freed; adding the costs of irrigation investments to the costs of maize policies would put an undue burden on the fiscal accounts. At the same time, policy makers in charge of agriculture will want to insure that if maize prices are freed, the resources required for irrigation investments will indeed be there; liberalizing agriculture in the absence of resources for adjustment would put an undue strain on the welfare of large numbers of the rural population. Thus the reform process needs a 'commitment technology' to insure that its two components -maize liberalization and the irrigation program- are carried out.

Signing maize price liberalization as part of the FTA solves the first half of the commitment problem. But the second half still needs attention because there are legal impediments to multi-year commitments of fiscal expenditures in Mexico. What guarantees do the rural groups potentially affected by maize liberalization have that the irrigation program will be completed once the FTA negotiations are finished, even if the government 'moves first' with its irrigation investments? What is optimal for the government to promise now may well not be optimal for it to deliver once the FTA has been signed.

The need for transitory financing for the adjustment program provides part of the solution. In particular, a multilateral organization could provide financing during the adjustment process to the FTA. Since the overall fiscal gains are positive in discounted value terms, the loan can be paid back out of the savings made later in time. If such financing is made contingent, not on the price reforms being carried out, but on the irrigation programs promised, it would become expensive to renege. The credibility of the program is then increased by increasing the costs of failing to follow it through.

Recall also that liberalization reduces the value of the main collateral owned by subsistence and rain-fed farmers. These farmers will have better access to credit only if commercial banks are certain that the land improvements that will raise the value of the land available for collateral will indeed incur. A program of public credit guarantees could insure farmers access to credit. But, equally important in our context, by committing itself through credit guarantees, the government not only signals its intent to implement the adjustment program, but also makes it more costly for itself to not implement it: after all, not following through on the irrigation program would reduce the value of the collateral for loans that carry a public guarantee. Again, increasing the expected cost of the guarantee scheme makes reneging on promises to implement the CNA program less attractive.

6. Conclusions

Empirical evidence and theoretical analysis overwhelmingly support the view that liberalizing international trade leads to efficiency gains. Recent forays in the economics of imperfect competition have created some question marks by bringing in rent-shifting and second best aspects, but have not led to any strong presumption against this claim (Krugman and Helpman (1989)). This paper fits the mold by demonstrating that the efficiency gains from liberalizing agricultural trade between the US and Mexico are quite large.

But if the gains are so large, why has agriculture turned out to be so hard to open up? Our analysis raises points that are likely to feature in any satisfactory answer to this question. We show, in a realistic analysis of the consequences of including agriculture in the currently-negotiated FTA between Mexico and the US, how efficiency gains fail to filter through to important groups in society. In particular we show that in the absence of adjustment measures all benefits accrue to the richer groups in both rural and urban areas. These effects are dramatically brought out early in the reform process by being capitalized in land values. This is surely a factor in the resistance by farmers against easing protection of agriculture.16/

Standard trade theory counters these arguments by pointing out that aggregate efficiency gains imply that winners can compensate losers and still

16/ Krugman (1982) also links resistance to trade liberalization to factor price effects.

be better off themselves. This paper starts from the premise that instruments to effect such lump-sum transfers are not available. Compensations could also occur, although imperfectly, through indirect taxes and subsidies (Dixit and Norman (1980)), but this would require a degree of differentiation in the tax structure that would itself trigger substantial administrative and incentive problems. In more realistic circumstances specific adjustment programs have to be designed to accompany a major trade reform.

Liberalizing maize in Mexico in the context of a permanent change like the FTA creates two incentive problems. First, it clearly hurts maize growers. But compensating farmers pro rata to their maize production would create an incentive to continue maize production, the opposite of what the reform is designed to achieve to begin with. Second, liberalizing maize has a substantial impact on rural labor markets and migration. Rural employment programs could be used to mitigate large labor dislocations and transfer income to workers. But such a program raises a key issue: how to get out of it as time goes by. If in current circumstances the Government feels compelled to assist, those affected have every incentive not to adjust so as not to lose the transfers by changing the incentive structure the Government itself faces (Tornell (1991)). Temporary adjustment programs need built in incentives for change.

We point out that to avoid these incentive problems adjustment programs should focus not on offsetting the income loss associated with past activities, since that provides an incentive to continue them; instead they should focus on improving the productivity of the assets owned by the groups harmed by the reforms. This solves both incentive problems; by not linking the program to past activities, there is no incentive to continue them; and once the assets of those affected are more productive, other opportunities will be easier to find, reducing pressure on the Government to help out.

This paper argues the need for such a program in the context of opening up Mexican agriculture, and designs one along the lines sketched before. In the specific circumstances of Mexican agriculture, this translates into investments that increase the productivity of rain-fed land via irrigation and other land improvements. We find that a program that transforms about 8% of the total stock of rain-fed land to irrigated restores the value of the land-holdings of those affected by the liberalization. This restores the collateral value of land, and thus enhance subsistence and rain-fed farmers' access to credit precisely at the time when credit is most needed. In addition, the program helps owners of labor by generating rural employment during the construction period. More fundamentally, it increases the long term demand for rural labor because irrigated land is substantially more labor-intensive than rain-fed. Thus, the program provides workers with alternatives once it ends; its transitory nature is thus credible.

Improving the value of assets people own is like an investment program and thus takes time. In contexts where capital markets are imperfect those affected may not be able to borrow against the value of future assets to smooth consumption overtime. This is particularly important if those affected are, as in Mexico's case, amongst the poorest groups in society. We therefore argue for a gradual pace of reform. We first compute the efficiency gains of trade reforms under different liberalization speeds, and find that gradualism is not too costly: spreading the liberalization over a five year period lowers the present discounted value of the efficiency gains by only 5-6%. We next show that careful timing of both the liberalization and the adjustment program implies that the rural poor have always higher utility along the adjustment path than under the protection path.

Embedding trade liberalization in a Free Trade Agreements is a form of commitment technology to the reform process; thus arguments for 'cold turkey' reforms on the grounds that this is the best form to show commitment to the reforms are less compelling in this case. But there is a different commitment problem, created by the time delays inherent in adjustment programs. How can the potential beneficiaries of adjustment programs be assured that those programs will be implemented once the trade liberalizations have been negotiated in the FTA? We argue that gradualism also contributes to solve this time-consistency problem. Because gradualism gives time to implement the productivity-enhancing programs, the beneficiaries do not have to give anything up before the benefits start coming in. Support by external organizations contingent on the adjustment programs can help in solving such commitment problems.

We hope the principles outlined in this paper for the design of adjustment programs will contribute to find efficient solutions to similar transitional problems. The analysis also suggests, however, that application of these principles requires careful analysis of the specifics of each case, and of the mechanisms through which the different groups are affected. There may be general principles, but there are unlikely to be rigid rules applicable to each and every reform program.

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TRANSITION PROBLEMS IN ECONOMIC REFORM:
AGRICULTURE IN THE MEXICO-US FREE TRADE AGREEMENT

APPENDIX

Available on request from:

S. van Wijnbergen
World Bank
1818 H str. NW
Washington DC

Appendix: Model Structure, Data and Calibration

I. Model Structure

I.1 Static Relations

We begin with the static relationships of the model before turning to the inter-temporal aspects. For ease of notation we omit a time sub-index for all variables (except where strictly necessary).

Goods, Factor Endowments and Factor Ownership

The economy produces seven goods: maize, m; basic grains, g; vegetables, v; other agriculture, o; livestock, l; industry, i; and services, s. The first five goods are produced in the rural areas; the last two in the urban areas. Goods are produced by seven factors of production: rural labor, LR, urban labor, LU, rain-fed land, T1, irrigated land, T2, livestock land, T3, industry capital, KI, and services capital, KS.[17/]

We distinguish between maize and tortillas, but model tortilla production in a very stylized fashion. Tortillas are obtained from maize via a Leontief transformation that, for simplicity, requires no primary factors. Tortillas are assumed to be non-traded, with their price being a function only of the tax/subsidy-inclusive producer price of maize, and any direct government taxes or subsidies to tortillas.

Factors of production are owned by six types of households: (i) landless rural workers, (ii) subsistence farmers, who each own two hectares of rain-fed land, and who allocate their labor between producing on their own land and participating in the rural labor market[18/], (iii) "rain-fed" farmers, who own the remainder of the rain-fed land and half of the land devoted to livestock and, (iv) "irrigated" farmers, who own all the irrigated land, and the other half of livestock land. For both rain-fed and irrigated farmers, land ownership is the only source of income.

Urban households consist of workers, who own all urban labor, and capitalists, who own the capital stock in industry and services. There are H_h of each type of households (h = 1,2,..,6). Ownership shares are given by matrix $M = (m_{hj})$ where m_{hj} is household's h share of factor of production j.

17/ We separate land devoted to livestock from land devoted to agriculture because Mexican land tenure regulations preclude the use of agricultural land for livestock activities (see Heath (1990)).

18/ Data on the distribution of ownership of land in Mexico are scarce. Various studies refer to the class of 'subsistence farmers', who are owners of such small quantities of land that they must also participate in the labor market (see Masera (1990) and Salinas (1990)). In this paper we define a 'typical' subsistence farmer as one who owns two hectares of rain-fed land. Of course, in reality there is a continuum of ownership.

Prices

World prices for traded goods, $\mathbf{pw}$[19], are exogenous. The price of services, the non-traded good, is ps. The vector of commodity goods prices is $\mathbf{p} = [\ \mathbf{pw} \mid ps]$. Modelling trade interventions as combinations of production and consumption subsidies and taxes we write producer prices as:

$$(I.1)\quad \mathbf{pp} = \mathbf{p}.*(1 + \mathbf{s})$$

where $\mathbf{s}$ is the vector of producer subsidies(+)/taxes(-), and .* denotes an element-by-element multiplication.

Consumer prices differ between rural and urban households, so we introduce separate vectors of consumer taxes(+) or subsidies(-), $\mathbf{ct}^r$ and $\mathbf{ct}^u$, for rural and urban areas, respectively:

$$(I.2)\quad \mathbf{cp}^r = \mathbf{p}.*(1 + \mathbf{ct}^r)$$

$$(I.3)\quad \mathbf{cp}^u = \mathbf{p}.*(1 + \mathbf{ct}^u)$$

Urban and rural tortilla prices may also differ[20]. Because tortillas are only produced with maize, their price is:

$$(I.4)\quad pt^r = a_{mt}*pp_m*(1 - ts^r) = a_{mt}*pw_m*(1 + s_m)*(1 - ts^r)$$

$$(I.5)\quad pt^u = a_{mt}*pp_m*(1 - ts^u) = a_{mt}*pw_m*(1 + s_m)*(1 - ts^u)$$

where a_{mt} is maize input per unit of tortillas, and ts^r/ts^u are rural/urban tortilla subsidies. Note that as long as ts^r (ts^u) is less than s_m, rural (urban) tortilla consumers pay a net tax, despite the fact that tortillas are 'subsidized'.

Intermediate input prices depend on production location (e.g., maize sold as input into livestock in rural areas vs. maize sold as input into industry in urban areas). Vectors $\mathbf{it}^r$ and $\mathbf{it}^u$ contain ad valorem taxes/subsidies on intermediate inputs for rural and urban areas respectively. Thus the vectors $\mathbf{ip}^r$ and $\mathbf{ip}^u$ of intermediate prices to producers in rural and urban areas, respectively, are in general different.

Finally, we denote by w^r and w^u the rural and urban wage rates, and by r1 and r2 the rental rates on rain-fed and irrigated lands, respectively.[21]

19/ All price vectors are defined as row vectors, and all quantity vectors as column vectors. All vectors are in bold.

20/ The government attempts to stop arbitrage on maize and tortillas via controls on maize distribution to tortilla mills and to other users of maize.

21/ In what follows the labels 1/2 on any variable refer to the rain-fed/irrigated distinction.

Technology

Intermediate inputs are used in in fixed proportions; primary inputs produce value added. Except for Hicks-neutral technical change, technology is constant through time. Matrix A contains intermediate input/output coefficients, with most elements exogenously given. However, we do allow substitution between maize and basic grains (mainly sorghum) as inputs into livestock. With a CES structure, the cost-minimizing I/O coefficients of maize and basic grains into livestock, a_{ml} and a_{gl}, are:[22/]

(I.6) $a_{ml} = \tau^{\mu}.(pa^{*}/ip^{r}_{m})^{\mu}.a^{*}$

(I.7) $a_{gl} = (1-\tau)^{\mu}.(pa^{*}/ip^{r}_{g})^{\mu}.a^{*}$

Land Use

Land allocated to any given crop is subject to diminishing returns. To capture this, we make a difference between effective land, $\tilde{T}$, and physical land, T. The latter refers to the actual hectares allocated to a crop; the former to the amount of land that is usable for producing that crop. The relationship between them is given by:

(I.8) $\tilde{T} = \tau.T^{\phi}$ $\quad\tau > 0 \quad ; \quad 0 < \phi < 1,$

so that as more (rain-fed or irrigated) physical land is applied to a crop, the amount of effective land grows less than proportionately. This captures incentives for crop rotation and other agricultural practices that result in crop diversification. Irrigated land is assumed to be better than rain-fed in the following way: $\phi 1 \leq \phi 2$, i.e., as more irrigated land is allocated to a given crop, diminishing returns obtain more slowly than in rain-fed lands. Hence, for the same price change the supply response in irrigated lands is stronger. As a result of yield differences, infra-marginal rents accrue to owners of irrigated land in standard Ricardian fashion.

Value Added

Production functions are Cobb-Douglas with constant returns to scale to labor and capital in the urban goods, and to labor and effective land in the

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22/ Let a^{*} be the exogenously given fixed quantity of feed per unit of livestock, given by:

$$a^{*} = [\tau.a_{ml}{}^{\mu-1/\mu} + (1-\tau).a_{gl}{}^{\mu-1/\mu}]^{\mu/(1-\mu)} \qquad \mu > 0,\ \mu \neq 1,\ \tau \in (0,1)$$

Given intermediate input prices an exact price index for a^{*} is:

$$pa^{*} = [\tau^{\mu}.ip^{r}_{m}{}^{1-\mu} + (1-\tau)^{\mu}.ip^{r}_{g}{}^{1-\mu}]^{1/(1-\mu)}$$

Substituting pa^{*} in (I.6) and (I.7) gives matrix A(p).

rural goods. For example, value added on maize cultivated in rain-fed lands is:

$$\text{(I.9)}\quad VA1_m = LR1_m^{(1-\alpha 1_m)} . \tilde{T}1_m^{\alpha 1_m} = LR1_m^{(1-\alpha 1_m)} . r1_m^{\alpha 1_m} . T1_m^{\phi 1_m . \alpha 1_m}$$

$$= \rho 1_m . LR1_m^{(1-\alpha 1_m)} . T1_m^{\lambda 1_m}$$

where $LR1_m$, $T1_m$ are rural labor and rain-fed lands allocated to maize production, $\rho 1_m = r1_m^{\alpha 1m}$ and $\lambda 1_m = \phi 1_m . \alpha 1_m$. Note that $0 < \lambda 1_m < \alpha 1_m < 1$, implying that (I.9) exhibits decreasing returns to scale between rural labor and physical land. As a result, although the number of agricultural goods exceeds the number of rural factors of production, there need not be full specialization.

Technical Change

Technical change is assumed to be Hicks-neutral in all sectors. A time-dependent constant pre-multiplies the Cobb-Douglas value added function in all sectors. The rate of technical change in rain-fed land (equal to the rate of technical change in livestock) is less than in irrigated land. Rates of technical change in industry and services are assumed to be equal.

Goods Supply

Output vectors in rain-fed and irrigated lands are q1 and q2, respectively. Output of livestock is denoted q3, while the output vector in the urban sector is qu. Hence, the vector of gross supplies is: qs = [(q1 + q2) | q3 | qu]. All sectors are perfectly competitive. Let **pn** be the vector of 'net' or value added prices, obtained by substracting from producer prices intermediate input costs. The derived demands for labor and land in agricultural production are (again using maize in rain-fed lands as example):

$$T1_m = \left((1-\alpha 1_m)^{1-\alpha 1_m} . \rho 1_m . pn_m . \lambda 1_m^{\alpha 1_m} . w^{r\,(\alpha 1_m - 1)} . r1^{-\alpha 1_m} \right)^{1/(\alpha 1_m - \lambda 1_m)}$$

(I.10)

$$LR1_m = \left((1-\alpha 1_m)^{(1-\lambda 1_m)(\lambda 1_m - \alpha 1_m)} \lambda 1_m^{-\lambda 1_m} . w^{r\,1-\lambda 1_m} . r1^{\lambda 1_m} (\rho 1_m . pn_m)^{-1} \right)^{1/(\lambda 1_m - \alpha 1_m)}$$

Similar equations follow for other crops. In industry and services capital is sector-specific, as is land in livestock, so that only demands for rural labor in livestock, LR3, and for urban labor in industry, LU_i, and services, LU_s, are derived. Goods supply follow from substituting optimal factor demands into the Cobb-Douglas production functions.

Household Incomes, Consumption and Savings

Production generates factor incomes: rural and urban wages, rents to rain-fed, irrigated and livestock land, and quasi-rents to capital in industry and services. **M**, the matrix of ownership shares, maps factor incomes **facinc** into household incomes.

In addition, households receive government transfers through the 'tortivales' program, with a market value of **vt**. But since urban and rural tortilla prices differ, the market value of a given quantity of freely distributed tortillas to households of type h, QT_h, depends on households' location. Thus, for example, for urban workers (the fifth household group) we have:

$$(I.11)\quad vt_5 = pt^u * QT_5$$

The fiscal cost of the 'tortivale' program, CT, is given by:

$$(I.12)\quad CT = \sum_{h=1}^{6} a_{mt} * pp_m . QT_h > \sum_{h=1}^{6} vt_h$$

since the government has to purchase maize from producers at prices pp_m to make tortillas for the tortivales. But because tortillas are subsidized, the value of the transfer to households is less than the fiscal cost of the transfer to the government. The difference is an 'implicit' subsidy to maize producers.

Collecting terms (and ignoring household's income taxes) we obtain **Y**, households' disposable income:

$$(I.13)\quad \mathbf{Y} = \mathbf{M} * \mathbf{facinc} + \mathbf{vt}$$

Households save a constant proportion of their disposable income, φ_h, so that savings for each household are:

$$(I.14)\quad S_h = \varphi_h . Y_h$$

$(Y_h - S_h)$ are consumption expenditures for households of type h. We assume a nested Cobb-Douglas/CES/CES utility function. The outer Cobb-Douglas nest allocates expenditures between three goods: industry, services and a composite agricultural good. The next CES nest aggregates the five rural goods into a composite rural good. Finally, the last CES nest distributes maize consumption between raw maize and tortillas.[23/] Solving the utility

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23/ Urban inhabitants consume maize mostly in the form of tortillas. In the rural areas the government purchases maize from producers at the price pp_m, but sells maize flour to consumers at the price pt^r because there are fewer tortilla distribution outlets in rural areas. (This is why the 'tortivale' program does not operate in rural areas.) Our model ignores the opportunity cost of time to rural households of making tortillas from maize flour, but allows for maize to be consumed either as raw maize or as tortillas.

maximization problem for each household we obtain consumption demands for tortillas, maize, the remaining agricultural goods, as well as livestock, industry and services. Demand for tortillas is then translated into maize demand given the input/output coefficient a_{mt}. This gives us the vector of total household consumption, **c**.

Given the homotheticity of preferences we can construct an exact price index for each household, CPI_h, that depends on the location of the household (given differences in rural, cp^r, and urban, cp^u, consumer prices), as well as on the particular parameters of its utility function. Given these indices, we compute an index of the real consumption wage to rural and urban workers, Ω^r and Ω^u, respectively, as:

$$(I.15a)\quad \Omega^r = w^r/CPI_2 \qquad\qquad (I.15b)\quad \Omega^u = w^u/CPI_5$$

where we use the preferences of landless rural workers and urban workers (household groups 2 and 5, respectively) for computing the relebant CPIs.

Investment and Total Demand

Private investment only takes place in industry and services. We take the rate of growth of the capital stock in industry and services in period t, gk_t, as exogenous. Let **invprop** be the vector of goods required to produce one unit of capital, and assume that capital produced for industry and services has the same composition. The vector of private investment demands, **z**, is then given by:

$$(I.16)\quad \mathbf{z}_t = (gk_t+gd_t).(KI_t + KS_t).\mathbf{invprop}$$

where gd_t is the depreciation rate. Then total value of private investment is:

$$(I.17)\quad I_t = \mathbf{p}_t.\mathbf{z}_t$$

We only consider public investment in irrigation infrastructure. Let RI_t be the number of hectares of rain-fed land that is transformed to irrigated in period t. Irrigation construction is assumed to require rural labor and intermediate inputs, given at the unit level by vector **inputirr** for goods, and by lrirr for labor. The real resource costs of irrigation are assume to be an increasing function of the stock of irrigated land, reflecting the fact that as these investments increase lands of poorer-quality are encountered (greater distance from water resources, steeper lands, etc.). We write:

$$(I.18)\quad Q_t = q.\left(\sum_{t=0}^{t-1} T2_t / T2_0\right)^{\gamma} \quad ; \quad q > 0, \quad \gamma > 1$$

where Q_t is an index of marginal costs applied to **inputirr** and lrirr, and $T2_0$ is the initial stock of irrigated land. Hence, the total demand for goods and labor required for irrigation investments is:

(I.19a) $g_t = Q_t.RI_t.inputirr$

(I.19b) $LRIRR_t = Q_t.RI_t.lrirr$

Ignoring other components of government expenditures, the vector of total goods' demand is:

(I.20) $qd = A*qs + c + z + g$

Migration

Let H_h be the total number of households of type h. Consumption quantities are divided by the total number of households of each type to obtain per-capita consumptions. Substituting per-capita consumptions into the utility function gives per-household utility for each type of household, U_h.

Utility functions are identical, but parameters differ between urban workers, landless rural workers and subsistence farmers, on the one hand, and rain-fed and irrigated land-owners and urban capitalists, on the other. The first group allocates a larger share of expenditure to rural goods compared to the second. Thus, changes in maize and tortilla prices have a larger impact on the first group. All members of the potential migrant population have the same utility function, so we can compare per-capita workers' utilities across locations.

Migration incentives result from rural-urban differences in consumption wages, Ω^r and Ω^u, and from differences in benefits derived from living in a given area (like the urban 'tortivale' program). Letting L^{ru} be the stock of migrants that move from the rural to the urban areas, U_r and U_u the (per capita) utility of a worker in the rural and urban areas, respectively, and the superscript 0 an initial equilibrium, we write:

(I.21) $L^{ru} = k[(U_u^0/U_r^0)/(U_u/U_r)]^\eta - k \quad ; \quad k > 0, \quad \eta \geq 0$

where k is a constant and η the elasticity of migration to urban-rural utility differentials. Note that $\eta = 0$ completely segments the urban and rural labor markets.

Excess Demands

At each period of time total demands for land and labor are:

(I.22a) $T1^D(r1) = \Sigma\, T1_j$

(I.22b) $T2^D(r2) = \Sigma\, T2_j$ for j = m,g,v,o.

(I.22c) $LR^D(w^r) = \Sigma\, LR1_j + \Sigma\, LR2_j + LR3 + LRIRR$

(I.22d) $LU^D(w^u) = LU_i + LU_s$

Note from (I.22c) that rural labor demand includes the workers employed in constructing irrigation.

Given taxes and subsidies domestic prices for tradeable goods follow from world prices, with net exports bringing tradeables supply and demand into balance. The same is not true of services. This market, jointly with the markets for rural and urban labor, and rain-fed and irrigated land, is cleared by prices. Our model thus determines factor prices and the real exchange rate.[24] Let P contain these prices, i.e., $P = [\ w^r \mid w^u \mid r1 \mid r2 \mid ps]$. Excess demand functions to determine P are:

(I.23a) $LR^D(P) + L^{ru}(P) - LR^0 = 0$

(I.23b) $LU^D(P) - L^{ru}(P) - LU^0 = 0$

(I.23c) $T1^D(P) - T1 = 0$

(I.23d) $T2^D(P) - T2 = 0$

(I.23e) $qs_s(P) - qd_s(P) = 0$

By construction, at the initial values for the exogenous variables $L^{ru} = 0$.

Given the value at time t for production and consumption taxes and subsidies, a solution to (I.23) provides allocations of rain-fed and irrigated land to each crop, a division of the total labor force between urban and rural areas as well as its allocation across goods, factor prices and the real exchange rate, and a utility level for each household.

I.2 Inter-Temporal Relationships

Accumulation Equations

At each period of time the economy is described by the solution to (I.23). But from one period to the next the economy changes as a result of exogenous and policy-induced changes. The exogenous changes are: (i) growth of labor and population[25], (ii) Hicks-neutral technical change in urban and rural sectors, (iii) growth of the capital stock in industry and services[26], (iv) government spending in non-agriculture items, and (v) the path of world prices. Policy-induced changes center on the path of taxes and subsidies, irrigation investments and government transfer policies.

24/ Recall that capital in industry and services (as well as land in livestock) are fixed. Thus, these factors just earn quasi-rents.

25/ To reflect Mexico's demographic transition the rate of growth of labor, 3%, is set higher than the rate of growth of population, 2%. During the transition period, see below, the rate of growth of labor slowly declines until in the steady-state it equals that of population. Thus, households who own labor initially grow faster than households who own only land or capital.

26/ In a fuller model of the impact of the FTA investment rates in industry and services would clearly be endogenous. Here, however, we are interested in the effects of changes in agricultural liberalization only.

The endowments of land evolve if there are irrigation programs transforming rain-fed land into irrigated land:

$$\text{(I.24a)}\ T1_t = T1_{t-1} - RI_{t-1} \quad ; \quad \text{(I.24b)}\ T2_t = T2_{t-1} + RI_{t-1}$$

Note that we assume a one-period gestation lag. All owners of rain-fed land (subsistence peasants and rain-fed farmers) are assumed to benefit from irrigation investments in proportion to the initial share of rain-fed land held by each group. The matrix of ownership shares, M_t, is therefore up-dated at each period to reflect the fact that when irrigation investments take place the increase in the endowments of irrigated land belongs to subsistence farmers and rain-fed farmers.

The number of households of each type also changes through time. Landless rural workers, subsistence farmers and urban workers grow at the rate of growth of the labor force, gl_t, so that the urban and rural allocation of labor evolves according to:

$$\text{(I.25a)}\ LR_t = (LR_{t-1} - L^{ru}_{t-1})(1 + gl_{t-1})$$

$$\text{(I.25b)}\ LU_t = (LU_{t-1} + L^{ru}_{t-1})(1 + gl_{t-1})$$

On the other hand, the number of rain-fed farmers, irrigated farmers and urban capitalists grows according to:

$$\text{(I.26)}\ H_t = H_{t-1}(1 + gp_{t-1})$$

where gp_t is the growth rate of population in period t.

Finally, the capital stock in industry and services evolves according to:

$$\text{(I.27a)}\ KI_t = KI_{t-1}.(1+gk_{t-1}); \quad \text{(I.27b)}\ KS_t = KS_{t-1}.(1+gk_{t-1})$$

<u>The Transition Path and the Steady-State</u>

We take as starting point for our analysis a particular date (t_0=1 for convenience), and divide the future into a transition path and a steady-state. The transition path lasts (at most) T-1 > t_0 years; the steady-state obtains in all periods from T onwards. All policy changes occur during the transition period. By assumption, static and intertemporal relative prices remain unchanged over the interval $[T,\infty)$. This allows us to Hicks-aggregate all of the steady-state path of the economy. It then suffices to simply calculate period T values, since all future periods will be identical up to a uniform scalefactor (growth rate) for all quantities. The aggregation process therefore only affects the discount factors, which is much larger for the T period to account for the fact that this 'period' is replicated (again, up to a uniform scale factor for all quantities) an infinite number of years.

If we label the common and constant post-T growth rate g, and the real interest rate r^w, this process works as follows. Define $\delta=1/(1+r^w)$, and $\delta_a=(1+g)/(1+r^w)$, where δ_a is the period-to-period growth adjusted discount factor. Then the following expressions obtain for the back-to-period-1 discount factors $\delta(i)$:

$$\delta(i) = \delta^{i-1} \quad \text{for } i < T$$
$$= \sum_T^\infty \delta^{i-1} \text{ for } i \geq T \quad (I.28)$$
$$= \frac{\delta^{T-1}}{1-\delta}$$

Consider now the Net Present Value, NPV_y, of (y_t), where $y_t = y_{t-1}(1+g)$ for all $t > T$:

$$NPV_y = \sum_1^\infty y_t . \delta^{t-1}$$
$$= \sum_1^{T-1} y_t . \delta^{t-1} + \delta^{T-1} . \sum_T^\infty y_T . (1+g)^{t-T} \delta^{t-T}$$
$$= \sum_1^{T-1} y_t . \delta^{t-1} + \delta^{T-1} \sum_T^\infty y_T . \delta_a^{t-T} \quad (I.29)$$
$$= \sum_1^{T-1} y_t . \delta^{t-1} + \frac{\delta^{T-1}}{1-\delta_a} . y_T$$

Thus the infinite horizon modeled can be captured by calculating period T only (out of all $[T,\infty)$ periods), but adjusting the period T discount factor to equal:

$$\delta(T) = \frac{\delta^{T-1}}{1-\delta_a} \quad (I.30)$$

Intertemporal Budget Constraints

With the exception of urban capitalists, we assume that private households do not save or invest. Thus, in each period their consumption equals their income. Thus, since they satisfy their period-by-period budget constraint, they will automatically satisfy their inter-temporal budget constraint.

Private investment by urban capitalists is given by (I.27), and private savings, all done by urban capitalists, by (I.14). Their savings rate, φ_t, is assumed to be exogenously given during the transition period. Thus, urban capitalists are assumed to have access to the world capital market, where they can lend or borrow as required at the world real interest rate r^w. However, this convention cannot be maintained in the steady state. If the savings rate would mechanically be extended through the steady state period, there would be no guarantee that urban capitalists would remain within their budget constraint, or, alternatively, exhaust all resources available to them. In both cases, welfare comparisons accross different simulation experiments would be illegitimate, since their opportunity set would in effect be varied arbitrarily.

To solve this problem we endogenise the period T savings rate in such a way that, if maintained over the interval $[T,\infty)$, urban capitalists will exactly satisfy their intertemporal budget constraint. This means that over the interval $[1,\infty)$, the discounted value of their consumption expenditure equals the discounted value of their after-tax income net of investment expenditure. In particular, if during the transition period urban capitalists accumulated debt, the steady-state savings rate is increased so that the discounted value at time T of future savings over investment equals the current value of the debt accumulated up through period T-1. The converse holds if during the transition period urban capitalists accumulated assets. Formally this can be represented as follows. Define after-tax savings net of private investment, all in period i, as x_i and income net of taxes and investment expenditure as y_i. Then $NPV_x(T)$ equals:

$$NPV_x(T) = \sum_T^{\infty} x_T \cdot \frac{(1+g)^{t-T}}{(1+r^w)^{t-T}} = \frac{x_T}{1-\delta_a} \qquad (I.31)$$

Define debt accumulated through period T-1 as D_{T-1}. To satisfy the intertemporal budget constraint, x_T needs to satisfy:

$$\frac{x_T}{1-\delta_a} = D_{T-1} \cdot (1+r^w)$$
$$\rightarrow \varphi_T \equiv \frac{x_T}{y_T} = \frac{D_{T-1}}{y_T} \cdot \frac{1-\delta_a}{\delta} \qquad (I.32)$$

Welfare Measures

To make welfare comparisons accross experiments it is not enough just to make sure that all groups satisfy their intertemporal budget constraints. In many cases, the time paths of period-by-period utility of a particular household accross two simulations will cross, making period-by-period comparisons difficult. The solution is to calculate net discounted utility, or welfare, using the rate of time preference to discount future welfare back to today. That procedure presents no problems for the interval [1,T-1]. However one cannot simply copy the procedure followed for NPV measures in equation (9), (13) for the interval [T,∞). The reason is, that per-household consumption grows at the rate gc[27], but because of declining marginal utility, per-household utility U_h will grow at a lower rate than gc. Since we use a constant relative risk aversion (CRRA) utility function to aggregate utility over time, the following relation between the two growth rates holds:

27/Note that gc < g because it is a per-household measure. If gp is the rate of population growth, g, gc and gp are linked as follows:

$$(1+g) = (1+gc) \cdot (1+gp)$$

$$\hat{U}_h = (1/\sigma)\,\hat{c} \quad (I.33)$$

where σ is the intertemporal substitution elasticity, and a hat over a variable denotes the rate of growth. This leads to the following expression for welfare, W_h, the net discounted utility for household h:

$$\begin{aligned} W_h &= \sum_1^{\infty} \frac{u_h(c_t)}{(1+\rho)^t} \\ &= \sum_1^{T-1} u_h(c_t)\,.\,\delta_{pref}^t \\ &\qquad + \frac{u_h(c_T)}{(1+\rho)^T} \sum_T^{\infty} \frac{(1+\sigma^{-1}.gc)^{t-T}}{(1+\rho)^{t-T}} \qquad (I.34) \\ &= \sum_1^{T-1} u_h(c_t)\,.\,\delta_{pref}^t + \frac{u_h(c_T)\,.\,\delta_{pref}^T}{1-\delta_{prefA}} \end{aligned}$$

$$\text{where } \delta_{pref} = \frac{1}{1+\rho} \text{ and } \delta_{prefA} = \frac{1+\sigma^{-1}.gc}{1+\rho}$$

II. Data Sources

We constructed a Social Accounting Matrix (SAM) for 1989, the last year for which information was available for all the variables required for the model.

Our departure point was data provided by the Ministry of Agriculture (SARH) on value of gross output, physical output and areas harvested (and thus yields) in rain-fed and irrigated lands in 1989 for 26 individual agricultural products. These products account for 68.3% of the value of output in agriculture in that year; unfortunately, no information was individually available for the other products that account for the remaining 31.7% of output, though we do have the totals for all the variables concerned. Table II.1 lists the products for which information was available and maps them into the four agricultural sectors included in our model. We interpret the physical totals (in hectares) of harvested rain-fed and irrigated lands in 1989 as the endowments of these two factors of production. SARH also provided us with value of output in livestock industry, as well as with cost data to divide, at the level of each of the five rural sectors, the value of total gross supply into: wages, aggregate rents (but not its division between rain-fed and irrigated lands), and a seven sector disaggregation of intermediate input costs.[28]

From the Sistema de Cuentas Nacionales de Mexico we obtain the 1989 totals for all the macroeconomic aggregates: national income, private

28/ Unfortunately, these data did not permit disaggregation of intermediate input costs between rain-fed and irrigated lands, forcing us to assume the same input structure in each case.

investment, private consumption, direct taxes (on households and factors), indirect taxes, total government spending, private savings, the trade balance, as well as gross value of demand and value added in industry and services. Data from Cuentas Nacionales was then combined with data from Banco de Mexico. This allowed us to disaggregate the trade balance (at world prices) into the seven sector aggregation used in our model. Substracting sectoral net exports from sectoral gross demands gave us sectoral domestic demand, which we proceeded to divide between private consumption, private investment and government demand using information from the 1985 I/O table, but insuring that the totals coincided with the 1989 National Accounts totals. With the information just described we pieced together a consistent Social Accounting Matrix (SAM) for 1989.

Table A.1: AGRICULTURAL OUTPUT, 1989

Sector/product	GVS Rain-fed	GVS Irrigated	GVS Total*
I Maize	3,610	1,180	4,790
II Basic Grains	1,437	3,711	5,149
1.Rice	175	186	362
2.Wheat	119	1,585	1,704
3.Sorghum	805	904	1,710
4.Barley	155	41	196
5.Soy-Beans	89	885	974
6.Cartamo	57	89	146
7.Sesame Seed	35	19	54
III Key Products	2,363	1,609	3,972
1.Beans	455	292	748
2.Cotton	59	124	184
3.Sugar Cane	1,396	1,071	2,467
4.Coffee	264	0	264
5.Tabbaco	0	121	121
6.Cacao	149	0	149
7.Henequen	37	0	37
IV Fruits, Veg. And Rest	7,089	9,626	16,715
1.Chile	98	515	613
2.Strawberries	0	68	68
3.Sunflower	0.7	0.7	1.4
4.Tomatoes	0.1	1,393	1,502
5.Avocadoes	151	194	345
6.Alfalfa	12	2,251	2,263
7.Copra	131	59	190
8.Lemon	159	478	637
9.Apples	80	322	403
10.Oranges	343	147	490
11.Bananas	332	156	488
12.Rest	5,671	4,040	9,711

* Millions of 1989 pesos; totals may not match due to rounding errors; GVS = gross value of supply.
Source: Direccion General de Estadistica, SARH.

The Sistema de Cuentas Nacionales also had data on the totals of employment in agriculture (including livestock), industry and services. We interpret total agricultural employment as the initial rural labor force, and total services and industry employment as the initial urban labor force. Employment figures are measured as number of workers. Data on the division of employment among the various crops (in each type of land) was unavailable; to remedy this situation we proceed in three steps. First, we use technological information contained in Norton and Solis (1983) to construct approximate labor/land ratios in rain-fed and irrigated lands for our model's crop aggregation. Second, we use the SARH 1989 data on rain-fed and irrigated land allocated to each crop to calculate the employment 'implied' by the observed land allocation. Third, because the total agricultural employment implied by these calculations fell short of the total employment registered in the National Accounts (by a factor of 27%), we augmented **all** labor/land ratios so that the calculated employment in fact matched the observed 1989 total. Note that since all labor/land ratios were augmented by the same factor, **relative** labor intensities are equal to those implied in Norton and Solis (1983).

Our model requires information on the parameters for the 'land transformation functions' [$\tau 1$, $\phi 1$] and [$\tau 2$, $\phi 2$]. Given our production technology the price elasticity of supply for any crop (in any given type of land) is:

(II.1) $e_S = 1/(\alpha - \alpha\phi)$

Given the shares of land in value added[29/], α, we selected values for ϕ in each type of land such that the aggregate supply elasticity (a production-weighted average of the supply elasticity in rain-fed and irrigated lands) matched, for the case of maize, estimated elasticities (see Levy and Van Winjbergen, 1991a). Lack of previously estimated elasticities made this procedure impractical for other crops. In these cases given the values for α we simply choose values for ϕ such that: (i) $\phi 1 \leq \phi 2$ and, (ii) the associated division of output between rain-fed and irrigated lands matched the SARH data.

To obtain parameters for the utility functions we used the 1984 Income-Expenditure Survey (IES) to compute expenditure shares for rural and urban households for each income decile. Unfortunately, however, our model's aggregation pattern was difficult to match with the IES expenditure classification. In particular, expenditures on food are not equal to expenditures on our composite rural good, since part of the output of rural goods is sold as input to industry, which in turn produces food (e.g., wheat into bread). To remedy this situation it would be necessary to dis-aggregate the industry sector into a food producing sector and a 'rest of industry' sector. Unfortunately, there was no 1989 data to carry this out. Hence, we arbitrarily re-allocated the IES expenditure shares between the composite rural good, industry and services. Such re-allocation insured that: first, the households that could potentially migrate (subsistence farmers, landless rural workers and urban workers) all had the same expenditure shares and

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29/ As mentioned earlier, the SARH data did not divide total rents to land between rain-fed and irrigated. We carried out this division assuming that the share of rents accruing to rain-fed land was, in each crop, equal to the share of gross value of rain-fed output in total output.

substitution elasticities. Second, all non-migrant households had equal shares and elasticities. Third, the aggregate consumption of each good resulting from the different household preferences and incomes matched the sectoral consumption totals registered in the SAM.

We turn to the tax and subsidy information. Elsewhere (Levy and Van Wijnbergen, 1991a) we calculated the implied urban and rural prices of maize for 1989 given that year's policy configuration. In addition, with the SARH and Banco de Mexico data mentioned above, we calculated the production-weighted tariff for basic grains, the other sector of agriculture with significant protection in 1989. For industry, on the other hand, we assume an average tariff rate of 5%. VAT rates for industry and services, as well as direct tax rates on factors and households were derived from our constructed SAM. For simplicity, we assumed that only urban capitalists pay direct income taxes.

Next, we discuss sources of data for the irrigation program. We obtained the complete portfolio of existing investment projects from the Comision Nacional del Agua (CNA) for both development of new irrigation districts and re-habilitation of existing ones. The data included average costs, internal rate of return and labor requirements per hectare renovated and/or irrigated for each project. All projects with an internal rate of return of 8% or more were ranked in order of increasing per-unit cost of renovated/irrigated hectares. For this sub-set of projects we computed average labor requirements for irrigation, and obtained an estimate for lrirr in (I.19b). We also ran a simple OLS regression for relation (I.18) to obtain estimates of γ. The regression took the form:

$$\text{(II.2)} \quad \ln C_i = \ln q + \gamma \ln \sum_{i=1}^{n} RI_i + \varepsilon_i$$

where C_i is the average cost of renovating and/or irrigating RI_i hectares with project i, and n is the total number of projects (ordered by increasing C_i). The regression had a very good fit, with (corrected) R^2 of 0.8630, and an estimated value for γ of 2.2118 (with a t-statistic of 36.895).

Finally, we assumed the following values for the other key parameters: (i) rate of time preference, 7%; (ii) the inter-temporal elasticity of substitution, 2; (iii) the world rate of interest, 7%; (iv) the rate of growth population, 2%. In addition, we assume that initial rate of growth of the labor force is 3%, and that it linearly converges to the rate of growth of population, 2%, over a 10-year period. Lastly, we assume that the capital stock in industry and services and non-irrigation real government expenditures all grow at 4%.

III. Model Calibration

Calibration for 1989

We combine the various sources of information described above to compute an initial solution to the excess demand equations. The initial solution only computes a one-period equilibrium. For convenience we set world prices, **pw**, equal to unity, and choose units such that in the initial solution **p** = [**pw** | **ps**] is the unit vector. The numeraire is a bundle of domestic goods with the composition observed in 1989. By construction the real exchange rate is unity in the base solution.

Table II.2 displays the difference between simulated and actual values for the main macroeconomic aggregates. Table II.3 shows results at the sectoral level for agriculture. Three comments are relevant. First, the performance of the model at the macro level is quite satisfactory: the difference between estimated and actual values being in most cases smaller than 1%. Second, the model is able to reproduce almost exactly the pattern of output in agriculture, as well as the composition of the balance of trade. Note that for maize and vegetables in particular, the differences between actual and simulated values are almost negligible.

A third significant aspect of the base solution is that the division of the total output of each agricultural commodity between output obtained in rain-fed and irrigated lands mirrors the actual one. In addition, note that the estimated land allocations also match the actual ones, implying in turn that estimated yields are very close to observed yields. Unfortunately, as mentioned above, there is no original data against which the calculated allocations of labor to each crop can be contrasted which, although the relative labor intensities calculated are similar to the data in Norton and Solis (1983).

Calibration for 1991

Significant changes occurred in agricultural policies between 1989 and 1991: (i) protection to maize was increased from 47% to 70%, (ii) tortilla subsidies were reduced substantially, particularly in urban areas, and (iii) protection to other basic grains increased on average from 10 to 15%.

We re-calibrated the model to reflect these changes. Starting from the 1989 base the changes just mentioned were incorporated into the model, and the resulting equilibrium was considered as a benchmark 1991 equilibrium. This procedure has significant drawbacks in that the calculated 1991 equilibrium cannot at this point be contrasted with actual values. Nevertheless, we pursued this route because the changes are significant, and because we believe this provides a more accurate estimate of the effects of the FTA.

We computed a 10 year reference path for the economy, where 9 years are the adjustment period and, as described above, the tenth period summarizes the steady-state. The reference path assumes that world prices are constant, but incorporates Hicks-neutral technical change and the growth of capital, labor, population and real government spending at the rates mentioned above. To focus on the effects of excluding/including maize in the FTA, the reference path incorporates a five-year liberalization of the sector basic grains, beginning in the second period. On the other hand, we assume that no investments in irrigation take place.

TABLE A.2: MODEL PERFORMANCE, MACRO

Variable	Observed Value	Calibrated Value	% Difference (absolute value)
Gross National Expenditure[a]	511.53	511.12	0.0008
1. Consumption	334.84	334.58	0.0007
2. Investment	117.81	117.82	0.0000
3. Government	54.45	54.47	0.0003
4. Trade Balance	4.41	4.24	0.0040
Gross National Income[a]	511.53	511.12	0.0008
1. Wages	131.96	136.30	0.0328
2. Rents	26.78	22.89	0.1699
3. Profits	304.97	303.56	0.0046
4. Indirect Taxes	47.79	48.36	0.0119
Employment[b]	21.88	21.88	0.0000
1. Rural	6.00	6.00	0.0000
2. Urban	15.88	15.88	0.0000

a/ millions of millions of pesos of 1989; b/ millions of workers.

TABLE A.3: MODEL PERFORMANCE, SECTORAL

Agricultural Sector	Observed Values	Calibrated Values	% Difference (absolute value)
I Maize			
GVS Rain-fed[a]	3,610	3,601	0.002
GVS Irrigated[a]	1,180	1,192	0.010
Rain-fed Land[b]	5,553	5,517	0.006
Irrigated Land[b]	915	902	0.014
Yields Rain-fed[c]	1.485	1.491	0.004
Yields Irrigated[c]	2.947	3.021	0.025
Net Exports[a]	-1083.7	-1077.7	0.005
II Basic Grains			
GVS Rain-fed	1,437	1,474	0.025
GVS Irrigated	3,711	3,713	0.000
Rain-fed Land	1,834	2,040	0.112
Irrigated Land	2,045	2,016	0.014
Yields Rain-fed	1.846	1.702	0.084
Yields Irrigated	3.925	3.983	0.014
Net Exports	-1754.1	-2165.4	0.234
III Key Products			
GVS Rain-fed	2,363	2,383	0.008
GVS Irrigated	1,609	1,584	0.015
Rain-fed Land	2,012	2,148	0.063
Irrigated Land	563	481	0.170
Yields Rain-fed	7.502	7.088	0.058
Yields Irrigated	20.190	23.242	0.151
Net Exports	1305.9	1469.4	0.125
IV Fr, Veg & Other			
GVS Rain-fed	7,089	7,069	0.002
GVS Irrigated	9,626	9,620	0.000
Rain-fed Land	3,865	3,557	0.086
Irrigated Land	1,393	1,515	0.080
Yields Rain-fed	5.906	6.399	0.083
Yields Irrigated	23.709	21.783	0.088
Net Exports	745.7	751.9	0.008

a/thousands of millions of pesos of 1989; b/thousands of harvested hectares; c/tons per hectare.

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COMMENTS ON PAPER 7

BY SHERMAN ROBINSON

Comments on

"Transition Problems in Economic Reform:
Agriculture in the Mexico-U.S. Free Trade Agreement"

by Santiago Levy and Sweder van Wijnbergen

Sherman Robinson
April 1992

Let me begin by sorting out the different types of models presented at this conference. In economics, one can think of at least three different kinds of models. Analytic theoretical models have lots of math and are very pretty, but the last thing anybody would want to see would be a number. Then there are stylized numerical models. The idea is to put some numbers to the theory. Theory may provide a sign, but one wants to have an idea of the magnitude as well. Stylized numerical models can also be useful when theory fails to provide a sign, which happens very often. Applying theory, one commonly ends up with complex second-best situations and must use simulation to get a sense of the sign, let alone the magnitudes, of the results.

Harris and Cox, the Sobarzo model of Mexico, and Hunter et al., are all stylized numerical models that provide a sense of where the quantitatively most important effects of trade liberalization may lie. Brown's paper was probably the neatest and most extreme example of this approach. She very carefully set it up as an exercise in trying to understand how models behave, rather than trying to understand how Mexico behaves.

Applied models, in contrast, are explicitly constructed to analyze Mexico and a U.S.-Mexico Free Trade Agreement. In applied models, a concerted effort is made to be more realistic. These models require that a lot more work be done on data and parameter estimation, on trying to capture a fairly wide range of important structural relations, and on trying to get the data up-to-date. The Michigan model, as applied to the U.S./Canada/Mexico Free Trade Agreement, could be classified as an applied model, and it has generated a number of very interesting results.

Let me provide some background on the economic development literature. Mexico is undergoing a shift in development strategy. Since the Revolution, Mexico has pursued an import-substitution-led industrial strategy along with much of the rest of Latin America and, indeed, the rest of the world. Since the mid-1980s, Mexico has shifted to an outward-oriented, export-led or trade-as-an-engine-of-growth development strategy. Much is known about this kind of strategy. It is a complicated process but when it works, it's very good. Kehoe discussed some recent theoretical growth models which seek to capture elements of the process, with some interesting insights but limited success. There has been 25 years of theoretical and empirical work devoted to trying to understand relations between trade strategies and the truly astounding success of the countries that have pursued them, and the work program is certainly not finished.

In countries that have done it successfully, most start off with some minimum industrial base from which to launch export-led growth, and I think one could argue that Mexico certainly has achieved such a base. The country has to be able to make major adjustments in its economic structure, fairly rapidly, in order to exploit opportunities opened up by expanding trade. Some of the papers presented in this symposium are concerned with this transformation, which is very important for Mexico. I would argue that the required transformation in Mexico is truly profound; on the order of what is going on in Hungary today.

The policy commitment to this transformation must be credible. All of the economic agents in the system have to really believe the government means it. Industrialists must correctly believe that the open-economy policies will remain long enough so that they can make long-run investment decisions. One major reason why the Mexican government is negotiating a free trade agreement is to commit future administrations to continue the process of U.S.-Mexican economic integration.

A country embarking on an export-led development strategy must be able to penetrate world markets. And for Mexico, that means penetrating the U.S. market without incurring major terms-of-trade losses. Countries have typically run deficits in the early phases of this process. Levy and van Wijnbergen's model indicates that the costs appear early, while the benefits appear later, and this timing problem must be addressed. Mexico faces a difficult task in this regard because it is starting this process with a major debt overhang. The only other country that has pulled this off is Turkey.

In addition, countries must be able to achieve high rates of total productivity growth. Economists do not understand this process very well, but it is a necessary one. If a country does not achieve high rates of total factor productivity growth, the development strategy will fail.

So, now I turn to the Levy and van Wijnbergen model. Unlike some of the other models we've seen, this model is explicitly dynamic. It is very nicely and cleanly done, with an elegant and careful treatment of the infinite time horizon problem. I find their treatment of income distribution quite reasonable. The land price results are also quite interesting. It is very common in agricultural economics to see policy changes rapidly capitalized in the price of land and the sorts of numbers that the authors have gotten are interesting, important, and are a good indicator of the sorts of stresses one would expect to observe. Their major conclusion is that it is very important to treat maize carefully in a U.S.-Mexico free trade agreement.

It's worth pursuing some additional implications of their results. They argue, I think quite correctly, that there will be a major need for public works and infrastructure investment in Mexico. Consider the experience of the European Community when it expanded. There was a long transition period. Spain spent 10 years getting ready to apply to join the EC and had a 10-year transition period after formal accession. Similar terms were made regarding Portugal, Ireland, and Greece. Also, the European Community set up a number of institutions to funnel development funds and investment funds into these relatively backward areas. Such investment and assistance are very important, and have been completely left out of the U.S.-Mexico discussions. This paper highlights the need to address such issues explicitly.

COMMENTS ON PAPER 7

BY LESLIE YOUNG

Comments on "Transition problems in Economic Reform: Agriculture in the Mexico-US Free Trade Agreement" by Santiago levy and Sweder van Wijnbergen.

This is a valuable paper which certainly enhanced my understanding of the rural sector of Mexico. The theoretical details are nicely worked out and are presented in a professional manner. There is a detailed analysis of the distributional effects of the liberalization in trade and of the transition to free trade, aspects of liberalization which are not often analyzed. The authors are to be commended for their constructive tone. They think through the consequences of trade liberalization on the rural sector and offer useful suggestions on ways in which equity and efficiency considerations can be made to work together.

My quibbles are minor. To begin with the utterly trivial: the notation is truly awful. For example, there are two types of land, denoted by "T1" and "T2". Sometimes you think its 2 times T and sometimes you don't. Elsewhere, there is a subscript on a superscript. However, these problems are easily remedied. Moving on to more substantive issues, the authors emphasize that certain groups experience declines in their asset values, and hence in the collateral available to back loans, just when investment in land improvements is needed to permit adjustment out of maize production. They also seem to suggest that rural irrigation should be supported by the government, or perhaps by international agencies. However, it is not clear why they should be so concerned about private asset values if the government is going to support the necessary investment.

The authors emphasize that supporting rural irrigation has desirable distributional benefits across the large categories of individuals that their model addresses. However, <u>within</u> the category of rain-fed farmers, there will remain severe distributional problems: some will gain, others will lose, from any allocation of irrigation projects. Moreover, government support of irrigation will harm other groups who might benefit from alternative uses of the investment funds. Neither of these distributional conflicts are stressed in this paper.

The authors do not consider in detail the effects of NAFTA on the urban sector, despite the central role on rural/urban migration in their model. One effect of NAFTA might be to increase the demand for labor in the urban sector, which would alleviate some of the problems that they feel indicate a need for irrigation investments.

The authors find that the current rates of return on irrigation are high. This seems to constitute a good case for supporting irrigation in the countryside — except that there are many projects in Mexico with potentially high rates of return, not only in industry but also in infrastructure. For example, improvements in railways and roads might have very strong benefits. In a situation where investment funds are scarce, a full evaluation of the authors' proposal requires a comparison with the returns on competing projects.

The last comments amount to saying that a bigger model is needed. Since one can always say that, these comments do not detract from the authors' efforts to date.

To cope with distributional effects, the authors come close to suggesting that the government fund the irrigation, but retreat from this suggestion (rightly in my opinion) when they discuss loan guarantees. Perhaps what is needed is clarification of land tenure rules, so that those people who think that irrigation investments are desirable will be motivated to undertake them. The government could then support these investments with loan guarantees, so that those who gain from the rising asset values end up paying for them. I think that the paper ends up with this suggestion and I certainly support it.

Of Mexico, Porfirio Diaz said "Poor Mexico! So far from God, so close to the United States!" Of Israel, he might instead have said: "Poor Israel! So close to God, so far from the United States!" However, this paper end up saying of Mexico exactly what today's newspapers are saying of Israel: "What they need are loan guarantees!"

Comments by Leslie Young, University of Texas at Austin

PAPER 8

"AN INTERTEMPORAL, LINKED, MACROECONOMIC CGE MODEL OF THE UNITED STATES AND MEXICO FOCUSSING ON DEMOGRAPHIC CHANGE AND FACTOR FLOWS," BY ROBERT K. MCCLEERY

February 14, 1992

Draft Report on Work in Progress-
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AN INTERTEMPORAL, LINKED, MACROECONOMIC CGE MODEL OF THE UNITED STATES AND MEXICO FOCUSSING ON DEMOGRAPHIC CHANGE AND FACTOR FLOWS

Robert K. McCleery*

*Dr. McCleery is a research associate with the Institute for Economic Development and Policy, East-West Center, Honolulu, Hawaii. Portions of this work are drawn from papers written jointly with Raul Hinojosa Ojeda at UCLA and Pearl Imada of the East-West Center. Financial support for this and earlier, related works from the Americas Program at Stanford, the Fraser Institute of Vancouver, the East-West Center, and other sources is gratefully acknowledged.

AN INTERTEMPORAL, LINKED, MACROECONOMIC CGE MODEL OF THE UNITED STATES AND MEXICO FOCUSSING ON DEMOGRAPHIC CHANGE AND FACTOR FLOWS

Introduction

The proposed free trade agreement with Mexico has generated heated debate in Washington D.C. since its conceptualization by the two Presidents, with voices becoming more strident and positions more intransigent as important milestones such as the fast-track vote arise. There has been a proliferation of studies purporting to address the relevant questions raised in the NAFTA discussions, regarding how NAFTA will affect specific countries, industries, and labor groups. Not surprisingly, these studies have taken as their point of departure the existing structure of trade between the two countries and the tariff reductions likely under a NAFTA. The tools for this sort of analysis, at least in the static sense, are quite well developed and standardized. Yet they leave out important elements of the story, elements which help to explain both the ardent support from some quarters and the strong opposition from other parties.

This study, while not pretending to provide definitive answers to all of the uncertainties accompanying the agreement, is meant to introduce some of the other key economic relationships that affect U.S.-Mexico economic interdependence, and to explore how these relationships would affect the size and distribution of gains from free trade, under a specific set of assumptions. The additional elements introduced here, with varying degrees for rigor and completeness, are demographic change, domestic and foreign investment patterns, and technology transfer. These elements provide insights into the U.S.-Mexico relationship well beyond those that can be drawn from conventional trade models. The model is capable of handling labor migration as well, but that feature was disabled in order to run a particular policy scenario. The trade-off is that, without a companion partial equilibrium study, this method of analysis is unable to provide the highly disaggregated sectoral picture given by standard CGE models.[1]

[1] In a recent, more policy oriented paper (McCleery and Imada, 1992) the results of the CGE model described here feed into a twenty-four sector, partial equilibrium model of manufacturing production and trade among the U.S., Canada, Mexico, and the rest of the world.

Crucial Assumptions and Different Viewpoints:

There are two significant challenges to this method of modeling U.S.-Mexico free trade. The first is to capture the dynamic effects that changes in or reallocations of production, investment, productivity, and demand have on wages and employment over time within a country. The second is to handle the added dimensions of international movements of goods, capital, and labor in a balanced way. A number of potential assumptions and policy scenarios are possible, but there is space here to focus on just a few, while trying to indicate in the process the sensitivity of the results to alternative assumptions about the world economic system in the year 2000, at the national and global levels.

Capital movements

While this study reaffirms the generally-held view that free trade benefits the two countries taken as a whole, the magnitude and distribution of the gains from free trade between the countries and among producer and consumer groups within each country depend on two key assumptions, one regarding capital movements and the other concerning labor mobility. The first element of uncertainty relates to the size of the investment flows that free trade is likely to generate. The larger the flow, the greater is the benefit to Mexico. And because free trade is not a zero sum game, even if a moderate percentage of the finance for Mexico's development comes from the United States, any decline in U.S. domestic investment as a result of the flow is likely to be short lived. A virtuous circle is foreseen, in which the direct benefits of investing in Mexico and the indirect benefits stemming from higher Mexican growth combine to increase the profitability of investment in both countries. If more lucrative investment opportunities in both countries motivate more savings and higher investment levels, which in turn spur capital accumulation and growth, then it is reasonable to project benefits to U.S. workers in terms of upgrading the skill level of the labor force and rising wages along with moderate capital outflows for development in Mexico.

A recent Economic Policy Institute Briefing Paper[2] cites a study that indicates the potential for high wage employment to declines due to free trade, if the capital flows are large enough and come at the expense of U.S. domestic investment. The administration has cited studies that either do not deal directly with the prospect of capital movement or assume that the entire increase in U.S. investment in Mexico comes from either third countries or a reshuffling of the current U.S. direct foreign investment (DFI) portfolio, as in the Peat Marwick study[3]. In other words, one side sees large ($5 billion/year) capital movements reducing U.S. domestic investment dollar-for-dollar, with no positive offset from savings rates in response to the higher return on these new investment opportunities, while the other side sees little or no additional U.S. investment in Mexico, and none at the expense of U.S. domestic capital formation. The truth surely lies somewhere in between these black and white alternatives, and such a middle ground is explored in this study.

The EPI study makes the common assumption that the economy has an aggregate savings rate, and savings are the product of this rate and total income or GDP. Yet economists also realize that savings tend to be much higher out of profits, rents, and other sources of income that may be seen as transitory. As will be shown below, a free trade agreement with Mexico is likely to create transitory profit-making opportunities in both the manufacturing and non-manufacturing sectors of the Mexican economy that will last 10 years or less. It is quite reasonable to expect a higher percentage of these windfall profits to be saved and invested than would be the case if the increase were viewed as permanent.

Economists have made little progress in devising a general theory of direct foreign investment (DFI) and other international capital flows. What is known from standard portfolio adjustment models is that when the rate of return increases (or risk falls) on one asset, holdings of that asset increase and holdings of most or all other assets decline. Holdings of assets most similar to that which has increased its share tend to decline the most. This implies that the greatest reductions will be in DFI flows to other NIEs, and

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[2] Spriggs, "Potential Effects of Direct Foreign Investment Shifts Due to the Proposed U.S.-Mexico Free Trade Agreement," Economic Policy Institute, Washington D.C., 1991.

[3] KMPG Peat Marwick's Policy Economics Group, The Effects of a Free Trade Agreement between the U.S. and Mexico (Washington, D.C.: U.S. Council of the Mexico-U.S. Business Committee) 1991.

domestic investment and DFI in OECD countries will be less strongly affected. Rather than embracing either extreme assumption (that none or all of the increase in investment in Mexico comes at the expense of U.S. domestic investment), an intermediate position is taken. The endogenous increase in investment in Mexico is calculated in the model, then 50 percent is allocated as a reduction in U.S. domestic investment and 50 percent as a reshuffling of the existing U.S. DFI holdings. More realism would be imparted by adding a 20 to 30% share to third country investment, but the reduction in investment diversion from the U.S. domestic economy would be largely offset by a much lower share of capital good procurement from the U.S. on third country investment, leaving the model more complicated but the results not substantively changed.

Labor movements

The second crucial assumption relates to the effect of free trade on undocumented migration flows from Mexico. It is assumed here that the Immigration Reform and Control Act of 1988 (IRCA) all but eliminates undocumented immigration, and enforcement levels are raised as needed to prevent a resurgence. This is an important assumption for two reasons. First other work in this area, including my own earlier writings, indicates that without a significant rise in resources devoted to enforcement of immigration laws at the border, growing labor market pressures in Mexico through the mid-1990s would, in the absence of free trade, result in new undocumented immigration flows. These pressures could be strong enough to bring the stock of undocumented migrants in the U.S. back up to a level reaching or exceeding the pre-legalization number by the end of the decade. This would create a situation many law-makers have sworn will not be allowed to occur. The corollary to this statement is we have shown that free trade could significantly reduce the amount of undocumented immigration from Mexico over time, particularly over the next critical 5-10 years, after which economic growth will have caught up to labor force increases.[4] Alternatively, as modeled here, one could view free trade with Mexico as an

[4] An important caveat must be introduced here. Models that focus specifically on agriculture, particularly the Robinson, et al model in this volume, which looks at the combined effect of NAFTA and a sharp reduction in subsidies on corn production, predict a sharp increase in undocumented immigration from the agreement. The actual outcome will depend on how quickly and accurately information is transmitted to economic actors, how strongly and rapidly investment responds, how mobile, both internally and internationally, is rural labor, and,

option that would significantly reduce the degree of militarization and the cost in resources of maintaining a given level of immigration. It should be pointed out that such savings are not included in the measures of economic benefits calculated in this study.

The importance of this assumption regarding labor movements resulting from free trade, as well as the interaction between the two assumptions, can again be seen in reference to other recent work. The U.S. high wage employment and output declines cited in separate studies by Hinojosa Ojeda and Robinson and the EPI are a result of a roughly one million person drop in the level of undocumented immigration due to higher wages in Mexico, caused by free trade and capital inflows.[5] Wages for U.S. low wage workers rise by about 6% and 5% in the two models respectively, and prices of the goods and services they produce soar, inducing a shift in investment to substitute for the lower labor input. Thus both a direct effect from greatly reduced U.S. domestic investment and a strong indirect sectoral shift to substitute capital for increasingly costly low wage labor lead to a net decline in high wage employment under their assumptions.

Other assumptions

This section concludes with a review of the assumptions about the paths of the exogenous variables that underlie the results of the model. The impacts of altering these assumptions for an earlier model are discussed in McCleery 1988, and the relative importance of the assumptions should still be valid.

Oil prices are assumed to recover to about 75% of 1982 levels, reaching 24 1988 dollars per barrel by 2000. While this recovery is by no means assured and the recent past confirms that spot prices will remain volatile, experts feel that an upward trend in prices can be anticipated even if OPEC ceases to be a dominant force in the international oil market.

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of course, on the terms of the agreement, especially in certain crucial labor-intensive sectors.

[5] Spriggs (op. cit) and Hinojosa Ojeda and Robinson (1991). The Hinojosa Ojeda and Robinson results cited are only one of seven scenarios presented in "Alternative Scenarios of U.S.-Mexico Integration: A Computable General Equilibrium Approach," (U.C. Berkeley Department of Agriculture and Resource Economics Working Paper 609) which, when taken as a whole, lead the authors to conclude "...the creation of a free trade area between Mexico and the U.S. can significantly benefit both countries, if it is accompanied by other policies tha(t) enable Mexico to shift to an open development strategy and achieve renewed growth based on increased trade with the U.S."

The trend of Mexican net savings available for domestic net investment is assumed to be 7.5% of GDP, modified by changes in the rate of return to capital in each sector in Mexico. The comparable figure for the United States is 5.1%, modified by the return on the total investment portfolio, consisting of domestic capital, loans to Mexico, and DFI in both Mexico and the rest of the world.

Mexico receives $3.0 billion in new loans per year (exogenously). This figure is both a substantial decline from the recent past (1977-1981) and, when the original model was first conceived in 1985, was an optimistic projection for the future. Recent events, including the implementation of the Brady Plan for Mexico, indicate that a return to limited international commercial borrowing by the private sector has already begun. This fact, coupled with the large and seemingly growing current account deficit in Mexico, argues for a rethinking of what is, in effect, a model of a country in a balance of payments crisis.

The world nominal interest rate is forecast at 8%, with 4.5% inflation. The nominal interest rate is a crucial variable for Mexico, affecting the balance of payments through debt service costs on its dollar-denominated debt. For reference, the average interest rate on Mexico's debt in 1990 was 8.2%, although recent debt relief measures and even more recent recession-fighting steps have since lowered it.

Labor force growth rates in the United States fall gradually from 1.65% in 1988 to 1.05% in 2000, consistent with but slightly above the Bureau of Labor Statistics projections. The BLS has a history of underestimating both female participation rates and immigration. Mexican labor force growth rates drop more sharply from over 3% to 2.1% during the same period. Preliminary results from Mexico's 1990 census are not yet generally available, and even the 1980 census contained some errors and ambiguities. Given the importance of demographic trends to the nature of U.S.-Mexico economic interdependence, the results presented here, particularly for wages and employment levels in Mexico, should be viewed as preliminary until the labor force projections can be double checked against the census data.

Assumptions for the baseline productivity growth rates are based on historical trends in the United States and Mexico, abstracting from the 1982-86 crisis period in the latter case. These productivity growth rates for the manufacturing and non-manufacturing sectors

(1 and 2) in Mexico are 3.8% and 1.3%. For the United States the rates are 1.9% and 0.4%, a weighted average only slightly higher than the 1% rate used in the DRI model for the Department of Labor projections of labor demand through the year 2000.

Sufficient theoretical justification exists for modeling productivity growth as an endogenous function of investment rates and capital goods production in the U.S. and of investment rates and capital inflows in the case of Mexico. This modeling extension has been attempted in the final alternative scenario, although conservative parameter estimates are chosen, given the lack of theoretical and empirical guidance in the literature.

The model tracks employment and real wages for three types of labor: manufacturing workers, high wage workers in non-manufacturing activities, and low wage non-manufacturing labor.[6] Full employment is maintained for each economy as a whole, thus workers displaced from a high wage sector are assumed to immediately find and accept work either in the other high wage sector or in the low wage sector, minimizing production and welfare losses. A more realistic labor market adjustment system with government adjustment assistance is planned for future work.

As mentioned above, half of the increase in U.S. DFI in Mexico is modeled as a shift in the total DFI portfolio and half as a reduction in U.S. domestic investment. In actuality, third country DFI in Mexico may be induced by a free trade agreement as well, which may reduce both of the above components.

Considerable empirical work by Anne Krueger (1985) and World Bank researchers indicates that the labor intensity of production for export is significantly higher than the labor intensity in import substitution industries in developing countries. This empirical observation could be built into the model for Mexico, representing a shift of employment between manufacturing sub-sectors. The companion partial equilibrium study and other disaggregate CGE models appear to confirm this shift.[7] But another empirical tendency pulls capital/labor ratios in the other directions. Increasing use of higher technology

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[6] Empirically, there is much less dispersion in wages in the manufacturing sector. Using the same criteria as in non-manufacturing, a low wage manufacturing labor category would have included less than 1.5 million workers, thus manufacturing labor is treated as a homogeneous group.

[7] McCleery and Imada (1992), (op. cit), Brown and Stern and Sobrazo in this volume, etc.

production methods in multinational corporations in Mexico, many of them transferred from the United States, will tend to raise the incremental capital/labor ratio, particularly in manufacturing.

Dynamic Considerations and Their Importance

An important element for understanding U.S.-Mexico interdependence is demographics. The basic elements are clear; the Mexican labor force is young and growing rapidly, while the U.S. labor force is growing slowly and aging. But few appreciate the power of the demographic changes at work in the two economies and how they will transform the economic relationship in the decade of the nineties.

The basic complementarities between the two economies are equally plain, as abundant labor and potential capital shortages in Mexico contrast with labor shortages and likely declines in the rate of return on investments in the U.S. Yet the timing of the 'crunches' is unfortunate. Mexico has been hampered in its recent development efforts in part by its burgeoning labor force, which has swamped the ability of the formal sector to provide jobs, overflowing into rural underemployment, urban 'informal' employment, and internal and international migration flows. But despite low unemployment levels through mid-1990, no consensus exists that the U.S. is facing a labor shortage; instead labor shortages are ascribed to jobs and workers being temporarily mismatched. An acute shortage should not develop before the end of the century.

The multi-period approach taken here also allows the impact of free trade on rates of savings and investment and on technological progress and technological diffusion to be studied. These areas, along with increasing returns to scale in manufacturing production, are the most commonly cited potential sources of gains from trade agreements in particular and economic integration in general. Yet the economics profession has been slow to extend formal models to deal with these important questions. Although Bela Belassa postulates the likelihood of dynamic gains more than three times larger than static gains in an early paper on European integration[8], only a handful of recent papers attempt to quantify these gains.[9] Those attempts have been subject to strong criticism from traditionalists, perhaps contributing to the lack of work in the area.

CGE Model Structure

The model detailed here is an extension of models presented previously.[10] The most general version of the model is outlined here, although the migration equations are suppressed in the actual simulations reported.

In this model, there are three "countries," the U.S., Mexico, and the rest of the world (ROW), with two goods being produced in each country. But there are many differences between this and the prototypical three country, three traded goods model, regarding factor mobility and allocation, the motivation for trade, and other areas, which will be detailed in this section.

The foundation of the economic model rests on a set of CES (constant elasticity of substitution) production functions by country and sector for the U.S. and Mexico, a set of marginal conditions for each production function by factor of production, a set of demand functions for each sector's output by social group (factor owner), behavioral equations regulating the movement of labor between sectors and countries, and a set of equilibrium conditions and adding-up constraints. Each type of equation will be described, and the salient points and implications noted. The annotated equation list at the end of this paper

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[8] "It would appear then that the benefits derived from economies of scale, the rationalization of production, and increased investment activity far overshadow the static gains and losses associated with trade creation and trade diversion in the Common Market." Belassa, "Trade Creation and Diversion in the European Common Market," Quarterly Journal of Economics, 1962.

[9] Notable attempts include Harris, Richard, "Applied General Equilibrium Analysis of Small Open Economies with Scale Economies and Imperfect Competition," American Economic Review 74, 1984, p. 1016-32 and Baldwin, Richard E. "Measurable Dynamic Gains from Trade," mimeo (University of Columbia), 1990.

[10] Robert McCleery, "U.S.-Mexican Economic Linkages: A General Equilibrium Model of Migration, Trade, and Capital Flows" (unpublished Ph.D dissertation, Stanford University, 1988) and Clark Reynolds and Robert McCleery, "The Political Economy of Immigration Law: Impact of Simpson-Rodino on the United States and Mexico," Journal of Economic Perspectives, Vol. 2, Number 3 (Summer 1988).

contains all of the relevant equations and a data appendix follows the equations, listing the values and sources of the coefficients used.

Supply, Demand, and Sectoral Definitions

The CES production functions and marginal conditions for the United States are of the standard form. The nature of the CES production function insures that the Inada conditions hold on marginal productivities.[11] The production functions exhibit constant returns to scale and factor incomes are based on, if not always equal to, marginal productivities.

Mexico's tradeable sector (sector 1) produces a composite manufactured output using labor, capital, and an imported intermediate good in a net output (value added) production function. Its output is sold as consumer goods both domestically and in the United States. Labor productivity is much higher in this sector, with 20 percent of the labor force combining with 18 percent of the country's capital stock to produce 22 percent of GDP in the base year of 1988.

In the non-traded sector in Mexico (sector 2), skilled and unskilled labor and capital combine with a fixed factor we shall call land in a production function that exhibits decreasing returns to scale in the first three factors. Output of the sector, which will be called subsistence agriculture and services, is not traded internationally. While technically tradeable, rain-fed corn production on small plots in central and southern Mexico is largely for household consumption and cannot compete cost effectively in international markets with other major grain producers under any reasonable set of factor prices and exchange rates. The resemblance of this economic activity to the service sector in capital/output ratio and wage level justifies the grouping, while irrigated, mechanized agribusiness in the north, which produces fruits and winter vegetables for export to the United States, is grouped with the manufacturing sector.[12]

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[11] That is, marginal productivities are diminishing, approaching zero as the quantity of a factor approaches infinity, and all factors are necessary for production, in that marginal productivities approach infinity as the quantity of a factor approaches zero.

[12] The problem with this specification, of course, is that this product is an importable. The same caveats mentioned earlier regarding migration apply to the results for non-traded goods in Mexico as well.

The tradeable sector (sector 1) in the United States produces a composite manufactured good with labor and capital that is consumed in the U.S. but is used as an intermediate good in the production of Mexico's good 1. As is the case in Mexico, sector 1 is more technologically advanced and capital intensive. It comprises about 17% of the labor and 28% of the output of the U.S. economy in the base year.

The non-traded sector (sector 2) in the United States includes many of the areas in which migrants compete directly with U.S. citizens for employment. In sector 2 capital and two types of labor combine to produce non-traded services. While it is true that some migrants still work in agriculture and others now work in manufacturing, the emerging profile of the 1990s undocumented migrant is that of a construction worker, janitor, maid, gardener, dishwasher, or other service worker producing goods and services that are not internationally tradeable.[13]

The demand specification used in the model is the Stone-Geary linear expenditure system (LES). In this system, an individual's demand for a good has two components: a constant or subsistence level of demand and a second term that is proportional to income. In addition to displaying proper relative price and income effects, the subsistence demand levels allow changes in the population of a country to have a significant impact on relative prices and production levels. In Mexico, for example, population growth spurs the demand for non-traded goods (subsistence agriculture and housing), while per capita income growth disproportionately boosts demand for domestic manufactures and imports.

The utility functions implied by the form of demands are log linear in non-subsistence or discretionary demand. Samuelson proves that ordinal utility must be of the form $U=F[B1*\log x1+...+Bn*\log xn]$ where the Bs are the income shares in demand and F is any function with $F'>0$.

[13] See Wayne Cornelius, "From Sojourners to Settlers: The Changing Profile of Mexican Migrants to the United States," in U.S.-Mexico Relations: Labor Market Interdependence. Ed.: J. Bustamante et al, Stanford, CA: Stanford Press, 1992 (forthcoming).

Labor Mobility Within Countries: How Dualism is Introduced and Perpetuated

Empirical evidence that wages are bimodal in Mexico and that an underclass of unskilled labor exists in the United States necessitates a departure from the neoclassical assumption that labor moves to equalize its marginal product across sectors. Equations 5 through 10A describe the allocation of labor between sectors within a country, defining incremental capital/labor ratios (IKLs) that link high wage labor growth in the four sectors with the level of new investment. Essentially, new investment determines new employment, subject to supply constraints.[14]

Adding-up constraints ensure the exhaustion of total product in the form of factor payments (Euler's theorem) and that production takes place on the production possibilities frontier.

Internal Equilibrium Conditions

There are five sets of equilibrium conditions in the status quo form of the model, covering price determination, exchange rate determination and trade flows, migration, direct foreign investment, and balance of payments (equations 39 to 42, 43, 45, 44-48 excluding 45, and 49-50). Note that neither wages nor rates of return to capital are equalized across sectors. How these variables are treated is explained in the section on international equilibrium conditions.

In equations 39-42, prices work to equate supply and demand for each good in each country (excess demand functions are driven to zero). The model is solved using Newton's method for a set of n-dimensional linear equations in n-1 free prices. As is well-known, Newton's method may converge at a local rather than the global maximum, if the functions are not well-behaved. No formal proof of uniqueness for the solutions presented here is offered, but the solutions proved to be robust to alternative assumptions and starting points. By Walras' law, only relative prices are determined in Mexico and the United States; good

[14] An alternative formulation, used in an earlier paper (Hinojosa Ojeda and McCleery, 1992), introduces a Stakelberg game between workers and capital owners in each country, where workers set a reservation wage, knowing the response function of capitalists and thus how many workers will be hired at that wage and how much the capitalists will save and reinvest at that equilibrium. Workers maximize the wage bill over the course of the scenario. All those not hired in the manufacturing sector are crowded in to the non-traded sector in each country, subject to utility-equilibrating migration.

two in each country is the numeraire, with its price set equal to one. All prices in all countries, including the exchange rates, which are merely the ratios of foreign to domestic prices for the same goods, are set equal to one in the base year of 1988.

Modeling Labor Flows: The First International Equilibrium Condition

The international equilibrium condition on labor migration, equation 43, is disabled in the current version of the model. As mentioned above, rather than modeling a flow of migrants in response to the difference in utility levels attainable from employment in the United States and Mexico, as has characterized my earlier work, this equilibrium equation is disabled and, implicitly, enforcement levels are adjusted to hold undocumented immigration levels constant.[15] See Hinojosa Ojeda and McCleery (1992) for a detailed description of the alternative formulation.

Debt, Trade, and Capital Flows

Debt service payments on Mexico's current foreign debt and imports of consumption goods and needed intermediate goods and capital goods are paid for through oil and non-oil exports to the United States and the ROW, migrant remittances, and flows of new finance to Mexico. Capital inflows to Mexico are in the form of direct foreign investment (endogenously determined by sector) or new loans (exogenous) with a concomitant flow to the source country or region of repatriated profits or additional interest payments. The dollar value of debt service payments is a product of the endogenous level of the debt and the exogenous world interest rate. Mexico's balance of payments constraint, given in equations 44 and 46, ensures that external obligations exactly match external revenues.

Equation 45 defines two "shadow prices of foreign exchange," defined as the net value of the additional quantity of goods that could be produced given a one unit increase in both non-oil exports and (1) capital goods imports or (2) intermediate goods imports. Substitution drives the two shadow prices to equality and exports are increased to drive both to zero. Suppose one additional unit of good 1 (the manufacture) could be exported. Its sale would net additional foreign exchange, which could be spent to import either

[15] "The hard-pressed Immigration and Naturalization Service will hire nearly 1,200 new workers and agents to handle the rising tide of legal and illegal immigrants...." (Washington Post Service story appearing in the Honolulu Star Bulletin, Sunday February 9, 1992).

intermediate goods or capital goods (subject to applicable tariffs). The additional quantity of each that could be purchased is multiplied by the value of the marginal product of that factor and from this value (in pesos) is subtracted the return to selling the unit domestically to judge the profitability of further exports. Importing based on the relative profitability of the two goods drives the two shadow prices toward equality, and increasing exports drives both to zero.

The profits from increasing exports must be diminishing, because of the elasticities involved.[16] As exports increase along the demand curve, the price of exports declines. Increased demand for imports raises their price, and increased use of a factor in production given relatively fixed amounts of other factors will decrease its marginal product.

Consumption goods imports are modeled as growing proportionally to income growth.[17] This is obviously a gross simplification, thus the model understates the benefits to consumers from trade liberalization, as well as the extent to which consumption spending on imports can (and some would argue, has in fact) "crowd out" imports by producers.[18]

International transfers of goods feed into the domestic price determination process, leading to the establishment of an equilibrium purchasing power parity exchange rate at which this level of Mexican exports is an equilibrium level of external demand. Thus the law of one price holds for tradeable goods in this model; a dollar buys the same quantity

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[16] The small country assumption (that Mexico can export all it wishes of a product without affecting its export price) is not employed in this study. Other work by the author (Reynolds and McCleery, 1989) indicates that the U.S. market share of six to ten crucial Mexican exports is greater than four percent, and the ratio of Mexican imports in total U.S. imports exceeds eight percent for a dozen key products, and for some reaches the 30-60 percent range. And these import penetration ratios have undoubtedly increased since that study.

[17] This assumption reflects more the atmosphere of the late 1980s than that of today. Some economists are arguing that a consumption goods import boom is currently underway in Mexico, now that numerous controls have been relaxed. Extremist point to the loss of control of imports in 1980-81 and the balance of payments pressures that precipitated the devaluation and initial collapse of the oil boom and suggest that those conditions are being replicated.

[18] An on-going argument between proponents and critics of trade liberalization is whether imports will be of the nature that will generate sufficient exports to prevent a foreign exchange crisis. The answer has historically been affirmative in most cases, but depends critically on the perceived commitment to reforms. If agents expect a reversal, consumers and producers alike will hoard imported consumption and intermediate goods and build excess capacity against such a reversal, particularly if the domestic exchange rate is allowed to become overvalued. The jury is still out on the Mexican experience, as the strong resolve of the current administration must be tempered by the abrupt policy changes experienced in the past.

of the tradeable product on each side of the Mexican border when exchanged for pesos at this endogenously determined equilibrium rate.[19] In addition, Mexico is modeled as carrying out all external transactions (trade, debt service payments, remittances, and other capital flows) in dollar terms, thus there is no explicit Peso exchange rate with ROW.

It must be pointed out that the process of exchange rate determination in the model is quite different from the workings of the actual market process. In the model, the exchange rate is determined solely by the interactions of real variables, whereas the monetary approach to the balance of payments holds that relative supplies and demands for the respective currencies should be the dominant factor.[20] Yet serious problems can arise from tacking a monetary "superstructure" on to a real CGE model.[21] Speculative demand for a currency is another potential factor excluded by the nature of this model but present in the real world.[22]

Equations 49 and 50 regulate direct foreign investment flows from the U.S. to Mexico. Capital flows drive the difference in rates of return to capital in each sector (in dollar terms) to to an equilibrium differential, which represents risk.

In the base case, new capital inflows are exogenously set at $3 billion a year, which is roughly consistent with the experience of the 1983-1986 period. There is considerable evidence to indicate that the recent (1978-1981) period of rapid debt accumulation, during which borrowers selectively chose the amount of debt they wished to incur, is gone for good. Mexico is not alone in this regard. Net borrowing by capital importing developing countries fell from $135 billion in 1981 to $31.2 billion in 1986. Of these amounts, long term official

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[19] Because PPP is valid only in the long run, and then it is merely indicative of a range in which exchange rates may vary, the caveat that this is a medium-term model and thus not well-suited to predicting any given year's exchange rate, trade and investment flows, etc. bears repeating.

[20] M. Mussa, "A Monetary Approach to Balance of Payments Analysis," Journal of Money, Credit, and Banking vol. 6, no. 3 (Aug. 1974), 333-51.

[21] K. Dervis, J. de Melo, and S. Robinson, General Equilibrium Models for Development Policy (New York, 1982).

[22] In operation, the model predicts modest depreciation of the peso/dollar exchange rate due to Mexico's expansion in non-oil exports, ignoring the impact that capital inflows, precipitated by "higher interest rates" in Mexico would have in the opposite direction.

borrowing has risen from less than 25% to 97% over the same period. A "resolution of the debt crisis," as appears to be taking place, will not return countries like Mexico to the status of large capital importers over any substantial period, but may mean that new financing can be handled without government intervention through voluntary lending.

The CES production functions have been discussed previously. The parameters of these functions are drawn from other work by economic modelers in this area and from data on the functional distributions of income in each country (see the list of sources in the data appendix). The former influenced the choice of the value of the (constant) elasticity of substitution in each production function and our use of constant returns to scale. The latter formed the basis for the values of the distributional parameters.

There was considerably less theoretical and empirical guidance for choosing the parameters of the demand functions, however. Work on demographic complementarities between the United States and Mexico stresses the growing demand for services such as health care, restaurants, domestic services, and care for the elderly, related to both continual income growth in the United States and demographic shifts in the U.S. population.[23] For that reason, sector two in the United States is modeled as having a slightly higher income elasticity of demand than sector one. Imports are also modeled as being relatively income elastic. In the LES, all goods are both gross and net substitutes.

Sector two in Mexico consists in large part of rain-fed agriculture (more than one-third of Mexico's labor force is still employed in agriculture), whose output has a low income elasticity of demand. Thus sector one in Mexico is modeled as having a significantly larger income elasticity of demand, but sector two makes up the lion's share of the subsistence level of consumption.[24]

Many theories of development are based on a feedback mechanism, with growth generating further growth. Higher wages and increased employment lead to greater aggregate demand, which generate higher production levels in the formal sector of the

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[23] David E. Hayes-Bautista, Werner O. Schink, Jorge Chapa, The Burden of Support: Young Latinos in an Aging Society (Stanford, CA: Stanford Press, 1988).

[24] See Nora Lustig, "Distribution of Income, Structure of Consumption, and Economic Growth: The Case of Mexico," Ph. D. diss Univ. of California, Berkeley, 1979.

economy (sector one), resulting in further employment gains and increased wages, etc. Thus income growth is perceived as an impetus for output growth in manufacturing. Feedbacks of this nature are important in general equilibrium models, yet they can coexist rather than compete with other development hypotheses, such as export-led growth.

Another well recognized engine of growth is capital accumulation. In many models, savings is Keynesian. Each country saves a constant fraction of its GDP, and all savings are translated into productive investment. In this model, a different tack is taken. Savings is now the product of capital income and a savings rate, which is an endogenously determined function of the rate of return on investments [$S=s(i)*Yk$]. Free trade generates capital flows in response to opportunities for profits in Mexico for both types of savings functions, but in the former case GDP falls as s(i) rises, and S falls slightly. In this model both s(i) and Yk rise, and the investment boom in Mexico sparks a mild savings boom in the United States.

Dollar Transfers and the Government Clearinghouse

A simplified treatment of the government sectors portrays them primarily as clearinghouses, taking in revenues based on tax rates and levels of economic activity and making transfer payments to individuals.[25] In the United States, the relationships are relatively simple. Tariff revenues on imports from Mexico and ROW, and income taxes paid by skilled labor in both sectors are collected. On the expenditure side, interest is paid on the existing national debt and transfer payments are made to dependents, which can be thought of as social security payments to retirees. The difference between revenues and expenditures is the deficit (equation 71A).

The workings of the Mexican government are much more involved, even though goods and services are not directly consumed and the basic purpose of a government sector is the same as in the United States. The two primary reasons for the added complexity are the modeling of the oil sector and the special nature of dollar denominated obligations and incomes. Oil is treated as a resource endowment providing a constant stream of product

[25] In reality, of course, governments produce and consume goods and services, provide public goods, and serve many other functions that could conceivably be modeled.

for the government to export over the time horizon of the model. In actuality, of course, the amount of oil to be exported is a policy decision, yet in practice the Mexican government has proven to be very reluctant to adjust the "export platform" even under emergency circumstances.

Oil revenues are just one of a set of external credits and debits that must balance for the Mexican economy as a whole. On the government's balance sheet, tariff revenues, oil revenues, new lending, and migrant remittances constitute foreign currency inflows, while debt service payments are the primary outflow (equation 44). When the government's dollar balance is positive it supplies dollars to the private sector at the purchasing power parity exchange rate for use in importing intermediate and capital goods (the private sector will always be willing to pay at least that many pesos per dollar). When the dollar balance is negative, due perhaps to high interest rates or low oil prices, the government must buy dollars from the private sector. It is assumed that the same exchange rate holds on these transactions, despite the fact that the private sector might not willingly enter into such transactions. There are no efficiency implications of the dollar transfer price; production is the same as it would be were the government to expropriate the needed dollars without payment.

Balancing the dollar accounts for the Mexican government results in a peso transfer to or from the private sector (see equation 46). The other peso inflow is the value added tax, which is assumed to be paid by capital owners. Peso costs include interest on the domestic debt and peso payments to those who were sent remittances. The annual peso deficit is added to the domestic debt (equation 72).

CGE Model Results and Their Implications

Four sets of tables are presented, giving values of the important variables in the years 1993 and 2000. Nine figures are appended to give the reader a feel for the time paths of the important endogenous variables of the simulation. These figures show projected values for the status quo and three alternative scenarios.

Figures 1A and B record real output growth in the U.S. and Mexico, respectively. The status quo paints a somewhat gloomy picture of the economic future of the United

States. The trend growth rate of gross domestic product (GDP) is projected to fall from 2.6% to 2.2% between 1990 and 2000, reflecting slower growth in the labor force, stable or declining rates of savings and investment, and continuing modest productivity growth[26]. The small decline in the profitability of investment in both manufacturing and non-manufacturing sectors will certainly not encourage either domestic savings and investment, or sustain the high levels of foreign capital inflows which have allowed the U.S. to maintain investment rates well above domestic savings rates.

Mexico's growth rate is less monotonic, varying in a band of nearly one percentage point around a mean of roughly 4.4%. Trade between Mexico and the United States continues to increase, but at a much slower rate than in the 1980s.[27] Imports of capital goods from the U.S. will surge to $6.6 billion per year by the year 2000 and imports of U.S. intermediate goods will grow only slightly less rapidly to top $7.1 billion in the same year. Mexican non-oil exports will post a sizeable gain to $18.7 billion by the end of the century, although that represents a deceleration from the phenomenal growth rates observed in the 1980s.[28]

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[26] This model is only appropriate for medium-term projections. Its purpose is not to accurately predict output, wages, and employment in a given year, but to identify a trend, abstracting from business cycles, and other events, such as the Persian Gulf crisis, that may have a strong influence on these macroeconomic variables in the short run. Thus the baseline projection and the alternative scenarios presented here are evaluated independently of variables such as the timing and strength of the economic recovery apparently underway in the second quarter of 1991.

[27] A number of factors contribute to the slower growth of Mexican exports to the U.S. in the status quo. First, the rapid growth of the 1980s came along with huge tariff reductions and a fundamental restructuring of the Mexican economy, and both factors would be halted without a new trade agreement. Second, the growth came during a period of large and growing macroeconomic imbalances in the United States, which cannot be maintained indefinitely, and have already been reversed to some extent. Third, the expansion took place at a time when a crushing debt burden and a virtual cessation of international lending combined to make export expansion a top priority in Mexico. Fourth, oil price declines led to increased reliance on non-traditional exports, and oil prices are forecast to be rising somewhat over the course of the scenario. Finally, reasons three and four above necessitated a policy of maintaining substantial undervaluation of the peso, making Mexican goods artificially cheap in external markets. The Mexican government is already moving away from this crisis-oriented policy.

[28] All dollar figures used in the text and tables are in real (1988) dollars, unless otherwise noted. These figures are from table 2. The time paths of the bilateral trade flows in the base case and alternative scenarios are shown in figures 2A and 2B.

Free Trade

In the first scenario, where trade restrictions equivalent to a Mexican average tariff of 10.8% and a U.S. average tariff of 7.4% are eliminated over a period of 10 years, the computable general equilibrium model employed predicts the present discounted value of free trade with Mexico to be over $13.5 billion for the United States between now and the year 2000. U.S. gross domestic product is over $11 billion higher and is growing nearly one-tenth of one percent more rapidly by the year 2000. Mexico's gains are smaller in magnitude ($2.8 billion over the same ten year period), but larger in relative terms (1% of GDP by 2000). Mexico's gains come in the first few years of free trade, when a burst of capital goods imports and DFI inflows raise growth rates well above those recorded in the status quo baseline, but the surge proves to be short-lived, and massive outflows of DFI in later years reduce the level of GDP to nearly that of the baseline in the year 2000.

Approximately 350,000 U.S. jobs and workers are upgraded from "low wage" to "high wage" by 2000, 50,000 in manufacturing and 300,000 in non-manufacturing activities. Income for those low wage workers not upgraded rises by almost 2%. High wage non-manufacturing workers register a marginal gain in purchasing power relative to the status quo despite the influx of new workers, but high wage manufacturing workers suffer a loss in purchasing power of just over 1%. If this were the end of the story, the benefits of free trade for the two countries would be welcome, but hardly worth the intense lobbying we have witnessed, especially from the Mexican perspective.

Free Trade with Increased Investor Confidence

The second scenario reflects the widely held view that a free trade agreement could result in a moderate capital outflow from the U.S. to Mexico if investors' perceptions of risk change. The change in capital flows modeled here reflect a reduction in the risk premium that U.S. investors require for investment in Mexico of a full percentage point in the manufacturing sector and some 700 basis points in non-manufacturing over ten years, beginning in 1991, in anticipation of an agreement. Note that the equilibrium differentials are declining through time in any event, from 5 and 7.5 percent respectively in 1993 to 2.4 and 6.9 percent even without the increase in investor confidence.[29]

The increase in DFI relative to free trade alone is computed to be $46 billion, or $5 billion per year on average between 1991 and 2000.[30] Under the assumptions of the model, this does not dampen the benefits of free trade for the U.S. as a whole, and it improves the situation for Mexico considerably. U.S. GDP is $17 billion higher in the year 2000, and growing more than 0.1 percent faster than the baseline. Mexican GDP is $9 billion higher, although growth again is slowing as net DFI turns negative in later years.

The division of gains is less favorable to workers, although additional gains to investors boost U.S. total benefits to $38 billion. Real wages for manufacturing workers rise more rapidly than with free trade alone, but are still one percent below the baseline in the year 2000. Wages for non-manufacturing workers fall farther below the baseline initially, but rise more rapidly thereafter, increasing insignificantly over the status quo for high wage workers and by 2.5 percent for low wage labor. Some 475,000 jobs are upgraded, with 100,000 additional manufacturing workers and 375,000 new high wage workers in non-manufacturing jobs.

Mexico shares much more in the benefits of free trade in the scenario, validating the perception of many Mexicans in the administration that capital movements are the key to their benefitting from such an agreement. Economic benefits of nearly $18 billion are realized and almost 800,000 jobs are upgraded. Mexico's 23 million low wage workers, a significant portion of them being potential migrants, enjoy a 5 percent rise in real income, making Mexico's poor by far the biggest winners from free trade south of the border.

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[29] The differences in the base case are even smaller, but no capital flows are taking place, thus they are not "equilibrium differentials."

[30] It may be that capital flows are less responsive to changes in rates of return to investment in actuality, leading to lower capital flows than those anticipated here. Several factors can contribute to 'crowding costs,' such that the costs of investing are a rising function of the level of investment. Despite the recent streamlining of investment regulation, the costs in time and money of getting bureaucratic approval, licenses, etc. rise when more people are seeking such approvals. When many investors enter a market at once, asset prices and land values will be bid up and infrastructure overloaded, raising costs to all investors. Examples of these costs can be found in the Tijuana maquiladoras, where high land prices and overburdened infrastructure have driven up the costs of doing business and caused the rationing of some crucial services.

Free Trade with Increased Investor Confidence and Dynamic Gains

Dynamic gains are introduced for the United States by making the rate of technological progress a function of the level of output of capital goods, proxied by total domestic investment plus total capital exports.[31] In this scenario, a modest multiplier is assumed, and the multiplicative adjustment factor to manufacturing sector productivity growth is one plus one-one hundredth of the increase in capital goods production. The multiplier for non-manufacturing productivity growth is one-half that in manufacturing. In Mexico, productivity growth can come more easily through diffusion of known technologies from the developed countries in the form of imports of increasingly sophisticated capital goods and through technology transfers from developed countries to Mexican subsidiaries of multinational corporations or joint venture partners. The assumed parameter relating the increase in capital inflows to productivity growth in Mexican manufacturing is a conservative 1/200, with the non-manufacturing parameter again being half as large. The substantial capital inflows in this scenario also result in a movement toward U.S. production technologies, particularly in manufacturing enterprises, with higher capital/labor ratios.

This scenario demonstrates that dynamic gains could easily add an addition $10 billion to U.S. GDP by the year 2000, over and above the gains already estimated in the second scenario. GDP growth is 0.2 percent higher by the year 2000 and exports to Mexico $1 billion greater. The gains for Mexico from technology transfer are potentially even more powerful, with the capacity to provide an additional $25 billion in GDP to Mexico, raising the year 2000 GDP in this scenario 11 percent above than the baseline.

Not only are the economic benefits to free trade projected to exceed $65 billion for the United States in this scenario, but the gains are split more evenly between capital owners and workers. This scenario is also the most positive for manufacturing employment, with 125,000 more workers securing jobs than in the baseline. After slower initial growth, non-manufacturing employment reaches a level 200,000 above the baseline in the year 2000. Non-manufacturing wages for high and low wage labor reach levels 0.2 and 1.8 percent

[31] Research on Japan and the newly industrializing Asian economies is establishing the importance of this link between the rate of capital accumulation in general and the level of capital goods production in particular and productivity growth.

higher than the baseline in the year 2000, despite some initial sluggish growth. Manufacturing wages dip to 0.7% below the baseline level, after rising as much as 1 percent higher in earlier years. In short, although economic benefits accrue to the country as a whole immediately after the commencement of free trade, the initial reactions of wages and employment levels may be the opposite of the long run changes, as evident from the compensating variations shown in table 4.

Mexico gains $55 billion through the year 2000 in this scenario, aided by even larger capital inflows. The capital stock in Mexico rises by 14 percent relative to the baseline ($92 billion). Mexican labor, particularly low wage labor, is the primary beneficiary, as more than a million high wage jobs are created in the Mexican economy and the real wage of the remaining low wage workers skyrockets by 14 percent over the baseline. In Mexico, the impact effect differs from the long run effect in only one instance. Mexican manufacturing workers initially experience a small income decline relative to the status quo before recording a healthy 5 percent increase in the year 2000.

It is important to point out that in all but one of the instances where wages or employment levels for labor groups fall relative to the status quo initially, before rising later in the scenario, no absolute decrease from the previous year occurs. In the one exception, the real annual wage for low wage manufacturing labor falls by $17 between 1991 and 1992. Thus, a reduction in non-manufacturing high wage in the first two years of free trade, relative to the base year, is not a displacement of existing workers, but a change in the proportion of new labor hired by each sector over the course of a year.

There will, of course, be transitional dislocations resulting from free trade with Mexico. Free trade, after all, implies a reallocation of resources to their highest value use. But this model yields no evidence of impending massive displacements of workers, albeit at a high degree of aggregation.

Possible Extensions

One important area for improvement has already been mentioned above. The process of exchange rate determination could be extended to include the impacts of financial transactions as well. Alternatively, in light of the recent ability of Mexico to return to the international credit markets, a version of the model fixing the exchange rate and allowing Mexico to borrow to support their balance of payments could be tried.

The second major area would be to better integrate the ROW into the CGE framework. This modification would require the incorporation of the much-maligned Armington assumption and/or utility functions that are separable between domestic and foreign expenditure.

A third approach would be to make the model truly dynamic by solving it recursively, assuming perfect foresight rational expectations. In the original model, this "enhancement" was seen as neither necessary nor desirable. In a model of immigration in which immigrants have a short time horizon, it is neither realistic nor appropriate to assume that actors know and base decisions on the infinite time paths of wages and prices in both countries. But if the focus is to change permanently to capital flows and trade, it is inappropriate to base decision-making on the maximization of single period profits and utilities.

A fourth area for improvement could be to incorporate more institutional detail in the labor markets in the two countries. Unemployment and unemployment compensation could be introduced in the U.S. as a buffer between high and low wage employment. The implicit education and training process could be made explicit, and a labor-leisure trade-off specified.

A number of other, smaller, improvements could be made in the area of data and parameter refinement, particularly the direct estimation of the assumed technology innovation and transfer parameters. But, on the other hand, this particular model may have reached the point of diminishing returns to further fine-tuning. While Sobrazo and others wait for more detailed information on the exact terms of the agreement by sector, this model is most useful now, at the preliminary stage, in identifying the importance of issues and variables normally left out of models of trade liberalization. My hope is that I can impress upon my fellow modelers the importance of the issues I am raising in the areas of demographic change and labor movement, investment flows, and technological progress and diffusion so that they will tackle these issues in their own work, notwithstanding the considerable difficulties involved.

Conclusion

The modeling results presented here indicate that free trade between the U.S. and Mexico will benefit the countries involved and provide more jobs for skilled workers and income gains for many in both nations. Yet behind the win-win scenario, we see that some powerful interest groups within each country will face at least transitory losses. As economists, we understand that Pareto optimality at the industry and occupation level is seldom if ever achieved in practice, and sometimes the compensation principle must be applied in order to reach efficient outcomes. Yet we must not forget the uncertainty involved and the tendency for those seeking compensation to paint worst-case scenarios or even to blatantly overstate potential losses in the course of the bargaining process. "Correcting" these "misperceptions" is made more difficult by the gaps in our own modeling and indeed understanding of the dynamic process of economic integration, and the speculative nature of some of the assumptions governing capital, technology, and labor flows.

In conclusion, it may be useful to put this study in perspective by touching on a recurring theme of past writings, namely, managed interdependence. The benefits of an FTA will come because of the motivation and drive of the private sector, but within a framework developed by the two governments. Policy coordination is a key, not just in the area of trade but by developing a broader understanding and sensitivity regarding how seemingly domestic policies have important spill-over effects on one's trading partners, effects that may be particularly strong when those partners are also neighbors.

In return for higher growth and a more open and flexible economy, Mexico is taking on added exposure to movements in international prices and business cycles. Increased policy coordination, beginning simply with advanced notification of intended policy changes and support for a regional forum where concerns can be aired among the three major North American trading partners, could reduce risk and simultaneously promote better relations and stronger economic growth. Such a process could be initiated without either great cost or a loss of autonomy for national governments.

The proposed FTA cannot be all things for all people. Serious efforts to coordinate and harmonize policies regarding the environment, the protection of intellectual property rights, trade in services, and trade related investment measures should proceed as well, in parallel with the trade agreement. Free trade with Mexico should not be viewed as an end in itself or a complete solution to Mexico's development problems, much less a cure for the stagnation of manufacturing employment and wages in the United States. Yet it can be an important stepping stone toward both goals, as it focusses attention on the strong and growing complementarities between the two countries and the importance of closer economic ties in North America, for the sake of all three countries. Free trade between the U.S. and Mexico and the symbolic commitment it represents on both sides to an open exchange of ideas as well as goods present too important an opportunity to squander in pursuit of the perfect multidimensional accord.

Table 1
Status Quo

Simulation Results for 1993, Summary Statistics

	United States	Mexico
Real GDP	4,569.13	221.81
GDP growth	2.49	4.76
Average growth since 1988	2.60	4.20
Real non-oil exports	4.35	13.92
Capital goods imports	-5.03	5.03

Sectoral Results for 1993

	US1	US2	MEX1	MEX2
Real GDP	1,344.76	3,224.37	57.45	164.36
Labor-high	21.27	82.98	7.75	4.05
Labor-low	0.00	20.05	0.00	21.77
Capital	7,302.13	2,310.70	109.99	415.29
Price	0.88	1.00	0.84	1.00
Return to capital	6.75	6.64	11.85	14.14
Real wage-high	35.57	38.07	3.96	4.97
Real wage-low	11.41	11.41	3.10	3.10
Direct foreign investment	-1.25	-1.95	1.25	1.95
DFI sum (position)			7.00	6.64

Simulation Results for 2000, Summary Statistics

	United States	Mexico
Real GDP	5,374.83	298.12
GDP growth	2.20	4.40
Average growth since 1988	2.40	4.30
Real non-oil exports	7.14	18.70
Capital goods imports	-6.65	6.65

Table 1 (continued)

Sectoral Results for 2000				
	US1	US2	MEX1	MEX2
Real GDP	1,688.57	3,686.26	100.96	197.16
Labor-high	23.24	91.81	10.17	5.36
Labor-low	0.00	22.30	0.00	23.92
Capital	8,118.93	2,807.37	169.26	520.69
Price	0.79	1.00	0.60	1.00
Return to capital	6.86	6.21	9.08	12.95
Real wage-high	37.50	40.03	4.12	5.49
Real wage-low	11.89	11.89	3.58	3.58
Direct foreign investment	0.00	0.00	0.00	0.00
DFI sum (position)			0.00	0.00

NOTES:
Real GDP, real non-oil exports, and capital figures in billions of 1988 dollars; GDP growth and average growth since 1988, and return to capital figures in percent; labor figures in millions of persons; direct foreign investment figures in billions of current dollars; and real wage figures in thousands of 1988 dollars.

Table 2
Free Trade Only

Simulation Results for 1993, Summary Statistics

	United States	Mexico
Real GDP	4,566.76	224.21
GDP growth	2.47	5.33
Average growth since 1988	2.60	4.40
Real non-oil exports	4.53	13.94
Capital goods imports	-8.06	8.06

Sectoral Results for 1993

	US1	US2	MEX1	MEX2
Real GDP	1,344.74	3,222.02	58.98	165.23
Labor-high	21.27	82.89	7.94	4.16
Labor-low	0.00	20.14	0.00	21.47
Capital	7,302.04	2,306.78	112.72	424.47
Price	0.88	1.00	0.82	1.00
Return to capital	6.79	6.65	11.63	13.89
Real wage-high	35.76	38.05	3.90	4.88
Real wage-low	11.33	11.33	3.17	3.17
Direct foreign investment	-2.74	-6.49	2.74	6.49
DFI sum (position)			9.69	15.15

Compensating Variations for 1993

Social group	Number of people	Amount ($/person)	Total (product)
U.S. high wage 1	21.27	0.15	3.28
U.S. high wage 2	82.89	-0.01	-1.11
U.S. low wage	20.05	-0.06	-1.21
From U.S. high 2 to U.S. low	0.09	-21.35	-1.84

Table 2 (continued)

Compensating Variations for 1993 (continued)

Social group	Number of people	Amount ($/person)	Total (product)
U.S. capitalists 1	1.00	2.14	2.14
U.S. capitalists 2	1.00	0.51	0.51
U.S. total (column sum)			1.76
Mexico high wage 1	7.75	-0.06	-0.45
Mexico high wage 2	4.05	-0.09	-0.34
Mexico low wage	21.47	0.07	1.46
From Mexico low to Mexico high 1	0.19	0.72	0.14
From Mexico low to Mexico high 2	0.10	1.63	0.17
Legalized migrants	1.50	-0.06	-0.09
Mexican capitalists 1	1.00	-0.05	-0.05
Mexican capitalists 2	1.00	-0.41	-0.41
Mexican landowners	1.00	0.24	0.24
Mexico total (column sum)			0.65
Total both countries			2.41

Simulation Results for 2000, Summary Statistics

	United States	Mexico
Real GDP	5,386.57	298.15
GDP growth	2.27	3.07
Average growth since 1988	2.50	4.30
Real non-oil exports	7.75	18.78
Capital goods imports	-6.85	6.85

Table 2 (continued)

Sectoral Results for 2000				
	US1	US2	MEX1	MEX2
Real GDP	1,692.48	3,694.09	101.54	196.61
Labor-high	23.30	92.11	10.14	5.34
Labor-low	0.00	21.94	0.00	23.96
Capital	8,137.90	2,822.73	168.24	515.93
Price	0.78	1.00	0.59	1.00
Return to capital	6.75	6.18	9.11	13.04
Real wage-high	36.96	40.08	4.13	5.50
Real wage-low	12.17	12.17	3.56	3.56
Direct foreign investment	4.86	9.67	-4.86	-9.67
DFI sum (position)			4.40	0.20

Compensating Variations for 2000

Social group	Number of people	Amount ($/person)	Total (product)
U.S. high wage 1	23.24	-0.43	-9.98
U.S. high wage 2	91.81	0.03	2.69
U.S. low wage	21.94	0.22	4.86
From U.S. low to U.S. high 1	0.05	19.65	1.05
From U.S. low to U.S. high 2	0.30	22.09	6.58
U.S. capitalists 1	1.00	-4.47	-4.47
U.S. capitalists 2	1.00	0.25	0.25
U.S. total (column sum)			0.98
Mexico high wage 1	10.14	0.01	0.05
Mexico high wage 2	5.34	0.01	0.05
Mexico low wage	23.92	-0.01	-0.31
From Mexico high 1 to Mexico low	0.03	-0.44	-0.01
From Mexico high 2 to Mexico low	0.02	-0.44	-0.01
Legalized migrants	1.50	0.22	0.33
Mexican capitalists 1	1.00	-0.42	-0.42
Mexican capitalists 2	1.00	0.04	0.04
Mexican landowners	1.00	-0.00	-0.00

Table 2 (continued)

Compensating Variations for 2000 (continued)			
Social group	Number of people	Amount ($/person)	Total (product)
Mexico total (column sum)			-0.29
Total both countries			0.70

Discounted Sum of Compensating Variations	
	1991-2000
U.S. high wage 1	4.41
U.S. high wage 2	-10.21
U.S. low wage	4.20
U.S. capitalists 1 and 2	12.54
Present value of changes	2.59
U.S. total	13.53
Mexico high wage 1	-3.88
Mexico high wage 2	-2.92
Mexico low wage	14.63
Mexican capitalists 1 and 2	-5.27
Mexican landowners	1.98
Present value of changes	-1.85
Mexico total	2.69
Total both countries	16.22

NOTES:
Real GDP, real non-oil exports, and capital goods figures in billions of 1988 dollars; GDP growth and average growth since 1988, and return to capital figures in percent; labor figures in millions of persons; direct foreign investment figures in billions of current dollars; and real wage figures in thousands of 1988 dollars. Compensating variations for 1993 and 2000 are in 1988 dollars, but are not discounted. Discounted compensating variations are deflated to 1991 by discount rates of 9 and 10 percent for the U.S. and Mexico. Present value of changes in stocks discounts differences in terminal year capital stocks and external and internal debt to 1991.

Table 3
Free Trade with Increased Investor Confidence

Simulation Results for 1993, Summary Statistics

	United States	Mexico
Real GDP	4,565.44	226.37
GDP growth	2.46	5.60
Average growth since 1988	2.60	4.60
Real non-oil exports	4.70	13.96
Capital goods imports	-9.71	9.71

Sectoral Results for 1993

	US1	US2	MEX1	MEX2
Real GDP	1,344.80	3,220.64	60.62	165.74
Labor-high	21.27	82.84	8.11	4.25
Labor-low	0.00	20.19	0.00	21.21
Capital	7,302.35	2,304.52	117.10	431.01
Price	0.89	1.00	0.80	1.00
Return to capital	6.81	6.65	11.22	13.71
Real wage-high	35.89	38.03	3.84	4.80
Real wage-low	11.29	11.29	3.24	3.24
Direct foreign investment	-4.24	-8.41	4.24	8.41
DFI sum (position)			14.30	21.36

Compensating Variations for 1993

Social group	Number of people	Amount ($/person)	Total (product)
U.S. high wage 1	21.27	0.26	5.56
U.S. high wage 2	82.84	-0.02	-1.95
U.S. low wage	20.05	-0.10	-1.91
From U.S. high 2 to U.S. low	0.14	-21.38	-2.90

Table 3 (continued)

Compensating Variations for 1993 (continued)

Social group	Number of people	Amount ($/person)	Total (product)
From U.S. high 2 to U.S. high 1	0.00	-1.73	-0.00
U.S. capitalists 1	1.00	3.86	3.86
U.S. capitalists 2	1.00	0.89	0.89
U.S. total (column sum)			3.55
Mexico high wage 1	7.75	-0.11	-0.87
Mexico high wage 2	4.05	-0.16	-0.65
Mexico low wage	21.21	0.13	2.69
From Mexico low to Mexico high 1	0.36	0.67	0.24
From Mexico low to Mexico high 2	0.19	1.56	0.30
Legalized migrants	1.50	-0.10	-0.14
Mexican capitalists 1	1.00	-0.31	-0.31
Mexican capitalists 2	1.00	-0.61	-0.61
Mexican landowners	1.00	0.45	0.45
Mexico total (column sum)			1.10
Total both countries			4.66

Simulation Results for 2000, Summary Statistics

	United States	Mexico
Real GDP	5,392.10	307.34
GDP growth	2.32	3.16
Average growth since 1988	2.50	4.50
Real non-oil exports	8.59	18.95
Capital goods imports	-5.20	5.20

Table 3 (continued)

Sectoral Results for 2000				
	US1	US2	MEX1	MEX2
Real GDP	1,696.45	3,695.64	108.98	198.36
Labor-high	23.35	92.19	10.69	5.63
Labor-low	0.00	21.81	0.00	23.12
Capital	8,157.17	2,826.66	186.46	540.82
Price	0.78	1.00	0.56	1.00
Return to capital	6.76	6.18	8.27	12.52
Real wage-high	37.01	40.05	4.00	5.31
Real wage-low	12.27	12.27	3.81	3.81
Direct foreign investment	2.12	9.46	-2.12	-9.46
DFI sum (position)			27.04	24.75

Compensating Variations for 2000			
Social group	Number of people	Amount ($/person)	Total (product)
U.S. high wage 1	23.24	-0.39	-9.07
U.S. high wage 2	91.81	0.01	0.89
U.S. low wage	21.81	0.30	6.43
From U.S. low to U.S. high 1	0.11	19.69	2.12
From U.S. low to U.S. high 2	0.37	22.07	8.26
U.S. capitalists 1	1.00	-1.27	-1.27
U.S. capitalists 2	1.00	2.10	2.10
U.S. total (column sum)			9.46
Mexico high wage 1	10.17	-0.12	-1.20
Mexico high wage 2	5.36	-0.17	-0.91
Mexico low wage	23.12	0.18	4.06
From Mexico low to Mexico high 1	0.52	0.31	0.16
From Mexico low to Mexico high 2	0.28	1.37	0.38
Legalized migrants	1.50	0.30	0.44
Mexican capitalists 1	1.00	-1.72	-1.72
Mexican capitalists 2	1.00	-1.35	-1.35
Mexican landowners	1.00	0.68	0.68

Table 3 (continued)

Compensating Variations for 2000 (continued)			
Social group	Number of people	Amount ($/person)	Total (product)
Mexico total (column sum)			0.53
Total both countries			9.99

Discounted Sum of Compensating Variations	
	1991-2000
U.S. high wage 1	22.03
U.S. high wage 2	-24.26
U.S. low wage	2.43
U.S. capitalists 1 and 2	34.32
Present value of changes	3.72
U.S. total	38.24
Mexico high wage 1	-7.97
Mexico high wage 2	-5.97
Mexico low wage	29.72
Mexican capitalists 1 and 2	-11.74
Mexican landowners	4.16
Present value of changes	9.46
Mexico total	17.66
Total both countries	55.90

NOTES:
Real GDP, real non-oil exports, and capital goods figures in billions of 1988 dollars; GDP growth and average growth since 1988, and return to capital figures in percent; labor figures in millions of persons; direct foreign investment figures in billions of current dollars; and real wage figures in thousands of 1988 dollars. Compensating variations for 1993 and 2000 are in 1988 dollars, but are not discounted. Discounted compensating variations are deflated to 1991 by discount rates of 9 and 10 percent for the U.S. and Mexico. Present value of changes in stocks discounts differences in terminal year capital stocks and external and internal debt to 1991.

Table 4
Free Trade with Increased Investor Confidence and Dynamic Gains

Simulation Results for 1993, Summary Statistics

	United States	Mexico
Real GDP	4,566.85	227.13
GDP growth	2.49	5.77
Average growth since 1988	2.60	4.70
Real non-oil exports	4.69	13.99
Capital goods imports	-9.30	9.30

Sectoral Results for 1993

	US1	US2	MEX1	MEX2
Real GDP	1,345.22	3,221.63	60.58	166.55
Labor-high	21.27	82.85	8.02	4.28
Labor-low	0.00	20.18	0.00	21.27
Capital	7,302.45	2,304.94	116.95	430.18
Price	0.89	0.00	0.81	1.00
Return to capital	6.81	6.65	11.32	13.81
Real wage-high	35.87	38.05	3.92	4.77
Real wage-low	11.30	11.30	3.24	3.24
Direct foreign investment	-4.12	-7.75	4.12	7.75
DFI sum (position)			14.19	20.58

Compensating Variations for 1993

Social group	Number of people	Amount ($/person)	Total (product)
U.S. high wage 1	21.27	0.24	5.10
U.S. high wage 2	82.85	-0.01	-1.05
U.S. low wage	20.05	-0.09	-1.72
From U.S. high 2 to U.S. low	0.13	-21.37	-2.69

Table 4 (continued)

Compensating Variations for 1993 (continued)			
Social group	Number of people	Amount ($/person)	Total (product)
From U.S. high 2 to U.S. high 1	0.00	-1.75	-0.00
U.S. capitalists 1	1.00	3.59	3.59
U.S. capitalists 2	1.00	0.87	0.87
U.S. total (column sum)			4.09
Mexico high wage 1	7.75	-0.04	-0.31
Mexico high wage 2	4.05	-0.18	-0.74
Mexico low wage	21.27	0.13	2.77
From Mexico low to Mexico high 1	0.27	0.74	0.20
From Mexico low to Mexico high 2	0.23	1.53	0.35
Legalized migrants	1.50	-0.09	-0.13
Mexican capitalists 1	1.00	-0.25	-0.25
Mexican capitalists 2	1.00	-0.47	-0.47
Mexican landowners	1.00	0.50	0.50
Mexico total (column sum)			1.91
Total both countries			6.00

Simulation Results for 2000, Summary Statistics		
	United States	Mexico
Real GDP	5,402.36	332.09
GDP growth	2.39	3.92
Average growth since 1988	2.50	5.20
Real non-oil exports	9.41	19.09
Capital goods imports	-5.42	5.42

Table 4 (continued)

Sectoral Results for 2000

	US1	US2	MEX1	MEX2
Real GDP	1,704.33	3,698.02	121.46	210.63
Labor-high	23.37	92.01	10.74	6.06
Labor-low	0.00	21.98	0.00	22.64
Capital	8,163.03	2,817.51	204.29	577.97
Price	0.78	1.00	0.54	1.00
Return to capital	6.79	6.20	8.15	12.40
Real wage-high	37.18	40.16	4.41	5.25
Real wage-low	12.17	12.17	4.22	4.22
Direct foreign investment	-2.63	5.54	2.63	-5.54
DFI sum (position)			45.53	55.11

Compensating Variations for 2000

Social group	Number of people	Amount ($/person)	Total (product)
U.S. high wage 1	23.24	-0.25	-5.83
U.S. high wage 2	91.81	0.09	8.47
U.S. low wage	21.98	0.21	4.71
From U.S. low to U.S. high 1	0.12	19.83	2.47
From U.S. low to U.S. high 2	0.20	22.15	4.36
U.S. capitalists 1	1.00	2.37	2.37
U.S. capitalists 2	1.00	4.58	4.58
U.S. total (column sum)			21.13
Mexico high wage 1	10.17	0.21	2.15
Mexico high wage 2	5.36	-0.23	-1.23
Mexico low wage	22.64	0.50	11.32
From Mexico low to Mexico high 1	0.57	0.63	0.36
From Mexico low to Mexico high 2	0.71	1.31	0.92
Legalized migrants	1.50	0.21	0.32
Mexican capitalists 1	1.00	-1.64	-1.64
Mexican capitalists 2	1.00	-1.46	-1.46
Mexican landowners	1.00	2.49	2.49

Table 4 (continued)

Compensating Variations for 2000 (continued)			
Social group	Number of people	Amount ($/person)	Total (product)
Mexico total (column sum)			13.23
Total both countries			34.36

Discounted Sum of Compensating Variations	
	1991-2000
U.S. high wage 1	32.95
U.S. high wage 2	-13.14
U.S. low wage	-4.17
U.S. capitalists 1 and 2	44.92
Present value of changes	4.59
U.S. total	65.15
Mexico high wage 1	0.51
Mexico high wage 2	-6.21
Mexico low wage	39.81
Mexican capitalists 1 and 2	-9.09
Mexican landowners	6.91
Present value of changes	23.06
Mexico total	54.99
Total both countries	120.14

NOTES:
Real GDP, real non-oil exports, and capital goods figures in billions of 1988 dollars; GDP growth and average growth since 1988, and return to capital figures in percent; labor figures in millions of persons; direct foreign investment figures in billions of current dollars; and real wage figures in thousands of 1988 dollars. Compensating variations for 1993 and 2000 are in 1988 dollars, but are not discounted. Discounted compensating variations are deflated to 1991 by discount rates of 9 and 10 percent for the U.S. and Mexico. Present value of changes in stocks discounts differences in terminal year capital stocks and external and internal debt to 1991.

FIGURE 1A
REAL GDP GROWTH, UNITED STATES
1991-2000

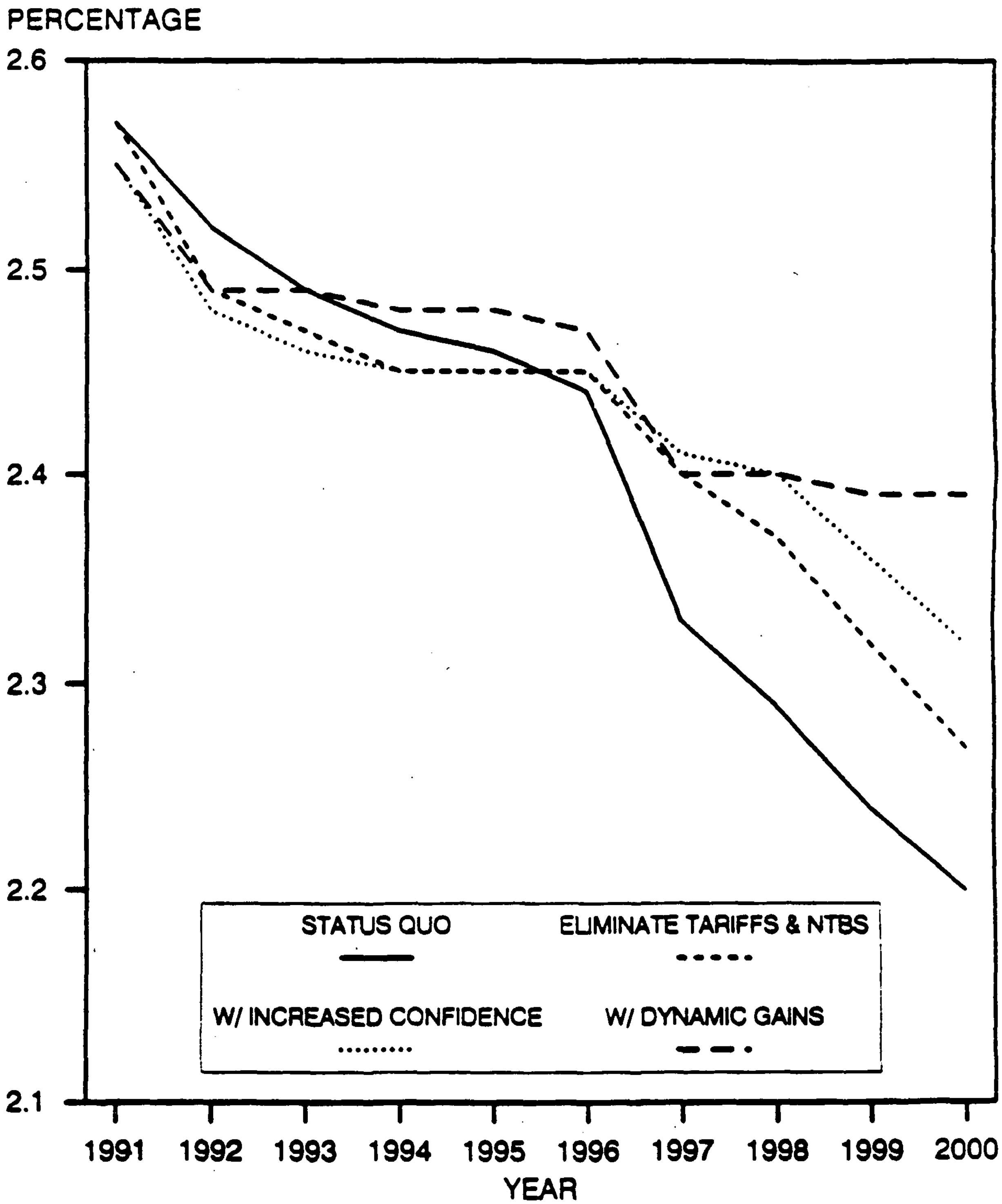


FIGURE 1B
REAL GDP GROWTH, MEXICO
1991-2000

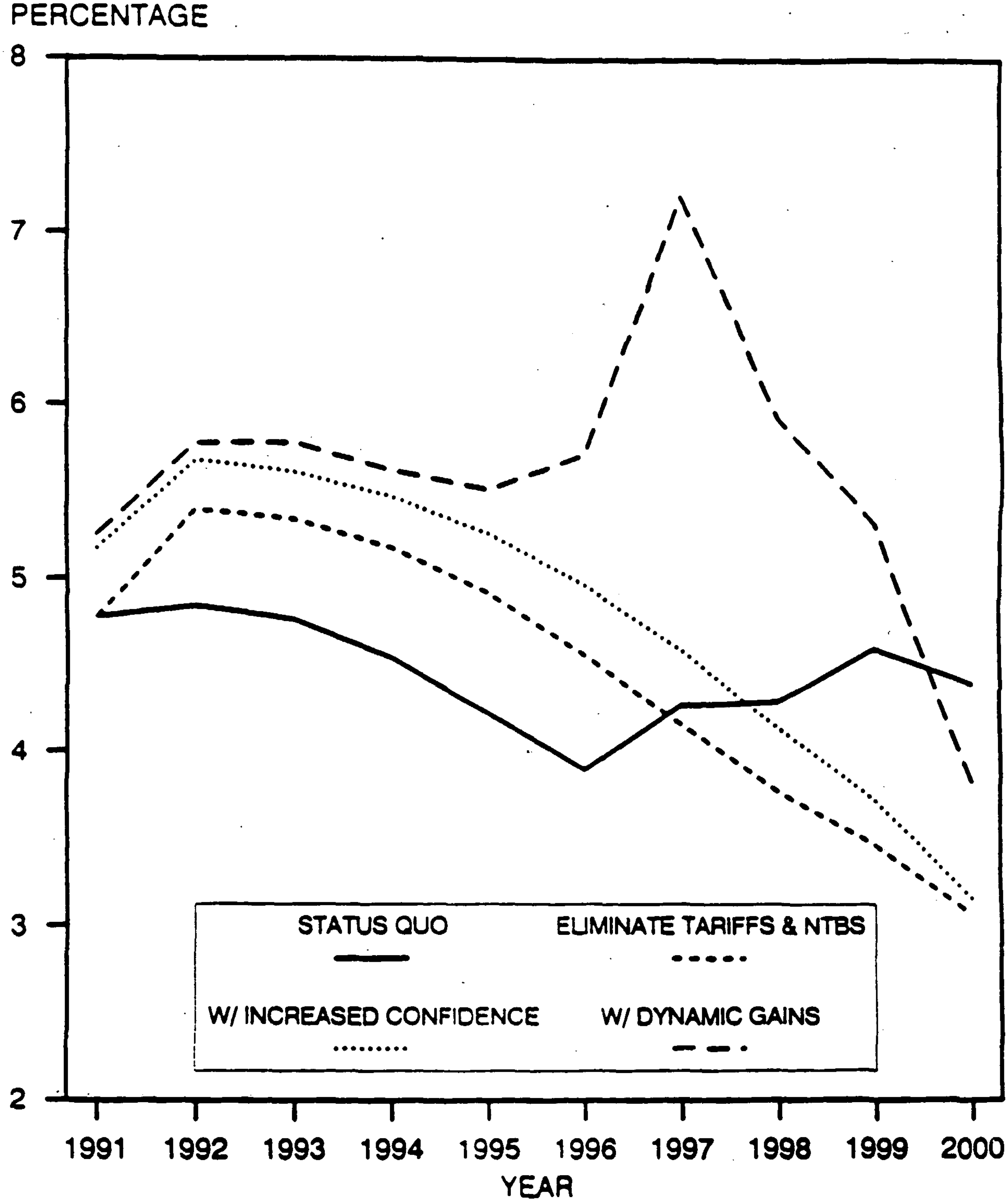


FIGURE 2A
CAPITAL GOODS EXPORTS TO MEXICO
1991-2000

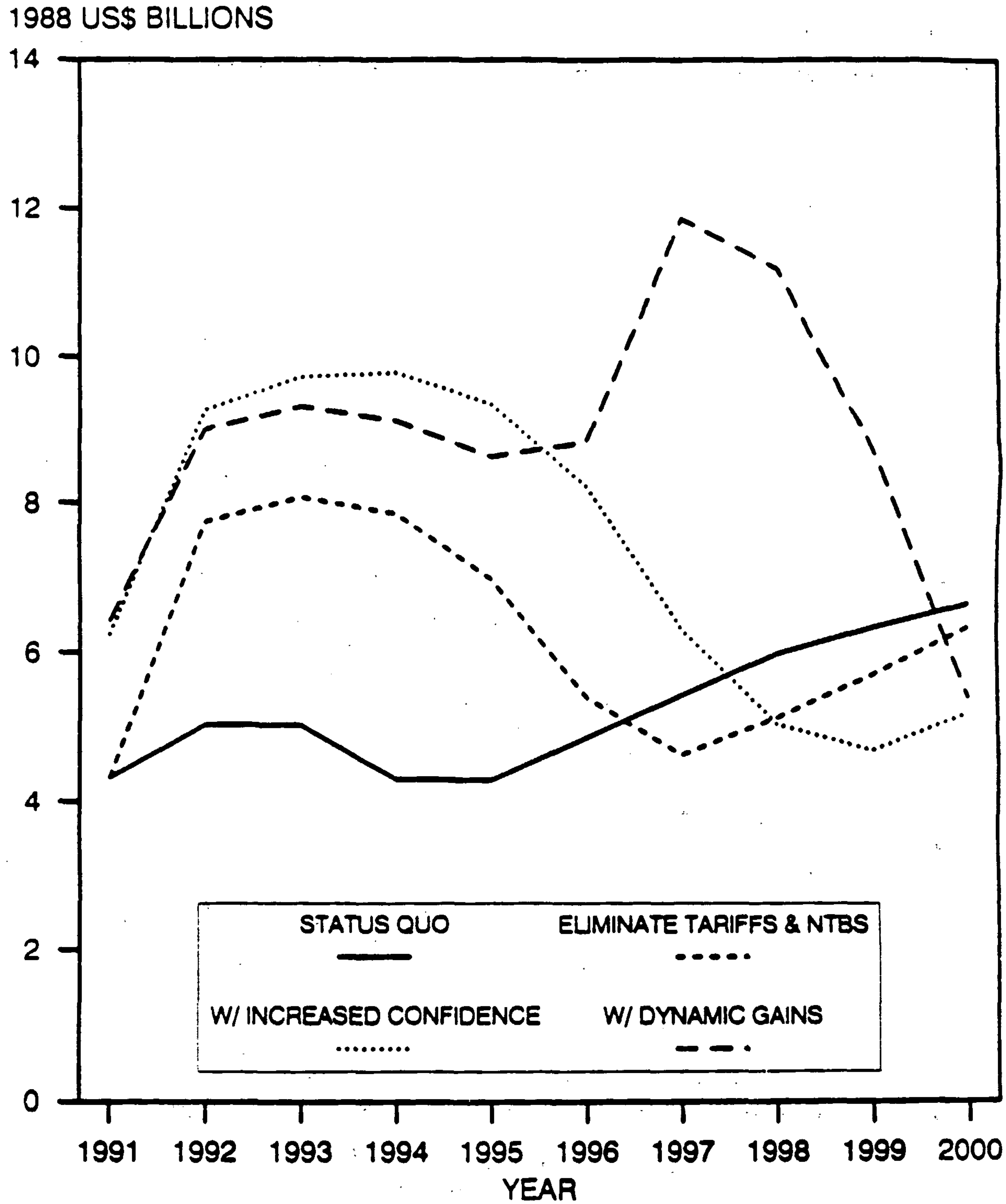


FIGURE 2B
INTERMEDIATE GOODS EXPORTS TO MEXICO
1991-2000

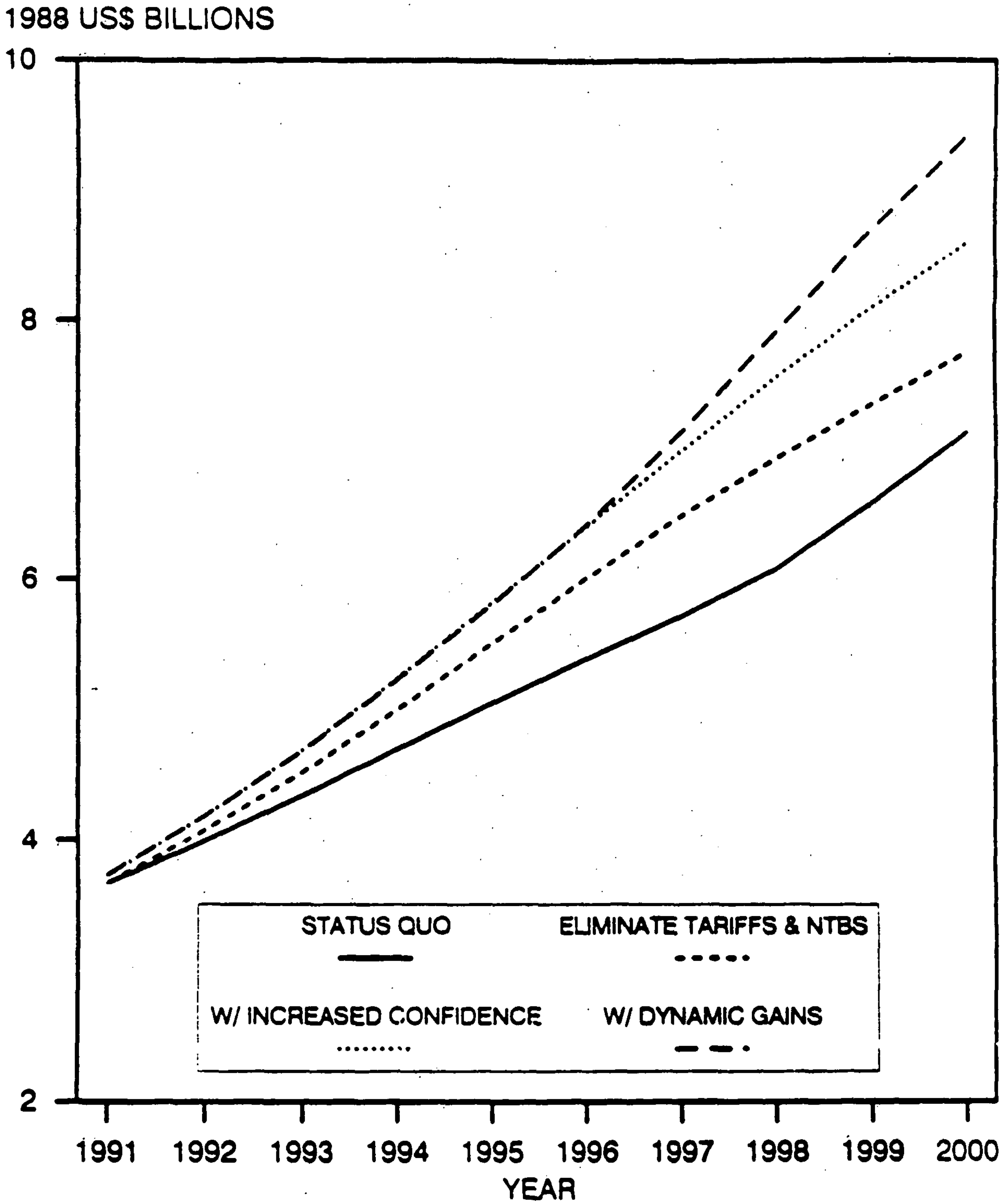


FIGURE 3A
U.S. DFI STOCK IN MEXICAN MANUFACTURING
1991-2000

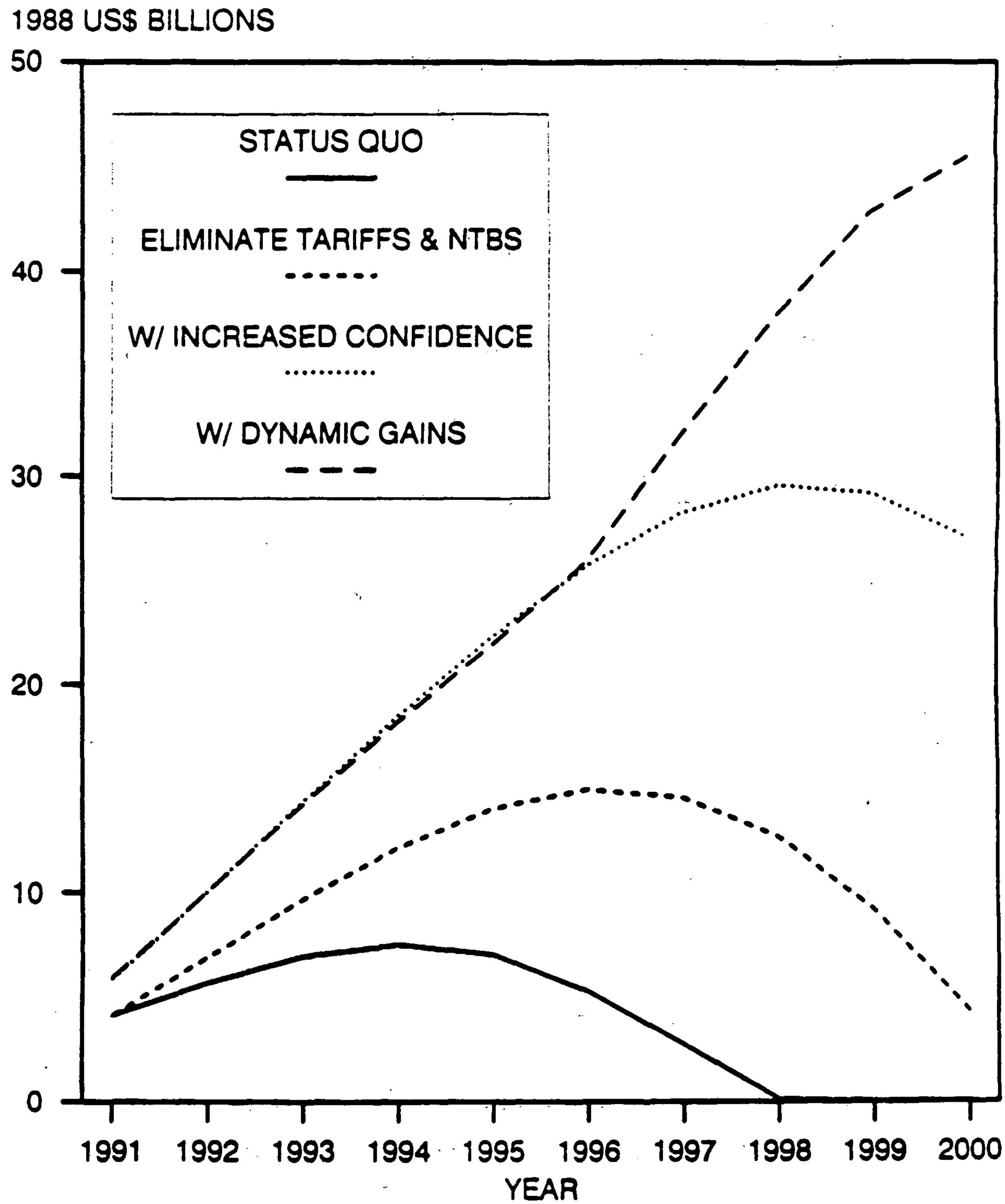


FIGURE 3B
U.S. DFI STOCK IN MEXICAN NON-MANUF. 1991-2000

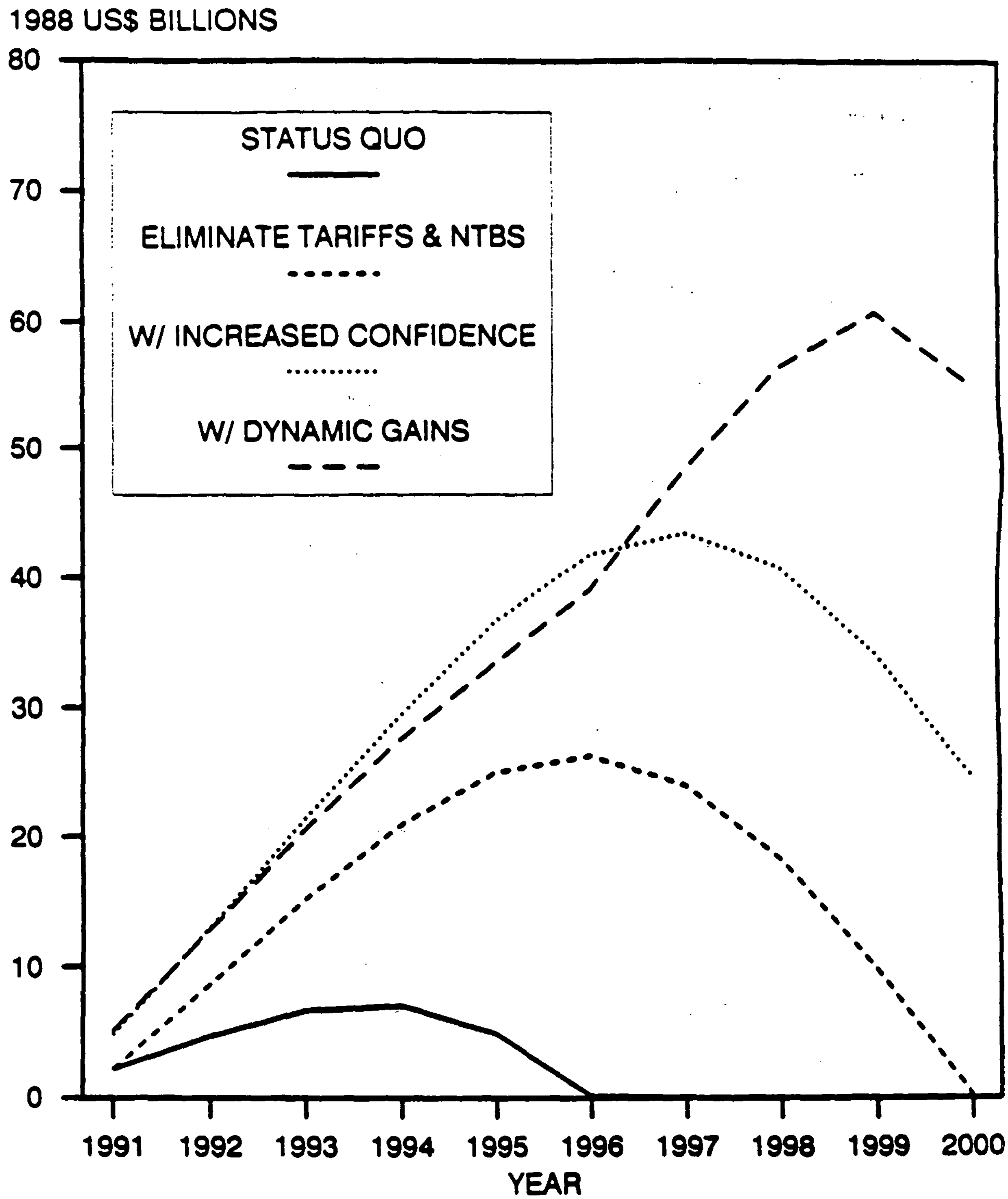


FIGURE 4A
WAGES IN U.S. MANUFACTURING
1991-2000

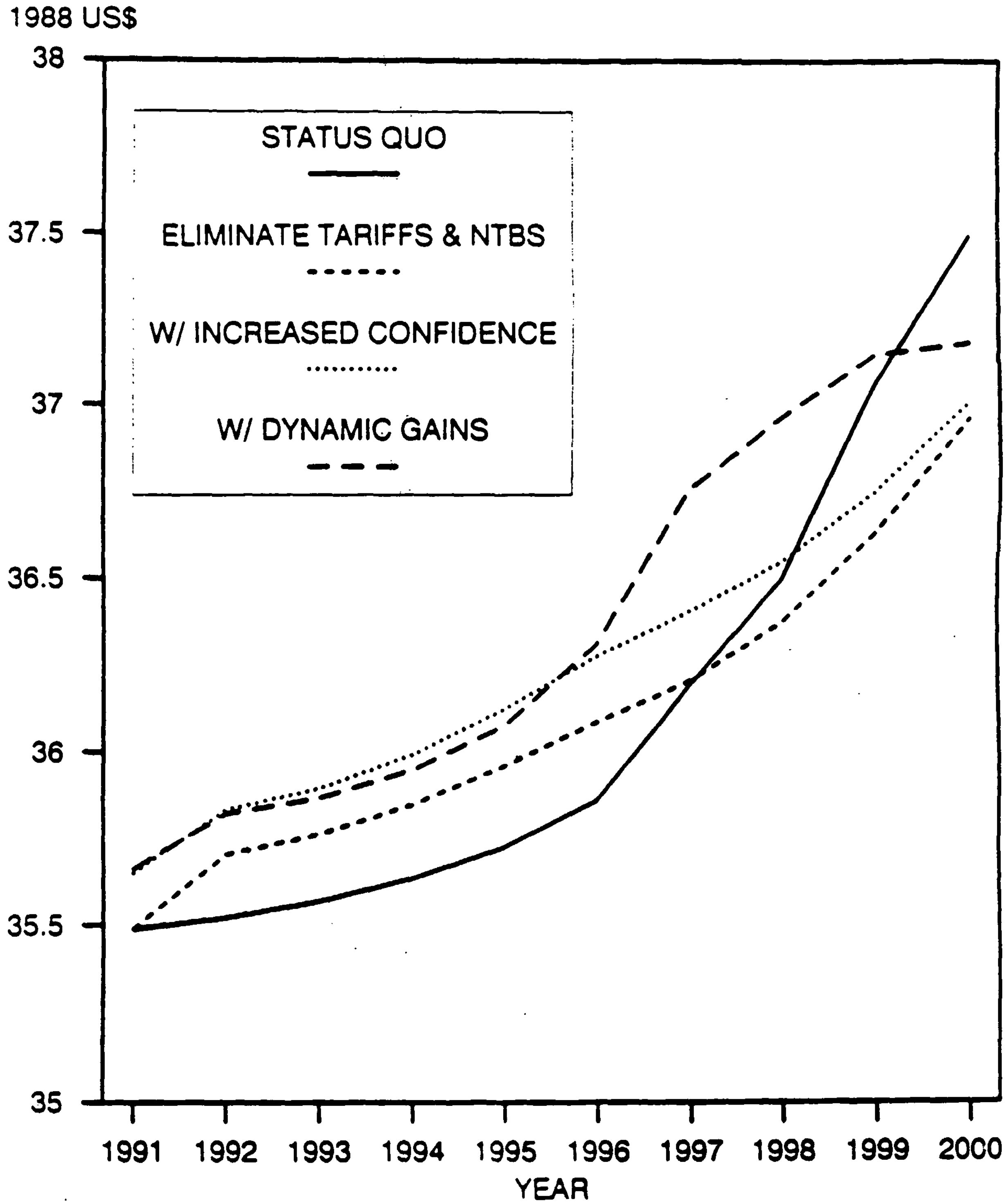


FIGURE 4B
U.S. NON-MANUF., HIGH WAGE
1991-2000

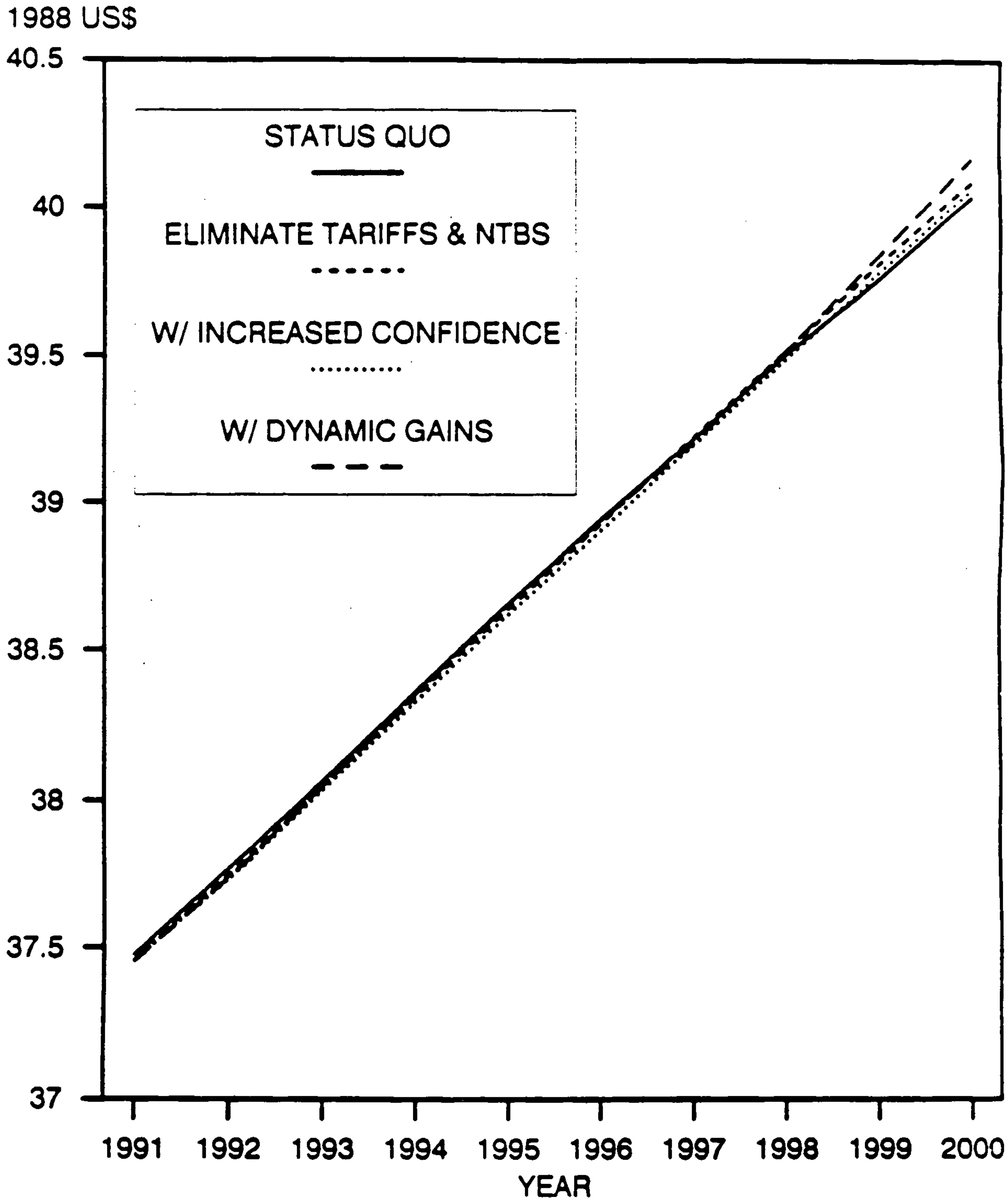
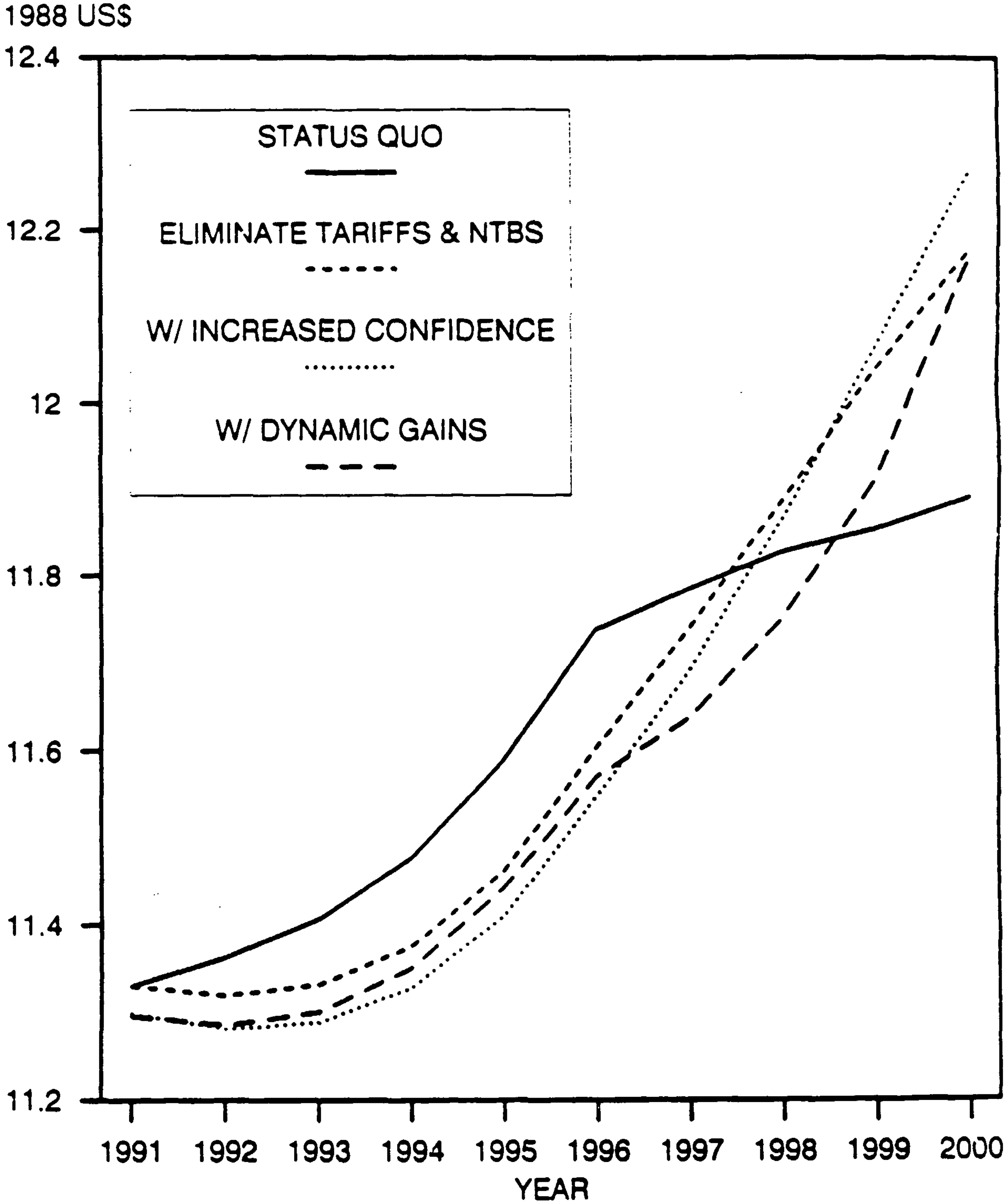


FIGURE 4C
U.S. NON-MANUF., LOW WAGE
1991-2000



Appendix 1
Annotated Equation List
9/91 MODEL

This is a partial listing of the parameters, sources, and equations that go into the formulation of the model. Short of providing an eighty page computer printout of the program, which would not be particularly helpful to the reader in any event, a complete list is not practical for this project. Examples of the form of equations is given--i.e. sample demand, production, utility, etc. functions are given, but not all are provided. For instance, the Newton-Raphson method requires convergence tolerances for both the function and the variable (Press, et. al 1989). They are replaced with a blanket statement that tolerances are generally set for the third, fourth, or fifth decimal place, making the results numerically significant (conservatively) at the $10 million range. Since the numerical significance is so much greater than the significance that can be reasonably placed on the assumptions and parameters involved, it is not terribly interesting or informative.

It is worthy of special note to point out that the trade values use are from the United Nations tradenet--the imports from partner countries reported by the importing country. As such, these figures are significantly lower than the U. S. Department of Commerce trade figures, particularly for U.S. exports to Mexico. Although the Commerce figures are probably more reliable, a consistent data base across countries was needed to support the linked partial equilibrium study of disaggregate manufacturing trade in North America.

Base Year (1988) Data and Parameters:

DISRATMX=0.900
DISRATUS=0.910
MEXSAVRT1=0.090*2.250
MEXSAVRT2=0.090*3.05
USSAVRT1=0.056*4.30
USSAVRT2=0.056*4.8
DEBT=102.0
CAPFLTSM=10.0
RATE=0.082
USRATE=RATE
MPESOPOS= - 10.0
USGOVPOS= - 1147.0
MRATE=0.08
OIMP=6.0
W2US=10.051
MTAX1=0.11
MTAX2=0.11
USITAX=0.186

MOILQ=14.7875
DEPEND=45.254582
DEPENDGRO=1.03
USDSLV=5.4
USDSLV1=1.7
USDSLV2=3.7
USDSLV3=0.0
USDSLV4=0.0

MMIG=1.50

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MXROW1=1.0/9.0
MXROW2=0.0752688
USROW1= 1.0/9.0
USROW2= 0.0752688

A1=3.15008141
A2=34.69044783
MA1=2.93956606
MA2=4.33736280

MKTOT = 419.1
LUSINIT = 112.87
LTOTTOT = 143.27

LMEXINIT=LTOTTOT-LUSINIT
ML11 = 6.0
ML12 = 3.11
MK10 = 76.20007796

MK2=MKTOT-MK1
LMEX=LMEXINIT-MEXMIG
ML1=ML11+ML12
ML2=LMEX-ML11-ML12

MALPHA1= 0.558
MALPHA2= 0.387
MBETA1=0.344
MBETA2=0.440
MKAPPA2=0.09
MDELTA1= 1.0-MALPHA1-MBETA1
MDELTA2= 1.0-MALPHA2-MBETA2-MKAPPA2
ALPHA1= 0.422
ALPHA2= 0.05700
KAPPA2= 0.8823
BETA1= 1.0 - ALPHA1
BETA2= 1.0 - ALPHA2 -KAPPA2
MT=0.18
MINTIM= 8.2
TARUS=0.074
TARMX=0.114
TARWOR=0.08

L11 = 19.403
L12 = 76.25

K10 = 6757.45273868
KTOT = 8762.8
K2=KTOT-K1
K20=K2
L2=LUSINIT+0.80*MEXMIG-L1
G1=0.15061150015382
G2= 5.2846668628462
G3= 0.0
G4= 0.0
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SUMGS=G1+G2+G3+G4
MG1=-0.24747004
MG2=1.73
MG3=0.0

MGDP  = 180.75
MGDP1 =  40.4
MGDP2=MGDP-MGDP1
GDP=  4021.4
GDP1= 1123.24
GDP2=GDP-GDP1

DSLV=0.125
REMIT = DSLV/PPPE
WINFLRT1=1.045
REMITN= (DSLV/PPPE)*(WINFLRTE**(IYEAR-1))

PTRF=P*(1.00+TARMX)
PIMTRF=PIM*(1.00+TARUS)
PEXTRF=PEX*(1.0+TARWOR)

MB1= 0.30199225
MB3= 0.01800775
MB2= 1.0 - MB1 -MB3
B1=0.15
B3=0.0035190921196499
B4=0.185379631
B2=1.0 - B1 - B3 -B4

G1MIG=1.31409215
G2MIG=2.43543349
G3MIG=0.0
G4MIG=0.0
SUMGMS=G1MIG+G2MIG+G3MIG+G4MIG

USINCKL1GR=1.024275
USINCKL2GR=1.024275
USDFIPOSW=327.8
RKUSDFIW=49.0/327.8
USDFIINCW=49.0
WDFIPOSUS=318.85

USDFIWGR=0.12
WDFIUSGR=0.12
WORGDP=17267.0-GDP-MGDP
WGDPGRO=1.03
WORGDP1=WORGDP*0.3
WOREXPMX=2.2
WOREXPUS=594.0
WORIMPUS=530.0
TUSTOWOR=0.08
TMXTOWOR=0.12
WORB1=WORIMPUS/WORGDP
MPWORTRF=1.1
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PWORTRF = 1.1
EQDIFRRC1 = 0.05150
EQDIFRRC2 = 0.07200
WORPTRFUS = (1.0 + TWORTOUS)
WORPTRFMX = (1.0 + TWORTOMX)

Sources: National Income and Product Accounts of the United States (employment by industry), Mexican census (1980 and interim 1985), Survey of Current Business (selected issues), International Financial Statistics (selected years), Anuario Estadistico de Mexico (selected years), Banco de Mexico Informe Anual (selected years), selected Secretaria de Programacion y Presupuesto (SPP) publications, Comercio Exterior (selected issues), Economic Report of the President (CEA), Monthly Labor Review (BLS), International Trade Statistics (Series D, 1988, UN), and Industrial Statistics Yearbook, 1990 (UN). See bibliography for full citations and other related works.

Note: All variables are implicitly time subscripted. The numbers 1 and 2 refer to sectors of the economy and the prefix M denotes variables in Mexico. In the annotations, country and sector prefixes and subscripts are implict.

Section 1- Production Functions and Factor Allocations

1) $MGDP1= MP*MA1*(Ma1*ML1^{-p1}+Mb1*MK1^{-p1}+Md1*MIMP^{-p1})^{-1/p1} -MIMP*PTRF*PPPE$

1A) $GDP1= P*A1*(a1*L1^{-p1}+b1*K1^{-p1})^{-1/p1}$

2) $MGDP2= MA2*(Ma2*ML2^{-p2}+Mc2*ML12^{-p2}+Mb2*MK2^{-p2}+Md2*MLAND^{-p2})^{-1/p2}$

2A) $GDP2= A2*(a2*L2^{-p2}+c2*L12^{-p2}+b2*K2^{-p2})^{-1/p2}$

3) MGDP= MGDP1+MGDP2

3A) GDP= GDP1+GDP2

4) MGDPRL= MGDP1/MP+MGDP2

4A) GDPRL= GDP1+GDP2

5) $ML11A= ML11_{t-1} +(MK1-MK1_{t-1})/MIKL1$

6) $ML11B= ML11_{t-1} *ML1GRO$

7) ML11= MIN(ML11A,ML11B)

5A) $L11A= L11_{t-1} +(K1-K1_{t-1})/IKL1$

6A) $L11= L11_{t-1} *L1GRO_t$

7A) L11= MIN(L11A,L11B)

8) $ML12A= ML12_{t-1} +(MK2-MK2_{t-1})/MIKL2$

9) $ML12B= ML12_{t-1} *ML1GRO$

10) ML12= MIN(ML12A,ML12B)

8A) $L12A= L12_{t-1} +(K2-K2_{t-1})/IKL2$

9A) $L12B= L12_{t-1} *L1GRO$

10A) L12= MIN(L12A,L12B)

11) ML2= MLINIT-ML11-ML12-MMIG

11A) L2= USLINIT-L11-L12+MMIG*SKILL

GDP=gross domestic product(bill 1988 $)
GDPRL=real GDP (at 1988 prices)
P=relative price of good1/good2

PIM = the price of Mexican exports in the US, in dollars
PTRF = the dollar price of intermediate goods imports to Mexico, inclusive of tariff
PPPE = the peso/dollar exchange rate, defined as MP/PIM
A = the production function constant, indicating the technological level
a,c = 'alphas', the labor share coefficients of the production function
L = the amount of labor, either in thousands of man-years or efficiency units. So-called skilled labor is used in both sectors and is therefore double subscripted
b = 'beta', the capital share coefficient
K = the amount of capital, in billions of 1988 dollars
d = 'delta', the distribution parameter related to the third factor of production in Mexico
MIMP = the amount of the imported intermediate good, in billions of 1988 dollars
MLAND = the amount of land, in millions of hectares, assumed to be a constant
p = 'rho', the coefficient related to the elasticity of substitution (s) by the eq. $s=1/(1+p)$
SAVRT = the savings rate out of capital income
MEXPORTS = Mexican exports to the U.S. of consumer goods (NOMINAL)
LINIT = the initial(pre-migration) labor force in millions of man-years
MMIG = undocumented Mexican migration to the U.S. in millions of person years
SKILL = a constant adjustment factor to convert migrants into efficiency units of labor
IKL = an incremental capital/labor ratio, regulating entry into high wage employment
L1GRO = the maximun rate of growth of skilled labor, based on the capacity of the country to educate and train new entrants for skilled work
$LGRO_t$ = the growth rate of the U.S. labor force in time t

Section 2: Marginal Conditions

12) $MRK1 = MP*MA1*Mb1*MK1^{(-p1-1)}*[Ma1*ML11^{-p1} + Mb1*MK1^{-p1} + Md1*MIMP^{-p1}]^{-(1/p1)-1}$

13) $MRK2 = MA2*Mb2*MK2^{-p2-1}*[Ma2*ML2^{-p2} + Mc2*ML12^{-p2} + Mb2*MK2^{-p2} + Md2*MLAND^{-p2}]^{-(1/p2)-1}$

12A) $RK1 = P*A1*b1*K1^{-p1-1}*[a1*L11^{-p1} + bi*Ki^{-p1}]^{-(1/p1)-1}$

13A) $RK2 = A2*b2*K2^{-p2-1}*[a2*L2^{-p2} + c2*L12^{-p2} + b2*K2^{-p2}]^{-(1/p2)-1}$

14) $MW11 = MP*MA1*Ma1*ML11^{(-p1-1)}*[Ma1*ML11^{-p1} + Mb1*MK1^{-p1} + Md1*MIMP^{-p1}]^{-(1/p1)-1}$

15) $MW2 = MA2*Ma2*ML2^{-p2-1}*[Ma2*ML2^{-p2} + Mb2*MK2^{-p2} + Mc2*ML12^{-p2} + Md2*MLAND^{-p2}]^{-(1/p2)-1}$

16) $MW12 = MA2*Mc2*ML12^{-p2-1}*[Ma2*ML2^{-p2} + Mb2*MK2^{-p2} + Mc2*ML12^{-p2} + Md2*MLAND^{-p2}]^{-(1/p2)-1}$

14A) $W11 = P*A1*a1*L11^{-p1-1}*[a1*L11^{-p1} + b1*K1^{-p1}]^{-(1/p1)-1}$

15A) $W2 = A2*a2*L2^{-p2-1}*[a2*L2^{-p2} + c2*L12^{-p2} + b2*K2^{-p2}]^{-(1/p2)-1}$

16A) $W12 = A2*c2*L12^{-p2-1}*[a2*L2^{-p2} + c2*L12^{-p2} + b2*K2^{-p2}]^{-(1/p2)-1}$

17) $MPMIMP = MP*MA1*Md1*MIMP^{(-p1-1)}*[Ma1*ML1^{-p1} + Mb1*MK1^{-p1} + Md1*MIMP^{-p1}]^{-(1/p1)-1} -1$

18) $MPMLAND = MA2*Md2*MLAND2^{-p2-1}*[Ma2*ML2^{-p2} + Mb2*MK2^{-p2} + Md2*MLAND^{-p2}]^{-(1/p2)-1}$

RKi = both the value of the marginal product of and return to capital in sector i i=1,2
Wi = both the value of the marginal product of labor and the wage rate in sector i i=1,2
MPMIMP = the value of the marginal product of the imported intermidiate good
MPLAND = the value of the marginal product of land

Section 3: Aggregate Demands and Sectoral Incomes, Demands, and Utilities

19) MAD1= MG1+(MB1/MP)*(MGDPC-MP*MG1-MG2)+MEXPORTSRL+WORIMPMXR

19A) AD1= G1+(B1/P)*(GDPC-P*G1-G2)+MIMPRL+WORB1*WORGDP

20) MAD2= MG2+MB2*(MGDPC-MP*MG1-MG2)+(MMIG+ML1*0.8+ML2*0.6)*MDSLV

20A) AD2= G2+B2*(GDPC-P*G1-G2)

21) MAD3=MB3/(WORPTRF*PPPE)*(MGDPC-MP*MG1-MG2)

21A*) AD3=MEXPORTSRL= (B3/PIM)*(GDPC-P*G1-G2)

22) AD4= B4/WORPTRF*(GDPC-P*G1-G2)

23) MIGY= W2*SKILL-COST-DISC-REMIT note: REMIT=MDSLV/PPPE, SKILL and DISC are constants, while:

24) COST=COST1982+0.1*(MMIG-2.5)

25*) MIGDi= giMIG+(Bi/Pi)*(MIGY-P*g1MIG-g2MIG-PIM*g3MIG) i=1,2,3,4
P2=1,P3=PIM,P4=WORPTRF

26) UMIG= [$R_{i=1,4}$ Bi*LOG(MIGDi-giMIG)]-PREF

27) ML2Y= MW2-0.6*MDSLV

28) ML2Di= Mgi+(MBi/MPi)*(ML2Y-MP*Mg1-Mg2) i=1,3
MP2=1,MP3=WORPTRF*PPPE

29) UML2 = $R_{i=1,3}$ MBi*LOG(ML2Di-Mgi)

27A) L2Y= W2

28A*) L2Di= gi+(Bi/Pi)*(L2Y-P*g1-g2-PIM*g3) i=1,4

29A) UL2= $R_{i=1,4}$ Bi*LOG(L2Di-gi)

30) ML11Y= MW11-0.8*MDSLV, ML12Y=MW12-0.6*MDSLV

31) MLjDi= Mgi+(MBi/MPi)*(MLjY-MP*Mg1-Mg2) i=1,3 j=11,12

32) UMLj = $R_{i=1,3}$ MBi*LOG(MLjDi-Mgi) j=11,12

30A) LjY= Wj*(1-USINCOMETAX) j=11,12

31A*) LjDi= gi+(Bi/Pi)*(LjY-P*g1-g2-PIM*g3) i=1,3 j=11,12

32A) ULj= $R_{i=1,4}$ Bi*LOG(LjDi-gi) j=11,12

33) MKYi= (MGDPi-NETCAPFLMiTOW-$R_{j=1,3}$ MWj*MLj-(i-1)*MPLAND*MLAND)*(1-
MSAVRTi)-MGDPRLi*MTAX i=1,2 j=2,11,12

34) MKDi = Mgi + (MBi/MPi)*(MKY-MP*Mg1-Mg2) i = 1,3

35) UMKj = $R_{i=1,3}$ MBi*LOG(MKjDi-Mgi) j = 1,2

33A) KiY = (GDPi-$R_{j=1,3}$ Wj*Lj)*(1-SAVRTi) + NETCAPFLWTOUSi i = 1,2 j = 2,11,12

34A*) KDi = gi + (Bi/Pi)*(KY-P*g1-g2-PIM*g3) i = 1,4

35A) UKj = $R_{i=1,4}$ Bi*LOG(KjDi-gi) j = 1,2

36) MLANDY = MPLAND*MLAND

37) MLANDDi = Mgi + (MBi/MPi)*(MLANDY-MP*Mg1-Mg2) i = 1,3

38) UMLAND = $R_{i=1,3}$ MBi*LOG(MLANDDi-Mgi)

note: in starred equations, PIM includes the US tariff.
ADi = aggregate demand for sector i output
GDPC = gross domestic product plus net factor income from abroad
Gi = the aggregate 'subsistance' level of demand Gi > 0 inplies an income elasticity < 1
Gi = Rgi*Li + DSLVi*DEPEND note: G3,G4 = 0
Bi = the share of 'discretionary income' spent on good i
PIM = the dollar price of Mexican exports in the U.S.
MIGY = the amount of money migrants spend on goods which they consume
SKILL = the productivity of Mexican migrants in the U.S. relative to native unskilled labor (see section 1)
COST = all costs of migration, from bus tickets to lost wages and bribes
COST1988 = cost in the base year of 1988
DISC = discrimination against migrants due to their undocumented status
REMIT = remittances from migrants to dependents who remain in Mexico, in dollars
MDSLV = the subsistance level of the dependents of migrants who remain in Mexico. Note that it is easiest to provide for dependents which in rural areas (proxied by working in sector 2) and most costly when living in the U.S. (MMIG)
DSLV = the subsistance level of demand of U.S. dependents, at 1988 prices
DEPEND = the number of dependents in the U.S. living outside the households of the employed; it can be thought of as the number of elderly receiving government transfers
PPPE = the peso/dollar exchange rate, converting dollar flows to pesos and the converse
MIGDi = consumption of good i in the U.S. by a representative migrant
gi = an individual's required consumption of good i
note: B's are the same for all social groups within each country
UMIG = utility of the representative migrant
PREF = the preference of Mexicans for living and working in Mexico
note: incomes, demands, and utilities for other social groups follow the same formula
RK = average return to capital
K = total capital stock of the country
DEBT = Mexico's total foreign debt
RATE = the average interest rate on the debt (exogenous)
NEWLOANS = net inflow of lending in dollars (exogenous)
KEXP = the dollar cost of capital exports to Mexico
MTAX = the Mexican tax rate

Section 4: Equilibrium Conditions

39) 0 = MEXD1 = [MGDP1/MP*(1-MSAVRT)]-MAD1

40) 0=MEXD2=[MGDP2*(1-MSAVRT)]-MAD2

41) 0=MEXD3=WOREXPMX*PPPE-MAD3

39A) 0=EXD1=[GDP1/P*(1-SAVRT)]-AD1

40A) 0=EXD2=[GDP2*(1-SAVRT)]-AD2

41A) 0=EXD3=MEXPORTSRL-AD3

42) 0=EXD4=WOREXPUS-AD4

//43) 0=UTILDIFF=UMIG-UML2

44) 0=MGOVBP$=MTAR*MIMP+TMXTOWOR*WOREXPMX+OILREV+NEWLOANS+MMIG*
REMIT-DEBT*RATE-DOLTRANS

45*) 0=SPFOREX=MPMIMP*PIM/P-MP=(MRK1*PIM/PMKUS)/(1.0-DISRATMX)- MP

46) 0=MPRIVBP$=(PIM*MEXPORTS+WORIMPMX-WOREXPMX*WORPTRF-
PTRF*MIMP-KEXP)+DOLTRANS-NETCAPITALFLIGHT+[(WDFIFM-
WDFIINCM)+(US1DFIFM1+US2DFIFM2-USDFIINC1-USDFIINC2)

47) -USINTLOANS= [WDFIFLUS+USDFIINCW-USDFIFLW-WDFIINCUS]+(-US1DFIFM1-
US2DFIFM2+USDFIINC1+USDFIINC2)+(DEBTSERV+NETCAPITALFLIGHT-
NEWLOANS)+(REMIT*MMIG-0.8*OILREV)+[WORIMPUS+MINTIM*P-
WOREXPUS*WORPTRF+TARUS*MEXPORTS+TUSTOWOR*WOREXPUS-
MEXPORTS*PIM

48) USINTLOANS=[-WDFIFLUS-USDFIINCW+USDFIFLW+WDFIINCUS]+(-WDFIFM+
WDFIINCM)-0.2*OILREV+[(WOREXPMX+WOREXPUS)*WORPTRF+TARWOR*
(WORIMPUS+WORIMPMX)-(WORIMPUS+WORIMPMX)]

49) 0=DIFRRC1=MRK1/(PPPE*PMKUS)-RK1/PK-EQDIFRRC1

50) 0=DIFRRC2=MRK2/(PPPE*PMKUS)-RK2/PK-EQDIFRRC2

note: in starred equation, P includes Mexican tariff, and/or PIM includes the US tariff.
EXDi=excess demand for good i
SPFOREX=the shadow price of foreign exchange, i.e. the value of the additional product that could be made and sold given a one unit increase in both exports and intermediate or capital imports
GOVBP=the balance of payments of the public sector. DOLTRANS is the free parameter
PRIVBP=the balance of payments constraint of the private sector. Here, DOLTRANS and CAPITALFLIGHT (after 1985) are the only truely exogenous variables
MTAR=the tariff rate set by the Mexican government on imports
UTILDIFF=the utility differential between migrants and non-migrants
DOLTRANS=the Mexican government's dollar deficit (surplus), which is borrowed from (loaned to) the private sector
KEXP=capital exports from the U.S. to Mexico
PMKUS=the price of Mexican capital goods from the U.S., which can differ from the price of U.S. capital
PK=the price of U.S. capital goods in the U.S.
DFIINC=income from DFI
EQDIFRRC=the equilibrium difference in the rate of return to capital, in other words, the premium required by U.S. investors operating in Mexico.

Section 5: Direct Foreign Investments

51) WDFIFLUS = WDFIPOSUS*WDFIUSGR + (RK1-0.07)*3.0*WDFIPOSUS
52) USDFIFLW = USDFIPOSW*USDFIWGR-DFISW
53) USDFIPOSW = USDFIPOSW + USDFIFLW
54) WDFIPOSUS = WDFIPOSUS + WDFIFLUS

55) NETUSDFI = WDFIFLUS-USDFIFLW
56) WDFIFM1 = WDFIM1*WDFIM1GR
57) WDFIFM2 = WDFIM2*WDFIM2GR
58) WDFIM1 = WDFIM1 + WDFIFM1
59) WDFIM2 = WDFIM2 + WDFIFM2

60) IF((DFI1 + US1DFIPM1).LT.0.0) DFI1 = -US1DFIPM1
61) IF((DFI2 + US2DFIPM2).LT.0.0) DFI2 = -US2DFIPM2

62) US1DFIPM1 = US1DFIPM1 + DFI1
63) US1DFIFM1 = US1DFIPM1-US1DFIPM1L
64) US2DFIPM2 = US2DFIPM2 + DFI2
65) US2DFIFM2 = US2DFIPM2-US2DFIPM2L

66) DFISW11 = (US1DFIFM1-US1DFIFM1SQ(JYEAR-1987))/2.0
67) DFISW22 = (US2DFIFM2-US2DFIFM2SQ(JYEAR-1987))/2.0
68) DFISW = DFISW11 + DFISW22

DFIF (or FL) = DFI flow
DFIP (or POS) = DFI position
DFISW = DFI "switching," from the rest of world to Mexico
Notes: U.S. DFI outflows are endogenous because DFISW is endogenous.
Mexico is modeled as having no DFI abroad (or more correctly, DFI is called "capital flight." The two IF statements prevent negative DFI flows from exceeding the current positive stock.
SQ variables are vectors across time saved from the baseline run.
World DFI to the U.S. is endogenous, dependent on the return to capital in U.S. manufacturing.
World DFI to Mexico is exogenous

Section 6: The Government Sector

69)MGOVREV = MTAX1*MGDP1 + MTAX2*MGDP2

69A) GOVREV = TAR*MEXPORTS + USINCOMETAX

70)MGOVEXP = PDEBTSRV + DOLTRANS + MTRANSFERS

70A) GOVEXP = DSLV*DEPEND + TRANSFERS + USDEBTSERV

71) MDEFICIT = MGOVREV-MGOVEXP

71A) DEFICIT = GOVREV-GOVEXP

72) MGOVDEBT = $MGOVDEBT_{t-1}$ + MDEFICIT

72A) GOVDEBT = $GOVDEBT_{t-1}$ + DEFICIT

GOVREV = government revenue

TAR = tariff rate (percent)
GOVEXP = government expenditure
PDEBTSRV = payments on the government's internal (peso) debt
TRANSFERS = transfer payments to individuals
DEFICIT = the government deficit
GOVDEBT = internal government debt

Section 7: Updating Exogenous Variables

73) $MLINIT_t = MLINIT_{t-1} * MLGRO_t$

73A) $LINIT_t = LINIT_{t-1} * LGRO_t$

74) $MK_t = MK_{t-1} + MSAVRT * MGDPRL_t$

74A) $K_t = K_{t-1} + SAVRT * GDPRL_t$

75) $MA_{i\,t} = MA_{i\,t-1} * MAGRO_{i\,t}$ for 1983-1986, else $= MA_{i\,t-1} * MAGRO_i$

75A) $A_{i\,t} = A_{i\,t-1} * AGRO_{i\,t-1}$ for 1983-1986, else $= A_{i\,t-1} * AGRO_i$

76) $DEPEND_t = DEPEND_{t-1} * DEPENDGRO$

$LINIT_t$ = the initial (pre-migration) labor force
$LGRO_t$ = growth rate of the labor force in year $_t$
K_t = the capital stock
$AGRO_{i\,t}$ = the rate of technological progress in year $_t$
DEPENDGRO = growth of dependents

Section 8: Calculation of Compensating Variations

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77) MXW11CV = DEXP(MW11UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW11DYSQ(JK)
MXW22CV = DEXP(MW2UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW2DYSQ(JK)
MXW12CV = DEXP(MW2UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW11DYSQ(JK)
MXW21CV = DEXP(MW11UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW2DYSQ(JK)
MXW31CV = DEXP(MW11UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW12DYSQ(JK)
MXW32CV = DEXP(MW2UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW11DYSQ(JK)
MXW13CV = DEXP(MW12UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW11DYSQ(JK)
MXW23CV = DEXP(MW12UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
```

```
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW2DYSQ(JK)
MXW33CV=DEXP(MW12UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXW12DYSQ(JK)
MXW3LCV=DEXP(MIGLUTIL+PREF-B1*DLOG(1000.0*B1/PSQ(JK))-
        B2*DLOG( 1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PWORTRFSQ(JK)))-MIGDYSQ(JK)

MXCP1CV=DEXP(MCAP1UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXCPDY1SQ(JK)
MXCP2CV=DEXP(MCAP2UTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXCPDY2SQ(JK)
MXLNCV=DEXP(MLANUTIL-MB1*DLOG(1000.0*MB1/MPSQ(JK))-
        MB2*DLOG(1000.0*MB2)-MB3*DLOG(1000.0*
        MB3/(PWORTRFSQ(JK)*PPPESQ(JK)))) - MXLNDYSQ(JK)

USW11CV=DEXP(W11UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PEXTRFSQ(JK)))-USW11DYSQ(JK)
USW22CV=DEXP(W2UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PEXTRFSQ(JK)))-USW2DYSQ(JK)
USW12CV=DEXP(W2UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PEXTRFSQ(JK)))-USW11DYSQ(JK)
USW21CV=DEXP(W11UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PEXTRFSQ(JK)))-USW2DYSQ(JK)
USW33CV=DEXP(W12UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PEXTRFSQ(JK)))-USW12DYSQ(JK)
USW23CV=DEXP(W12UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PEXTRFSQ(JK)))-USW2DYSQ(JK)
USW13CV=DEXP(W12UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PEXTRFSQ(JK)))-USW11DYSQ(JK)
USW31CV=DEXP(W11UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
        PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
        PEXTRFSQ(JK)))-USW12DYSQ(JK)
USW32CV=DEXP(W2UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
        1000.0*B2)-B3*DLOG(1000.0*B3/
```

```
         PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
         PEXTRFSQ(JK)))-USW12DYSQ(JK)
USCP1CV=DEXP(CAP1UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
         1000.0*B2)-B3*DLOG(1000.0*B3/
         PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
         PEXTRFSQ(JK)))-USCPDY1SQ(JK)
USCP2CV=DEXP(CAP2UTIL-B1*DLOG(1000.0*B1/PSQ(JK))-B2*DLOG(
         1000.0*B2)-B3*DLOG(1000.0*B3/
         PIMTRFSQ(JK))-B4*DLOG(1000.0*B4/
         PEXTRFSQ(JK)))-USCPDY2SQ(JK)

MXW3LCV=USW22CV

MXTOTCV=MXWT11*MXW11CV+MXWT12*MXW12CV+MXWT21*
             MXW21CV+MXWT22*MXW22CV+MXWT23*
             MXW23CV+MXWT32*MXW32CV+MXWT33*
             MXW33CV+MXWT3L*MXW3LCV+MXCP1CV +
             MXCP2CV + MXLNCV

USTOTCV=USWT11*USW11CV+USWT12*USW12CV+
      USWT21*USW21CV+USWT22*USW22CV +USCP1CV +USCP2CV

    IF(JYEAR.EQ.1999) USTOTCV99=USTOTCV
    IF(JYEAR.EQ.2000) USTOTCV00=USTOTCV

    IF(JYEAR.EQ.1999) MXTOTCV99=MXTOTCV
    IF(JYEAR.EQ.2000) MXTOTCV00=MXTOTCV

SUMTOTCV=MXTOTCV+USTOTCV


US1CVSUM=US1CVSUM+USWT11*USW11CV*DISRATUS**(JL-1)+
             USWT12* USW12CV*DISRATUS**(JL-1)+USWT13*USW13CV*
             DISRATUS**(JL-1)

US2CVSUM= US2CVSUM+USWT22*USW22CV*DISRATUS**
             (JL-1)+USWT21*USW21CV*DISRATUS**(JL-1)+
             USWT23*USW23CV*DISRATUS**(JL-1)

US3CVSUM= US3CVSUM+USWT32*USW32CV*DISRATUS**
             (JL-1)+USWT31*USW31CV*DISRATUS**(JL-1)+
             USWT33*USW33CV*DISRATUS**(JL-1)

USCPCVSUM=USCPCVSUM+USCP1CV*DISRATUS**(JL-1)+
       USCP2CV*DISRATUS**(JL-1)

USCVSUM= US1CVSUM+US2CVSUM+USCPCVSUM

MX1CVSUM=MX1CVSUM+MXWT11*MXW11CV*DISRATMX**(JL-1)+
             MXWT12*MXW12CV*DISRATMX**(JL-1)+
             MXWT13*MXW13CV*DISRATMX**(JL-1)
MX2CVSUM=MX2CVSUM+(MXWT22*MXW22CV+MXWT23*MXW23CV
             +MXWT21*MXW21CV+MXWT3L*MXW3LCV)*
             DISRATMX**(JL-1)
```

MX3CVSUM = MX3CVSUM + (MXWT33*MXW33CV + MXWT32*MXW32CV
+ MXWT31*MXW31CV)*DISRATMX**(JL-1)

MXCPCVSUM = MXCPCVSUM + MXCP1CV*DISRATMX**(JL-1) +
MXCP2CV*DISRATMX**(JL-1)

MXLNCVSUM = MXLNCVSUM + MXLNCV*DISRATMX**(JL-1)
MXCVSUM = MX1CVSUM + MX2CVSUM + MX3CVSUM + MXCPCVSUM + MXLNCVSUM

TOTCVSUM = MXCVSUM + USCVSUM

WTij = weights, reflecting labor movement within countries (and in the extended model, between the U.S. and Mexico. For instance, if a scenario yields higher employment levels in both high wage groups, WT21 will be the increase in manufacturing employment relative to the status quo, WT23 will be the increase in high wage non-manufacturing employment, and WT22 will be the new, lower level of low wage employment. WT11 and WT33 will be the status quo level of employment in the two high wage sectors, with the sum of all weights being equal to the labor force and all other cross weights (i not= j) equal to zero.

Section 9: Modifications for free trade scenarios

1) free trade only:

PHASEIN = 10.0
IF(JYEAR .GE. 1992)
TARUS = TARUS-0.074/PHASEIN
TARMX = TARMX-0.114/PHASEIN
MXINCKLGR = MXINCKLGR + 0.0005

2) with increased investor confidence:

IF(JYEAR .GE. 1991)
EQDIFRRC1 = EQDIFRRC1-0.010/PHASEIN
EQDIFRRC2 = EQDIFRRC2-0.007/PHASEIN

3) with dynamic gains:

IF(JYEAR .GE. 1992)

MA1 = MA1*((CGOODSIM/CGOODSIMSQ(JYEAR-1987)-1.0)/200.0 + 1.0)

A1 = A1*((CGOODSRL/CGOODSRLSQ(JYEAR-1987)-1.0)/100.0 + 1.0)

PHASEIN = phase in period in the agreement, assumed to be ten years
CGOODSIM = capital goods imports into Mexico
CGOODSRL = capital goods production in the U.S.
Note: increased investor confidence preceeds the agreement, begining in 1991. The agreement is assumed to have begun at the begining of 1992, thus tariff reductions and dynamic gains begin then.

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COMMENTS ON PAPER 8

BY SHANTAYANAN DEVARAJAN

Comments on
"An Intertemporal, Linked, Macroeconomic CGE Model of the United States and Mexico Focussing on Demographic Change and Factor Flows," by Robert K. McCleery

by

Shantayanan Devarajan
World Bank and Harvard University
February 1992

In this paper, the author shows that the GDP gains of a free-trade agreement (FTA) between the U.S. and Mexico are large (roughly $14 billion in present value terms) and increase when the effects of greater investor confidence and factor productivity growth in manufacturing are incorporated. He shows all this using a linked CGE model of the two countries which highlights the role of factor flows arising from the FTA. My comments will first concentrate on the economics of the conclusions reached and then turn to some modelling issues.

Economics: The joint increase in GDP from just the FTA is due to the standard efficiency gains from removing tariff barriers as well as to the related increase in DFI to Mexico. Two points are worth noting here. First, each country has only one tradable sector in the model. Hence, imports represent net imports, so that the base on which tariffs are applied is smaller than the "true" base (which would be gross imports.) This results in an effective tariff rate which is higher than the real one, biasing the efficiency gains from liberalization upwards. Second, the welfare gain from the FTA are reported in terms of GDP, rather than some welfare function. In particular, if some function representing the utility of consumption were used, the gains would be smaller, since some of the GDP gains come from higher investment and therefore savings at the cost of consumption.

These results about gains from the FTA were obtained assuming no increase in labor migration between Mexico and the U.S.; the migration "module" was disabled for the present paper. However, it is worth asking how different the results would be in the presence of migration. The factor price equalization theorem (FPET) tells us that we need not have any labor migration to obtain the maximum gains from trade. To be sure, the model in this paper does not satisfy all the assumptions of the FPET (in particular, there are nontraded goods in the present model). Yet, the effect of the FPET is to diminish the potential additional welfare gains from migration.

As for the two additional simulations -- increased investor confidence and dynamic productivity gains -- these are more the result of exogenous assumptions than the inner workings of the model. Too see this, note that since the model is one of full employment, the economy's GDP growth rate can be approximated by the growth of the aggregate production function,

$$Y = AF(K,L) \qquad (1)$$

where Y is GDP, A is a parameter denoting total factor productivity, K is total capital stock and L employment. Log-differentiating (1), we obtain

$$\hat{Y} = \hat{A} + \alpha\hat{K} + (1-\alpha)\hat{L} \qquad (2)$$

where a "^" denotes growth rates and α represents capital's share in value added. Thus, the growth rate of GDP is given by the growth rate of the two factors and of productivity.

The first extension to the basic free-trade simulation involves allowing for increased investor confidence in Mexico. The author assumes that the risk premium required for investment in Mexico will decline by one percentage point in manufacturing and 0.7 percentage points in non-manufacturing. The result is an increase in DFI which in turn contributes to capital accumulation in the economy, raising GDP through the channel described by equation (2). There is nothing magical about this result. Any outgrowth of the FTA which increased K in Mexico would have yielded qualitatively the same outcome. Furthermore, the increase in DFI to Mexico does not result in one-for-one lower capital accumulation in the U.S. because, again by assumption, U.S. savings increase, thanks to improved investment opportunities in Mexico. Leaving aside the realism of this assumption, we should bear in mind that the joint gains would be considerably lower if a more standard assumption were made.

The second extension amounts to drawing yet another exogenous link, this time between capital accumulation and factor productivity growth. The author assumes that the higher is K^, the higher is A^. Again, given equation (2), it is easy to see how this translates into greater gains from the FTA. But it is not the model which generates the result but the particular assumption about the link between capital accumulation and productivity growth.

<u>Modelling Issues</u>: Even though the main results of the paper are not driven by the model but by additional assumptions, the model deserves some scrutiny. I turn now to some particular features of the model being used.

1. **Aggregation:** I have already alluded to the problem of having one tradable good. It is also not clear in which sector U.S. agriculture fits.

2. **Labor Market:** The most puzzling aspect of the model is the treatment of the labor market. Although full employment is

assumed (recall that the migration function has been disabled), labor does not flow between sectors in one country to equalize its marginal revenue product. Instead, a peculiar function is assumed whereby employment in a sector is driven by that sector's capital stock and an exogenous incremental capital-labor ratio. This is peculiar because we do not know what this implies for the functioning of the labor market in these economies. Furthermore, wage-determination in such an economy remains a mystery. Finally, given that there is no international migration, it is not clear why the author needed this particular specification. Would a neoclassical specification have given substantially different welfare gains?

3. **Large country assumption:** If Mexico is considered a "large" country (footnote 14), then its welfare can be increased by levying an optimal export tax. In the absence of such taxes, import tariffs play the same role. Thus, removing import tariffs could result in a welfare loss to Mexico. Is this effect captured?

4. **Implicit numeraires:** The treatment of government involves several sets of transfers which appear to be exogenous and not multiplied by a price index (e.g., equation 70). If this is the case, the model is not homogeneous of degree zero, and there may be several, implicit numeraires.

To conclude, the author has posed an important and relevant question about the U.S.-Mexico FTA: How does the incorporation of factor flows affect our calculations about gains from trade? Furthermore, the model developed here is a potentially rich and powerful tool for answering this question. However, it should be answered by modelling, endogenously, the response of capital flows to the free-trade agreement, rather than assuming the change in a particular parameter.

COMMENTS ON PAPER 8

BY ELLEN E. MEADE

February 25, 1992

Meade Comments on McCleery Paper:
"An Intertemporal, Linked, Macroeconomic CGE Model
of the United States and Mexico
Focussing on Demographic Change and Factor Flows"

Before turning to my comments, it is important to review some of Tim Kehoe's remarks, which are quite pertinent for the McCleery paper. Tim outlined what he thought what were the most important issues to be treated by a model of a free trade agreement (FTA) with Mexico that have been omitted from many of the models formulated so far. Three of the issues that Tim mentioned as important are factors in this paper: first, the changing demographic patterns in the United States and Mexico, with the U.S. work force aging substantially over the next decade or two while much of the Mexican population comes of working age; second, the role of increased investment flows in response to the continued relaxation of Mexican laws that dramatically limit foreign investment; third, the transfer of technology that provides a mechanism for increasing the returns to scale as explored in the "new" growth literature associated with Romer and others. Incorporation of these factors certainly would add the dynamic element that is absent from many models. Another important factor that was mentioned by Tim and other presenters is the cross-hauling evident in trade flows. While the McCleery paper does not address cross-hauling, it is nevertheless quite ambitious in scope.

In his paper, Bob attempts to incorporate the demographic, investment, and technology transfer elements into a model and look directly at the dynamic gains associated with a U.S.-Mexico FTA. Let me briefly review the results. Bob uses a 2-country, 2-good model with a limited rest-of-world sector and some additional structure (to which I will return later) to generate a baseline simulation for which he presents results for 1993 and 2000. The baseline assumes no FTA, but it does incorporate the growth in labor force growth assumptions important for the demographic changes that will occur over that time period -- specifically, labor force growth rates are assumed to slow dramatically in the United States and to remain relatively higher in Mexico over the simulation period. While this addresses to some extent the issue of demographics, there is no mechanism in the model for linking savings behavior with this change in demographics to pick up life-cycle effects on savings patterns. I gather from discussions with Bob that this is a goal for future research. But this link from demographics to savings is important, and really must be incorporated before the paper can claim to deal adequately with the demographics issue.

Following the presentation of the baseline simulation, Bob discusses a free trade scenario in which U.S. and Mexican tariffs are eliminated over a 10-year period. I note that tariffs are the only trade barrier as such modelled in the paper, although the charts make reference to the elimination of non-tariff barriers as well.

The second scenario attempts to model the investment flows into Mexico that result from an FTA. This is modelled as a reduction in the risk premium that foreign direct investors need to be compensated for the additional risk involved in investment in Mexico. Generally, this reduction in the risk premium is an interesting way to model the regime change that would occur in investment behavior. In fact, since we would expect investors to be forward-looking, it is likely that this risk premium would have already fallen. Bob treats this forward-looking behavior by phasing in the reduction in the risk premium beginning in 1991, at the announcement of FTA negotiations.

The additional investment is modelled as coming in equal shares from reduced investment in the United States, and from reduced U.S. investment in the rest of the world. Bob prefers this treatment because it does not require that U.S. investment or ROW investment bear the entire hit of increased investment in Mexico. I am not sure that I agree that Bob's treatment is an improvement, because the assumption is still *ad hoc*. I would welcome some simulations under alternative hypotheses to guide me about the sensitivity of the results to this assumption.

The final scenario adds increasing returns from technology transfer by making productivity growth a function of capital goods production. Not surprisingly, the benefits of the FTA as measured by the compensating variation increase further in each scenario for both the United States and Mexico. Since I would expect this to be the case, the results accord with my intuition.

Bob has been very ambitious in this paper, and I commend him for this. What I don't like, however, is the overall structure of the model. Onto a standard set of demand and production functions characteristic of a CGE model, Bob has imposed a super-structure of "macro" elements. There are equations that model the balance-of-payments crisis in Mexico. Net new lending from commercial banks is assumed at be $3 billion per year, debt payments are owed in dollars and assessed at the exogenous world interest rate, and capital flight from Mexico is exogenously assumed. This additional super-structure is added to stylize the model to the particulars of the Mexican economy, but is entirely exogenous and contributes nothing to the results of the model and the quantitative estimates.

In effect, the empirical results are not surprising because the model is set up to produce the desired effects. Of course the exogenous reduction of the risk premium for investment in Mexico induces flows of investment into Mexico; of course the exogenous augmentation of productivity as a proxy for technology transfer boosts output. None of this is surprising. Given that the results are simply an outcome of a number of pre-determined assumptions, then there should be sensitivity analysis so that the reader can assess the sensitivity of the results to the assumed parameters.

To wrap up, the good news is that the McCleery paper attempts to incorporate some crucial elements that have been missing in other papers, elements that will likely determine the long-run gains associated with a free trade agreement. The bad news is that the structure of the model is *ad hoc* and much of the interesting behavior is generated through exogenous assumption.

PAPER 9

"AGRICULTURAL POLICIES AND MIGRATION IN A U.S.-MEXICO FREE TRADE AREA: A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS," BY SHERMAN ROBINSON, MARY E. BURFISHER, RAUL HINOJOSA-OJEDA, AND KAREN E. THIERFELDER

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA AT BERKELEY

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AGRICULTURAL POLICIES AND MIGRATION IN A U.S.-MEXICO FREE TRADE AREA: A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

by

Sherman Robinson
University of California, Berkeley

Mary E. Burfisher
Economic Research Service
U.S. Department of Agriculture

Raul Hinojosa-Ojeda
University of California, Los Angeles

Karen E. Thierfelder
Economic Research Service
U.S. Department of Agriculture

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
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Abstract

We use an 11-sector, three-country, computable general equilibrium (CGE) model to analyze alternative scenarios for the formation of a U.S.–Mexico free trade area (FTA). The model explicitly incorporates agricultural programs and labor migration, and also uses a flexible functional form for specifying sectoral import demand functions. The model identifies the trade-offs among bilateral trade growth, labor migration, and agricultural program expenditures under alternative FTA scenarios. Trade liberalization in agriculture greatly increases rural-urban migration within Mexico and migration from Mexico to the U.S. Migration is reduced if Mexico grows relative to the U.S., a major goal of the FTA, and also if Mexico retains farm support programs. Trade liberalization leads to an immediate increase in rural outmigration, while the increased growth needed to absorb the displaced labor takes longer. The results suggest that Mexico will need a lengthy transition period and must allocate resources to agriculture during the transition. Undue haste in introducing free trade in agriculture and eliminating Mexican agricultural support programs may not be desirable for either country when the social and economic costs associated with increased migration are weighed against the benefits of increased trade growth.

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1. Introduction

In June 1990, Mexican President Salinas de Gortari and President Bush agreed to negotiate the establishment of a free trade area (FTA) between their two countries. An agreement between the U.S. and Mexico will complement the U.S.–Canada free trade agreement, which went into effect in January 1988, creating a North American free trade area (or NAFTA). The trade block will not, in fact, be a "free trade" area, in which all trade barriers among member countries are removed. Assuming that U.S.–Mexico negotiations follow the precedent set in the U.S.–Canada agreement, tariffs will fall to zero over intervals negotiated sector by sector, but liberalization of nontariff barriers will be selective. U.S.–Canadian agricultural trade, although substantially liberalized by the gradual elimination of tariffs, was liberalized less than other sectors. Domestic agricultural programs in both countries, and the nontariff barriers used to support them, remained essentially intact [Goodloe and Link (1991)].

Drawing on experience with the U.S.–Canada FTA, realistic analysis of a U.S.–Mexico FTA should consider alternative treatments of agricultural trade, including partial liberalization scenarios and scenarios for retention or restructuring of domestic agricultural programs. This article provides an analysis of the U.S.–Mexico free trade agreement using a three-country, 11-sector, computable general equilibrium (CGE) model. Our "FTA–CGE" model focuses on three modeling issues which are especially important in analyzing a U.S.–Mexico FTA. First is the explicit modeling of agricultural policies in the two countries in order to capture the linkages, particularly in Mexico, between bilateral agricultural trade barriers and social policy objectives. Mexican agricultural policies that are modeled include tariffs; import quotas for beans, corn,and other grains; input subsidies to producers and processors; and low income tortilla subsidies to consumers. The tariff equivalents of quotas are determined endogenously and are not treated as fixed *ad valorem* wedges. U.S. policies included in the model are deficiency payments and the Export Enhancement Program (EEP). Since government agricultural program expenditures on subsidies for farmers and processors are included in the model, one can analyze the fiscal impacts of changes in agricultural output and trade.

A second issue is labor migration, and the effect that liberalization of trade in agriculture in particular is likely to have in stimulating rural-urban migration in Mexico and migration from Mexico to the U.S. rural and urban labor markets. Migration issues are not explicitly part of the FTA negotiations. However, labor migration is sensitive to relative economic conditions in the two countries, and to the mix of trade and domestic policies in Mexican agriculture. The FTA–CGE model includes migration equations and the results indicate the importance of migration in different FTA scenarios.

The third modeling issue concerns the specification of import demand. The standard approach in trade-focused CGE models has been to adopt the "Armington" assumption of product differentiation coupled with use of a constant elasticity of substitution (CES) import aggregation function. The CES specification has been criticized because it constrains import demand equations to have an expenditure elasticity of one, and also implies that every country has market power in its export markets.[1] Brown (1987) shows that these assumptions have led earlier multi-country trade models to generate unrealistically large terms-of-trade effects under trade-liberalization scenarios. The FTA–CGE model employs the Almost Ideal Demand System (AIDS) to describe import demand, a flexible functional form

[1]The CES formulation has also been criticized on econometric grounds [Alston *et al.* (1990)].

which allows non-unitary expenditure elasticities and yields more realistic empirical results, while retaining the essential property of imperfect substitutability.

In sections 2 to 5, we present the core CGE model and describe how we model import demand, migration, and agricultural programs. In section 6, we present model simulations. Our analysis with the FTA–CGE model focuses on the trade-offs between bilateral export growth, migration, and farm program expenditures. Trade liberalization, in which both tariffs and quotas are removed, results in significant bilateral export growth but also large Mexican migration flows. We estimate how much Mexican growth is required to absorb the increased rural migration without increased migration to the U.S. We show that migration can be reduced by simultaneously lowering trade barriers and increasing agricultural program expenditures in Mexico to support rural employment. Our results indicate that it is feasible to design transition policies so that Mexico can adjust gradually to the structural changes induced by trade liberalization, and so reap the benefits over time from the creation of an FTA without a precipitous shock to the labor markets in both countries from a dramatic increase in migration.

2. Core Three–Country CGE Model

The FTA–CGE model is an 11-sector, three-country, computable general equilibrium model composed of two single-country CGE models linked through trade and migration flows, plus a set of export-demand and import-supply equations to represent the rest of the world. The model is an extension of earlier CGE modeling undertaken at the USDA, which began with the single-country, USDA/ERS CGE model, designed to provide a framework for analyzing the effects of changes in agricultural policies and exogenous shocks on U.S.

agriculture [Robinson, Kilkenny, and Hanson (1990)]. The USDA/CGE model was extended by Kilkenny and Robinson (1988, 1990), and Kilkenny (1991) to model U.S. agricultural programs explicitly. The specification of import demand with the AIDS function was incorporated into the USDA/ERS CGE model by Hanson, Robinson, and Tokarick (1989). The multi-country application of the USDA/CGE was initially developed by Hinojosa and Robinson (1991), who also used the AIDS import-demand function and introduced the use of domestic and international migration functions. The FTA–CGE model extends the Hinojosa and Robinson model with an explicit modeling of domestic farm programs in both the U.S. and Mexico.

Table 1 and Figure 1 present aggregate data on the two economies and their trade, which are used to generate the benchmark or base solution of the FTA–CGE model. Mexico is a much smaller and poorer economy than the U.S. The gap between Mexico and the U.S. is wider than that between Spain and Portugal and the European Community.[2] Mexico has a higher trade share than the U.S. and is very dependent on the U.S. market, which accounts for 75 percent of Mexican exports. Most U.S. trade, on the other hand, is with the rest of the world. While Mexico is the third largest market for the U.S., it takes only about 3 percent of total U.S. exports. Mexico, typical of a developing country, has a much larger share of its labor force in agriculture: 13.1 percent compared to 1.4 percent.

Table 2 shows the sectoral structure of GDP, employment, and trade for the two countries, as well as existing trade barriers. The model's 11 sectors include four farm and one food processing sector. The corn sector refers to corn used for human consumption. In

[2]The gap remains large, even using purchasing power parity comparisons such as those provided by the United Nations/World Bank International Comparisons Project (ICP). See Kravis and Summers (1982) for the latest comparative figures that include Mexico and Summers and Heston (1991) for the latest update on the ICP methodology..

Table 1 — Comparative Aggregate Data, U.S. and Mexico

	Mexico	U.S.
GDP ($US billions, 1988)	176.7	4,847.4
Per Capita GNP ($US, 1988)	1,760	19,990
Trade flows (percent of GDP)		
Total exports	13.6	7.1
Exports to partner	10.1	0.2
Total imports	12.0	10.1
Imports from partner	6.3	0.4
Employment structure (percent)		
Rural labor	13.1	1.4
Urban unskilled labor	13.6	17.3
Urban skilled labor	38.8	48.6
White collar workers	34.6	32.7
Total	100.0	100.0
Population, ages 15-64 (millions)	49	162
Total population (millions)	84	246

Sources:
GDP, per capita GNP, and population data refer to 1988 and come from World Bank, World Development Report 1990. All other data come from U.S. and Mexican social accounting matrices developed by the Economic Research Service, U.S. Department of Agriculture (USDA/ERS).

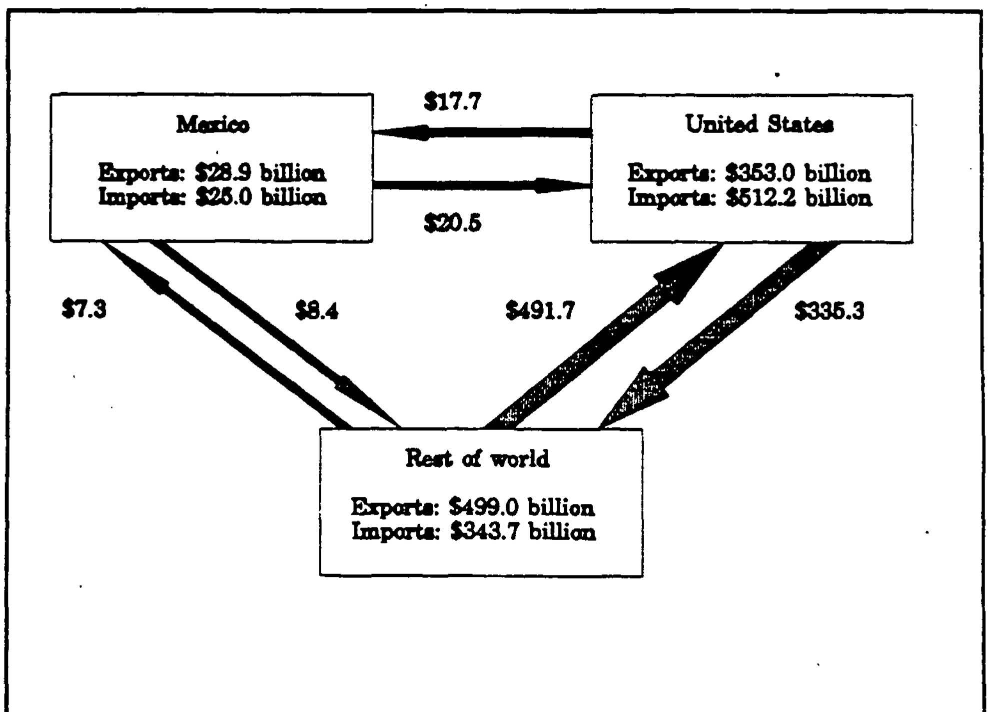

Figure 1: U.S.-Mexico Trade, Base Run

Table 2 — Sectoral Structure of U.S. and Mexican Economies, Base Solution

	Sectoral shares (percent) in:									
	GDP		Employment		Imports		Exports		Bilateral import barriers	
Commodity	U.S.	Mexico	U.S.	Mexico	U.S.	Mexico	U.S.	Mexico	U.S.	Mexico
Food corn	0.0%	0.6%	0.0%	6.3%	0.0%	1.2%	0.3%	0.0%	0.0%	55.0%
Program crops	0.5%	1.0%	0.4%	5.5%	0.0%	3.3%	3.3%	0.1%	0.0%	23.1%
Fruits/vegetables	0.2%	0.9%	0.4%	3.1%	0.4%	0.1%	0.4%	3.0%	13.2%	12.5%
Other agriculture	0.8%	4.6%	1.4%	8.9%	1.5%	1.3%	0.4%	3.8%	0.6%	8.9%
Food processing	1.7%	7.6%	1.5%	2.5%	2.3%	5.2%	2.9%	3.7%	7.0%	8.2%
Other light mfg.	4.5%	5.3%	5.1%	2.7%	16.2%	4.3%	7.0%	6.0%	4.7%	8.1%
Oil and refining	2.2%	2.5%	0.5%	0.5%	11.6%	5.0%	2.6%	10.2%	1.5%	8.8%
Intermediates	5.6%	7.9%	4.5%	3.2%	12.7%	16.7%	13.9%	12.3%	2.2%	8.0%
Consumer durables	1.8%	2.6%	1.7%	0.8%	28.4%	14.8%	10.0%	18.6%	1.8%	12.0%
Capital Goods	5.2%	3.5%	4.9%	2.2%	25.0%	26.4%	31.7%	12.0%	3.6%	12.7%
Services	77.4%	63.6%	79.6%	64.4%	1.8%	21.6%	27.5%	30.3%	0.1%	0.0%

Notes:
Bilateral import barriers are the combined rate of trade-weighted tariffs and tariff equivalents of quotas on trade between Mexico and the U.S. Percent composition columns sum to 100%, except for rounding error.
Sources:
U.S. and Mexican social accounting matrices, USDA/ERS. 1987 for U.S. and 1988 for Mexico.

Mexico, this includes white corn, the small proportion of yellow corn used for food, and No. 2 yellow corn imports from the U.S., which are assumed to enter food use. In the U.S., the food corn sector refers to No. 2 yellow corn, which is an export quality. The composition of the program crops sector corresponds to the other crops eligible for U.S. deficiency payments — feed corn, food grains, soybeans, and cotton. Other agriculture includes livestock, poultry, forestry and fishery, and other miscellaneous agriculture. The fruits and vegetables sector in Mexico includes beans, a major food crop.

There are six primary factors, including four labor types, capital, and agricultural land. The four labor types are rural, urban unskilled, urban skilled, and professional. The base year for Mexico is mostly 1988.[3] The U.S. uses a 1987 base year because of the severe contraction of agricultural output following the 1988 drought. Bilateral trade flows are from 1988. Because of the volatility in U.S. 1987-88 agricultural output, the model follows Adams and Higgs (1986) and Hertel (1990) in the use of a "synthetic" base year for the U.S., imposing 1988 U.S.–Mexican bilateral trade flows on a 1987 base U.S. economy. This approach has the advantage of achieving a more representative U.S. base year, with minimal adjustment to the data.[4] Tariffs and tariff equivalents of quotas are 1988 trade-weighted rates.

[3]The data base is documented in Burfisher, Thierfelder, and Hanson (1992). Hinojosa developed the data on employment structure. Some of the Mexican agricultural support data refer to 1989. The Mexican agricultural programs have changed dramatically over the past few years, and it is important to use the latest data available.

[4]A comparison of 1987 and 1988 U.S.-Mexico trade shows that Mexican farm imports increased in 1988 as U.S. agricultural output fell. Use of a 1987/88 split year for the U.S. moderates the importance of Mexico in U.S. agricultural trade relative to 1988.

The core model follows the standard theoretical specification of trade-focused CGE models.[5] Each sector produces a composite commodity that can be transformed according to a constant elasticity of transformation (CET) function into a commodity sold on the domestic market or into an export. Output is produced according to a CES production function in primary factors, and fixed input-output coefficients for intermediate inputs. The model simulates a market economy, with prices and quantities assumed to adjust to clear markets. All transactions in the circular flow of income are captured. Each country model traces the flow of income (starting with factor payments) from producers to households, government, and investors, and finally back to demand for goods in product markets.

Consumption, intermediate demand, government, and investment are the four components of domestic demand. Consumer demand is based on Cobb-Douglas utility functions, generating fixed expenditure shares. Households pay income taxes to the government and save a fixed proportion of their income. Intermediate demand is given by fixed input-output coefficients. Real government demand and real investment are fixed exogenously.

In factor markets, full employment for all labor categories is assumed. Aggregate supplies are set exogenously. The model can incorporate different assumptions about factor mobility. In the experiments reported here, we assume that agricultural land is immobile among crops, but that all other factors are mobile, including capital.[6] The results should be

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[5]See the appendix for a complete equation listing. Robinson (1989) and de Melo (1988) survey single-country, trade-focused, CGE models. The FTA-CGE model is implemented using the GAMS software, which is described in Brooke, Kendrick, and Meeraus (1988).

[6]Note, however, that labor markets are segmented. Rural labor does not work in the industrial sectors, and urban labor does not work in agriculture. These labor markets are linked through separate migration equations.

seen as reflecting adjustment in the long-run, with capital able to leave the agricultural sectors.

There are three key macro balances in each country model: the government deficit, aggregate investment and savings, and the balance of trade. Government savings is the difference between revenue and spending, with real spending fixed exogenously but revenue depending on a variety of tax instruments. The government deficit is therefore determined endogenously. Real investment is set exogenously, and aggregate private savings is determined residually to achieve the nominal savings-investment balance.[7] The balance of trade for each country (and hence foreign savings) is set exogenously, valued in world prices.

Each country model solves for relative domestic prices and factor returns which clear the factor and product markets, and for an equilibrium real exchange rate given the exogenous aggregate balance of trade in each country. The GDP deflator defines the numeraire in each country model, and the currency of the rest of the world defines the international numeraire. The model determines two equilibrium real exchange rates, one each for the U.S. and Mexico, which are measured with respect to the rest of the world. The cross rate (U.S. to Mexico) is implicitly determined by an arbitrage condition.

The model specifies sectoral export supply and import demand functions for each country, and solves for a set of world prices that achieve equilibrium in world commodity markets. At the sectoral level, in each country, demanders differentiate goods by country of origin and exporters differentiate goods by country of destination.

[7]Enterprise savings rates are assumed to adjust to achieve the necessary level of aggregate savings in each country.

3. Import Demand Equations

As noted above, the standard approach in trade-focused CGE models is to assume that domestic and imported goods are imperfect substitutes and to specify a constant elasticity of substitution (CES) import aggregation function.[8] In the case of a multi-country model, the function aggregates imports from all countries of origin. In the simplest case, the CES function is extended to include goods from many countries, with the substitution elasticity assumed to be the same for all pairwise comparisons of goods by country of origin.[9] The first-order conditions define import demand as a function of relative prices and the elasticity parameter. In our model, with three countries of origin, there are fifteen prices associated with each sector in each country of destination, including the prices of the CES and CET aggregates.

As noted earlier, the use of CES functions in multi-country Armington trade models has led to empirical problems due to the restrictive nature of the CES functions. Instead of the CES import aggregation function, we use import demand equations based on the Almost Ideal Demand System (or AIDS).[10] The AIDS function is a flexible functional form in that it can generate arbitrary values of substitution elasticities at a given set of prices, and also allows expenditure elasticities different from one.

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[8]The properties of single-country CGE models incorporating CES import aggregation functions have been extensively studied. See, for example, de Melo and Robinson (1989) and Devarajan, Lewis, and Robinson (1990).

[9]Other generalizations of the CES function could allow different, but fixed, elasticities of substitution between goods from different countries. See, for example, the CRESH function described in Dixon *et al.* (1982). It is also common to use nested CES functions, with a two-good CES function specifying substitution between domestically produced goods and a composite of imports, which is itself a CES function of goods from various countries of origin.

[10]The AIDS specification in this model draws heavily on work by Robinson, Soule, and Weyerbrock (1991). The discussion below is based on their paper.

In the AIDS approach, the expenditure shares are given by:

$$S_{i,k,c1} = \alpha_{i,k,c1} + \sum_{c2} \gamma_{i,k,c1,c2} \log(PM_{i,k,c2}) + \beta_{i,k,c1} \log \left[\frac{\bar{C}_{i,k}}{P_{i,k}} \right] \tag{1}$$

where subscript i refers to sectors; subscript k refers to the U.S. and Mexico; and subscript c1 refers to the U.S., Mexico, and the rest of the world. $S_{i,k,c1}$ is the expenditure share on imports of good i into country k from country c1. $\bar{C}_{i,k}$ is nominal expenditure on composite good i in country k, $PM_{i,k,c2}$ is the domestic price of imports, and $P_{i,k}$ is the aggregate price of the composite good. The Greek letters are parameters.

We adopt the notation convention that when k = c1,

$M_{i,k,k} = D_{i,k}$, $PM_{i,k,k} = PD_{i,k}$, and $S_{i,k,k} = \dfrac{PD_{i,k} \cdot D_{i,k}}{\bar{C}_{i,k}}$

where $M_{i,k,c1}$ is the import of good i into country k from country c1, $D_{i,k}$ is the domestically produced good sold on the domestic market, and $PD_{i,k}$ is the price of $D_{i,k}$. Deaton and Muellbauer (1980) define the aggregate price index, $P_{i,k}$, by a translog price index. In econometric work, the translog price index is often approximated by a geometric price index — a procedure we have followed in the results presented below.[11]

Various restrictions on the parameters are required to have the system satisfy standard properties of expenditure functions such as symmetry, homogeneity, adding up, and local concavity. We calibrated the parameters for the FTA–CGE model by starting from a set of expenditure elasticities and substitution elasticities for each sector in each country. We assumed that substitution elasticities are the same for goods from any pair of countries,

[11]The geometric price index is usually called a Stone index. Robinson, Soule, and Weyerbrock (1991) analyze the empirical properties of different import aggregation functions in a three-country model of the U.S., European Community, and rest of world, which is a close cousin of the FTA–CGE model. Green and Alston (1990) discuss the computation of various elasticities in the AIDS system when using the Stone or translog price indices.

so our AIDS functions are effectively simple extensions of the multi-country CES functions to include expenditure elasticities different from one.[12]

4. Migration

The FTA–CGE model specifies three migration flows: rural Mexico to rural U.S. labor markets, urban unskilled Mexico to urban unskilled U.S. labor markets, and internal migration within Mexico from rural to unskilled urban labor markets. Migration is assumed to be a function of wage differentials between the two countries. In equilibrium, migration levels are determined which maintain a specified ratio of real wages, $wgdf_{mig}$, for each labor category in the two countries, measured in a common currency, and a specified ratio of real wages between the rural and unskilled urban markets in Mexico:

$$WF_{mig,mx} = wgdf_{mig} \cdot WF_{mig,us} \cdot \frac{EXR_{mx}}{EXR_{us}} \tag{2}$$

where the index *mig* refers to the three migration flows, WF is the wage, and EXR is the exchange rate. The domestic labor supply in each skill category in each country is then adjusted by the migrant labor flow.

An implication of this specification of migration flows is that real wages measured in a common currency are equated, but they can grow at different rates measured in the domestic currency. It is therefore possible to observe migrants moving from a labor market where real wages are rising to one in which they are falling in domestic currency terms. The issue is in the specification of what motivates migrants. For example, if they are motivated

[12]We drew on work at the International Trade Commission for estimates of the various elasticities. See Reinert and Shiells (1991) who present estimates of substitution elasticities. They are currently working on estimating AIDS functions.

by the desire to accumulate savings which they intend to repatriate, then migration will be sensitive to the exchange rate. On the other hand, if they are motivated by observations on relative changes within the two economies then migration could be expected to be insensitive to the exchange rate. The model probably overstates the sensitivity of migration to the exchange rate, generating a backward flow of migrants into Mexico when the Mexican peso appreciates.

Migration flows generated by the FTA–CGE model refer to changes in migration from a base of zero. They should be seen as additional migration flows due to the policy change, adding to current flows. Current migration flows are substantial, both within Mexico and between Mexico and the U.S.[13] In addition, the net migration flows generated by the model represent workers, or heads of households. In recent years, a substantial share of migrants have been family members. The model thus probably understates total increased migration due to a policy change, since family members will tend to migrate with workers.

5. Agricultural Programs

In both the U.S. and Mexico, the agricultural sector is characterized by a complex set of trade policies and domestic agricultural programs. These policies distort production, consumption and trade, and require significant fiscal expenditures in both countries. Tables 3 and 4 present data on their agricultural program expenditures in the base year. Mexican agricultural program expenditure in 1988, totaling $1.6 billion, represented over one-half of

[13]Various researchers have placed the net increase of undocumented Mexican immigrants in the U.S. to be around 100,000 a year during the 1980s. See Bean, Edmonston, and Passel (1990).

Table 3 — Mexican Agricultural Program Expenditures

Subsidy	Food corn	Other program crops	Fruits & vegetables	Other agriculture	Food processing	Total
			- - - Billion Pesos - - -			
Credit (CSUB)	169.4	183.8	78.1	44.2	0.0	475.4
Fertilizer (FSUB)	77.4	217.8	18.0	0.0	0.0	313.2
Insurance (INSUB)	138.4	293.7	16.9	0.0	0.0	448.9
Irrigation (IRSUB)	189.4	533.2	44.1	0.0	0.0	766.6
Feed (FDSUB)	0.0	0.0	0.0	31.7	0.0	31.7
Direct payment (DSUB)	0.0	0.0	0.0	0.0	325.1	325.1
Price (PSUB)	0.0	0.0	0.0	0.0	1,085.1	1,085.1
Tortilla (LOSUB)	0.0	0.0	0.0	0.0	223.8	223.8
Total (billion pesos)	574.6	1,228.4	157.0	75.9	1,633.9	3,669.9
Total ($US millions)	$253.1	$541.1	$69.2	$33.4	$719.8	$1,616.7
Producer incentive equivalent (PIE), %	16.4%	20.8%	3.1%	0.2%	0.4%	

Notes:
"Food Corn" refers to corn used for human consumption (85% of total corn output). "Fruits & vegetables" includes beans (frijoles). CSUB, FSUB, INSUB, IRSUB, and FDSUB refer to 1989. DSUB, PSUB, and LOSUB refer to 1988. The PIE rates are given *ad valorem*, although they are modelled as specific subsidies (per unit output).

Source:
Burfisher, *et al.* (1992). The data are from USDA/ERS (1991), "Estimates of Mexican Producer and Consumer Subsidy Equivalents."

Table 4 — U.S. Agricultural Program Expenditures

	Food corn	Other program crops	Total
		- - - $ billion - - -	
Deficiency payments	0.76	9.85	10.62
Export Enhancement Program (EEP)	0.00	0.88	0.88
EEP for exports to Mexico	0.00	0.03	0.03
Total	0.76	10.74	11.50
Producer incentive equivalent (PIE), %	18.7%	18.8%	

Notes:
Programs include deficiency payments and the Export Enhancement Program (EEP) for wheat in 1987. EEP payments for exports to Mexico refer to 1988. "Food corn" refers to No. 2 yellow corn. Deficiency payments for food corn are computed as a share of total deficiency payments, using the share of No. 2 corn (which is what is exported to Mexico) in total corn output (11%). PIE rates are given *ad valorem*, although they are modelled as specific rates (per unit ouput).

Sources:
Agricultural Outlook, April 1991 and unpublished USDA data.

total national subsidy expenditure, and equaled almost one percent of GDP.[14] In the U.S., deficiency payments and expenditures on the export enhancement program (EEP) in 1987 totalled $11.5 billion, or one percent of government spending and 10 percent of the fiscal deficit.

In the FTA–CGE model, agricultural policies are modeled either as price wedges, which affect output decisions, or lump-sum income transfers. The wedges and transfers are either specified exogenously or determined endogenously, based on the institutional characteristics of the program being modelled. The various programs and how they are treated in the model are summarized in Table 5.

Border policies (tariffs, quotas, and export subsidies) affect producers through their effect on the output price, $PX_{i,k}$, which is effectively a weighted average of the prices of output sold in the domestic market, $PD_{i,k}$, and in each export market, $PE_{i,k,c1}$. Similarly, they affect consumers through the price of the composite good, $P_{i,k}$, which is effectively a weighted average of the domestic currency price of the imported good, $PM_{i,k}$, and the domestic good price, $PD_{i,k}$.[15] Given the CET and AIDS functions, the link between trade policy and domestic prices is weaker than in a model where all goods are perfect substitutes.

5.1 Mexican Agricultural Programs

Six Mexican policies are modeled.[16] In the four agricultural sectors, these are input subsidies, tariffs, and quotas. In the food processing sector, we model direct subsidies and

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[14]This total represents agricultural expenditures for 1989 and subsidies to food processing for 1988.

[15]PX is a CET aggregation of PD and PE, while P is a translog or Stone aggregation of PD and PM.

[16]Mexican agricultural policies are described in Krissoff and Neff (1992); Burfisher (1992); Mielke (1989, 1990); O'Mara and Ingco (1990); and Roberts and Mielke (1986).

Table 5 — How Agricultural Programs are Modeled

	Program instruments: Fixed	Program instruments: Endogenous	Program: United States	Program: Mexico
<u>Price Wedges</u>				
PX, output price		PIE	Deficiency payment program	CSUB: credit FSUB: fertilizer INSUB: insurance IRSUB: irrigation FDSUB: feed DSUB: direct
PD, domestic sales price	itax psub		itax: indirect tax	psub: price subsidy
PM, import price	tm	TM2	Tariffs and quotas on imports	Tariffs and quotas on imports
PE, export price	tee		EEP: Export enhancement program	
PVA, value added price	vatr			Value added tax
<u>Income Transfers</u>				
Households	losub			losub: low income tortilla subsidy

<u>Notes</u>:
PIE refers to "producer incentive equivalent." In the model, the PIE variable equals the sum of all price-wedge instruments that affect the output price (PX). Tariff rates, tm, are fixed parameters. The tariff equivalent of a quota, TM2, is a variable determined endogenously, given the fixed import quota.

price subsidies, in addition to tariffs and quotas. The sixth Mexican policy is the low income, or tortilla, subsidy.

Mexico provides its farmers with input subsidies on credit, fertilizer, insurance, irrigation, and feed. Input subsidies are represented in the model as a per-unit mark-up on output price measured as a fixed number of pesos per unit of output.[17] Reflecting their effect on the producer's output decision, input subsidies are summed into a Producer Incentive Equivalent ($PIE_{i,k}$), in pesos per unit of output. For the U.S. and Mexico, the producer incentive equivalents in *ad valorem* terms range from 16 to 21 percent (Tables 3 and 4). Given the assumption of fixed input-output coefficients, the profit maximization problem uses the value added-price ($PVA_{i,k}$) in computing the marginal revenue product as an argument to determine demand for primary factors. PVA is the price received by producers (PX, defined net of indirect taxes), minus the cost of intermediate inputs (given by input-output coefficient, $IO_{j,i,k}$), and plus all subsidies (PIE):

$$PVA_{i,k} = PX_{i,k} - \sum_{j} (IO_{j,i,k} \cdot P_{j,k}) + PIE_{i,k} \tag{3}$$

Increasing the producer's value-added price with a positive PIE increases factor returns and induces a resource pull of factors toward the subsidized sector, causing output in the sector to expand.

Import quotas in agriculture are used by the Mexican government as a supply management tool to maintain targeted domestic farm prices. Import licenses are generally issued after the domestic crop has been harvested and purchased. To acquire a license, private importers or Mexico's food parastatal, the Compania Nacional de Subsistencias

[17]Input subsidies can be tied directly to output because intermediate demand is modeled with fixed input-output coefficients. With more complex production functions, input subsidies should be directly tied to input usage. A "u" as the final letter in the name of a subsidy signifies that it is provided per unit of output.

Populares (CONASUPO), must show that domestic supplies are being purchased for not less than the government target price. Mexico is assumed to be a small country in the world market for its agricultural imports, so that their quotas do not affect the world price. The tariff equivalent of the quota, $TM2_{i,k,c1}$, can be calculated as the "price-gap" between the world price and the domestic price. Following Dervis, de Melo, and Robinson (1982) and Kilkenny (1991), $TM2_{i,k,c1}$ is determined endogenously, so that the quota's *ad valorem* equivalent (and hence the value to license holders of the import premia) changes with the price gap.

Premium income from each sector is distributed to the holders of import licenses. Since only Mexicans are awarded licenses, the rent is retained domestically. In the FTA–CGE model, the rent is allocated between government revenue and enterprise income according to the share of the government and private sector in imports.[18] Tariffs are modelled with fixed *ad valorem* rates, $TM_{i,k,c1}$, and tariff revenues are paid by consumers to the government.

Since December 1987, Mexico has placed price controls on almost all basic foods, including corn products, wheat products, dairy, eggs, poultry, and pork. To enable food processors to sell their output at low consumer prices fixed by price controls, the government offsets processors' high input prices with two types of subsidies. One is a direct subsidy, $DSUB_{i,k}$. This is a modeled as a fixed budgetary transfer from the government to the processing sector, with a unit value ($DSUBU_{i,k}$) that varies with a change in output:

[18]Tariffs and quotas are modelled identically for the U.S. and Mexico, except that in the U.S., quota premia accrue to capital income.

$$DSUBU_{i,k} = \frac{DSUB_{i,k}}{XD_{i,k}} \tag{4}$$

where $DSUBU_{i,k}$ is included in the $PIE_{i,k}$ price wedge on producer's value-added price, and the direct subsidy expenditure is treated as a fixed component of Mexican farm program expenditures.

The Mexican government also provides processors with an input price subsidy, $PSUB_{i,k}$, to compensate them for the high purchase price of domestic agricultural inputs, and to enable them to sell their output on the domestic market at the controlled retail price $\bar{P}_{i,k}$. $PSUBU_{i,k}$ is the input price subsidy in pesos per unit of output. Its initial value is calculated from data on sectoral government expenditures on price subsidies, $PSUB_{i,k}$, and domestic sales, $D_{i,k}$ as:

$$PSUBU_{i,k} = \frac{PSUB_{i,k}}{D_{i,k}} \tag{5}$$

Price subsidies increase a processor's domestic sales price to $PDA_{i,k}$, the "actual" domestic sales price received by each producer:

$$PDA_{i,k} = PD_{i,k} + PSUBU_{i,k} \tag{6}$$

In a model with more sectoral disaggregation, the unit price subsidy should be modeled endogenously as the price wedge on a processor's domestic sales price that is required to maintain the fixed retail price of the composite good, $\bar{P}_{i,k}$. Because the 11-sector model aggregates all food processing into a single sector, $PSUBU_{i,k}$ is represented as a fixed price wedge and consumer food prices are permitted to vary. Quota removal under an FTA is simulated by simply removing the wedge, rather than allowing the model to determine the change in $PSUBU_{i,k}$. The cost of the price subsidy to the government increases with an increase in domestic sales, and is included in agricultural program expenditures.

Mexico provides low income consumers with subsidized corn tortillas. Under one program, low prices are offered in CONASUPO-owned retail outlets located in low-income neighborhoods. More recently, the government has provided low-income households with one kg. per day of tortillas, approximately one-half the daily average household consumption [Levy and van Wijnbergen (1991)]. Since the FTA–CGE model has only a single aggregate household, with no differentiation by income, the tortilla subsidy is represented as a lump-sum income transfer to the single household. Similar to direct subsidies to processors, expenditure by the government on low income corn subsidies, $LOSUB_{i,k}$, is fixed and enters into Mexican agricultural program expenditures.

5.2 U.S. Agricultural Programs

Two U.S. farm programs could be affected by an FTA — deficiency payments and the EEP.[19] The U.S. deficiency payments program provides payments to farmers who participate in feed grain, wheat, rice, or cotton programs. The payment rate is calculated as the difference between a fixed target price ($TP_{i,k}$) and the market price ($PX_{i,k}$) or loan rate, whichever difference is less. The total payment a farm receives ($DEFPAY_{i,k}$) is the payment rate multiplied by eligible base production ($XP_{i,k}$):[20]

$$DEFPAY_{i,k} = \left(TP_{i,k} - PX_{i,k}\right)\cdot XP_{i,k} \qquad (7)$$

[19]Our modeling of these programs in the FTA–CGE model follows Kilkenny and Robinson (1988, 1990) and Kilkenny (1991).

[20]The initial value of the target price is calculated from base-year data on the aggregate cost of deficiency payment (DEFPAY) which is then used to estimate the mark-up on the market price. The model also implicitly fixes participation rates at the base year rate, implying that any increase in U.S. program crop output comes from outside the deficiency payments program. In recent years, the market price has been above the loan rate, so we have not had to model the non-recourse loan program.

The U.S. EEP program is intended to counter competitors' subsidies and other "unfair" trade practices in targeted U.S. agricultural export markets, and to develop, expand, or maintain foreign markets. Under the EEP program, the USDA approves an initiative to permit an importing country to tender for a specified quantity of a designated commodity. Exporting firms bid for the sale, which are contingent on receiving an EEP bonus from the Commodity Credit Corporation (CCC). EEP bonuses are fungible, in-kind certificates backed by commodities owned by the CCC. The firms estimate the per unit subsidy they will need to complete the sale and then compete against each other for the EEP bonus. The CCC then accepts one of the bids, based on the price and bonus ranges. In effect, the EEP program works as an *ad valorem* export subsidy, which is how it is treated in the FTA–CGE model. The subsidy rate, $TEE_{i,k,c1}$, is applied as a mark-up on the world export price:

$$PE_{i,k,cl} = PWE_{i,k,cl} \cdot EXR_k \cdot (1 + TEE_{i,k,cl}) \tag{8}$$

which allows U.S. producers to lower the world price of their goods relative to other suppliers, while maintaining their received price (PE). Total EEP expenditures are included in farm program expenditures.

For each country, the policy-ridden, value-added producer price becomes:

$$PVA_{i,k} = \frac{\left[(1 - ITAX_{i,k}) \cdot PD_{i,k} + PSUBU_{i,k}\right] \cdot D_{i,k} + \sum_{cl} PE_{i,k,cl} \cdot E_{i,k,cl}}{XD_{i,k}} - \sum_{j} (IO_{j,i,k} \cdot P_{j,k}) + PIE_{i,k} \tag{9}$$

where: ITAX is the indirect tax rate, PSUBU is the subsidy rate on domestic sales (by food processors in Mexico), and PIE is a bundle of subsidies in domestic currency per unit of total output (Table 5). The other variables are defined above.

Four types of elasticity parameters are used in the model. The production specification requires sectoral elasticities of substitution among primary factors. The CET export supply functions require elasticities of transformation between goods sold on the home and export markets. The AIDS import demand functions require sectoral income elasticities and substitution elasticities for home goods and for goods from each import source. We have drawn on estimates and "quesstimates" from various studies, including Hinojosa and Robinson (1991); Hanson, Robinson, and Tokarick (1989); and Reinert and Shiells (1991). In lieu of econometric estimation, sensitivity analysis was carried out to check for the robustness of the model results using alternative elasticity parameters.

6. Model Results

6.1 Scenarios

We analyze the effects of a U.S.–Mexico FTA under six scenarios, which are summarized in Table 6. All the scenarios involve changes in policies between the U.S. and Mexico, leaving unchanged their policies with respect to the rest of the world. The first scenario is the removal of all non-agricultural protection between the U.S. and Mexico, leaving all agricultural protection and programs intact. The second scenario is removal of tariffs and quotas in all industrial and agricultural sectors, but again leaving all agricultural programs, except for the removal of the U.S. EEP program with respect to Mexico.[21] A third scenario considers trade and agricultural liberalization, removing all Mexican subsidies to farmers and food processors, in addition to full trade liberalization. We also ran a variant of Scenario 3, 3a, in which input subsidies to the food corn sector were eliminated, but all

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[21]U.S. quotas on sugar imports (in the processed food sector) were also left intact. As a net sugar importer, Mexico is unlikely to become a sugar exporter to the U.S. under an FTA, except insofar as it attempts to increase its quota rents from arbitrage sales to the U.S. market. In any event, trade in sugar and items of high sugar content was not liberalized under the U.S.—Canada FTA, and is likely to be excluded from the U.S.—Mexico FTA.

Table 6 — Description of Scenarios

No.	Scenario	Description
1.	Industrial trade liberalization	Remove all non-agricultural tariffs and quotas.
2.	Trade liberalization	Remove all tariffs and quotas. Remove U.S. EEP program subsidizing exports to Mexico.
3.	Trade and Mexican agricultural liberalization	Scenario 2 plus eliminate all agricultural support programs in Mexico.
3a.	Trade and Mexican corn liberalization	Scenario 2 plus eliminate input subsidies for corn sector in Mexico.
4.	Trade liberalization plus common agricultural policies	Scenario 2 plus add a deficiency payment program for corn and other program crops in Mexico.
5.	Partial trade liberalization	Tariffication of Mexican agricultural import quotas at 50% of tariff equivalent. Add deficiency payment program to Mexico in corn. Leave all existing agricultural programs intact.
6.	Partial liberalization plus capital growth in Mexico	Tariffication of Mexican agricultural import quotas at 50% of tariff equivalent. Mexican capital stock 10% higher. Mexican agricultural subsidies (PIE) cut in half for corn and other program crops. No deficiency payment program in Mexico.

other Mexican agricultural programs remained intact.[22] The fourth and fifth scenarios explore the effects of restructuring Mexican domestic agricultural policies in conjunction with an FTA. In the fourth scenario, in addition to full U.S.–Mexico trade liberalization, Mexico adopts a deficiency payments program for corn and program crops similar to the U.S. program and continues its farm and food processing subsidies. This mix of policies has the effect of protecting Mexican producers through domestic programs rather than trade barriers. In the fifth scenario, a deficiency payments program is combined with the tariffication of Mexican quota protection in the corn and program crops sectors at one-half the level of the tariff equivalents of base year quotas. This partial trade liberalization scenario reduces the fiscal burden of protecting Mexican producers because some tariff barriers are maintained. In the sixth scenario, the Mexican aggregate capital stock is assumed to be augmented by 10 percent, simulating the effects of the anticipated increased capital inflows under an FTA, which should lead to Mexican growth relative to the U.S.

6.2 Aggregate and Sectoral results

Table 7 presents the macro results from the six scenarios. All scenarios result in slight increases in GDP in both countries. In all but the first scenario, there is a very small real appreciation of the U.S exchange rate. In Mexico, there is a small real depreciation, except in the case of Mexican growth (scenario 6).

Bilateral trade increases in all the scenarios. Mexico increases its exports both to the U.S. and to the rest of the world. The FTA results in some trade diversion for Mexico, whose imports from the rest of the world decline by 2–3 percent. An FTA with Mexican growth

[22]The scenarios of full trade and program liberalization of Mexican agriculture are designed to replicate the scenarios described by Levy and van Wijnbergen (1991) in their single-country CGE model of Mexico.

Table 7 — Aggregate Results of an FTA Under Alternative Scenarios

Scenario	1 Industry trade lib	2 All trade lib	3 Trade + all ag	3a Trade + corn	4 Common ag policy	5 Partial trade lib	6 Growth + partial lib
Real GDP			- - - Percent change from base model solution - - -				
U.S.	0.01	0.23	0.28	0.34	0.11	0.04	0.00
Mexico	0.07	0.27	0.24	0.31	0.23	0.15	7.43
Real exchange rate							
U.S.	0.0	-0.8	-0.3	-0.9	-0.7	-0.3	-0.6
Mexico	0.4	2.6	2.2	1.6	3.5	1.5	-0.5
Exports (world prices)							
U.S. to Mexico	6.1	9.1	10.6	9.5	8.6	7.3	16.6
U.S. to rest	0.0	0.3	0.9	0.5	0.1	0.0	-0.3
Mexico to U.S.	4.1	5.2	5.7	5.4	5.1	4.8	6.3
Mexico to rest	1.6	3.8	5.4	4.2	3.4	2.2	17.2
Rest to U.S.	0.0	0.4	0.9	0.6	0.2	0.1	0.2
Rest to Mexico	-2.0	-2.8	-2.4	-2.7	-2.9	-2.3	6.5
Real wages: U.S.							
Rural	0.0	-1.3	-3.4	-2.1	-0.6	-0.2	0.2
Urban unskilled	0.0	-1.7	-4.2	-2.5	-0.8	-0.3	0.0
Urban skilled	0.0	0.1	0.3	0.2	0.1	0.0	0.0
Professional	0.0	0.1	0.3	0.2	0.1	0.0	0.0
Land rental	0.0	1.3	2.3	1.6	1.0	0.3	0.8
Capital rental	0.0	0.1	0.3	0.2	0.1	0.0	0.0
Real wages: Mexico							
Rural	0.6	1.8	-0.1	2.6	1.4	1.2	4.5
Urban unskilled	0.6	-0.2	-3.0	-1.1	0.7	0.7	3.2
Urban skilled	0.6	1.1	0.3	1.1	1.2	0.8	3.5
Professional	0.5	1.0	0.2	0.9	1.0	0.7	3.4
Land rental	0.6	-8.8	-24.2	-14.1	-3.2	-0.5	0.1
Capital rental	0.6	1.1	0.0	1.1	1.2	0.8	-1.4
Net farm program expenditure							
U.S.	0.3	0.3	0.2	0.3	0.4	0.5	0.3
Mexico	5.2	15.9	-96.9	-0.7	35.4	17.6	-24.3
Migration			- - - 1000's persons - - -				
Mexican rural-US rural	1	26	66	39	12	4	0
Mexican urban-US urban	7	212	544	324	100	39	-2
Mexican rural-Mex urban	1	290	773	464	119	40	21

Notes:
The "real exchange rate" is the price-level deflated exchange rate, using the GDP deflator. A positive change represents a depreciation. Exports are value at world prices (in dollars). "Net farm program expenditure" equals farm program expenditures minus tariff revenue and import quota premium revenue accruing to the government from agriculture and food processing.

(scenario 6), however, does result in an increase of imports from the rest of the world. An FTA is trade creating for the U.S., with U.S. imports increasing from both Mexico and the rest of the world in all scenarios. The Mexican growth scenario results in a slight diversion of U.S. exports away from the rest of the world as part of a large increase in U.S. exports to Mexico. This result emphasizes the importance of investment growth in Mexico in determining the overall benefits of an FTA for the U.S.

Sectoral results are given in Tables 8a and 8b. U.S. export growth to Mexico is highest in the agricultural sectors where Mexican protection has remained relatively high. U.S. export growth corresponds to the decline in Mexican food corn and program crop output under all five agricultural trade and liberalization scenarios. Full liberalization of the Mexican food corn sector (scenarios 3 and 3a) result in a nearly 20 percent fall in output while U.S. food corn output rises about 5 percent and exports to Mexico soar by almost 200 percent.

Mexico's fruit and vegetable sector undergoes less spectacular yet significant export growth (ranging from 18 percent to 21 percent) under an FTA which includes agriculture, reflecting the high initial U.S. tariff rates in this sector. Trade liberalization leads to a significant increase in two-way trade in fruits and vegetables, with exports expanding in both countries. Mexican fruit and vegetable output expands, while U.S. output hardly changes. A policy mix in Mexico that maintains some trade barriers for agriculture (scenario 5) results in much lower, although still significant, growth in U.S. exports of corn and program crops to Mexico.

Table 8a — Sectoral Results, Scenarios 1 - 3a

Scenario	1 Industry trade lib		2 All trade lib		3 Trade + all ag		3a Trade + corn	
	Output	Exports	Output	Exports	Output	Exports	Output	Exports
United States			--- Percent change from base model solution ---					
Food corn	0.0	-1.0	4.1	156.0	5.1	185.4	5.3	196.3
Program crops	0.0	-0.4	0.8	40.5	1.7	88.2	1.0	39.2
Fruits/vegetables	0.0	-0.7	0.1	14.2	0.7	13.6	0.2	14.0
Other agriculture	0.0	-0.4	0.2	8.3	0.6	6.8	0.4	8.2
Food processing	0.0	6.6	0.3	6.3	0.7	5.7	0.4	6.4
Other light mfg.	0.0	6.4	0.2	6.0	0.5	6.0	0.3	6.2
Oil & refining	0.0	13.8	0.0	13.9	0.0	13.9	0.0	14.0
Intermediates	0.0	4.8	0.2	4.7	0.5	4.7	0.3	4.9
Consumer durables	0.2	11.2	0.3	10.8	0.7	10.8	0.4	10.9
Capital goods	0.0	4.7	0.2	4.7	0.5	4.6	0.3	4.7
Services	0.0	-0.4	0.2	-0.8	0.6	-1.0	0.4	-0.7
Mexico								
Food corn	-0.1	0.0	-10.2	0.0	-19.4	0.0	-19.1	0.0
Program crops	0.2	0.0	-7.1	0.0	-21.1	0.0	-6.7	0.0
Fruits/vegetables	0.0	0.3	5.3	19.1	3.1	17.6	6.1	20.8
Other agriculture	0.0	0.3	0.9	3.0	-1.3	1.8	1.0	3.4
Food processing	0.0	13.4	0.9	11.0	-2.0	7.1	0.9	10.9
Other light mfg.	0.7	9.2	0.9	10.5	1.2	11.8	1.0	10.8
Oil & refining	0.0	3.7	0.0	3.7	0.0	3.7	0.0	3.6
Intermediates	0.2	2.9	0.4	3.7	0.7	4.8	0.5	4.0
Consumer durables	1.0	3.9	2.4	5.4	4.5	7.5	2.7	5.7
Capital goods	0.1	5.2	0.6	6.1	1.2	7.4	0.7	6.3
Services	-0.1	0.7	0.0	1.0	0.4	1.9	0.2	1.2

Notes:
Real output and exports. Exports are to the partner country (U.S. or Mexico).

Table 8b — Sectoral Results, Scenarios 4 - 6

Scenario	4 Common ag policy		5 Partial trade lib		6 Growth + partial lib	
	Output	Exports	Output	Exports	Output	Exports
United States	--- Percent change from base model solution ---					
Food corn	3.3	128.0	1.2	49.0	2.6	100.6
Program crops	0.6	36.3	0.2	13.7	0.5	54.3
Fruits/vegetables	-0.1	14.4	-0.2	14.8	-0.3	26.4
Other agriculture	0.1	8.3	0.1	8.6	0.0	17.8
Food processing	0.1	6.2	0.1	6.4	0.0	16.1
Other light mfg.	0.1	5.9	0.0	6.2	-0.1	14.2
Oil & refining	0.0	13.8	0.0	13.8	0.0	23.0
Intermediates	0.1	4.6	0.0	4.7	0.0	14.8
Consumer durables	0.2	10.8	0.2	11.0	0.1	14.0
Capital goods	0.1	4.6	0.1	4.6	0.0	10.5
Services	0.1	-0.8	0.0	-0.6	0.0	1.2
Mexico						
Food corn	-3.1	0.0	-1.5	0.0	-4.5	0.0
Program crops	-6.0	0.0	-2.6	0.0	-3.6	0.0
Fruits/vegetables	4.6	18.0	4.2	17.4	8.1	17.4
Other agriculture	0.9	2.7	0.2	1.5	8.8	5.5
Food processing	0.9	11.0	0.3	8.7	9.5	17.4
Other light mfg.	0.8	10.2	0.7	9.6	10.0	20.2
Oil & refining	0.0	3.7	0.0	3.7	0.0	-1.5
Intermediates	0.3	3.5	0.2	3.1	7.0	7.7
Consumer durables	2.1	5.1	1.4	4.3	12.2	12.8
Capital goods	0.5	5.9	0.2	5.4	6.0	11.5
Services	-0.1	0.8	-0.1	0.6	7.4	5.9

Notes:
Real output and exports. Exports are to the partner country (U.S. or Mexico).

6.3 Migration and Farm Program Expenditure

Complete trade liberalization and the accompanying removal of subsidies to Mexican agriculture and food industries (scenario 3) has a major effect on migration. About 12 percent of Mexico's rural labor force (839,000 workers) migrate either to the U.S. or to Mexican urban areas (Table 7). These workers come from the corn, program crop, and other agricultural sectors, which contract sharply with quota and program removal. Expansion of fruit and vegetable output, spurred by export growth to the U.S., is insufficient to absorb the displaced agricultural workers. A total of 610,000 Mexican workers migrate to the U.S., 66,000 directly from the Mexican rural sector to the U.S. rural sector and another 544,000 urban unskilled migrants moving to the U.S. from Mexican cities. There is a domino effect at work, with rural-urban migration in Mexico leading, in turn, to migration from Mexico to U.S. urban areas. Isolating the impact of Mexican food corn liberalization (scenario 3a) indicates that about 60 percent of the total outmigration associated with complete agricultural trade and program liberalization is due to liberalization of the corn sector.

In addition to large migration flows, scenarios 3 and 3a also generate the worst distributional outcomes. Real wages of both rural and urban unskilled workers fall sharply in the U.S., due to increased migration, and fall in Mexico for the same reason, although to a lesser degree. Full trade liberalization and removal of agricultural programs in Mexico yields a pattern of integration with lower wages for the poorest members of both societies.[23]

Scenarios 4 and 5 were designed to ameliorate the impact of trade liberalization on Mexican migration. They are successful in reducing the migration flows, but they also

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[23]In scenario 3a, the FTA–CGE model shows Mexican rural wages rising. This result is explained by the large exodus of rural workers out of the food corn sector, while the rest of the higher paying program crops continue to be supported. The Mexican government, however, has already begun to cut support for other program crops, leaving food corn relatively protected at this time.

increase Mexican agricultural program expenditures. Scenario 4, which adds a deficiency payments program in Mexico similar to that in the U.S., supports the corn and program crop output that had previously been supported by a quota. Mexican agricultural output falls only slightly in these sectors, but Mexican agricultural imports from the U.S. still increase sharply because removal of trade barriers lowers the relative price of imports. The deficiency payments program leads to a much smaller increase in migration, but incurs a 35.4 percent increase in Mexican net farm program expenditures (which take account of change in import tariff and premium revenue, as well as budgetary outlays).

Scenario 5, which replaces agricultural quotas with tariffs set at half of the tariff equivalents of base year quotas, supports the Mexican corn and program crop producer prices and results in only a small contraction in output. Only 44,000 workers leave Mexican agriculture. While scenarios 4 and 5 both reduce Mexican migration flows, the increase in Mexican agricultural program expenditures is much lower when partial trade barriers are maintained (scenario 5), increasing only 17.6 percent.

Scenario 6 results in very low Mexican migration flows and only a slight contraction in output in the corn and program crops sectors (3–5 percent). Expansion of other sectors absorbs Mexican rural labor and eliminates any new net increases in the migration flow to the U.S. (indeed, reversing it by 2,000). Net agricultural program expenditures fall 24.3 percent, due both to decreased input subsidies and to increased tariff revenue. Scenario 6 is the only agricultural liberalization FTA scenario where real wages rise for all labor groups in both countries. This scenario indicates the importance to the success of the FTA for both countries of Mexico achieving more rapid growth.

Figures 2 and 3 show the trade-offs between migration and Mexican agricultural program spending and growth. Both figures start from the full trade and Mexican agricultural

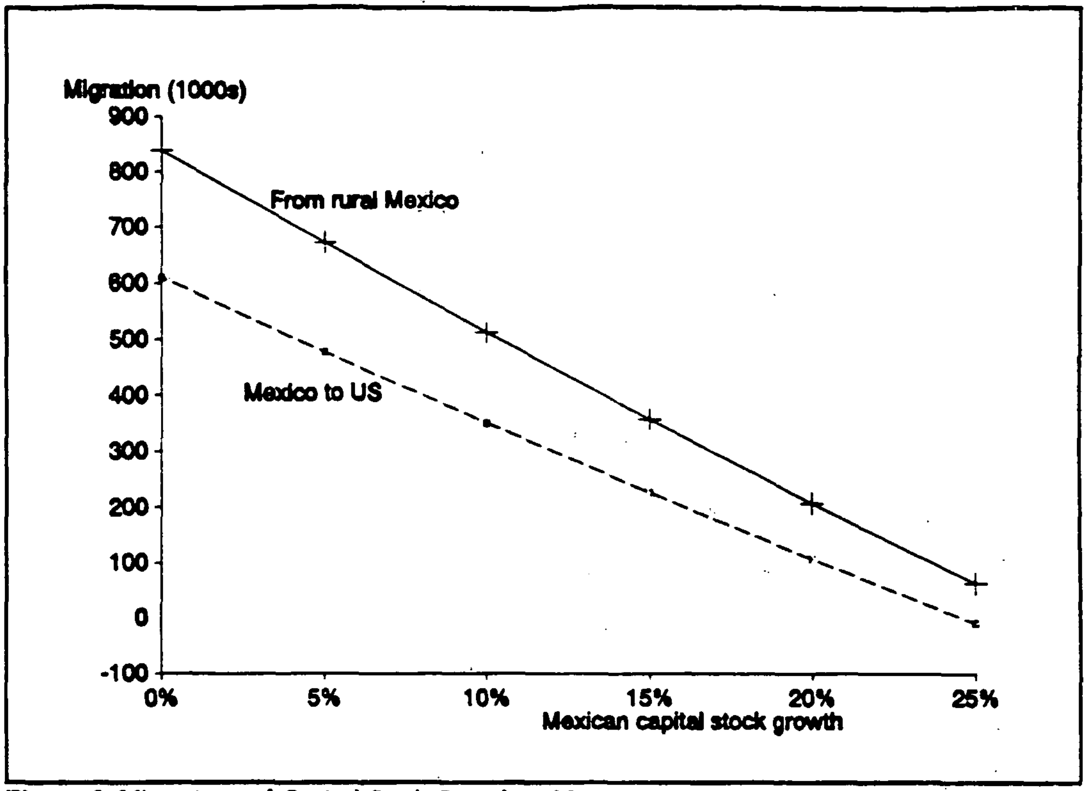

Figure 2: Migration and Capital Stock Growth in Mexico

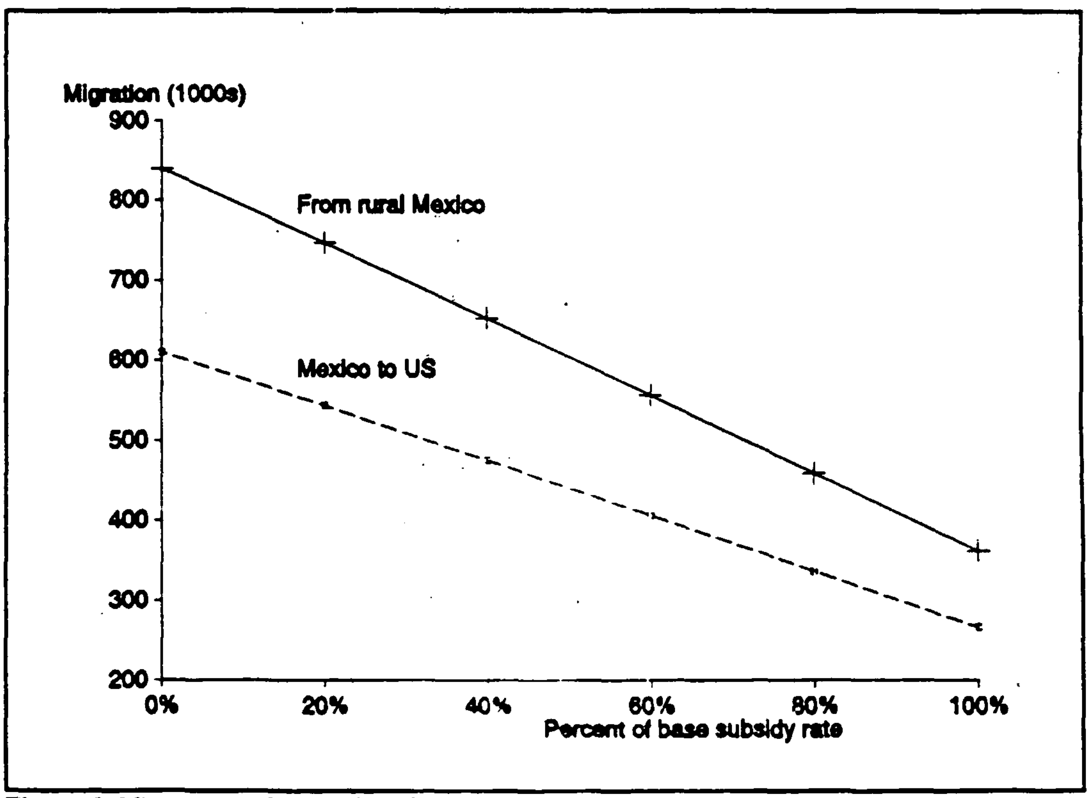

Figure 3: Migration and Agricultural Input Subsidies in Mexico

program liberalization (scenario 3) as their base, and then show the results of five experiments changing capital stock growth or the aggregate input subsidy rate (consisting of all the policies affecting PIE in Table 5 except feed and direct subsidies, FDSUB and DSUB). Figure 2 shows the sensitivity of different types of migration to increased growth. In order to counteract completely the increases in migration resulting from scenario 3, the Mexican capital stock would have to grow 25 percent relative to the U.S. Figure 3 demonstrates the sensitivity of migration to spending on agricultural input subsidies. With a 100 percent reinstatement of input subsidies, the level of migration is close to that of scenario 2, which is still significant. It is interesting to note that both for increased capital growth and agricultural support policies, the migration relationship is almost linear. Each percentage point increase in the Mexican capital stock reduces migration to the U.S. by roughly 25,000 workers and each percent increase toward the base level of agricultural input subsidies reduces migration by 3,500 workers.

7. Conclusion

This article analyzes the effects of a U.S.–Mexico free trade agreement using a multicountry CGE model in which labor migration and domestic agricultural programs are modeled explicitly, and a flexible functional form is used for import demand equations. The model is used to analyze six scenarios. These represent complete bilateral trade liberalization and Mexican agricultural program elimination; two combinations of Mexican agricultural programs that would reduce the labor migration caused by an FTA; and trade liberalization with a capital inflow into Mexico.

Our results show that both countries achieve welfare gains under an FTA, even in scenarios in which some production and trade distorting policies are maintained. Bilateral trade increases significantly with removal of trade barriers. An FTA is trade creating for both countries in all scenarios, but some scenarios lead to trade diversion for Mexico, with slightly reduced imports from the rest of the world. As Mexico grows, however, its trade with both the U.S. and the rest of the world grows.

We show that alternative structures of FTA's generate trade-offs between the growth in exports that is stimulated by lower trade barriers, versus the cost such liberalization generates in agricultural program expenditures and new net increases in labor migration flows. Free trade increases bilateral trade, but induces large rural outmigration from Mexico. Mexico can reduce labor migration through the adoption of a deficiency payments program that maintains agricultural income, but the fiscal effects are prohibitive. Retaining some trade barriers in agriculture reduces bilateral trade growth, but also reduces migration and growth in agricultural program expenditures. Increased capital inflows into Mexico result in expanded bilateral trade, much lower migration flows, and a large reduction in Mexican agricultural program expenditures. Dynamic effects are clearly very important in achieving the full benefit of an FTA.

These findings suggest that Mexico will need a lengthy transition period and must allocate resources to agriculture during the transition. Trade liberalization leads to an immediate increase in rural outmigration, while the increased growth needed to absorb the displaced labor takes longer. Undue haste in introducing free trade in agriculture and eliminating Mexican agricultural support programs may not be desirable for either country when the social and economic costs associated with increased migration are weighed against the benefits of increased trade growth.

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Appendix: The US-Mexico FTA-CGE Model

Introduction

This appendix presents the equations of the US-Mexico, FTA-CGE model in the format of the software in which the program was written, GAMS. GAMS stands for "General Algebraic Modeling System" and the software is described in Brooke, Kendrick, and Meeraus (1988). For ease of exposition, the model equations are somewhat simplified. The agricultural support programs are represented by *ad valorem* equivalents, while the full model specifies the programs explicitly. All sectors are shown with CET transformation functions between goods supplied to the domestic and export markets. The full model assumes that two agricultural sectors (corn and other program crops) have an infinite elasticity of transformation between domestic and export goods. In the full model, the output of the oil sector in both countries is fixed exogenously.

GAMS statements are case insensitive. However, we use a number of notation conventions to improve readability:

Variables are all in upper case.
Variable names with a suffix 0 represent base-year values and are specified as parameters (or constants) in the model.
Parameters are all in lower case.
Sets are all in lower case.

In the GAMS language:

Parameters are treated as constants in the model and are defined in separate "PARAMETER" statements.
"SUM" represents the summation operator, sigma.
"PROD" represents the product operator, pi.
"LOG" is the natural logarithm operator.
"$" introduces a conditional "if" statement.
The suffix .FX indicates a fixed variable.
The suffix .L indicates the level or solution value of a variable.
The suffix .LO indicates the lower bound of a variable.
The suffix .UP indicates the upper bound of a variable.
An asterisk (*) in column one indicates a comment. Some alternative treatments are shown commented out.
A subset is denoted by the subset name followed by the name of the larger set in parentheses. In statements, the subset name is then used by itself.
A semicolon (;) terminates a GAMS statement.
Items betweeen slashes ("/") are data.

The US-Mexico FTA-CGE Model in GAMS

```
*#################### Definition of sets #####################

  SETS

  cty1    universe            / US          USA
                                MX          Mexico
                                RT          Rest of world /

  k(cty1) countries           / US          USA
                                MX          Mexico /

  i  sectors of production    / corn        food corn
                                agprog      other program crops
                                frtveg      fruits and vegetables
                                othag       other agriculture
                                food        food processing
                                lmfg        other light mfg
                                oil         oil and refining
                                int         intermediates
                                cdur        consumer durables
                                kgood       capital goods
                                svc         services              /

  iag(i)  ag sectors           / corn, agprog, frtveg, othag /
  iagn(i) non ag sectors

  iqr(i,k,cty1)   import rationed sectors
  iqrn(i,k,cty1)  non rationed sectors

  ied(i,k)  sectors with export demand function for rt
                               / corn.us, agprog.us /
  iedn(i,k) not ied

  iff  factors of production / capital    capital
                               rulab      rural labor
                               urbunlab   urban unskilled labor
                               skillab    skilled labor
                               proflab    professional labor
                               land       ag land   /

  nmig(iff)  non-migrating factors
                               / capital, skillab, proflab, land /

  mig  migrant types           / usag   migrants to us rulab
                                 usurb  migrants to us urbunlab
                                 mxurb  migrants to mx urbunlab /

  hh   households              / hhall /

  ins  institutions            / labr    labor
                                 ent     enterprises
                                 prop    property income /
  ;
  iagn(i)         = not iag(i) ;
  iqr(i,k,cty1)   = NO ;
  iqrn(i,k,cty1)  = not iqr(i,k,cty1) ;
  iedn(i,k)       = not ied(i,k) ;

  ALIAS(i,j) ;
```

```
  ALIAS(k,l) ;
  ALIAS(cty1,cty2) ;
  ALIAS(la,lb) ;
  ALIAS(iff,f) ;

  SET pt(k,cty1)  three trading partners   /   us. (mx,rt)
                                               mx. (us,rt)
                                           / ;

  SET pt3(cty1,cty2) two trading partners  /   us. (mx)
                                               mx. (us)
                                           / ;
*################# Definition of variables #################

 VARIABLES

*## PRICE BLOCK

   EXR(k)                 exchange rate
   P(i,k)                 price of composite good
   PD(i,k)                domestic price
   PE(i,k,cty1)           domestic price of exports
   PINDEX(k)              numeraire price index
   PM(i,k,cty1)           domestic price of imports
   PWE(i,cty1,cty2)       world price of exports from cty1 to cty2
   PWM(i,cty1,cty2)       world price of imports into cty1 from cty2
   PX(i,k)                average output price
   PVA(i,k)               value added price
   TM2(i,k,cty1)          import premium rate

*## PRODUCTION AND TRADE BLOCK

   E(i,cty1,cty2)         exports from cty1 to cty2
   M(i,cty1,cty2)         imports into cty1 from cty2
   X(i,k)                 composite goods supply
   XD(i,k)                domestic output
   XXD(i,k)               domestic sales
   SMQ(i,k,cty1)          import value share (AIDS function)
   INT(i,k)               intermediate demand

*## FACTOR BLOCK

   WFDIST(i,iff,k)      factor price distortion constants
   YFCTR(iff,k)         factor income
   FS(iff,k)            factor supply
   FDSC(i,iff,k)        factor demand by sector
   WF(iff,k)            average factor price

*## INCOME AND EXPENDITURE BLOCK

   CDD(i,k)               final demand for private consumption
   FSAV(k,cty1)           net foreign savings
   FBAL(k)                current account balance
   INDTAX(k)              indirect tax revenue
   SSTAX(k)               factor taxes
   TARIFF(k,cty1)         tariff revenue
   PREM(i,k)              premium income from import rationing
   YH(hh,k)               household income
   YINST(ins,k)           institutional income
   WALRAS                 Walras law for system
   WALRAS2(k)             Walras law for each country
```

```
GDTOT(k)              government real consumption
GD(i,k)               governmend demand by sector
GOVSAV(k)             government saving
GOVREV(k)             government revenue
HHT(k)                govt transfers to households
ENTT(k)               govt transfers to enterprises
ID(i,k)               investment demand by sector of origin
DST(i,k)              inventory investment demand
ZTOT(k)               aggregate nominal investment
ZFIX(k)               aggregate real fixed investment
HSAV(k)               aggregate household savings
REMIT(k)              remittance income to households
FKAP(k)               foreign capital flow to enterprises
FBOR(k)               foreign borrowing by government
FSAVE(k)              foreign savings
ENTSAV(k)             enterprise savings
ESR(k)                enterprise savings rate
VATAX(k)              value added taxes
ENTAX(k)              enterprise taxes
HTAX(k)               household taxes

EEP(i,k,cty1)         US bilateral export subsidy expenditures
PIE(i,k)              producer incentive equivalent per unit of output
PDS(i,k)              domestic price subsidies per unit domestic supply

*## MIGRATION BLOCK

USMIGAG               Mexican rural migrants to US rural sector
USMIGURB              Mexican urban migrants to US urban sector
MXMIG                 Mexican internal rural to urban migrants

*##################### Definition of Parameters #################

PARAMETERS

mrat(i,k,cty1)        rationed import level
tm(i,k,cty1)          tariff rates on imports
tee(i,k,cty1)         export subsidy (EEP) rates
pwts(i,k)             price index weights
sprem(i,k)            allocation share of premium income

io(i,j,k)             input output coefficients by country

rhoc(i,k)             CES import aggregation parameter
rhot(i,k)             CET export transformation parameter
etae(i,k)             export demand elasticity for rest of world
ac(i,k)               CES import function shift parameter
ad(i,k)               production function shift parameter
alpha(i,iff,k)        Cobb-Douglas factor share parameter
alpha2(i,iff,k)       CES factor share parameter
at(i,k)               CET export function shift parameter
delta(i,k,cty1)       CES import function share parameter
gamma(i,k,cty1)       CET export function share parameter

aq(i,k)               constant in translog price index
aqs(i,k)              constant in Stone price index
smq0(i,k,cty2)        share parameter in Stone price index

amq(i,k,cty1)         constant in aids function
betaq(i,k,cty1)       income coefficients in aids function
gammaq(i,k,cty2)      price coefficients in aids function
```

```
  cles(i,hh,k)          household consumption shares
  gles(i,k)             government expenditure shares
  zshr(i,k)             investment demand shares
  mps(hh,k)             savings propensities by households
  sintyh(hh,ins,k)      institution to household income mapping shares
  rhsh(hh,k)            remittances to household income mapping shares
  thsh(hh,k)            household transfer income shares
  sstr(iff,k)           factor income tax rate
  hhtr(hh,k)            household income tax rate
  entr(k)               enterprise income tax rate
  vatr(i,k)             value added tax rate
  itax(i,k)             indirect tax rate

*## Parameters for migration

  cost(mig)             fixed cost of migration
  wgdf(mig)             wage differential
 ;

*################### EQUATION DECLARATION #####################

  EQUATIONS

*## PRICE BLOCK

   PMDEF(i,k,cty1)        definition of domestic import prices
   PEDEF(i,k,cty1)        definition of domestic export prices
   ABSORPTION(i,k)        value of domestic sales
   SALES(i,k)             value of domestic output
   PINDEXDEF(k)           definition of general price level
   ACTP(i,k)              value added price inclusive of subsidies

*## PRODUCTION BLOCK

   ACTIVITY(i,k)          production function
   PROFITMAX(i,iff,k)     first order conditions for profit maximum
   INTEQ(i,k)             intermediate demand
   CET(i,k)               CET function
   ESUPPLY(i,k,cty1)      export supply
   EDEMAND(i,k)           Export demand from rest of world (rt)
*  ARMINGTON(i,k)         composite good aggregation function
*  COSTMIN(i,k,cty1)      FOC for cost minimization of composite good
   PDAIDS(i,k)            price transformation for AIDS
*  TRLOGP(i,k)            translog price index
   STONEP(i,k)            stone price index
   AIDS(i,k,cty1)         aids import share equation
   AIDS2(i,k,cty1)        definition of import expenditure shares
   AIDS3(i,k)             demand for domestic good

*## INCOME BLOCK

   YFCTREQ(iff,k)         factor income
   TARIFFDEF(k,cty1)      tariff revenue
   PREMIUM(i,k)           import premia
   INDTAXDEF(k)           indirect taxes on domestic production
   YINST1(k)              labor institution income
   YINST2(k)              enterprise institution income
   YINST3(k)              property institution income
   HHY(hh,k)              household income
   ENTAXEQ(k)             enterprise taxes
   SSTAXEQ(k)             social security tax
   HTAXEQ(k)              household taxes
```

```
   VATAXEQ(k)              value added tax
   GOVREVEQ(k)             government revenue
   GOVSAVEQ(k)             government savings
   HSAVEQ(k)               household savings
   ENTSAVEQ(k)             enterprise savings
   TOTSAVE(k)              total savings
   FORSAVE(k)              foreign savings

*## EXPENDITURE BLOCK

   CDDEQ(i,k)              consumer demand
   GDEQ(i,k)               government expenditure
   INVEST(i,k)             fixed investment demand by sector
   INVEST2(k)              total investment demand
   EEPDEF(i,k,cty1)        US EEP subsidies expenditure

*## MIGRATION BLOCK

   WGEQ1                   Mex-US rural wage equalization
   WGEQ2                   Mex-US urban wage equalization
   WGEQ3                   Mexican rural-urban wage equalization
   FS1                     US rural labor migration equilibrium
   FS2                     US urban labor migration equilibrium
   FS3                     Mexican rural labor migration equilibrium
   FS4                     MX urban labor migration equilibrium

*## MARKET CLEARING

   EQUIL(i,k)              goods market equilibrium
   FMEQUIL(iff,k)          factor market equilibrium

*## BALANCE OF TRADE EQUILIBRIUM

   CAEQ(k,cty1)            trade balance by trade partner
   FBALEQ(k)               aggregate trade balance by country

*## TRADE CONSISTENCIES

   TRCON(i,cty1,cty2)      export import symmetry conditions
   TRCON7                  fsav consistency
   TRCON10(i,cty1,cty2)    PWM to PWE consistency
 ;


*#################### EQUATION ASSIGNMENT #################

*## PRICE BLOCK

 PMDEF(i,k,cty1)$pt(k,cty1)..  PM(i,k,cty1) =E= PWM(i,k,cty1)*EXR(k)
                                 *(1 + tm(i,k,cty1) + TM2(i,k,cty1) ) ;

 PEDEF(i,k,cty1)..   PE(i,k,cty1) =E= PWE(i,k,cty1)
                                 *(1 + tee(i,k,cty1))*EXR(k) ;

 ABSORPTION(i,k)..   P(i,k)*X(i,k) =E= PD(i,k)*XXD(i,k) +
                       SUM(cty1, (PM(i,k,cty1)*M(i,k,cty1))) ;

 SALES(i,k)..      PX(i,k)*XD(i,k) =E= PDA(i,k)*XXD(i,k) +
                       SUM(cty1, (PE(i,k,cty1)*E(i,k,cty1))) ;

 PINDEXDEF(k)..    PINDEX(k) =E= SUM(i, pwts(i,k)*PX(i,k)) ;
```

```
 PDADEF(i,k)..     PDA(i,k) =E= PD(i,k)*(1 - itax(i,k)) + PDS(i,k) ;

 ACTP(i,k)..       PVA(i,k) =E= PX(i,k) - SUM(j, io(j,i,k)*P(j,k))
                           + PIE(i,k);

 ## PRODUCTION AND TRADE BLOCK

*Cobb-Douglas Production Function Equations

* ACTIVITY(i,k)..      XD(i,k) =E= AD(i,k)*PROD(iff$alpha(i,iff,k),
*                           FDSC(i,iff,k)**alpha(i,iff,k));

* PROFITMAX(i,iff,k)$wfdist0(i,iff,k)..
*                       WF(iff,k)*WFDIST(i,iff,k)*FDSC(i,iff,k) =E=
*                       XD(i,k)*(1 - vatr(i,k))
*                       *PVA(i,k)*alpha(i,iff,k) ;

*CES Production Function (alternative to Cobb-Douglas)

 ACTIVITY(i,k)..    XD(i,k) =E= ad(i,k)*( SUM(iff$fdsc0(i,iff,k),
                           alpha2(i,iff,k)*FDSC(i,iff,k)
                           **(-rhop(i,k))))**(-1/rhop(i,k)) ;

 PROFITMAX(i,iff,k)$wfdist0(i,iff,k)..  WF(iff,k)*WFDIST(i,iff,k) =E=
                    (1 - vatr(i,k))*PVA(i,k)*ad(i,k)
                    *( SUM(f$fdsc0(i,f,k), alpha2(i,f,k)*FDSC(i,f,k)
                    **(-rhop(i,k)))  )**((-1/rhop(i,k)) - 1)
                    *alpha2(i,iff,k)*FDSC(i,iff,k)**(-rhop(i,k)-1);

 INTEQ(i,k)..         INT(i,k)  =E= SUM(j, io(i,j,k)*XD(j,k));

 CET(i,k)..  XD(i,k) =E= at(i,k)*(SUM(cty1$E0(i,k,cty1),
                 gamma(i,k,cty1)*E(i,k,cty1)**(-rhot(i,k)))
               + (1 - SUM(cty1, gamma(i,k,cty1)))*XXD(i,k)
               **(-rhot(i,k)))**(-1/rhot(i,k)) ;

 ESUPPLY(i,k,cty1)$E0(i,k,cty1)..
                    E(i,k,cty1)/XXD(i,k) =E= (PDA(i,k)/PE(i,k,cty1)
                    *gamma(i,k,cty1)/(1 - SUM(cty2$PT(k,cty2),
                    gamma(i,k,cty2))))**(1/(1 + rhot(i,k))) ;

 EDEMAND(i,k)$ied(i,k)..    E(i,k,"rt") =E= E0(i,k,"rt")
                       *(PWE(i,k,"rt")/PWE0(i,k,"rt"))**(-etae(i,k)) ;

*## CES import demand equations

* ARMINGTON(i,k)..  X(i,k) =E= ac(i,k)*(SUM(cty1$M0(i,k,cty1),
*                         delta(i,k,cty1)*M(i,k,cty1)
*                         **(-rhoc(i,k))) + (1- SUM(cty1$pt(k,cty1),
*                         delta(i,k,cty1)))*XXD(i,k)
*                         **(-rhoc(i,k)))**(-1/rhoc(i,k)) ;

* COSTMIN(i,k,cty1)$M0(i,k,cty1)..
*                      M(i,k,cty1)/XXD(i,k) =E=
*                      (PD(i,k)/PM(i,k,cty1)*delta(i,k,cty1)/
*                      (1 - SUM(cty2$pt(k,cty2), delta(i,k,cty2))))
*                       **(1/(1 + rhoc(i,k))) ;
```

```
*## AIDS import demand equations.  Alternative to CES version.  In AIDS
*## version, can use Stone or translog price index.  Notation
*## is that domestically produced goods sold on the domestic
*## market are indicated as imports from a country to itself.

 PDAIDS(i,k)..       PM(i,k,k) =E= PD(i,k) ;

*## Translog price index
* TRLOGP(i,k)..       LOG(P(i,k)) =E= aq(i,k) + SUM(cty2, amq(i,k,cty2)
*                         *LOG(PM(i,k,cty2))) + (1/2)*SUM((cty1,cty2),
*                         gammaq(i,k,cty1,cty2)*LOG(PM(i,k,cty1))
*                         *LOG(PM(i,k,cty2))) ;

*## Stone price index
 STONEP(i,k)..        LOG(P(i,k)) =E=  LOG(aqs(i,k)) + SUM(cty2,
                         SMQ0(i,k,cty2)*LOG(PM(i,k,cty2))) ;

 AIDS(i,k,cty1)..     SMQ(i,k,cty1) =E= amq(i,k,cty1) + betaq(i,k,cty1)
                         *LOG(X(i,k)) + SUM(cty2, gammaq(i,k,cty1,cty2)
                         *LOG(PM(i,k,cty2))) ;

 AIDS2(i,k,cty1)$pt(k,cty1)..
                      PM(i,k,cty1)*M(i,k,cty1) =E=
                         SMQ(i,k,cty1)*P(i,k)*X(i,k) ;

 AIDS3(i,k)..         PD(i,k)*XXD(i,k) =E= SMQ(i,k,k)*X(i,k)*P(i,k) ;

*## INCOME BLOCK

 YFCTREQ(iff,k)..  YFCTR(iff,k) =E= SUM(i, WF(iff,k)*WFDIST(i,iff,k)
                                     *FDSC(i,iff,k));

 TARIFFDEF(k,cty1)..   TARIFF(k,cty1) =E= SUM(i, tm(i,k,cty1)
                          *M(i,k,cty1)*PWM(i,k,cty1))*EXR(k) ;

 PREMIUM(i,k)..   PREM(i,k) =E= SUM(cty1, TM2(i,k,cty1)*M(i,k,cty1)
                                     *PWM(i,k,cty1))*EXR(k) ;

 INDTAXDEF(k).. INDTAX(k) =E= SUM(i, itax(i,k)*PD(i,k)*XXD(i,k)) ;

 YINST1(k)..     YINST("labr",k) =E= SUM(la, (1.0 - sstr(la,k))
                                   *YFCTR(la,k));

 YINST2(k)..     YINST("ent",k)  =E= YFCTR("capital",k)
                          *(1.0-sstr("capital",k))
                          + EXR(k)*FKAP(k) - ENTSAV(k)
                          - ENTAX(k) + ENTT(k)
                          + SUM(i, (1-sprem(i,k))*PREM(i,k)) ;

 YINST3(k)..     YINST("prop",k) =E= YFCTR("land",k)
                                   *(1.0 - sstr("land",k)) ;

 HHY(hh,k)..     YH(hh,k)   =E= SUM(ins, sintyh(hh,ins,k)*YINST(ins,k))
                          + rhsh(hh,k)*EXR(k)*REMIT(k)
                          + HHT(k)*thsh(hh,k) ;

 ENTAXEQ(k)..    ENTAX(k)   =E= ENTR(k)*(YFCTR("capital",k) + ENTT(k)) ;

 SSTAXEQ(k)..    SSTAX(k)   =E= SUM(iff, sstr(iff,k)*YFCTR(iff,k));

 HTAXEQ(k)..     HTAX(k)    =E= SUM(hh, hhtr(hh,k)*YH(hh,k)) ;
```

```
VATAXEQ(k)..    VATAX(k)   =E= SUM(i, vatr(i,k)*PVA(i,k)*XD(i,k)) ;

GOVREVEQ(k)..   GOVREV(k)  =E= SUM(cty1, TARIFF(k,cty1)) + INDTAX(k)
                             + SUM(i, sprem(i,k)*PREM(i,k))
                             + SSTAX(k) + HTAX(k)
                             + ENTAX(k) + VATAX(k) + FBOR(k)*EXR(k);

GOVSAVEQ(k)..   GOVSAV(k)  =E= GOVREV(k)
                             - SUM(i, GD(i,k)*P(i,k)) - HHT(k)
                             - ENTT(k) - FPE(k)
                             - SUM((j,cty1) EEP(j,k,cty1)) ;

HSAVEQ(k)..     HSAV(k)    =E= SUM(hh, mps(hh,k)*
                              ((1.0-hhtr(hh,k))*YH(hh,k)));

ENTSAVEQ(k)..   ENTSAV(k)  =E= ESR(k)*YFCTR("capital",k) ;

TOTSAVE(k)..    ZTOT(k)    =E= GOVSAV(k) + HSAV(k)
                             + ENTSAV(k) + EXR(k)*FSAVE(k);

FORSAVE(k)..    FSAVE(k)   =E= FBAL(k)-FKAP(k)-FBOR(k)-REMIT(k);

*## EXPENDITURE BLOCK

CDDEQ(i,k)..    P(i,k)*CDD(i,k) =E= SUM(hh, cles(i,hh,k)*YH(hh,k)
                                  *(1 - hhtr(hh,k))*(1 - mps(hh,k)));

GDEQ(i,k)..     GD(i,k) =E= gles(i,k)*GDTOT(k) ;

INVEST(i,k)..   ID(i,k) =E= zshr(i,k)*ZFIX(k) ;

INVEST2(k)..    ZTOT(k) =E= SUM(i, P(i,k)*(ID(i,k) + DST(i,k)))
                          + WALRAS2(k) ;

EEPDEF(i,k,cty1)..  EEP(i,k,cty1) =E= tee(i,k,cty1)*PWE(i,k,cty1)
                                     *E(i,k,cty1)*EXR(k) ;

*## MARKET CLEARING
*## PRODUCT MARKETS

EQUIL(i,k)..    X(i,k) =E= INT(i,k)+CDD(i,k)+GD(i,k)+ID(i,k)+DST(i,k);

*## FACTOR MARKETS

FMEQUIL(iff,k)..   SUM(i, FDSC(i,iff,k)) =E= FS(iff,k) ;

WGEQ1..    WF("rulab","mx")=E=(wgdf("usag")*WF("rulab","us")
                  - COST("usag"))*(EXR("mx")/EXR("us")) ;

WGEQ2..    WF("urbunlab","mx")=E=(wgdf("usurb")*WF("urbunlab","us")
                  - COST("usurb"))*(EXR("mx")/EXR("us")) ;

WGEQ3..    WF("rulab","mx")=E=(wgdf("mxurb")*WF("urbunlab","mx")
                  - COST("mxurb")) ;

FS1..    FS("rulab","us")    =E= FS0("rulab","us") + USMIGAG ;

FS2..    FS("urbunlab","us") =E= FS0("urbunlab","us") + USMIGURB ;

FS3..    FS("rulab","mx")    =E= FS0("rulab","mx") - MXMIG - USMIGAG ;

FS4..    FS("urbunlab","mx") =E= FS0("urbunlab","mx") + MXMIG
```

```
                              - USMIGURB;

*## BALANCE OF TRADE

 CAEQ(k,cty1)..    SUM(i, PWM(i,k,cty1)*M(i,k,cty1)) =E=
                         SUM(i, PWE(i,k,cty1)*E(i,k,cty1))
                         + FSAV(k,cty1) ;

 FBALEQ(k)..    FBAL(k) =E= SUM(cty1, FSAV(k,cty1)) ;

*## TRADE CONSISTENCIES AND FIXED WORLD PRICES

 TRCON7..       WALRAS  =E= SUM((i,k), PWM(i,k,"rt")*M(i,k,"rt")
                          - PWE(i,k,"rt")*E(i,k,"rt"))
                          - SUM(k, FBAL(k)) ;

 TRCON10(i,cty1,cty2)$PT3(cty1,cty2)..
                         PWE(i,cty1,cty2) =E= PWM(i,cty2,cty1) ;

 TRCON(i,cty1,cty2)..   M(i,cty1,cty2)   =E= E(i,cty2,cty1) ;

 PWM.FX(i,k,"rt")              = PWM0(i,k,"rt") ;
 PWE.FX(i,k,"rt")$iedn(i,k)    = PWE0(i,k,"rt") ;

*#################### MODEL CLOSURE ##################

*## FACTOR MARKET CLOSURE

*## In this version, factors are fully mobile, factor returns adjust,
*## with base year factor return distortions (WFDIST) fixed.

  FS.FX(nmig,k)                = FS0(nmig,k) ;
  WFDIST.FX(i,iff,k)           = WFDIST0(i,iff,k) ;

  FDSC.FX(i,iff,k)$(wfdist0(i,iff,k) EQ 0)    = 0 ;
  WFDIST.FX(i,iff,k)$(wfdist0(i,iff,k) EQ 0) = 0 ;

*### Following statements fix land in agricultural sectors

  FDSC.FX(i,"land",k)          = FDSC0(i,"land",k) ;
  WFDIST.LO(i,"land",k)        = -inf ;
  WFDIST.UP(i,"land",k)        = +inf ;
  WF.FX("land",k)              = 1 ;
  FS.LO("land",k)              = -inf ;
  FS.UP("land",k)              = +inf ;

*## FOREIGN MARKET CLOSURE
* In this version, the exchange rate is the equilibrating variable,
* and the foreign balance (current account balance) is fixed
* exogenously.  Note that there is one exchange rate variable for each
* country and one balance of trade constraint, FBAL(k).  Note that FBAL is
* defined for each country with respect to the aggregate of trade balances
* with all its trading partners.  Cross rates are implicitly set by arbitrage
* conditions.  There is no attempt to fix the balance of trade bilaterally.
* The model also has below-the-line variables to finance the balance of trade
* (FBOR, REMIT, FKAP, and FSAVE).  In this version, FSAVE is determined
* residually.

   FBAL.FX(k)           = FBAL0(k) ;
*  EXR.FX(k)            = EXR0(k) ;
   FBOR.FX(k)           = FBOR0(k) ;
   REMIT.FX(k)          = REMIT0(k) ;
```

```
   FKAP.FX(k)          = FKAPO(k) ;

*# IMPORT RATIONING

  TM2.FX(i,k,cty1)$iqrn(i,k,cty1)  = TM20(i,k,cty1) ;
  M.FX(i,k,cty1)$iqr(i,k,cty1)     = mrat(i,k,cty1) ;

*## GOVERNMENT CLOSURE
* Real government spending (GDTOT) is fixed exogeneously.
* The government deficit (GOVSAV) is determined residually.

  GDTOT.FX(k)          = GDTOTO(k) ;
  GD.FX(i,k)           = GDO(i,k) ;
  HHT.FX(k)            = HHTO(k) ;
  ENTT.FX(k)           = ENTTO(k) ;

*## INVESTMENT CLOSURE
* In this version, total real investment is fixed exogenously
* and savings adjusts.  The inventory component of investment
* is fixed exogenously.

*  ZTOT.FX(k)          = ZTOTO(k) ;
*  ESR.FX(k)           = ESRO(k) ;
   DST.FX(i,k)         = DSTO(i,k) ;
*  ID.FX(i,k)          = IDO(i,k) ;
   ZFIX.FX(k)          = ZFIXO(k) ;

*## FARM PROGRAM CLOSURE
*## In this version, programs are given by ad valorem equuivalents.
*## Value added subsidies are included in vatr and import rationing
*## is treated above.

   PIE.FX(i,k)         = PIEO(i,k) ;
   PDS.FX(i,k)         = PDSO(i,k) ;

*## NUMERAIRE PRICE INDEX

   PINDEX.FX(k)        = PINDEXO(k) ;

*## ADDITIONAL RESTRICTIONS

  FDSC.FX(i,iff,k)$(wfdist0(i,iff,k) EQ 0)  = 0 ;
  PWE.FX(i,cty1,cty1)                        = 0 ;
  PWM.FX(i,cty1,cty1)                        = 0 ;
  E.FX(i,cty2,cty1)$(E0(i,cty2,cty1) eq 0)   = 0 ;
  M.FX(i,cty2,cty1)$(M0(i,cty2,cty1) eq 0)   = 0 ;
```

COMMENTS ON PAPER 9

BY JOSEPH W. GLAUBER

"Agricultural Policies and Migration in a U.S. - Mexico Free Trade Area"

Comments

Joseph W. Glauber
Council of Economic Advisers

The paper by Robinson, Burfisher, Hinojosa-Ojeda, and Thierfelder is an ambitious effort to analyze the effect of a Mexico - United States Free Trade Agreement on the agricultural sector. In contrast to most of the computable general equilibrium models presented at this conference, the paper presents a more disaggregated view of how a free trade area would affect agriculture in the two countries. This is important because agriculture is not monolithic. In the United States, as well as in Mexico, there will be clear "winners" and "losers" in the agricultural sector. And as Robinson et al. show, these gainers and losers will have differing effects on labor migration.

The authors present a careful modeling of the agricultural sector. The strengths of their analysis include: the modeling of agricultural policies, including export subsidies and income supports; a set of behavioral equations aimed at capturing labor migration within Mexico and from Mexico to the United States; and the use of Almost Ideal Demand System functions to model import demands.

In the main, their results appear credible. In particular, the paper shows the likely detrimental effect on the Mexican corn sector and resulting structural adjustment in the Mexican labor market, including migration to the United States. It helps explain why liberalization of the Mexican corn sector is so highly contentious within Mexico, and suggests why rapid liberalization of the Mexican corn sector may have social implications for the United States as well.

I have a few minor quibbles with the paper:

- The use of price wedges to model deficiency payments will bias cost estimates when large price movements are expected. Increases in expected market prices will tend to result in decreased program participation. Savings from a decline in participating area may actually be as significant as decreases in the deficiency payment rate.

  Given that the anticipated impacts on prices is small, however, the potential bias is likely quite small.

- I question the results showing a large migration from rural Mexico to rural United States in many of the scenarios. Many of the U.S. crops that currently employ Mexican labor (e.g., fresh fruit and vegetable crops in border states) will likely suffer a slight negative impact under a free trade agreement. While production of some fruits and vegetables in the United States will likely increase under a FTA (e.g., deciduous fruits in the Northwest, California grapes), it remains somewhat problematic whether these crops are sufficient to absorb the number of migrants implied by paper.

- The model ignores potential third country effects. For example, liberalization of U.S. tariffs on frozen concentrated orange juice (FCOJ) will likely increase imports of Mexican FCOJ at the expense of Brazil, a major U.S. supplier. Columbian cut flower exporters would likely suffer some loss of market share to Mexican exporters under a FTA. In modeling the elimination of U.S. export subsidies for wheat to Mexico, the authors ignore the potential shift towards EC wheat imports if the EC continues its policies of heavily subsidized wheat exports.

But these are minor quibbles to what is otherwise a fine paper. The authors are to be commended for their ambitious effort in modeling the effects of a free trade agreement on Mexico and U.S. agriculture. Their results will help policy makers and negotiators to better understand the potential effects of proposed agreements.

COMMENTS ON PAPER 9

BY WILL MARTIN

DISCUSSANT'S COMMENTS ON "AGRICULTURAL POLICIES AND MIGRATION IN A US-MEXICO FREE AREA: A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS"

Even though I've seen this paper presented twice before, I very much enjoyed the opportunity to read the paper again and to listen to Sherman's presentation. I think one of the very impressive things about this paper is the way it has evolved over time, with the authors actively seeking and taking into account comments from colleagues and discussants.

A keynote of the paper is the careful and thorough treatment of the areas on which it focuses. I think the treatment of interventions is very, very thorough and painstaking, particularly in the formal modeling. We see quantitative restrictions modeled as quantitative restrictions. We see the inframarginal distortions on consumption modeled as inframarginal distortions rather than as simple *ad valorem* wedges. It is more difficult to capture policies as they actually operate instead of in summary form but the authors have devoted considerable effort to doing so. This care seems to me to have been very well directed.

Another instance of the careful and thorough approach used in this paper is in the disaggregation of factors. We have capital, agricultural land, and four types of labor all separately identified.

The use of the Almost Ideal Demand system rather than the standard Constant Elasticity of Substitution form to model import allocation is another example of the careful and thorough approach characteristic of this paper.

One other thing I really liked was to see the documentation of the model in GAMS at the back, accessible to those who want to be able to see exactly what is going on.

The model is also innovative in the breadth of its approach, and particularly for making the migration issue explicit even though it is not directly on the agenda for negotiation. This is an absolutely essential issue. It needs to be captured, and it is captured in detail.

What happens to the capital stock in Mexico is also going to be important, is captured in the paper, and turns out to be a very important influence on the outcome for migration levels and other key variables.

One quibble I do have concerns the use of the real GDP measure which will, in the absence of a specific welfare measure, inevitably be used as an indicator of the welfare consequences of policy change. Real GDP measures as they have been constructed in this paper are really capturing in some sense the volume of output. Now, in the absence of factor market distortions, there is really nothing to cause changes in the volume of output, or the position of the production possibility frontier, unless there are movements of factors between countries.

In this context, I am not quite sure what is driving the small positive changes in real GDP observed in the experiments reported here. I think we need to pay a lot of attention to the way we measure these welfare changes, especially since they are typically small numbers despite all our attempts to uncover large numbers for static welfare gains. In this context, the specification we use is going to be very, very important in determining whether we even get the right sign. Unless explicit measures of welfare change are presented, policymakers will use real GDP estimates as a proxy for the overall welfare impact of the change. If real GDP changes were negative, but welfare rose, then good policy proposals could be undermined by exclusive reliance on real GDP measures. We certainly wouldn't want to see good policies rejected solely because of mis-specification in the modeling of their welfare consequences.

One other thing I would like to see is a little more interpretation of the results obtained with the model in terms of the underlying theory. Interestingly, even though all factors are perfectly mobile between sectors in the model, many of the results seem closer to what would be expected with a specific-factors model than with a mobile-factors model.

If all goods in the model were homogeneous, it would be an extended Heckscher-Ohlin model and there would be international factor price equalization at any common level of prices. The Stolper-Samuelson theorem suggests that a decline in the domestic price of a relatively labor intensive commodity such as Mexican corn is likely to depress the returns to labor. However, there is no scope in such a model for increases in the capital stock to change factor returns and hence the incentives for migration. Despite this, the model finds quite a strong effect of capital investment on *ex ante* wages in Mexico and hence on the rate of migration. In this respect, the model behaves like a specific-factors model where increases in the capital stock raise wage rates both directly by increasing the marginal productivity of labor and indirectly by raising the demand for and price of non-traded goods, which are likely to be relatively labor-intensive in production. More discussion of the underlying basis for this behavioral response would be a welcome addition to the paper.

Finally, on the policy interpretation, it is rare to have the opportunity to forge a new set of policies, or rather to establish a set of rules under which policy settings will be chosen in the future. Most of the time policies are driven by private interest groups lobbying within the established framework of rules. The North American Free Trade Agreement seems to be an opportunity to set up a new framework of rules which can lead to better policies.

I'm just a little cautious about the implicit acceptance in the paper of retaining heavy agricultural supports, even on a ostensibly short-term basis. There is too much risk of these remaining in place indefinitely. Particularly as Mexican incomes rise, we are likely to see powerful pressures for distortionary policies to assist agriculture, as we have seen in so many other countries.

It seems that there are opportunities to identify options which involve less in the way of distortions. Policy prescriptions such as those discussed in the paper by Santiago Levy and Sweder van Wijnbergen seem to provide one option which overcomes the transitional problems and does not prejudice the goal of establishing a policy framework for less distorting policies. I'm sure other feasible policy options to assist in the transition to a less distorted agriculture are also worthy of detailed analysis.

This is a wonderful opportunity for reform; it would be a shame to waste it with the old policies.

Will Martin
The World Bank
March 1992

PAPER 10

"NORTH AMERICAN TRADE LIBERALIZATION AND THE ROLE OF NONTARIFF BARRIERS,"
BY DAVID ROLAND-HOLST, KENNETH A. REINERT, AND CLINTON R. SHIELLS

North American Trade Liberalization and the Role of Nontariff Barriers

David Roland-Holst
Mills College

Kenneth A. Reinert
U.S. International Trade Commission

Clinton R. Shiells
U.S. International Trade Commission

ABSTRACT

Tariff protection between the North American economies is relatively low by world standards, having declined significantly with unilateral reductions undertaken by Mexico since 1983. Despite this move toward a more liberal trade regime, however, it is apparent that non-tariff barriers and other deterrents still exert a pervasive influence on trade. In this paper, we use a calibrated general equilibrium model to evaluate the opportunity cost of residual nominal protection and the trade reducing effects of non-tariff barriers. Our results indicate that the United States, Canada, and Mexico could realize substantial gains from a more comprehensive approach to trade liberalization, but that the process of adjustment to full liberalization differs in important ways from adjustment to tariff liberalization alone.

Paper prepared for the NAFTA Economywide Modeling Conference, U.S.I.T.C., Washington, D.C., February 24-25, 1992. The opinions expressed here are those of the authors and should not be attributed to their affiliated institutions.

4/12/92 *Preliminary - Do Not Quote*

1. Introduction

The North American Free Trade Agreement (NAFTA) is representative of a worldwide trend toward regionalism in trade negotiations. This shift away from multilateralism is a result of both the strengths and weaknesses of the GATT framework. On the one hand, GATT has been quite successful at demonstrating once and for all that relatively low nominal protection can greatly expand global trade opportunities. At the same time, however, these norms have lowered the stakes for regionalists, who can now remove residual protection with their neighbors secure in the knowledge that severe retaliation is not individually rational for other trading partners. The success of the GATT in reducing average nominal protection has also narrowed the negotiating agenda down to its more stubborn elements, such as food security and other agricultural policies.

The GATT's weaknesses have also become more apparent and problematic over time. In its early days, the multi-lateral negotiating framework faced a relatively easy task, with a few dominant economies leading the way by leveling nominal barriers on a lion's share of international trade. Now the family of influential traders is much larger, their geographic and economic interests are more diverse, and consensus is more difficult to achieve or even approximate. Finally, an emphasis in the multi-lateral negotiations on nominal protection has led to proliferation of non-tariff trade control measures which in many instances threaten to reverse the long term trend toward a more liberalized global trading regime. A prominent example of this is the Multifiber Arrangement governing textile and apparel trade.

As it is currently under negotiation, the NAFTA is a partial response to the shortcomings each country might perceive in the Uruguay Round. Its full promise, in terms of regional economic efficiency and expanded trade is unlikely to be realized, however, unless the removal of non-tariff barriers is also negotiated. Empirical evidence presented below indicates that North American trade is significantly impeded by barriers of this type. Unilateral liberalization of nominal protection, particularly on the part of Mexico, and the earlier bilateral pact between Canada and the United States have already stimulated continental trade and initiated extensive structural adjustments. Only complete liberalization can realize the economic potential of the North American economy, but a very different adjustment process may result from the simultaneous removal of both tariff and non-tariff barriers to regional trade.

With these considerations in mind, this paper examines the potential impact of the NAFTA with a calibrated general equilibrium (CGE) model. The model is calibrated to a three-country social accounting matrix (SAM) which details twenty-six sectors of production and is estimated for 1988. We also used detailed estimates on nominal import protection and non-tariff barriers to compare the effects of partial and full liberalization. Our results indicate that all three countries stand to gain substantially at either stage in the reduction of trade barriers. It is apparent, however, that the pattern of adjustment in domestic production, factor use, demand, and trade in all three countries differs significantly between partial and complete liberalization. This means that current negotiations can only partially fulfill the stated objectives of greater economic efficiency and gains from trade. More seriously, the negotiating framework for nominal liberalization may provide very imperfect guidance toward the domestic and international issues governing the larger agenda of complete liberalization.

In the next section, we provide an overview of domestic economic structure and trade relations between the three countries. With this in mind, section three surveys the current evidence on North American trade barriers. The fourth section discusses the structure and conventions of the calibrated general equilibrium model, followed in section five by the simulation results we obtained from it. A sixth and final section presents concluding remarks.

2. The Structure of North American Production, Demand, and Income

Our model is calibrated to a detailed three-country social accounting matrix (SAM) for Canada, the United States, and Mexico, estimated for the year 1988. This North American SAM and its construction are described in greater detail in Reinert, Roland-Holst and Shiells (1992). The first step in its construction was to transform the macro accounts of the three countries into a North American macroeconomic SAM. This was done using data from Statistics Canada (March, 1991 and April, 1991), Reinert and Roland-Holst (forthcoming), and Estados Unidos Mexicanos (1990). Trilateral trade flows were taken from U.S. Department of Commerce (1988), Globerman and Bader (1991), and U.S. International Trade Commission (February, 1991). Factor service and capital flows were taken from U.S. Department of Commerce (1991).

The second stage in the construction of the North American SAM was estimation of detailed sectoral accounts, including value added, domestic final demand, import, export, and inter-industry transactions. Each of these were estimated for 26 production sectors. For value added, this was done using 1988 Canadian input-output accounts from Statistics Canada, 1988 U.S. data from Reinert and Roland-Holst (forthcoming), and 1988 and 1985 Mexican data from Estados Unidos Mexicanos (1990) and Sobarzo (1991), respectively. For Canada, domestic final demand was taken from the 1988 Canadian input-output accounts. For the United States, sectoral domestic final demands were taken directly from Reinert and Roland-Holst (forthcoming). For Mexico, sectoral domestic final demands were estimated based on 1985 shares from Sobarzo (1991).

Sectoral trade flows were estimated with SITC trade data from the United Nations, while domestic sectoral flows were estimated from individual country sources. Canadian inter-industry flows for 1988 were re-balanced slightly to row and column controls calculated from the new sectoral data using a simple algebraic RAS procedure.[1] U.S. inter-industry flows were taken directly from Reinert and Roland-Holst (forthcoming-a). Mexican inter-industry flows from Sobarzo (1991) were updated from 1985 using row and column controls calculated from the estimated 1988 sectoral data and the RAS procedure.

[1] The RAS procedure is described in Stone and Brown (1965).

While the structural detailed in the 90x90 three country SAM is the essential information set for the CGE model, it is too large to be readily interpreted by inspection. In the following three tables, we summarize the information from the SAM in a more accessible format. This information on the general structure of production, demand, income, and trade in each country will facilitate understanding of the simulation results obtained later in this paper.

Table 2.1 presents structural information on the United States. For each of the twenty-six sectors and three aggregate sectoral categories (Primary, Manufacturing, and Services), the base year data for shares of gross output (column 1), value added (2), demand (3), exports (4), and imports (5) are given. These columns provide a snapshot of the sectoral composition of production, income, supply, demand, and trade in the U.S.. Services obviously dominate the production side of this economy, generating 63 percent of gross output 77 percent of total value added. Manufacturing's share of gross output (31 percent) far exceeds its value added share (19 percent) because of its higher degree of intermediate use. Demand includes imports, and these raise the overall share of Manufactures while lowering that of Services. U.S. exports are also concentrated in Agriculture (9 percent) and Manufacturing (63 percent), and imports are even more Manufacture dependent (71 percent).

Column 6 lists the ratios of labor to capital value added in percentage terms, and these vary widely across sectors. Agriculture has a weighted average of 56 percent labor to capital value added, while Manufacturing spends nearly twice as much on labor as capital and Services two and a half times as much. Ferrous metals (sector 14) are dominated by returns to labor, who get over ten times the value added accruing to capital in 1988.[2] Value added ratios in Services vary widely, from lows of 42 and 43 percent in the capital intensive Electricity and Finance sectors to over 600 percent in Construction.

[2] This appears to be symptomatic of the "endgame" process discussed by Lawrence [1990].

Table 2.1: Structure of Production, Demand, Income, and Trade for the United States, 1988

(all figures in percentages)

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
		X	*VA*	*D*	*E*	*M*	*Vl/Vk*	*E/X*	*M/D*	*Mr/M*	*Mc/M*	*Mu/M*	*Mm/M*	*Er/E*	*Ec/E*	*Eu/E*	*Em/E*
1	**Agriculture**	2	2	3	5	1	55	10	7	75	11	0	15	87	6	0	7
2	**Mining**	0	0	0	1	0	180	18	30	85	9	0	5	47	51	0	2
3	**Petroleum**	3	2	4	2	7	28	4	29	70	20	0	10	88	8	0	4
	All Primary	5	4	6	9	9	56	8	20	72	18	0	10	82	13	0	6
4	**Food Processing**	3	2	6	3	2	130	4	5	84	12	0	5	80	13	0	6
5	**Beverages**	1	0	1	0	1	149	1	9	81	11	0	8	83	14	0	2
6	**Tobacco**	0	0	0	1	0	41	9	4	94	3	0	4	100	0	0	0
7	**Textiles**	1	1	1	1	1	294	4	10	90	7	0	2	55	34	0	11
8	**Apparel**	1	0	2	0	5	312	1	35	96	2	0	2	60	12	0	28
9	**Leather**	0	0	0	0	2	137	3	67	98	0	0	2	16	47	0	37
10	**Paper**	2	2	3	3	1	211	5	9	33	64	0	3	72	20	0	8
11	**Chemical**	2	1	4	8	4	109	15	12	91	3	0	7	84	12	0	4
12	**Rubber**	2	1	2	4	2	240	14	13	88	9	0	4	84	10	0	6
13	**NonMetMinProd**	1	1	1	1	2	298	3	17	95	4	0	0	58	37	0	5
14	**Iron and Steel**	1	0	2	3	3	1073	16	19	86	12	0	2	90	7	0	4
15	**NonFer Metals**	1	0	1	1	2	403	3	16	68	24	0	7	17	67	0	15
16	**WoodMetal Prod**	3	2	4	3	4	485	5	13	67	27	0	6	67	27	0	6
17	**NonElec Mach**	2	1	3	6	6	310	14	24	87	11	0	2	45	41	0	14
18	**Electrical Mach**	4	3	6	11	17	359	13	33	88	5	0	8	76	13	0	11
19	**Transport Eqp**	5	2	7	16	12	274	17	31	57	39	0	4	59	38	0	3
20	**Other Manufact**	1	1	2	2	7	154	8	39	90	7	0	3	73	24	0	2
	All Manufactures	31	19	46	63	71	170	10	20	78	18	0	5	69	24	0	7
21	**Construction**	7	5	9	0	0	622	0	0	0	0	0	0	100	0	0	0
22	**Electricity**	4	4	4	0	11	42	0	29	100	0	0	0	100	0	0	0
23	**Commerce**	11	13	7	10	0	258	4	0	0	0	0	0	100	0	0	0
24	**TransptCommun**	5	6	4	6	6	173	6	18	100	0	0	0	100	0	0	0
25	**FinInsRlEstate**	14	16	9	6	3	43	2	3	100	0	0	0	100	0	0	0
26	**Other Services**	24	33	15	6	1	366	1	0	100	0	0	0	100	0	0	0
	All Services	63	77	48	28	20	267	2	4	100	0	0	0	100	0	0	0
	Economywide	100	100	100	100	100	240	5	13	81	15	0	4	79	16	0	5

Note: Columns 1-6 contain totals, 7-17 contain denominator-weighted averages.

Table 2.2: Structure of Production, Demand, Income, and Trade for Canada, 1988

(all figures in percentages)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		X	VA	D	E	M	VL/Vk	E/X	M/D	Mr/M	Mc/M	Mu/M	Mm/M	Er/E	Ec/E	Eu/E	Em/E
1	Agriculture	3	3	4	4	1	53	17	9	26	0	72	2	99	0	0	1
2	Mining	2	3	1	3	1	91	20	91	17	0	80	4	92	0	7	1
3	Petroleum	3	2	4	7	6	60	28	18	77	0	21	2	4	0	96	0
	All Primary	8	8	9	14	7	68	22	20	45	0	53	3	50	0	50	0
4	Food Processing	4	2	6	2	3	174	8	13	50	0	49	1	52	0	46	2
5	Beverages	1	1	1	0	1	111	8	16	83	0	14	3	15	0	85	0
6	Tobacco	0	0	0	0	0	65	4	3	48	0	52	0	75	0	25	0
7	Textiles	1	1	1	1	2	272	11	43	50	0	49	1	50	0	50	1
8	Apparel	1	1	1	0	4	431	5	33	93	0	7	0	25	0	75	0
9	Leather	0	0	0	0	2	648	6	57	77	0	23	0	84	0	16	0
10	Paper	4	4	4	12	1	172	39	15	18	0	82	0	42	0	58	0
11	Chemical	2	2	3	1	4	94	4	44	32	0	67	0	45	0	55	0
12	Rubber	1	1	1	1	1	385	17	38	22	0	78	0	36	0	63	0
13	NonMetMinProd	1	1	1	1	1	156	13	34	39	0	60	1	72	0	27	0
14	Iron and Steel	1	1	2	2	2	302	15	26	54	0	45	1	20	0	78	2
15	NonFer Metals	1	1	1	3	1	121	32	36	21	0	78	0	32	0	68	0
16	WoodMetal Prod	4	3	5	8	3	388	24	23	28	0	71	1	35	0	65	0
17	NonElec Mach	3	1	5	6	7	279	24	59	26	0	72	2	52	0	47	1
18	Electrical Mach	3	2	4	4	6	270	19	51	32	0	66	2	27	0	72	0
19	Transport Eqp	9	3	15	31	10	314	44	42	18	0	81	1	6	0	93	0
20	Other Manufact	1	1	2	2	6	358	20	51	56	0	43	1	23	0	77	0
	All Manufactures	38	24	52	73	54	251	25	36	31	0	68	1	26	0	74	0
21	Construction	9	9	8	0	0	351	0	0	0	0	0	0	0	0	0	0
22	Electricity	2	4	1	1	0	41	4	4	100	0	0	0	100	0	0	0
23	Commerce	11	18	5	3	2	340	4	4	100	0	0	0	100	0	0	0
24	TransptCommun	7	8	6	6	5	185	10	9	100	0	0	0	100	0	0	0
25	FinInsRlEstate	8	10	5	1	13	168	1	30	100	0	0	0	100	0	0	0
26	Other Services	17	20	13	3	18	71	2	15	100	0	0	0	100	0	0	0
	All Services	54	68	39	13	39	203	3	11	100	0	0	0	100	0	0	0
	Economywide	100	100	100	100	100	204	13	25	43	0	56	1	39	0	61	0

Note: Columns 1-6 contain totals, 7-17 contain denominator-weighted averages.

Table 2.3: Structure of Production, Demand, Income, and Trade for Mexico, 1988

(all figures in percentages)

		1 X	2 VA	3 D	4 E	5 M	6 Vl/Vk	7 E/X	8 M/D	9 Mr/M	10 Mc/M	11 Mu/M	12 Mm/M	13 Er/E	14 Ec/E	15 Eu/E	16 Em/E
1	Agriculture	8	8	8	3	8	23	5	22	43	2	55	0	9	3	87	0
2	Mining	1	2	1	3	2	44	26	28	69	4	27	0	77	11	11	0
3	Petroleum	8	3	11	38	2	12	61	5	42	0	58	0	72	0	28	0
	All Primary	17	13	21	44	13	23	32	13	46	2	52	0	67	1	31	0
4	Food Processing	8	6	12	3	7	19	4	10	53	3	44	0	43	4	53	0
5	Beverages	1	1	2	1	1	30	7	6	91	0	9	0	3	5	92	0
6	Tobacco	0	0	0	0	0	31	5	0	0	0	100	0	41	0	59	0
7	Textiles	1	1	2	1	1	43	7	19	18	1	81	0	42	10	48	0
8	Apparel	1	1	2	1	0	35	14	15	12	0	88	0	3	1	96	0
9	Leather	1	1	1	1	0	53	9	15	0	0	100	0	6	1	93	0
10	Paper	2	2	2	1	3	27	8	41	27	3	70	0	10	1	90	0
11	Chemical	4	3	6	4	11	29	14	32	54	0	46	0	33	1	66	0
12	Rubber	1	1	2	1	1	38	11	49	13	1	86	0	5	0	95	0
13	NonMetMinProd	1	2	1	0	1	25	3	17	41	2	57	0	82	11	8	0
14	Iron and Steel	2	1	3	1	14	37	7	53	79	1	19	0	26	4	70	0
15	NonFer Metals	1	1	1	2	1	28	29	39	24	0	76	0	6	1	94	0
16	WoodMetal Prod	3	1	4	3	3	34	16	24	35	0	64	0	3	2	95	0
17	NonElec Mach	3	1	4	3	11	41	12	85	30	1	69	0	9	22	69	0
18	Electrical Mach	4	1	6	19	8	51	65	70	19	0	81	0	8	3	89	0
19	Transport Eqp	5	2	7	12	22	41	31	54	58	2	41	0	20	4	76	0
20	Other Manufact	1	1	2	3	5	23	34	39	74	0	26	0	11	3	86	0
	All Manufactures	40	25	58	56	87	31	17	37	40	1	59	0	15	4	81	0
21	Construction	6	4	8	0	0	184	0	0	0	0	0	0	0	0	0	0
22	Electricity	1	2	1	0	0	50	0	0	0	0	0	0	0	0	0	0
23	Commerce	15	25	0	0	0	23	0	0	0	0	0	0	0	0	0	0
24	TransptCommun	5	8	4	0	0	39	0	0	0	0	0	0	0	0	0	0
25	FinInsRlEstate	5	8	2	0	0	29	0	0	0	0	0	0	0	0	0	0
26	Other Services	10	16	5	0	0	116	0	0	0	0	0	0	0	0	0	0
	All Services	43	63	21	0	0	60	0	0	0	0	0	0	0	0	0	0
	Economywide	100	100	100	100	100	48	12	24	41	1	58	0	38	3	59	0

Note: Columns 1-6 contain totals, 7-17 contain denominator-weighted averages.

Columns 7 and 8 present measures of overall trade dependence, exports in gross output and imports in total demand, respectively. Generally speaking, average sectoral import dependence is greater than export dependence in 1988. The U.S. economy exports only 5 percent of gross output overall, but imports 13 percent of total demand. The most export intensive sectors in the current aggregation are Mining (18 percent), Transport Equipment (17 percent), Iron and Steel (16 percent), and Chemicals (15 percent). Together these sectors account for 28 percent of exports (column 4). The most import dependent sectors are Leather goods (67 percent), Other Manufactures (39 percent), Apparel (37 percent), and Electrical Machinery (33 percent), together accounting for 31 percent of all imports (column 5).

The last eight columns of table 2.1 contain import (9-12) and export (13-16) shares for each trading partner in total imports or exports.[3] It is apparent from columns 9 and 13 that the U.S. relies for most of its import supply and export demand upon markets outside of North America, with economywide average of 81 percent for imports and 79 percent for exports. Thus the potential for trade diversion in response to the NAFTA may be considerable. The U.S. and Canada do maintain the world's largest bilateral trade relationship, however (U.S.-Japan is second), and U.S. trade shares with respect to its northern neighbor are significant in many sectors. About two thirds (64 percent) of U.S. Paper imports and 39 percent of Transport Equipment imports come from Canada. Canada in turn buys two-thirds of U.S. NonFerrous Metal product exports, over half (51 percent) of its Mining exports, and over one third of its exports of Leather (47 percent), NonElectric Machinery (41 percent), Transport Equipment (38 percent), NonMetal Mineral Products (37 percent), and Textiles (34 percent). Generally speaking, the U.S. had significantly higher export dependence on Canada than import dependence under 1988 protection patterns.

United States' trade dependence on Mexico is generally lower, as would be expected given the relative magnitude of the three economies. Import dependence averages only 10 percent in primary sectors and 5 percent in manufactures (column 12), but is as high as 15 percent in Agriculture and 8 percent in beverages. As an export market, Mexico is more attractive to some U.S. sectors (column 16), although the averages for primary and manufacturing are only 6 and 7 percent, respectively. U.S. Leather producers direct 37 percent of their exports to Mexico and 28 percent of U.S. Apparel exports were destined there in 1988. The lower economywide averages for U.S.-Mexico trade shares indicate

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[3] The subscripts r, c, u, and m denote the Rest of the World, Canada, U.S.A., and Mexico, respectively.

considerable scope may exist for trade creation within and diversion to a North American Free Trade Area.

Table 2.2 presents comparable structural information for Canada, and close inspection reveals interesting contrasts with its main trading partner. Canada's economy is more concentrated in Primary (8 percent) and Manufacturing (38 percent) than the U.S., with significantly greater relative shares for Mining, Paper, and Transport Equipment and less concentration on Service sector activities. The value added distribution also reflects this, but is again skewed toward services. Canadian demand exhibits similar compositional differences, and exports are even more Primary and Manufacturing dependent. Canada has 50 percent more export concentration (14 percent) than the U.S., three quarters (73 percent) of its exports are Manufactures, and it has less than half the Service export concentration (13 percent) of the U.S..

The ratio of labor to capital value added in Canada varies significantly from comparable sectors in the U.S.. In many cases (e.g., Mining, Petroleum, and Construction), this may be due to differing products or technologies, but the differences here are generally greater than one might reasonably expect from these sources alone.[4] Broad sectoral and economywide averages are more similar, but labor still receives substantially more in Canadian Primary and Manufacturing sectors, less in Services.

Generally, Canada appears to be about twice as trade dependent as the United States, with 13 percent of output going to exports and 25 percent of demand met by imports. Moreover, over half of both its import (56 percent) and export (61 percent) activity was with the U.S. This represents almost fourfold greater bilateral dependence on the part of Canada. In some sectors, the U.S. holds a dominant or near monopoly/monopsony position in Canadian trade. Examples of the former are Canadian import market shares of over 70 percent in Agriculture, Mining, Paper, Rubber, Non Ferrous Metals, Wood and Metal Products, Non Electrical Machinery, and Transport Equipment. The U.S. also buys more than three quarters of Canadian exports of Petroleum, Beverages, Apparel, Iron and Steel, Electrical Machinery, and Other Manufactures.

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[4] For Canada, the capital and labor components of value added came directly from the 1988 Canadian input-output accounts. Unfortunately, data availability is less current in the United States. Therefore, the value added data from Reinert and Roland-Holst (forthcoming-a) are less precise than the Canadian data. However, the Reinert and Roland-Holst study made use of the most recent value added data available at the time.

Nearly three quarters of all Canadian Manufactured goods are directed to the U.S. market, indicating quite there may be limited scope for bilateral trade diversion as a result of the NAFTA. Indeed, Mexico may have more potential as a diversionary source of Canadian imports and destination for exports. As of 1988, Mexico only met 1 percent of Canada's import needs and bought a negligible amount of the latter's exports. These levels are well below its potential, as indicated by the observed Mexican shares in U.S. trade.

The Mexican economy is summarized in table 2.3, and these figures clearly delineate structural differences vis-a-vis its northern trading partners. As one might expect, Mexico is two to three times more Primary intensive than the more industrialized countries. Its Manufacturing concentration is more comparable largely because of a relatively smaller service economy. Demand is also much more oriented toward subsistence and Manufacturing necessities (e.g., Food Processing) and less on Services.

Trade shares are also consistent with intuition about Mexico's comparative advantages, with almost half (44 percent) of exports from Primary sectors and 87 percent of imports in Manufacturing. One striking difference is the ratio of labor to capital value added, which in some sectors is an order of magnitude less than in the more affluent countries. Mexico is generally more trade dependent than the U.S. but less so than Canada, with 12 percent exports in gross output and 24 percent imports in total demand. The sectoral patterns of this dependence vary considerably from the other two countries, with much greater Primary export dependence and more variation in Manufacturing import dependence.

Mexico exhibits about the same average level of U.S. trade dependence as Canada, but its composition is quite different. The U.S. has an even more dominant position in selected Mexican sectors, with more than 80 percent share in six Mexican import markets and 9 Mexican export markets. Overall, 81 percent of Mexican Manufacturing exports went to the U.S. in 1988. Again, this implies that trade diversion between members of the NAFTA is more likely than from outside the region.

The structural data reviewed in this section provide considerable detail on the three domestic economies and their trade linkages, and the detailed portrait is generally consistent with intuition about them. We see the U.S. at the center of a regional economy, the largest and most self-sufficient member. Its Northern neighbor shares many of its attributes as a relatively affluent and industrialized country, but Canada exhibits considerably more bilateral trade dependency and less diversity in structure and trade. Mexico is unique in having a large subsistence sector, low value added shares for labor across the economy, and even higher trade dependency and less diversity.

All these structural features will have important implications for the adjustment patterns which would ensue from the NAFTA. Even this detailed information cannot be considered in isolation, however, since market conduct in every one of the countries and sectors will also have a decisive influence on the adjustment process. It is on this point where the specification in the CGE model may be most rigorously tested, particularly in light of the U.S. market share dominance in many Canadian and Mexican sectors.

3. An Overview of North American Protection Patterns

Domestic policies which distort the pattern of international trade fall into three broad categories: import control measures, export controls or subsidies, and domestic policies such as producer subsidies which distort industry costs and sectoral resource allocation. In this paper, we focus on the role of the first category of trade distortion. Import restraints themselves take a wide variety of forms, including tariffs and surcharges, quantitative restrictions, and supervisory mechanisms such as registration and inspection requirements. In terms of CGE modeling, the most tractable type of import restraint to specify and simulate is an ad valorem tariff. As the discussion of our model in the next section explains, however, we have also allowed for the principal type of non-tariff barriers (NTBs), quantity restrictions (quotas or VERs) which induce an ad valorem premium distortion on domestic prices. These two categories of protection, tariffs and quantity restrictions, represent the majority of import coverage by distortionary trade control measures. Among the many other types of NTBs, however, some are severe enough to distort prices. In this section we discuss the data and methods used to calibrate our model for the most significant import distortions affecting North American trade.

Four primary data sources have been consulted for our estimates. The first of these is the 1988 three-country SAM discussed in the previous section. The SAM includes estimates of sectoral tariff and other duty collections for each country, bilaterally for North American partners and with respect to the rest of the world. We used the collections to impute ad valorem equivalent tariff rates (as opposed to statutory rates) which measure the rates of actual percent distortion against the world prices of imports. These estimates are presented in table 3.1 below. As the trade-weighted averages indicate, North American tariff protection is relatively low by world standards, although some sectoral flows are significantly distorted.

Table 3.1: Tariff Collection Rates, 1988

(percentages)

		USA			Canada			Mexico		
		ROW	*Canada*	*Mexico*	*ROW*	*USA*	*MExico*	*ROW*	*USA*	*Canada*
1	Agriculture	1	2	6	1	1	2	0	1	0
2	Mining	0	0	1	0	0	0	0	2	0
3	Petroleum	1	0	0	0	0	0	1	4	0
	All Primary	1	1	2	0	0	0	0	1	0
4	Food Processing	4	2	6	4	4	5	1	3	2
5	Beverages	3	3	2	35	35	35	0	0	0
6	Tobacco	10	17	8	8	8	0	0	0	0
7	Textiles	10	6	7	12	12	12	3	2	0
8	Apparel	19	9	16	18	18	20	5	2	0
9	Leather	9	22	5	13	14	0	0	1	0
10	Paper	1	0	2	4	4	0	2	2	3
11	Chemical	5	17	2	5	5	8	2	3	0
12	Rubber	6	10	4	7	7	0	4	1	0
13	NonMetMinProd	6	1	0	5	5	8	4	8	0
14	Iron and Steel	4	3	3	4	4	5	1	4	0
15	NonFer Metals	1	1	0	2	2	0	2	4	0
16	WoodMetal Prod	4	1	2	6	6	6	4	3	0
17	NonElec Mach	3	1	1	2	2	2	5	3	5
18	Electrical Mach	3	2	3	4	4	4	7	1	5
19	Transport Eqp	3	0	2	7	0	7	1	2	1
20	Other Manufact	4	1	3	4	4	5	2	10	0
	All Manufactures	5	1	3	7	3	5	3	2	2
21	Construction	0	0	0	0	0	0	0	0	0
22	Electricity	0	0	0	0	0	0	0	0	0
23	Commerce	0	0	0	0	0	0	0	0	0
24	TransptCommun	0	0	0	0	0	0	0	0	0
25	FinInsRlEstate	0	0	0	0	0	0	0	0	0
26	Other Services	0	0	0	0	0	0	0	0	0
	All Services	0	0	0	0	0	0	0	0	0
	Economywide	3	1	3	4	2	4	2	2	2

Note: Averages are weighted but their respective bilateral trade flows.
Source: The three country social accounting matrix.

Table 3.2: Independent Estimates of Sectoral Import Distortions

(percentages)

		USA			Canada			Mexico		
		Row	*Canada*	*Mexico*	*Row*	*USA*	*Mexico*	*Row*	*USA*	*Canada*
1	Agriculture	0	0	5	0	2	0	0	10	10
2	Mining	0	0	0	0	0	0	0	0	0
3	Petroleum	0	0	0	0	0	0	0	0	0
	All Primary	0	0	1	0	1	0	0	7	8
4	Food Processing	0	1	2	0	1	0	0	0	0
5	Beverages	0	0	0	0	0	0	0	0	0
6	Tobacco	0	0	0	0	0	0	0	10	10
7	Textiles	0	0	10	0	0	0	0	0	0
8	Apparel	0	0	30	0	0	0	0	0	0
9	Leather	0	0	0	0	0	0	0	0	0
10	Paper	0	0	0	0	0	0	0	0	0
11	Chemical	0	0	0	0	0	0	0	0	2
12	Rubber	0	0	0	0	0	0	0	0	0
13	NonMetMinProd	0	0	0	0	0	0	0	0	0
14	Iron and Steel	0	0	5	0	0	0	0	0	0
15	NonFer Metals	0	0	0	0	0	0	0	0	0
16	WoodMetal Prod	0	0	0	0	0	0	0	0	0
17	NonElec Mach	0	0	0	0	0	0	0	0	0
18	Electrical Mach	0	0	0	0	0	0	0	0	0
19	Transport Eqp	0	0	0	0	0	0	0	40	40
20	Other Manufact	0	0	0	0	0	0	0	0	0
	All Manufactures	0	0	1	0	0	0	0	5	10
21	Construction	0	0	0	0	0	0	0	0	0
22	Electricity	0	0	0	0	0	0	0	0	0
23	Commerce	0	0	0	0	0	0	0	0	0
24	TransptCommun	0	0	0	0	0	0	0	0	0
25	FinInsRlEstate	0	0	0	0	0	0	0	0	0
26	Other Services	0	0	0	0	0	0	0	0	0
	All Services	0	0	0	0	0	0	0	0	0
	Economywide	0	0	1	0	0	0	0	5	10

Note: Averages are weighted but their respective bilateral trade flows.

Sources: See Appendix 4 below

Despite the low tariff protection which is apparent from the SAM, other evidence suggests that NTBs are pervasive enough to exert a significant effect on trade prices in the region, particularly in some sectors. As a second source of information for the model, we have consulted the public and private published sources on estimates of ad valorem equivalents for NTBs in the U.S., Canada, and Mexico. The results of this survey are summarized in table 3.2.[5] Actual estimates of ad valorem equivalents for specific sectors are rather scarce, but a number of authors have attempted to impute and use these values in preference to the assumption of no NTB price distortions across the board.

In this paper, we attempt to further elucidate the composition of bilateral NTB protection. The third source of data we obtained is by far the most detailed, consisting of three-digit SITC tabulations of bilateral import NTBs for the U.S., Canada, and Mexico and the same three countries plus a ROW aggregate as exporters. The data were obtained by extraction from the combined UNCTAD-GATT database of four-digit trade control measures in Geneva.[6] The four-digit NTB information is too detailed for inclusion in the paper, but we summarize our results for ten aggregate NTB categories in tables 3.3-3.5.[7] The data were also aggregated from three-digit SITC to the twenty-six sectors of the CGE model. These estimates reveal that North American trade is subject to extensive non-tariff barriers.

Implementation of the CGE model with tariff data or ad valorem equivalent estimates is a routine matter. While the NTB data in table 3.3-3.5 give very detailed information on the composition of NTB protection, however, they do not precisely measure induced price disadvantages against covered imports. The translation of such NTB coverage measures into ad valorem equivalents is difficult and uncertain exercise which we have not attempted at this stage.[8]

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[5] A more detailed discussion of the sources and our use of them is given in Appendix 4 below.
[6] See e.g. UNCTAD [1987].
[7] The four-digit NTB classification and its concordance to the ten categories presented here are simmarized in appendix 3.
[8] For a discussion of the problems, see Laird and Yeats [1990], Pritchett [1991], and Roland-Holst [1992]. A subsequent paper will treat estimation of North American ad valorem equivalents in greater detail.

Table 3.3: Non-tariff Barriers for the United States

(percentage value of imports covered)

		ALL NTBS			BROAD			NARROW			AD/CV ACT.			NAL/Q			AL			PRICE ACT			QUANT RESTR			TEXT RESTR			VERs		
		Can	Mex	ROW	Can	Mex	ROW	Can	Mex	ROW	Can	Mex	ROW	Can	Mex	ROW	Can	Mex	ROW	Can	Mex	ROW	Can	Mex	ROW	Can	Mex	ROW	Can	Mex	ROW
1	Agriculture	12	36	23	10	0	10	0	0	2	10	0	7	0	0	2	0	0	0	10	0	7	0	0	2	0	0	0	0	0	0
2	Mining	6	36	4	6	36	4	0	0	0	6	36	4	0	0	0	0	0	0	6	36	4	0	0	0	0	0	0	0	0	0
3	Petroleum	65	98	91	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Food Processing	21	16	23	20	4	20	5	4	13	15	0	4	5	4	13	0	0	7	15	3	7	5	4	13	0	0	0	0	0	6
5	Beverages	94	90	94	0	0	30	0	0	30	0	0	0	0	0	30	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0
6	Tobacco	64	15	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Textiles	0	78	41	0	78	41	0	57	38	0	51	5	0	57	38	0	0	0	0	51	5	0	57	38	0	57	38	0	0	0
8	Apparel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Paper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Chemical	1	7	2	1	7	2	0	0	0	1	7	1	0	0	0	0	0	0	1	7	1	0	0	0	0	0	0	0	0	0
12	Rubber	7	1	5	7	1	5	0	0	0	7	1	5	0	0	0	0	0	0	7	1	5	0	0	0	0	0	0	0	0	0
13	NonMetMinProd	0	57	3	0	57	3	0	0	0	0	57	3	0	0	0	0	0	0	0	57	3	0	0	0	0	0	0	0	0	0
14	Iron and Steel	45	72	79	45	72	79	38	72	76	7	2	3	38	72	76	0	0	0	7	2	3	38	72	76	0	0	0	0	64	67
15	NonFer Metals	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
16	WoodMetal Prod	4	8	9	4	8	9	0	3	5	1	5	4	0	3	5	0	0	0	1	5	4	0	3	5	0	0	0	0	3	5
17	NonElec Mach	1	0	8	1	0	8	0	0	2	1	0	7	0	0	2	0	0	0	1	0	7	0	0	2	0	0	0	0	0	2
18	Electrical Mach	5	0	10	5	0	10	0	0	2	5	0	9	0	0	2	0	0	0	5	0	9	0	0	2	0	0	0	0	0	2
19	Transport Eqp	65	4	68	65	4	68	0	0	43	45	0	15	0	0	43	0	0	0	45	0	15	0	0	43	0	0	0	0	0	43
20	Other Manufact	2	21	24	2	21	24	0	20	22	2	1	4	0	20	22	0	0	0	2	1	4	0	20	22	0	20	22	0	0	0
21	Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Commerce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	TransptCommun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	FinInsRlEstate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Other Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Weighted Ave	30	26	33	25	6	25	1	4	16	17	2	7	1	4	16	0	0	0	17	2	7	1	4	16	0	3	4	0	1	11

See Table A3.1 for and explanation of the NTB measures.

Table 3.4: Non-tariff Barriers for Canada

(percentage value of imports covered)

		ALL NTBS			BROAD			NARROW			AD/CV ACT.			NAL/Q			AL			PRICE ACT			QUANT RESTR			TEXT RESTR			VERs		
		USA	Mex	ROW	USA	Mex	ROW	USA	Mex	ROW	USA	Mex	ROW	USA	Mex	ROW	USA	Mex	ROW	USA	Mex	ROW	USA	Mex	ROW	USA	Mex	ROW	USA	Mex	ROW
1	Agriculture	82	97	80	9	0	7	4	0	3	5	0	4	4	0	3	0	0	0	5	0	4	4	0	3	0	0	0	0	0	0
2	Mining	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
3	Petroleum	48	7	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Food Processing	54	73	54	26	39	27	21	39	24	5	0	3	21	39	24	0	0	0	5	0	3	21	39	24	0	0	0	0	0	0
5	Beverages	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Textiles	67	91	73	20	31	26	20	21	26	0	11	0	20	21	26	0	0	0	0	11	0	20	21	26	0	0	9	0	0	0
8	Apparel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Leather	89	39	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Paper	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
11	Chemical	7	0	9	2	0	2	1	0	1	1	0	1	1	0	1	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0
12	Rubber	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	NonMetMinProd	9	3	14	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
14	Iron and Steel	70	90	82	70	90	82	0	0	0	9	0	20	0	0	0	70	90	81	9	0	20	0	0	0	0	0	0	0	0	0
15	NonFer Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	WoodMetal Prod	8	3	10	3	2	6	0	0	0	0	0	1	0	0	0	3	2	5	0	0	1	0	0	0	0	0	0	0	0	0
17	NonElec Mach	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
18	Electrical Mach	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Transport Eqp	57	76	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Other Manufact	13	12	26	5	4	17	3	4	15	1	0	2	3	4	15	0	0	0	1	0	2	3	4	15	0	0	8	0	0	0
21	Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Commerce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	TransptCommun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	FinInsRlEstate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Other Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Weighted Ave	26	23	29	3	5	6	1	3	3	1	0	1	1	3	3	1	2	2	1	0	1	1	3	3	0	0	1	0	0	0

See Table A3.1 for and explanation of the NTB measures.

Table 3.5: Non-tariff Barriers for Mexico

(percentage value of imports covered)

		ALL NTBS			BROAD			NARROW			AD/CV ACT.			NAL/Q		
		USA	Can	ROW	USA	Can	ROW	USA	Can	ROW	USA	Can	ROW	USA	Can	ROW
1	Agriculture	83	100	84	65	87	64	65	87	64	0	0	0	65	87	64
2	Mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Petroleum	85	0	85	85	0	85	85	0	85	0	0	0	85	0	85
4	Food Processing	98	80	94	51	59	51	51	59	51	0	0	0	51	59	51
5	Beverages	100	0	100	0	0	0	0	0	0	0	0	0	0	0	0
6	Tobacco	100	0	100	100	0	100	100	0	100	0	0	0	100	0	100
7	Textiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Apparel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Leather	2	0	2	2	0	2	2	0	2	0	0	0	2	0	2
10	Paper	64	84	62	64	84	62	64	84	62	0	0	0	64	84	62
11	Chemical	4	9	7	1	9	3	1	9	3	0	0	0	1	9	3
12	Rubber	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	NonMetMinProd	3	0	3	3	0	3	3	0	3	0	0	0	3	0	3
14	Iron and Steel	39	0	46	39	0	46	0	0	0	39	0	46	0	0	0
15	NonFer Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	WoodMetal Prod	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	NonElec Mach	1	0	2	1	0	2	1	0	1	0	0	2	1	0	1
18	Electrical Mach	7	10	6	7	10	6	7	10	5	0	0	0	7	10	5
19	Transport Eqp	17	0	12	17	0	12	17	0	12	0	0	0	17	0	12
20	Other Manufact	1	0	1	1	0	1	1	0	1	0	0	0	1	0	1
21	Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Commerce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	TransptCommun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	FinInsRlEstate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Other Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Weighted Ave	31	49	27	23	40	20	22	40	18	1	0	2	22	40	18

		AL			PRICE ACT			QUANT RESTR			TEXT RESTR			VERs		
		USA	Can	ROW	USA	Can	ROW	USA	Can	ROW	USA	Can	ROW	USA	Can	ROW
1	Agriculture	0	0	0	0	0	0	65	87	64	0	0	0	0	0	0
2	Mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Petroleum	0	0	0	0	0	0	85	0	85	0	0	0	0	0	0
4	Food Processing	0	0	0	0	0	0	51	59	51	0	0	0	0	0	0
5	Beverages	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Tobacco	0	0	0	0	0	0	100	0	100	0	0	0	0	0	0
7	Textiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Apparel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Leather	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0
10	Paper	0	0	0	0	0	0	64	84	62	0	0	0	0	0	0
11	Chemical	0	0	0	0	0	0	1	9	3	0	0	0	0	0	0
12	Rubber	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	NonMetMinProd	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0
14	Iron and Steel	0	0	0	39	0	46	0	0	0	0	0	0	0	0	0
15	NonFer Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	WoodMetal Prod	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	NonElec Mach	0	0	0	0	0	2	1	0	1	0	0	0	0	0	0
18	Electrical Mach	0	0	0	0	0	0	7	10	5	0	0	0	0	0	0
19	Transport Eqp	0	0	0	0	0	0	17	0	12	0	0	0	0	0	0
20	Other Manufact	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
21	Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Commerce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	TransptCommun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	FinInsRlEstate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Other Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Weighted Ave	0	0	0	1	0	2	22	40	18	0	0	0	0	0	0

See Table A3.1 for and explanation of the NTB measures.

A fourth and final source of information on North American trade distortion comes from inter-country price comparison data. Relatively good information on comparable commodity groups is now available from the International Comparison Project (ICP) sponsored by the United Nations, World Bank, and University of Pennsylvania.[9] The researchers who assembled this database have gone to great lengths to achieve comparability of commodity groups, and we feel North American comparisons with this data are valid across the relatively aggregated sectors of our model. Price relatives for the three countries are given in table 3.6.

The first four columns of table 3.6 give simple ratios of sectoral prices to domestic average prices, all of which were obtained from PPP price indices in the ICP database. The last three columns reflect an imaginary price harmonization scenario, where North American domestic prices converge to their regional minima and intercountry disparities are eliminated. We assumed that, for each sector, the lowest price relative for the three countries represented a free trade or harmonized price. For the two countries with higher price relatives, we give the ad valorem percent distortions in the last three columns of table 3.6.[10]

To the extent that one accepts the comparability of these product groups, it is apparent that significant price disparities do exist between the countries. Such disparities are traceable to two primary sources, domestic market structure/conduct and trade policy. The former might explain disparities between institutionally different economies like Mexico and its northern partners, but is unlikely to explain much of the disparity in prices between the U.S. and Canada.

Sectoral comparisons indicate a substantial degree of conformality between NTB coverage (tables 3.3-3.5) and these price disparities, particularly in sectors with high import shares. Thus nontariff protection appears to impose price disadvantages on regional imports which can significantly exceed tariff rates (table 3.1).

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[9] See Kravis, Heston, and Summers [1982] for a discussion of the project.

[10] In some cases, all three countries have positive distortions because these price disparities were aggregated from data on 147 sectors. At the detailed level, the minimum price country always has a zero distortion.

4. A Calibrated General Equilibrium Model for Trade Policy Analysis

The three-country calibrated general equilibrium (CGE) model described here is in most respects typical of comparative static, multi-sectoral, economywide models in use today.[11] Generally speaking, all these models simulate price-directed resource allocation in commodity and factor markets. They maintain detailed information on sectoral prices, output, trade, consumption, and factor use in a consistent framework which also accounts for aggregates such as income, employment, revenue, etc. The present model (the analytics of which are summarized in table 4.1 below) differs from the mainstream of CGE specifications in three important ways. Firstly, it is a detailed three-country model, so domestic supply, demand, and bilateral trade for the United States, Canada, and Mexico countries are fully endogenous at a twenty-six sector level of aggregation. The three countries maintain six pairs of sectoral trade flows between them, governed by six endogenous price systems (US-Canada, US-Mexico, and Canada-Mexico imports and exports). With respect to the Rest of the World (ROW), each country faces import supply and export demand schedules, totaling six more price systems (US-ROW, Canada-ROW, and Mexico-ROW, imports and exports).[12]

The extent of price adjustments, as well as the volume and pattern of trade creation and trade diversion, are important factors in determining the ultimate welfare effects of bilateral trade policy. A second important feature of the model is its differentiated product specification of the demand and supply for tradable commodities. Domestic demand is constituted of goods which are differentiated by origin (domestic goods, imports from North American trading partners, and imports from ROW) and domestic production is supplied to differentiated destinations (domestic market, exports to the trading partner, and exports to ROW). Similar devices appear elsewhere in the CGE literature; the present model uses a CES specification for demand and CET for supply.[13]

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[11] Dervis, de Melo, and Robinson [1982] give a complete introduction to this methodology.

[12] ROW import supply and export demand elasticities have been estimated by the authors for the United States, and in every case for the present aggregation the small country assumption appears to be applicable. We have extended this reasoning to Canada and Mexico, and thus the ROW price systems are essentially exogenous.

[13] The CES specification for demand is used provisionally in this model. The shortcomings of this usage are now well-known, and the authors are presently at work on estimating more flexible functional forms for tradable demand (Shiells, Roland-Holst, and Reinert (in process)). For an example of North American trade modeling where terms-of-trade appear to play a prominent role, see Roland-Holst [1991].

Table 3.6: Price Distortions Based on International Comparisons

		Domestic Price Relatives				Price Distortions (percent)		
		USA	*Canada*	*Mexico*	*Average*	*USA*	*Canada*	*Mexico*
1	**Agriculture**	1.19	1.04	1.02	1.08	10	0	0
2	**Mining**	.76	.65	1.01	.81	15	15	26
3	**Petroleum**	1.33	1.01	2.09	1.47	0	0	43
	All Primary	1.10	.90	1.37	1.12	9	5	23
4	**Food Processing**	1.12	1.00	1.07	1.06	13	10	13
5	**Beverages**	1.13	.87	1.31	1.10	21	6	29
6	**Tobacco**	1.37	1.30	1.01	1.22	17	12	10
7	**Textiles**	1.05	.72	.88	.88	19	0	2
8	**Apparel**	.94	.87	.77	.86	17	7	0
9	**Leather**	.84	.95	.71	.83	4	14	2
10	**Paper**	.90	1.01	.89	.93	0	9	3
11	**Chemical**	.81	.83	.94	.86	3	20	19
12	**Rubber**	1.36	2.15	1.16	1.56	0	38	0
13	**NonMetMinProd**	1.00	1.00	1.00	1.00	1	1	1
14	**Iron and Steel**	1.00	1.00	1.00	1.00	1	1	1
15	**NonFer Metals**	1.00	1.00	1.00	1.00	1	1	1
16	**WoodMetal Prod**	1.17	.62	.52	.77	52	0	0
17	**NonElec Mach**	1.08	.89	1.63	1.20	3	0	35
18	**Electrical Mach**	1.12	.90	1.82	1.28	3	1	43
19	**Transport Eqp**	1.15	.95	1.94	1.35	1	0	44
20	**Other Manufact**	.99	.98	1.09	1.02	7	15	17
	All Manufactures	1.06	1.00	1.10	1.06	10	8	13
21	**Construction**	1.06	.97	.83	.96	0	0	0
22	**Electricity**	.94	.32	1.09	.78	0	0	0
23	**Commerce**	.75	.89	.47	.70	0	0	0
24	**TransptCommun**	.72	.97	.33	.67	0	0	0
25	**FinInsRlEstate**	1.01	1.25	.56	.94	0	0	0
26	**Other Services**	.73	1.11	.63	.82	0	0	0
	All Services	.87	.92	.65	.81	0	0	0
	Economywide	1.00	1.00	1.00	1.00	6	4	12

Source: Kravis, Heston, and Summers [1982]

Table 4.1: Equations for the North American CGE Model

Equations

Consumer Behavior

$C_{ni} = LES^{C}_{ni}(P^{D}_{ni}, Y_{n}; \eta_{ni})$	$n \varepsilon N, i \varepsilon I$	(4.1)

Production Technology

$S_{ni} = CES^{S}_{ni}(L^{D}_{ni}, K^{D}_{ni}; \phi_{ni})$	$n \varepsilon N, i \varepsilon I$	(4.2)
$V_{ni} = \Sigma_j a_{nij} S_{nj}$	$n \varepsilon N, i \varepsilon I$	(4.3)

Factor Demands

$L^{D}_{ni} = \Psi^{L}_{ni}(w_n, P^{S}_{ni}; \phi_{ni})$	$n \varepsilon N, i \varepsilon I$	(4.4)
$K^{D}_{ni} = \Psi^{K}_{ni}(r_n, P^{S}_{ni}; \phi_{ni})$	$n \varepsilon N, i \varepsilon I$	(4.5)

Factor Markets

$w_n = w^{*}_{n}$	$n \varepsilon N$	(4.6)
$\Sigma_i K^{D}_{ni} = K_n$	$n \varepsilon N$	(4.7)

Commodity Demands, Supplies, and Allocation of Traded Goods

$D_{ni} = CES^{D}_{ni}(D_{n.i}; \sigma_{ni})$	$n \varepsilon N, i \varepsilon I$	(4.8)
$D_{nki} = \Phi^{D}_{nki}(P^{D}_{ni}, P^{D}_{nki}; \sigma_{ni})$	$n \varepsilon N, k \varepsilon K, i \varepsilon I$	(4.9)
$S_{ni} = CET^{S}_{ni}(S_{n.i}; \tau_{ni})$	$n \varepsilon N, i \varepsilon I$	(4.10)
$S_{nki} = \Phi^{S}_{nki}(P^{S}_{ni}, P^{S}_{nki}; \tau_{ni})$	$n \varepsilon N, k \varepsilon K, i \varepsilon I$	(4.11)

Commodity Prices

$P^{D}_{ni} D_{ni} = \Sigma_k P^{D}_{nki} D_{nki}$	$n \varepsilon N, i \varepsilon I$	(4.12)
$P^{S}_{ni} S_{ni} = \Sigma_k P^{S}_{nki} S_{nki}$	$n \varepsilon N, i \varepsilon I$	(4.13)

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Domestic Market Equilibrium

$$D_{ni} = C_{ni} + V_{ni} \qquad n \in N,\ i \in I \qquad (4.14)$$

$$S_{nni} = D_{nni} \qquad n \in N,\ i \in I \qquad (4.15)$$

Income and Government Revenue

$$Y_n = (1-t_n^L)\Sigma_i w_n L_{ni}^D + (1-t_n^K)\Sigma_i r_n K_{ni}^D + Y_n^g + B_n - \Sigma_i \Sigma_{k \neq n} e_{nk} \theta_{nki} \rho_{nki} \pi_{nki}^D D_{nki}$$

$$n \in N \qquad (4.16)$$

$$Y_n^g = \Sigma_i \Sigma_{k \neq n} t_{nki}^D P_{nki}^D D_{nki} + t_n^L \Sigma_i w_n L_{ni}^D + t_n^K \Sigma_i r_n K_{ni}^D \qquad n \in N \qquad (4.17)$$

Foreign Balance

$$B_n = \Sigma_i \Sigma_{k \neq n} e_{nk} (\pi_{nki}^D D_{nki} - \pi_{nki}^S S_{nki}) \qquad n \in N \qquad (4.18)$$

Foreign Commodity Prices

$$P_{nki}^D = (1+\rho_{nki})(1+t_{nki}^D) e_{nk} \pi_{nki}^D \qquad n \in N,\ k \in K,\ i \in I \qquad (4.19)$$

$$P_{nki}^S = e_{nk} \pi_{nki}^S \qquad n \in N,\ k \in K,\ i \in I \qquad (4.20)$$

Numeraire

$$\Sigma_i \omega_{ni} P_{ni}^D = 1 \qquad n \in N \qquad (4.21)$$

Sets

I = {1,...,26}	Production sectors
N = {Canada(C), Mexico(M), United States(U)}	North American countries
K = {C,M,U, Rest of World(R)}	World countries

Indices

$i,j \in I$
$n \in N$
$k \in K$

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Quantity Variables

C_{ni}	Final demand for sector i in country n
D_{ni}	Composite consumption good i in country n
D_{nki}	Demand for good i from country k in country n
$D_{n.i}$	Vector of demands for good i from countries k in country n
K^D_{ni}	Demand for capital in sector i of country n
K_n	Exogenous capital stock in country n
L^D_{ni}	Demand for labor in sector i of country n
S_{ni}	Gross domestic output for sector i in country n
S_{nki}	Supply of good i from country n to country k
$S_{n.i}$	Vector of supplies of good i from country n to countries k
V_{ni}	Intermediate demand for sector i in country n

Price Variables

e_{nk}	Country n exchange rate with country k
P^D_{ni}	Domestic purchaser price of composite consumption good i in country n
P^D_{nki}	Domestic purchaser price of good i from source country k in country n
P^S_{ni}	Domestic producer price of composite producer good i in country n
P^S_{nki}	Domestic producer price of good i sold to country k in country n
π^D_{nki}	World price of imports of good i from country k
π^S_{nki}	World price of exports of good i to country k
r_n	Average capital rental rate in country n
w_n	Average wage rate in country n
w^*_n	Exogenous average wage rate in country n

Nominal Variables

B_n	Exogenous net foreign borrowing by country n
Y_n	Income in country n
Y^g_n	Government income in country n

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Behavioral, Policy and Other Parameters

η_{ni}	Income elasticity for good i in country n
ϕ_{ni}	Elasticity of substitution between labor and capital in sector i of country n
a_{nij}	Intermediate use coefficient for sector j in country n
σ_{ni}	Elasticity of substitution between imports and domestic competing good in sector i of country n
τ_{ni}	Elasticity of transformation between exports and domestic supply in sector i of country n
t_n^L	Tax rate on labor income in country n
t_n^K	Tax rate on capital income in country n
t_{nki}^D	Tariff rate in country n on imports of good i from country k
ρ_{nki}	Tariff equivalent of NTB in country n on imports of good i from country k
θ_{nki}	Proportion of NTB rent accruing to foreign exports
ω_{ni}	GDP share of sector i in country n

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Thirdly, the CGE model allows for some appraisal of the role of increasing returns to scale in determining the ultimate effects of trade policy. A number of authors have demonstrated that the presence of scale economies, realized or unrealized, can significantly influence the gains from trade liberalization.[14] The direction and magnitude of this influence generally depend upon the direction and magnitude of the induced scale adjustments, with aggregate efficiency and welfare moving in the opposite direction of average costs. The direction of average cost adjustment depends on the specification of industry conduct, partly a methodological and partly an empirical issue. The magnitude of cost adjustments (shape and scale of average cost curves) is purely an empirical question.

Given the diversity of the domestic markets involved and the absence of a clear methodological consensus on modeling firm behavior, we have chosen a very parsimonious specification of structure and two alternatives for conduct under increasing returns to scale. We hope this approach will facilitate interpretation of our results as general indicators of scale effects.

Increasing returns are specified with one parameter, a cost disadvantage ratio (CDR) which measures the share by which average total cost exceeds marginal cost, (ATC-MC)/ATC for the aggregate firm in each industry (sector).[15] This is in turn calibrated to an equivalent fixed cost for the observed output and factor use in each sector.[16] Our estimates of the magnitude of unrealized scale economies in the base case are obtained from a variety of sources and reproduced in table 4.2 below.

For firm conduct, we assume in the first case a kind of contestability, with no firm entry, where the representative firm prices at average cost. Since the number of firms (or cost curves) in the industry is constant, this implies that efficiency varies directly with industry output.[17] If trade policy expands sectoral output, the incumbent firms move down their average cost curves, price accordingly, and confer the newly realized scale economies upon domestic consumers. Sectoral output contraction leads to the opposite results.

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[14] An example is Harris [1984, 1986].

[15] A common misconception in this work is that the number of firms in the calibrated base can influence the results. The aggregate firm is simply a normalization of the actual firm population in each sector and that population is irrelevant to the simulation results.

[16] This approach is explained more thoroughly in de Melo and Tarr [1992], to whom we are indebted for this idea.

[17] de Melo and Tarr [1992] and de Melo and Roland-Holst [1991]compare a variety of specifications for firm conduct.

The second specification of firm behavior uses the so-called conjectural variations method to evaluate Cournot behavior in each sector. Market entry and exit are assumed to be costless, and firms implement a markup pricing rule of the form $(P-MC)/P = 1/n\varepsilon$, where ε is the domestic price elasticity of demand and n denotes the number of firms in the industry. We further assume that firms maintain base profit rates (normalized to zero in this model). Thus prices and the (now endogenous) number of firms are jointly determined by the elasticity of demand and average costs. In this case, the ultimate realization of scale economies depends on per firm average costs, and market entry or exit can alter the effects of aggregate sectoral expansion of contraction. For example, sectoral output expansion, which would have yielded efficiency gains for the fixed population of incumbent firms, may in fact induce inefficient firm entry or where new firms "crowd in" the industry and drive incumbents up their average cost curves. On the other hand, industry contraction need not contribute to higher average costs if firm rationalization counteracts this, allowing survivors to move down their cost curves.

The North American CGE model was calibrated to the 1988 SAM discussed in section 2. Structural parameters of the model were obtained by calibration, direct estimation, or imputation from other sources. Calibrated values were obtainable for most share parameters, input-output coefficients, nominal ad valorem taxes, and tariffs from the SAM itself. Employment data were obtained from official publications. The basic data source for behavioral parameters was a weighted aggregation of detailed parameters compiled for the United States by Reinert and Roland-Holst (April, 1991). The U.S. parameters were applied to Canada and Mexico except for those cases where alternatives were available. Elasticities of substitution between labor and capital for Canada were taken from Delorme and Lester (1990). Non-nested Armington elasticities are taken from Reinert and Shiells [1991].

Table 4.2: Structural Parameter Estimates

		CDR (percent)			Phi			Sigma			Tau		
		USA	*Canada*	*Mexico*	*USA*	*Canada*	*Mexico*	*USA*	*Canada*	*Mexico*	*USA*	*Canada*	*Mexico*
1	**Agriculture**	0	0	0	.680	.768	.680	1.500	1.500	2.250	3.786	3.786	3.786
2	**Mining**	5	5	5	.900	.950	.900	1.062	1.062	.781	1.050	1.050	1.050
3	**Petroleum**	10	10	8	.861	.861	.861	.660	.660	.580	.892	.892	.892
4	**Food Processing**	18	18	12	.710	1.100	.710	.889	.889	1.007	.752	.752	.752
5	**Beverages**	13	13	18	.710	1.100	.710	.326	.326	.726	.492	.492	.492
6	**Tobacco**	7	7	24	.708	1.100	.708	1.008	1.008	1.008	.784	.784	.784
7	**Textiles**	9	9	14	.900	1.100	.900	.918	.918	1.022	.394	.394	.394
8	**Apparel**	6	6	13	.900	1.100	.900	.479	.479	.802	.129	.129	.129
9	**Leather**	2	2	14	.900	1.100	.900	1.007	1.007	1.066	1.164	1.164	1.164
10	**Paper**	16	16	22	.900	1.100	.900	.967	.967	.734	.425	.425	.425
11	**Chemical**	12	12	19	.960	1.100	.960	.903	.903	.702	.367	.367	.367
12	**Rubber**	13	13	18	.960	1.100	.960	1.026	1.026	.763	.276	.276	.276
13	**NonMetMinProd**	25	25	16	.901	1.100	.901	1.152	1.152	.826	.216	.216	.216
14	**Iron and Steel**	14	14	13	.740	1.100	.740	.931	.931	.716	.424	.424	.424
15	**NonFer Metals**	14	14	20	.740	1.100	.740	.825	.825	.663	.499	.499	.499
16	**WoodMetal Prod**	9	9	14	.811	.811	.811	.888	.888	.594	.541	.541	.541
17	**NonElec Mach**	8	8	9	.740	.740	.740	1.012	1.012	.694	.379	.379	.379
18	**Electrical Mach**	8	8	28	.740	.740	.740	1.035	1.035	.705	.311	.311	.311
19	**Transport Eqp**	10	14	27	.867	.867	.867	.982	.982	.679	1.010	1.010	1.010
20	**Other Manufact**	9	9	12	.740	.740	.740	.550	.550	.463	.411	.411	.411
21	**Construction**	0	0	0	.900	.500	.900	1.500	1.500	1.200	.500	.500	.500
22	**Electricity**	0	0	0	.521	.300	.521	1.500	1.500	1.200	1.100	1.100	1.100
23	**Commerce**	0	0	0	.800	.300	.800	1.500	1.500	1.200	1.100	1.100	1.100
24	**TransptCommun**	0	0	0	.502	.300	.502	1.500	1.500	1.200	1.100	1.100	1.100
25	**FinInsRlEstate**	0	0	0	.800	.800	.800	1.500	1.500	1.200	1.100	1.100	1.100
26	**Other Services**	0	0	0	.800	.800	.800	1.500	1.500	1.200	1.100	1.100	1.100

Notes: CDR: Cost disadvantage ratios are taken from sources described in Appendix Table A4.1.
Phi: Elasticities of substitution between labor and capital are taken from Reinert and Roland-Holst [April, 1991] for the United States and Mexico and from Delorme and Lester [1990] for Canada.
Sigma: Elasticities of substitution between imports and domestic competing goods are taken from Reinert and Shiells [1991] for the United States and Canada and from Sobarzo [1991] for Mexico.
Tau: Elasticities of transformation between domestic supply and exports are taken from Reinert and Roland-Holst [April, 1991].

5. Simulation Results

This section presents the results of a variety of trade policy simulation experiments with the North American model described above. The policies we consider entail NAFTA type trade liberalization between the three countries. We consider removal of tariff protection as well as NTB induced price distortions, but each North American trading partner maintains its existing protection with respect to the rest of the world.[18] Our results indicate that all three countries could realize substantial gains from more liberal trade relations, and that each economy would undergo significant shifts in its trade and domestic resource use patterns. It is also apparent from these simulations that the pattern of adjustment would vary significantly, depending upon whether the liberalization negotiated in the NAFTA were to include non-tariff sources of price distortions.

In the presence of unrealized scale economies of the type described in the previous section, the welfare gains from North American liberalization can be even greater, but again their scope and composition depend upon whether the liberalization is partial or complete. The specification of market conduct under increasing returns also influences both the pattern of adjustment and the gains from liberalization. We present the results in three stages, beginning with a description of the experiments, followed by discussion of the aggregate results for several experiments and ending with a detailed sectoral discussion of two representative experiments.

5.1 Description of the Simulation Experiments

The aggregate results below were obtained in four simulation experiments. First, we simulated simple tariff removal with constant returns to scale and competitive pricing in all sectors. This experiment provides one reference point in terms of both the policy stimulus and the capacity of the economy to respond efficiently. The second experiment maintained the constant returns, competitive specification under a more extensive liberalization including non-tariff barriers. Using the NTB coverage information in tables 3.3-3.5 above, we posited a liberalization scenario where North American import prices are calibrated to ad valorem distortions equal to coverage rates plus observed tariffs. For the

[18] It is possible that harmonization of ROW protection would alter the results given here, but such policies are not presently under consideration.

present analysis, we assume that the composition of observed NTB protection reflects the composition of price disadvantages, rather than their precise levels.[19]

The policy specification of the third and fourth experiments corresponds to that of the second. The difference is that here we have allowed for the existence of unrealized domestic scale economies according to the information presented in table 4.2 above. This technological component increases the scope for efficiency gains to be realized under more liberal trade relations. In experiment 3, we assume contestable markets, where domestic incumbent firms price at average cost to forestall new entrants. In experiment 4, domestic firms are Cournot competitors with fixed profits and free entry and exit.

Before presenting the experimental results, a word about closure of the CGE model. For a simulation model of this type to be fully determined, assumptions must be made about the adjustment process in domestic factor markets, commodity markets, and the market for foreign exchange. In the experiments which follow, we assume that labor in all three countries is mobile between sectors and in excess supply in the aggregate. Thus the domestic average wage is fixed and aggregate employment varies to meet demand.

In each domestic product market, we assume prices are normalized to a fixed numeraire price index weighted by the base composition of sectoral final demand. On the external accounts, we assume that ROW exchange rates are flexible while trade balances are fixed.[20]

Discussion of the experimental results is divided into two parts. Aggregate economywide results are discussed first, followed by more detailed examination of sectoral adjustments in the increasing returns experiments. In a disaggregated neoclassical model such as the one used here, the most interesting results are at the sectoral level, where the real structural adjustments and reallocations occur in response to policy changes. Aggregate results are of some interest but tend to be more homogeneous. Since protection policy in particular is usually formulated from the bottom up, most of the discussion below is devoted to sectoral effects.

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19 The attribution of ad valorem distortions here is very approximate, but useful comparisons can be made if they are interpreted with care.

20 The adjustment in ROW exchange rates is dictated by the exchange rate arbitrage condition, so there is really only one ROW exchange rate. We experimented with other foreign closures, but the results did not change significantly.

5.2 *Aggregate Results*

The aggregate results of four experiments are summarized in table 5.1. It is immediately apparent that North American liberalization is beneficial to the regional economies in every case. Equivalent variation welfare effects vary from about a tenth of a percent of base GNP to over 6 percent, depending upon the degree of liberalization and the extent to which economies of scale can be realized in the adjustment process. In every case, increases in aggregate domestic employment and average rental rates are accompanied by extensive sectoral reallocation of labor and capital. Our assumptions of perfectly elastic aggregate labor and inelastic aggregate capital supply are somewhat restrictive, and the more likely result would be a combined increase in employment and wage on the one hand and rentals and foreign capital inflows on the other.[21] Trade for all three countries increases in each experiment, both within the region and with the rest of the world, with the former significantly outweighing the latter because of strong trade diversion effects.

The results of experiments one and two indicate dramatic differences in the implications of tariff-only and more complete NAFTA liberalization. The aggregate effects generally differ by more than an order of magnitude, and the differences in sectoral adjustments are even more extreme. Thus it is doubtful whether the experience of tariff liberalization can give substantive guidance to policy makers contemplating a fuller realization of gains from more liberalized North American trade.

Experiments three and four are companions to the second, simulating tariff and NTB liberalization under increasing returns to scale. Judging from these, it is apparent that the aggregate effects of liberalization can differ considerably, depending both upon the extent of unrealized scale economies and the conduct of domestic firms. If firm entry and exit is limited and pricing is contestable, then gains from tariff and NTB liberalization can be up to 50% greater for some countries. If entry and exit are unrestricted and Cournot pricing prevails, the aggregate gains are about the same as would prevail under constant returns and perfect competition. We also carried out tariff liberalization under the two increasing returns scenarios, but these differed little from the constant returns case. This is because industry output adjustments are relatively minor under tariff removal. As already has been observed, North American bilateral tariffs are relatively low by global standards,

[21] In the present study, we have chosen not to specify an ad hoc foreign capital inflow process, but we are presently configuring the model to simulate endogenous direct foreign investment. This analysis will appear in a subsequent paper.

so their removal occasions relatively little output adjustment and efficiency gain, regardless of the shape of domestic costs curves.

Trade diversion and creation play an important role in all the experiments, with NAFTA trade increasing by a larger percent in every case than total trade (rows 6-9). The diversion measures in rows 10 and 11 give a normalized index of the extent to which each country's composition of trade has changed between partners.[22] The employment adjustment index (row 12) is a measure of the extent of sectoral labor re-allocation.

The dramatic welfare increases under full liberalization (tariffs plus NTBs) represent as standard general equilibrium response. The removal of significant market distortions stimulates efficiency, reducing real costs and prices, stimulating domestic and external demand and employment, and ultimately fueling a broadly based expansion of domestic production in all three countries. The aggregate income effects of this are so significant that nearly every sector expands in the three countries, almost uniformly outweighing the benefits of prior protection. Thus liberalization appears to be individually rational for most sectors if it can be implemented multilaterally, although this may not have been true for unilateral liberalization. We next turn to a closer examination of sectoral results, with particular attention to the specification of increasing returns and market conduct.

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[22] In the case of imports, for example, the diversion measure is given by $d(m_0, m_1) = 100 * \|m_1/|m_0| - m_0\| / \|m_0\|$, where e.g. $m_1 = (m_{ic}, m_{im}, m_{ir})$ denotes the 3-tuple of partner (for e.g., the U.S.) and ROW imports and $\|.\|$ and $|.|$ denote the Euclidean and simplex norms, respectively.

Table 5.1: Aggregate Effects of North American Liberalization

(Percentages)

		Experiment 1 CRTS, Tariffs Only			Experiment 2 CRTS, Tariffs and NTBs			Experiment 3 IRTS, Cournot			Experiment 4 IRTS, Contestable		
		USA	Canada	Mexico	USA	Canada	Mexico	USA	Canada	Mexico	USA	Canada	Mexico
1	***EV Welfare***	.07	.24	.11	1.67	4.87	2.28	1.58	4.08	2.47	2.55	6.75	3.29
2	***Real GDP***	.06	.38	.13	1.34	7.22	2.27	1.30	5.82	2.57	2.07	10.57	3.38
3	***Employment***	.08	.61	.33	1.88	8.96	1.49	1.79	7.29	1.73	2.47	11.02	2.40
4	***Rental Rate***	.10	.94	.45	2.43	14.50	5.18	2.49	13.57	5.77	3.40	20.74	6.57
5	***Real Exch Rate***	-.09	.69	-.21	-.37	4.51	-3.51	-.25	3.11	-2.71	-1.04	6.89	-4.20
6	***Total Imports***	.36	.64	1.15	8.95	19.54	14.74	8.31	18.71	15.01	12.34	24.18	17.70
7	***Total Exports***	.27	1.20	1.12	8.05	29.43	13.06	7.87	26.25	14.36	10.43	39.83	16.72
8	***NAFTA Imports***	1.33	1.29	1.56	36.13	28.98	21.12	33.71	27.87	21.25	46.44	35.07	23.82
9	***NAFTA Exports***	1.34	1.14	1.99	27.17	42.76	14.23	26.31	39.25	15.51	32.47	55.22	17.29
10	***Import Diversion***	.28	.72	.46	8.03	8.93	6.28	7.47	8.70	6.14	9.82	9.91	5.84
11	***Export Diversion***	.35	.07	1.03	6.07	12.39	1.13	5.84	12.39	1.08	6.90	13.26	.58
12	***Employment Adj***	.01	.18	.18	.71	4.15	4.86	.45	2.28	4.69	.71	3.22	5.21

5.3 *Sectoral Results*

Thus the aggregate results above are intuitive and relatively homogeneous since removing import distortions leads to expanded trade, intensified comparative advantage, and greater efficiency. All these contribute to aggregate welfare, but rarely play a decisive role in the formulation of trade policy. Individual sectors usually seek import protection, so aggregate real income or equivalent variation measures have relatively little to say about the real forces influencing trade policy. In this section, we look into the consequences of North American trade liberalization for individual sectors.

For more detailed discussion, we have chosen to analyze experiments 3 and 4. Both are calibrated to increasing returns as discussed in section 4. Tables 5.2-5.4 present sectoral results for each of the three countries assuming increasing returns sectors are populated with Cournot oligopolists. Such firms price according a markup rule of the form $(P-MC)/P = 1/n\varepsilon$, where n is the number of firms in the sector and ε is the own price elasticity of domestic market demand. The number of firms n is endogenous in the Cournot experiment, and we assume market entry and exit are costless. We also assume that fixed average sectoral profits are maintained before and after liberalization.

The results for full liberalization for the United States (table 5.2) are almost uniformly expansionary, with real output growing several percentage points in most sectors. The strongest expansion is in the transport equipment sector (15.90 percent), which had high levels of prior protection but enjoys a sharp increase in domestic and external demand that more than offsets increased imports. Average costs in this industry drop 2.76 percent, and this leads to price cutting which makes U.S. products more attractive both at home and abroad. The combined price and income effects of liberalization increase domestic real consumption by 18.70 percent while exports to the ROW (E_r), Canada (E_c), and Mexico (E_m) increase by 19.40, 51.80, and 24.20 percent, respectively. Other leading U.S. sectors are Ferrous and Nonferrous metals, Leather, Non Electric Machinery, and Textiles.

The experience of U.S. Transport Machinery is typical of other non service sectors. While the expansionary effects of full liberalization bid up average factor prices, increasing returns outweigh this in 9 of 19 increasing returns sectors. This allows them to price more competitively, expanding domestic demand and export opportunities so that output rises despite increased import penetration (M_r,M_c, and M_m). It is also noteworthy that, despite extensive trade diversion, trade with the Rest of the World still increases in most sectors.

Employment increases in every sector of the economy under this fixed wage scenario, although it would be more realistic to expect some sectoral re-allocation of workers. The composition of employment in the economy does change significantly, since the large nontradable sectors expand employment only about half as much as do manufacturers. Capital is fixed in total supply in these experiments, and is thus re-allocated from sectors which less competitive, both those which contract and those whose prices or costs force them into more labor intensive methods in the face of the capital constraint.

Because of its higher degree of regional trade dependency and higher prior protection levels, Canada's adjustment is considerably more dramatic than that of the U.S.. The same basic processes are driving the adjustment, but this time some sectors expand so dramatically that capital becomes very scarce and over half the expanding sectors are forced to substitute away from it and reduce capital use. This is of course a boon for domestic employment, but is it reasonable to ask whether this degree of transformation to more labor intensive techniques would be feasible. The sectoral output, consumption, and trade results for Canada are similar to the U.S. in qualitative terms, but this economy expands by over twice as much in terms of percentage real GNP. This robust expansion also raises average costs almost across the board, so less scale economies can be realized under Cournot behavior, where firms are entering most of these growing markets.

Mexico's results are in a sense intermediate between the other two (in percentage terms). Expansion is again broadly based, but is more focused on primary and tertiary sectors than is the case for its two industrialized neighbors. Manufacturing capacity does expand in Mexico, especially in Transport Vehicles, but domestic and external demand drive significant relative expansion in Mining, Petroleum, and service infrastructure. Because of its relatively low levels of combined (tariff and NTB) prior protection, Mexico experiences a modest exchange rate appreciation. This is too small to offset the improved pricing of its exports in the liberalized North American region, but it does reduce ROW export demand and thus limits the expansion of domestic output.

One arresting result is the 9 percent contraction of Mexican agriculture, resulting from a combination of increased import penetration by the U.S. and Canada and reduced ROW export opportunities. The problem here is aggravated by constant returns in this sector, which is unable to price competitively in the face of rising factor prices and loses both capital and labor.

The sectoral results for Contestable market pricing are given in tables 5.5-5.7. While these are broadly comparable to the other increasing returns specification, the gains from full liberalization and sectoral output adjustments are about 50 percent higher on average. The Contestable model specifies that the number of firms in each sector is held fixed, market entrance and exit being forestalled by pricing which maintains sectoral profit rates at their base levels. Since the number of firms is fixed, scale economies vary with industry output. Because average factor prices inevitably rise in this expansionary scenario, however, the direction of average total cost depends upon the relative of factor price increase and scale adjustment. Individual sectors do expand more in this experiment, but despite this, average costs are lower in most cases than under Cournot conduct. Of course it is the moderation of average costs which really impels the greater sectoral expansion via competitive pricing and greater demand expansion.

The U.S. economy again expands in 24 of 26 sectors, with the same leading sectors but higher average growth in all sectors. The same qualitative comparability applies to Canada and Mexico, and both countries also expand more robustly than under Cournot competition. Canada experiences dramatic ROW trade growth because of its nearly 7 percent real exchange rate depreciation and very competitive pricing of Transport Vehicles. Given the stronger resource pulls in this country, some sectors have higher average costs under Contestable than under Cournot conduct, but overall the Canadian economy realizes substantial efficiency gains. Mexican agriculture again contracts in the face of regional import penetration and reduced ROW exports, but the remaining sectors of the economy more than compensate for this and additional scale economies realized under Contestable pricing raise aggregate welfare half again as much as under Cournot competition.

To summarize the results of the full liberalization experiments, it is apparent that the closer North America comes to a unified marketplace, the greater will be its manufacturing prowess and self-reliance. All three countries see substantial expansion of their domestic production, even under the capital constraints we have imposed in the model specification. These results also indicate that the potential for trade in this region is far from realization, even when this trade does not crowd out the rest of the world. All three countries exhibit quite substantial trade expansion to nearly all markets, and this new external income fuels broadly based domestic demand expansion and rising welfare.

Table 5.2: Sectoral Results for Full Liberalization, United States

Experiment 3: **Increasing Returns to Scale, Cournot Pricing**

Figures in Percentages

		Real Output	Real Cons	LD	KD	ATC	Mr	Mc	Mm	Er	Ec	Em
1	Agriculture	2.40	.50	3.50	1.80	.68	1.90	12.20	38.90	-1.50	87.90	128.60
2	Mining	2.50	.90	3.30	1.00	.68	2.60	5.70	19.60	1.40	7.00	7.60
3	Petroleum	.30	4.50	2.00	-.20	-.90	-.50	26.30	38.10	.90	20.10	35.00
4	Food Processing	1.10	.70	1.90	.09	.30	1.00	10.70	8.90	.70	21.60	37.60
5	Beverages	.50	.90	1.20	-.50	-.10	.50	20.90	19.30	.40	9.40	43.40
6	Tobacco	-.60	-.20	.60	-1.10	1.41	1.40	33.00	10.80	-1.90	3.10	.50
7	Textiles	3.10	1.10	3.70	1.40	.10	2.40	7.40	43.60	2.70	39.70	5.40
8	Apparel	.80	.80	1.40	-.80	.00	.90	6.20	4.80	.50	7.80	4.10
9	Leather	4.00	1.30	4.90	2.60	1.06	1.70	16.40	1.70	2.30	53.30	5.90
10	Paper	1.30	.90	2.00	-.20	.20	1.50	1.10	1.60	.60	4.50	28.20
11	Chemical	1.80	1.10	2.90	.70	.10	1.80	12.20	4.80	1.40	10.70	6.70
12	Rubber	3.20	1.40	3.90	1.60	-.10	3.00	19.10	3.30	3.10	13.90	4.60
13	NonMetMinProd	1.90	1.10	2.50	.30	-.10	1.80	4.20	28.00	1.70	13.70	9.80
14	Iron and Steel	5.20	3.60	5.30	3.40	-.48	3.30	38.40	41.80	5.40	51.90	25.50
15	NonFer Metals	4.30	2.30	4.70	2.80	-.38	3.70	8.20	.30	4.60	16.50	7.70
16	WoodMetal Prod	2.60	.90	2.90	.90	-.19	2.40	8.20	6.50	2.50	12.90	5.20
17	NonElec Mach	3.40	1.70	3.80	2.00	-.19	2.90	6.90	4.00	3.20	5.70	8.50
18	Electrical Mach	1.90	.80	2.30	.40	.10	1.90	9.00	4.20	1.40	7.80	6.30
19	Transport Eqp	15.90	18.70	16.50	14.10	-2.76	5.60	71.30	15.90	19.40	51.80	24.20
20	Other Manufact	1.70	1.50	2.40	.60	.29	1.70	4.20	11.00	.90	10.70	9.50
21	Construction	.90	.90	1.20	-1.00	.10				.70		
22	Electricity	.90	.50	1.80	.50	.50	2.10			-.02		
23	Commerce	.90	.30	1.40	-.60	.59				-.20		
24	TransptCommun	.90	.50	1.40	.10	.40	2.00			.20		
25	FinInsRlEstate	-.20	-.50	1.20	-.80	1.40	2.40			-2.20		
26	Other Services	.80	.60	1.20	-.80	.30	1.70			-.01		

Table 5.3: Sectoral Results for Full Liberalization, Canada

Experiment 3: **Increasing Returns to Scale, Cournot Pricing**
Figures in Percentages

		Real Output	Real Cons	LD	KD	ATC	Mr	Mu	Mm	Er	Eu	Em
1	Agriculture	-6.30	2.60	-.08	-9.40	5.02	-3.20	87.90	93.10	-12.60	12.20	145.00
2	Mining	6.20	-1.70	12.70	.50	6.40	11.70	7.00	4.60	2.20	5.70	7.20
3	Petroleum	13.60	5.90	21.70	9.10	5.72	5.40	20.10	12.90	11.10	26.30	
4	Food Processing	1.70	3.20	7.00	-7.00	2.26	-.07	21.60	26.70	2.20	10.70	32.90
5	Beverages	2.60	.90	9.60	-4.70	4.68	1.20	9.40	9.10	.30	20.90	
6	Tobacco	.50	.10	9.40	-4.90	5.57	2.10	3.10	.00	-1.30	33.00	.00
7	Textiles	1.40	8.40	5.30	-8.50	-.59	-3.40	39.70	47.70	6.80	7.40	5.90
8	Apparel	4.50	3.80	7.20	-6.80	-.77	2.30	7.80	7.10	9.70	6.20	6.60
9	Leather	4.50	6.70	6.50	-7.40	.38	.70	53.30	17.70	7.90	16.40	
10	Paper	1.40	1.20	6.80	-7.20	4.14	3.10	4.50	1.40	.10	1.10	35.90
11	Chemical	5.00	2.00	12.80	-2.00	4.48	6.00	10.70	6.90	3.00	12.20	7.80
12	Rubber	14.90	3.70	18.30	2.80	1.91	12.20	13.90	5.20	16.70	19.10	8.80
13	NonMetMinProd	6.50	2.00	12.50	-2.20	3.57	7.30	13.70	7.00	6.00	4.20	6.30
14	Iron and Steel	19.70	10.30	24.00	7.80	2.17	13.50	51.90	60.40	21.40	38.40	10.40
15	NonFer Metals	16.20	-1.50	23.80	7.60	4.22	21.90	16.50	11.10	14.40	8.20	8.70
16	WoodMetal Prod	7.50	2.80	9.90	-.90	1.95	5.90	12.90	8.40	9.40	8.20	5.60
17	NonElec Mach	6.90	3.90	9.60	-.20	1.96	5.10	5.70	5.80	8.60	6.90	10.90
18	Electrical Mach	7.40	1.80	10.20	.30	2.89	6.50	7.80	7.40	7.70	9.00	11.30
19	Transport Eqp	55.00	32.20	59.20	42.50	-4.45	18.90	51.80	68.10	69.70	71.30	31.70
20	Other Manufact	5.20	5.70	7.40	-2.20	2.19	4.90	10.70	10.70	6.50	4.20	7.00
21	Construction	2.30	2.20	3.80	-2.60	3.03	.00			.00		
22	Electricity	1.60	-3.60	4.50	.60	8.96	11.00			-4.80		
23	Commerce	3.10	1.80	4.10	.20	3.39	3.60			2.80		
24	TransptCommun	3.40	.70	4.90	.90	4.35	5.70			2.00		
25	FinInsRlEstate	1.70	.40	5.70	-4.60	5.01	4.60			-.50		
26	Other Services	2.00	-.80	8.30	-2.20	6.18	6.80			-1.60		

Table 5.4: Sectoral Results for Full Liberalization, Mexico

Experiment 3: **Increasing Returns to Scale, Cournot Pricing**
Figures in Percentages

		Real Output	Real Cons	LD	KD	ATC	Mr	Mu	Mc	Er	Eu	Ec
1	**Agriculture**	-9.10	4.80	-5.20	-9.90	1.54	-4.80	128.60	145.00	-22.40	38.90	93.10
2	**Mining**	3.90	-.20	7.60	2.30	2.89	10.60	7.60	7.20	-2.90	19.60	4.60
3	**Petroleum**	19.40	11.80	24.70	18.80	.08	11.50	35.00		16.40	38.10	12.90
4	**Food Processing**	.90	3.90	4.30	.20	-.50	2.70	37.60	32.90	-.90	8.90	26.70
5	**Beverages**	2.70	1.70	5.80	1.70	.49	3.10	43.40		-2.20	19.30	9.10
6	**Tobacco**	2.00	1.80	5.20	1.10	-.49		.50	.00	.30	10.80	.00
7	**Textiles**	3.70	2.10	7.40	2.10	1.83	5.30	5.40	5.90	-2.80	43.60	47.70
8	**Apparel**	1.80	1.50	5.70	.50	1.77	4.70	4.10	6.60	-3.50	4.80	7.10
9	**Leather**	1.20	1.60	4.60	-.50	1.88		5.90		-4.00	1.70	17.70
10	**Paper**	-.30	12.90	3.70	-1.40	-2.11	-.08	28.20	35.90	-1.20	1.60	1.40
11	**Chemical**	2.00	4.10	6.10	.90	.29	4.10	6.70	7.80	-2.20	4.80	6.90
12	**Rubber**	1.70	3.50	5.50	.30	.88	4.30	4.60	8.80	-2.90	3.30	5.20
13	**NonMetMinProd**	1.30	-.10	5.40	.20	3.26	6.60	9.80	6.30	-5.90	28.00	7.00
14	**Iron and Steel**	7.20	9.10	10.50	6.00	1.12	5.30	25.50	10.40	1.50	41.80	60.40
15	**NonFer Metals**	1.70	2.30	5.00	.70	2.46	6.30	7.70	8.70	-6.00	.30	11.10
16	**WoodMetal Prod**	3.30	2.70	6.80	2.10	.19	4.20	5.20	5.60	-1.40	6.50	8.40
17	**NonElec Mach**	6.20	6.60	9.40	4.90	-.94	8.00	8.50	10.90	3.60	4.00	5.80
18	**Electrical Mach**	3.80	6.10	6.70	2.40	-2.02	2.70	6.30	11.30	2.90	4.20	7.40
19	**Transport Eqp**	17.20	19.40	21.30	15.50	-5.12	12.80	24.20	31.70	20.70	15.90	68.10
20	**Other Manufact**	7.50	6.40	11.20	6.70	1.58	7.10	9.50	7.00	1.30	11.00	10.70
21	**Construction**	1.80	1.80	3.60	-1.50	1.18						
22	**Electricity**	6.10	.50	8.20	5.00	2.36						
23	**Commerce**	.20	-1.80	3.90	-.60	4.59						
24	**TransptCommun**	2.10	-.30	4.30	1.40	3.13						
25	**FinInsRlEstate**	.01	-1.30	3.60	-1.00	4.09						
26	**Other Services**	2.50	.70	4.60	.03	2.15						

Table 5.5: Sectoral Results for Full Liberalization, United States

Experiment 4: **Increasing Returns to Scale, Contestable Pricing**

Figures in Percentages

		Real Output	Real Cons	LD	KD	ATC	Mr	Mc	Mm	Er	Ec	Em
1	**Agriculture**	2.10	.60	3.70	1.30	1.18	4.00	15.20	37.80	-5.90	88.90	130.30
2	**Mining**	3.90	1.70	5.00	1.90	.58	4.60	10.20	19.30	1.70	10.30	9.90
3	**Petroleum**	.50	5.40	2.80	-.10	-.80	.40	31.50	41.00	.30	21.30	36.70
4	**Food Processing**	1.40	1.20	2.50	.07	.30	2.10	13.20	8.40	.40	21.80	38.70
5	**Beverages**	.80	1.20	1.80	-.60	-.10	1.10	22.30	19.30	-.50	9.90	44.40
6	**Tobacco**	-.90	-.30	.80	-1.60	2.12	2.80	34.60	10.50	-3.30	2.30	.70
7	**Textiles**	4.70	2.00	5.50	2.30	-.57	4.20	11.60	44.50	4.00	42.40	7.00
8	**Apparel**	1.50	1.60	2.20	-.80	-.30	1.80	8.20	5.10	.60	8.50	5.20
9	**Leather**	5.80	2.90	7.20	4.00	.00	3.00	20.80	1.40	4.70	56.40	8.40
10	**Paper**	1.90	1.80	2.80	-.20	.00	2.70	4.70	.40	.30	5.50	29.70
11	**Chemical**	2.50	1.80	4.00	.90	.00	3.40	16.60	4.60	1.10	13.40	7.90
12	**Rubber**	5.00	2.70	6.00	2.80	-.57	5.20	28.20	3.80	4.50	17.90	6.40
13	**NonMetMinProd**	3.00	2.10	3.80	.70	-.49	3.30	10.90	27.80	2.40	15.20	11.60
14	**Iron and Steel**	8.50	6.20	8.70	6.10	-1.66	5.70	50.30	45.40	9.60	60.70	28.60
15	**NonFer Metals**	6.90	5.00	7.40	4.80	-1.50	5.70	14.50	.50	7.60	25.00	10.20
16	**WoodMetal Prod**	4.10	1.80	4.60	1.80	-.58	4.20	13.50	7.20	3.50	15.60	6.60
17	**NonElec Mach**	5.50	3.40	6.10	3.50	-.76	5.10	12.70	5.60	5.10	8.60	10.90
18	**Electrical Mach**	2.90	1.50	3.50	1.00	-.19	3.60	14.20	4.90	1.80	10.10	7.40
19	**Transport Eqp**	25.70	28.50	26.60	23.00	-6.52	9.40	100.10	21.80	34.60	66.60	33.20
20	**Other Manufact**	2.80	2.90	3.80	1.30	.10	3.20	7.00	12.00	1.20	12.80	11.40
21	**Construction**	1.50	1.60	2.00	-1.10	.00				1.00		
22	**Electricity**	1.40	1.00	2.60	.80	.79	4.30			-.90		
23	**Commerce**	1.40	.70	2.20	-.50	.89				-.80		
24	**TransptCommun**	1.40	.90	2.00	.30	.49	4.10			-.50		
25	**FinInsRlEstate**	-.02	-.40	1.90	-.80	1.92	4.70			-3.50		
26	**Other Services**	1.30	1.00	1.90	-.80	.49	3.70			-.60		

Table 5.6: Sectoral Results for Full Liberalization, Canada

Experiment 4: **Increasing Returns to Scale, Contestable Pricing**

Figures in Percentages

		Real Output	Real Cons	LD	KD	ATC	Mr	Mu	Mm	Er	Eu	Em
1	Agriculture	-3.30	3.00	6.30	-8.00	8.58	-.80	88.90	92.10	-9.00	15.20	154.80
2	Mining	12.80	-1.10	23.30	4.10	9.84	17.90	10.30	6.30	9.20	10.20	12.10
3	Petroleum	18.90	9.80	31.70	11.90	5.21	7.80	21.30	16.30	20.60	31.50	
4	Food Processing	3.80	4.50	11.90	-9.10	4.53	.60	21.80	25.80	5.50	13.20	36.60
5	Beverages	3.90	1.80	14.50	-6.90	6.83	1.90	9.90	9.20	4.00	22.30	
6	Tobacco	1.20	.60	14.60	-6.80	8.79	2.10	2.30	.00	-.30	34.60	.00
7	Textiles	6.00	9.60	12.00	-8.90	1.04	-1.10	42.40	49.30	14.60	11.60	10.30
8	Apparel	6.50	5.40	10.70	-10.10	1.03	3.30	8.50	7.40	14.50	8.20	9.60
9	Leather	9.00	7.80	12.00	-9.00	2.02	2.50	56.40	17.70	15.00	20.80	
10	Paper	5.90	3.80	14.20	-7.20	5.85	4.90	5.50	.50	7.30	4.70	41.00
11	Chemical	10.90	3.30	23.30	.20	6.94	10.70	13.40	8.50	10.90	16.60	11.80
12	Rubber	26.00	7.10	31.40	6.80	1.83	18.20	17.90	7.50	34.00	28.20	15.90
13	NonMetMinProd	14.20	5.40	23.80	.60	3.59	9.50	15.20	7.10	18.60	10.90	12.80
14	Iron and Steel	33.30	15.40	40.30	14.00	1.05	21.30	60.70	68.90	44.30	50.30	18.40
15	NonFer Metals	28.10	-.01	40.70	14.30	6.17	34.00	25.00	17.00	29.50	14.50	14.60
16	WoodMetal Prod	14.10	4.80	17.80	1.10	2.98	9.30	15.60	10.10	20.80	13.50	9.80
17	NonElec Mach	14.00	6.30	18.40	3.00	3.33	8.60	8.60	8.10	19.50	12.70	16.30
18	Electrical Mach	13.60	3.00	18.00	2.70	4.49	10.30	10.10	9.30	17.00	14.20	15.60
19	Transport Eqp	83.70	44.00	91.20	62.40	-11.27	27.70	66.60	80.20	129.80	100.10	51.00
20	Other Manufact	8.90	7.50	12.40	-2.30	4.22	7.60	12.80	12.60	13.00	7.00	10.30
21	Construction	5.00	4.80	7.30	-2.30	4.95	0			0		
22	Electricity	4.70	-3.60	9.10	3.10	13.66	15.5			-2.7		
23	Commerce	6.60	4.50	8.10	2.10	5.25	4.00			8.50		
24	TransptCommun	7.70	2.60	9.90	3.90	6.69	7.30			7.90		
25	FinInsRlEstate	4.60	2.20	10.70	-4.80	7.65	5.70			3.80		
26	Other Services	4.90	.40	14.60	-1.40	9.53	9.00			1.90		

Table 5.7: Sectoral Results for Full Liberalization, Mexico

Experiment 4: **Increasing Returns to Scale, Contestable Pricing**

Figures in Percentages

		Real Output	Real Cons	LD	KD	ATC	Mr	Mu	Mc	Er	Eu	Ec
1	**Agriculture**	-9.60	5.10	-5.30	-10.60	1.88	-1.00	130.30	154.80	-28.50	37.80	92.10
2	**Mining**	4.10	-.60	8.30	2.20	3.65	14.10	9.90	12.10	-5.40	19.30	6.30
3	**Petroleum**	23.20	15.20	29.40	22.50	-2.19	14.30	36.70		20.90	41.00	16.30
4	**Food Processing**	.70	4.10	4.60	-.01	.20	4.90	38.70	36.60	-2.60	8.40	25.80
5	**Beverages**	2.80	1.90	6.40	1.70	.78	4.70	44.40		-4.80	19.30	9.20
6	**Tobacco**	2.10	1.90	5.70	1.00	-.10		.70	.00	-1.20	10.50	.00
7	**Textiles**	4.30	3.10	8.50	2.50	1.44	7.20	7.00	10.30	-3.80	44.50	49.30
8	**Apparel**	2.30	2.10	6.80	.80	1.86	6.70	5.20	9.60	-4.90	5.10	7.40
9	**Leather**	1.50	2.10	5.30	-.50	2.17		8.40		-5.90	1.40	17.70
10	**Paper**	-.70	12.90	3.90	-1.90	-.70	1.90	29.70	41.00	-5.60	.40	.50
11	**Chemical**	2.10	4.70	6.70	.80	.78	5.90	7.90	11.80	-4.80	4.60	8.50
12	**Rubber**	2.30	4.60	6.70	.70	1.08	6.30	6.40	15.90	-4.40	3.80	7.50
13	**NonMetMinProd**	1.80	.20	6.60	.70	3.83	9.10	11.60	12.80	-7.70	27.80	7.10
14	**Iron and Steel**	9.60	12.90	13.40	8.20	-.91	7.10	28.60	18.40	4.40	45.40	68.90
15	**NonFer Metals**	2.10	3.30	6.00	1.10	3.13	8.50	10.20	14.60	-8.60	.50	17.00
16	**WoodMetal Prod**	4.00	3.60	8.10	2.70	.10	5.80	6.60	9.80	-2.80	7.20	10.10
17	**NonElec Mach**	8.10	9.00	11.80	6.60	-1.67	10.70	10.90	16.30	4.20	5.60	8.10
18	**Electrical Mach**	4.50	7.50	7.80	2.80	-2.78	4.00	7.40	15.60	2.40	4.90	9.30
19	**Transport Eqp**	23.50	27.10	28.40	21.50	-7.61	17.80	33.20	51.00	29.00	21.80	80.20
20	**Other Manufact**	8.80	8.40	13.10	7.90	1.19	9.50	11.40	10.30	.70	12.00	12.60
21	**Construction**	2.60	2.60	4.70	-1.10	1.17						
22	**Electricity**	7.50	1.00	9.90	6.30	2.60						
23	**Commerce**	.70	-1.70	4.90	-.30	5.26						
24	**TransptCommun**	2.90	.10	5.30	2.00	3.50						
25	**FinInsRlEstate**	.40	-1.20	4.50	-.70	4.78						
26	**Other Services**	3.30	1.20	5.70	.50	2.42						

6. Conclusions and Extensions

With this paper we intended to fulfill two objectives, to assemble an extended dataset on economic structure and protection patterns for the North American economies, and to implement a general equilibrium simulation model with this information. Although the present work is preliminary, we have assembled a large body of relevant data and used it to obtain some initial estimates on economic adjustment to a more liberal North American trade regime.

A detailed three-country SAM has been constructed for 1988 and it was used to analysis the composition of production, demand, income, and trade among the United States, Canada, and Mexico. Generally speaking, our results bear out conventional wisdom about these economies. The U.S. is the largest and most self-sufficient member at the center of a regional economy. Canada is a relatively affluent and industrialized country like the U.S., but is more dependent on bilateral trade and less diverse in domestic structure and trade. Mexico is distinctive for its large subsistence sector, low value added shares for labor across the economy, and even higher trade dependency and less diversity.

The information presented on North American protection patterns indicates that tariff distortions are moderate by world standards. Extensive data on NTBs between the three countries indicates that these are now operating in most sectors of the economy, however, and their coverage in many is large enough to imply serious distortions of prices and trade patterns. Price comparison data also support the view that North American tradable prices are far more distorted than tariff levels alone would imply.

To test the real significance of tariff and non-tariff distortions, we simulated a variety of liberalization scenarios with a calibrated general equilibrium model. Our results indicate that the North American economies each have much to gain from more liberal regional trade relations. The size of the potential gains depends primarily on two factors, the extent of real liberalization and the extent to which the adjustment process realizes economies of scale in production. Liberalization of tariffs alone would have a relatively minor effect, although some efficiency gains would accrue to all three countries. If a fuller liberalization were undertaken to include non-tariff barriers, aggregate welfare gains might increase by more than tenfold in all three countries. Using the data we have assembled on base year scale economies, we estimate that scale economies apparently have the potential to increase these gains by another 50 percent or more.

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APPENDIX 2: Sectoring Scheme for the Model and Database

Table A2.1 Agriculture and Manufacturing Sectors for the CGE Model

CGE Sectors	*Three-digit SITC (Revision 2)*
1 **Agriculture**	001, 031, 041, 043, 044, 045, 051, 054, 221, 261, 262, 263, 264, 265, 291, 292
2 **Mining**	272, 273, 274, 275, 276, 281, 283, 285, 286, 321
3 **Petroleum**	331, 332, 341
4 **Food Processing**	011, 012, 013, 022, 023, 024, 025, 032, 042, 046, 047, 048, 052, 053, 055, 061, 062, 071, 072, 073, 074, 075, 081, 091, 099, 411, 412, 421, 422, 431
5 **Beverages**	111, 112
6 **Tobacco**	121, 122
7 **Textiles**	267, 651, 652, 653, 654, 655, 656, 657
8 **Apparel**	841, 842
9 **Leather**	211, 212, 611, 612, 613, 831, 851
10 **Paper**	251, 641, 642, 892
11 **Chemical**	271, 511, 512, 513, 514, 515, 521, 531, 532, 533, 541, 551, 552, 553, 554, 561, 571, 599
12 **Rubber**	231, 266, 581, 621, 629, 893
13 **NonMetMinProd**	661, 662, 663, 664, 665, 666, 667
14 **Iron and Steel**	282, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679
15 **NonFer Metals**	284, 681, 682, 683, 684, 685, 686, 687, 688, 689
16 **WoodMetal Prod**	241, 242, 243, 244, 631, 632, 633, 691, 692, 693, 694, 695, 696, 697, 698, 699, 812, 821
17 **NonElec Mach**	711, 712, 714, 715, 716, 717, 718, 719, 861, 862
18 **Electrical Mach**	721, 722, 723, 724, 725, 726, 729, 891
19 **Transport Eqp**	731, 732, 733, 734, 735
20 **Other Manufact**	863, 864, 894, 895, 896, 897, 899

APPENDIX 3 - Definitions and Sectoring for Non-tariff Estimates

Table A3.1: NTM Classification Scheme

The Ten NTM Categories of Tables 3.3-3.5 were constructed from four-digit UNCTAD classificiations of NTMs as follows:

1.	ALL NTBs	1, 2, 3, 4, 5, 6, 7, 8
2.	BROAD	3, 4, 5, 60, 61, 62, 63, 6400, 6410, 6420, 6430, 7, 81, 8820
3.	NARROW	21, 26, 3, 60, 61, 62, 6430, 7
4.	AD.CV ACT	25, 63, 6400, 6410, 6420
5.	NAL/Q 3	
6.	AL	4
7.	PRICE ACT	25, 26, 60, 61, 62, 63, 6400, 6410, 6420
8.	QUANT RESTR	3, 7
9.	TEXT RESTR	35, 36
10.	VERs	34, 6430

The UNCTAD-GATT Four-digit NTM Categories Follow	
TARIFF QUOTA	1140
TARIFF QUOTA / AD VALOREM	1141
TARIFF QUOTA / SPECIFIC	1142
SEASONAL TARIFFS	1150
SEASONAL TARIFFS / AD VALOREM	1151
SEASONAL TARIFFS / SPECIFIC	1152
INCREASED TARIFFS	1171
INCREASED TARIFFS / RETALIATION	1172
INCREASED TARIFFS / OTHER	1179
PREFERENTIAL RATES	1190
PREF. RATES / UNDER TARIFF QUOTA	1191
ADDITIONAL FISCAL CHARGES	2100
CUSTOMS SURCHARGES	2110
AD VALOREM CHARGES	2111
SPECIFIC CHARGES	2112
SPECIAL TAXES (PRODUCT SPECIFIC)	2200
INTERNAL TAXES LEVIED ON IMPORTS	2300
EXCISE TAX	2340
EXCISE TAX APPLIED TO SEL PRODUCTS	2342
COMMODITY TAX (TROPICAL PRODUCTS)	2370
ANTI-DUMPING DUTIES	2510
COUNTERVAILING DUTIES	2520
VARIABLE LEVY	2610
VARIABLE COMPONENT	2620
FLEXIBLE IMPORT FEES	2640
NON-AUTOMATIC LICENSING	3100
LICENCE	3111
DISCRETIONARY LICENCE	3112
IMPORT PERMIT	3114
IMPORT RESTRICTED TO SEL.PURCHASERS	3140
DEPENDENT ON PURCHASE OF LOCAL GOODS	3150
IMPORT AUTHORIZATION	3170
SEASONAL RESTRICTION, UNSPECIFIED	3190
QUOTAS	3200

GLOBAL QUOTA (UNALLOCATED)	3210
GLOBAL QUOTA (ALLOCATED)	3220
BILATERAL QUOTA	3230
SEASONAL QUOTA	3240
PROHIBITIONS	3300
TOTAL PROHIBITIONS	3310
SUSPENSION OF ISSUANCE OF LICENCES	3320
TEMPORARY PROHIBITIONS	3340
PROHIBITION ON THE BASIS OF ORIGIN	3350
EMBARGO	3360
"VOLUNTARY" EXPORT RESTRAINT	3410
"VOLUNTARY" EXPORT RESTRAINT	3415
ORDERLY MARKETING ARRANGEMENT	3420
MFA RESTRAINT AGREEMENT	3500
MFA QUOTA AGREEMENT	3511
MFA QUOTA	3512
MFA QUOTA / EXPORT RESTRAINT	3513
MFA QUOTA / IMPORT RESTRAINT	3514
MFA QUOTA / EXPORT CONTROL	3515
MFA CONSULTATION AGREEMENT	3521
MFA CONSULTATION	3522
TEXTILES RESTRAINT AGREEMENT	3600
TEXTILES QUOTA	3612
TEXT. AGR./ QUOTA/ EXPORT RESTRAINT	3613
TEXT. AGR./ QUOTA/ IMPORT RESTRAINT	3614
TEXTILES CONSULTATION AGREEMENT	3621
TEXTILES CONSULTATION	3622
QUANT. RESTRICTION (METHOD UNSPEC.)	3900
QUANT. RESTRICTION (NAL AND/OR QUOTA)	3910
QUANT. RESTR. (REG. (EEC) 3420/83)	3920
SEASONAL RESTRICTION, UNSPECIFIED	3930
QUANT. RESTR. WITHOUT LIM.OF QUANT.	3990
AUTOMAT. LICENSING AND IMPORT SURV.	4000
AUTOMATIC LICENSING	4100
OPEN GENERAL LICENSING	4110
AUTOMATIC LICENSING	4120
LIBERAL LICENCES	4130
IMPORT SURVEILLANCE	4200
SURVEILLANCE LICENCE	4210
IMPORT MONITORING	4220
RETROSPECTIVE SURVEILLANCE	4230
COMMUNITY SURVEILLANCE	4240
INTRA-COMMUNITY SURVEILLANCE	4250
MFA SURVEILLANCE AGREEMENT	4311
MFA SURVEILLANCE	4312
MFA ADMIN CO-OPERATION AGREEMENT	4320
MFA EXPORT AUTHORIZATION SYSTEM	4330
TEX EXPORT AUTHORIZATION SYSTEM	4430
ADVANCE IMPORT DEPOSITS	5100
ADVANCE PAYMENT OF CUSTOMS DUTIES	5200
PRICE CONTROLS	6000
MINIMUM PRICES	6100
MINIMUM PRICES	6110
REFERENCE PRICES	6120
BASIC IMPORT PRICES	6130
TRIGGER PRICES	6140
PRICE SURVEILLANCE	6200
ANTI-DUMPING INVESTIGATION	6310

COUNTERVAILING DUTY INVESTIGATION	6320
UNDERTAKING	6400
UNDERTAKING (ANTI-DUMPING CASE)	6410
UNDERTAKING (CVD CASE)	6420
"VOLUNTARY" EXPORT PRICE RESTRAINT	6430
STATE MONOPOLY OF IMPORTS	7110
SOLE IMPORTING AGENCY	7120
OTHER IMPORT MEASURES	8000
ADDITIONAL CUSTOMS FORMALITIES	8130
ENTRY CONTROL MEASURES N.E.S.	8190
CUSTOMS VALUATION	8510
CUSTOMS VALUATION / BASIC PRICE	8511
CUSTOMS VALUATION / REFERENCE PRICE	8512
HEALTH AND SAFETY REGULATIONS	8710
HEALTH AND SAF. REG./ PROHIBITION	8711
HEALTH AND SAF. REG./ OTHER REGUL.	8712
HEALTH AND SAF. REG./ CERTIFICATION	8713
HEALTH AND SAF. REG./ QUARANTINE)	8714
TECHNICAL STANDARDS	8720
TECHNICAL STANDARDS / PROHIBITION	8721
TECHNICAL STANDARDS / OTH REGULATIONS	8722
TECHNICAL STANDARDS / CERTIFICATION	8723
MARKING, PACKING REQUIREMENTS	8730
MARKING, PACKING REQ. / PROHIBITION	8731
MISC. REGUL./ NON-COMMERCIAL PURPOSES	8790
PROHIBITION / NON COMMERCIAL PURPOSES	8791
MISC. REGULATIONS / CERTIFICATION	8793
LOCAL CONTENT	8820

APPENDIX 4: Sources for Quota Premia Estimates

This appendix describes the sources for quota premia estimates of non-tariff barriers within North America. We consider the 20 merchandise sectors of the model.

1. Agriculture

Ten Kate and de Mateo Venturini (1989) report that over 60 percent of Mexican agricultural production was covered by import licenses in May 1988 (Table 7 of that study). These licenses are used to maintain domestic farm prices. The United States General Accounting Office (1990) reports: "The Mexican government sets quotas for almost all major imported agricultural commodities. These quotas are set by estimating the size of the domestic harvest and the amount of imports necessary to bridge the gap between domestic production and demand. Import licenses are the mechanism used to enforce these quotas" (p. 11). We assume an ad valorem tariff equivalent rate of 10 percent for these quotas. Since the importation rights are held by domestic importers, we assume that the quota rents accrue to Mexico. The United States also has a number of quotas on agricultural products. However, a weighted average of ad valorem equivalents given in Reinert and Roland-Holst (April 1991) for the agricultural sector as a whole and all U.S. trade partners in aggregate turns out to be very close to zero. Since this is for all import sources and may ignore some specific restraints to trade with Mexico (perhaps fresh vegetables, cotton, and sugar), we assume an ad valorem tariff equivalent of 5 percent for this sector. Many U.S. agricultural quotas (including cotton and sugar) are allocated abroad, so we assume that the quota rents accrue to Mexico. There is evidence that U.S. exports of poultry, eggs, milk, and grains into Canada were restricted with non-tariff barriers (Morici 1989). To reflect this, we assume an ad valorem equivalent of 2 percent for agriculture, with the rents accruing to U.S. exporters.

2. Mining

We have found no evidence of the presence of significant non-tariff barriers against mining product trade in North American.

3. Petroleum

Ten Kate and de Mateo Venturini (1989) report that 100 percent of Mexican petroleum production and 87 percent of Mexican petroleum product production are covered by import licenses. However, the U.S. International Trade Commission (February 1991) reports no impediments to energy product trade between Mexico and the United States other than the ban on foreign investment in Mexico's petroleum sector. There do not appear to be any impediments to the export of U.S. natural gas to Mexico. For this reason, we assume that there are no non-tariff barriers in this sector.

4. Food Processing

There is evidence that U.S. exports of dairy products and meat into Canada were restricted with non-tariff barriers (Morici 1989). To reflect this, we assume an ad valorem equivalent of 1 percent for food processing as a whole, with rents accruing to U.S. exporters. In our base year, the U.S. imposed restrictions on Canadian sugar-containing products (Morici 1989). To reflect this, we assume an ad valorem equivalent of 1 percent for food processing as a whole, with the rents accruing to Canadian exporters. Mexican exports of beef and sugar products to the United States are subject to quantitative restrictions (United States General Accounting Office, 1990). We assume an ad valorem equivalent of 2 percent for the food processing sector as a whole with the rents accruing to Mexican exporters.

5. Beverages

With regard to beverages, there is evidence that Canadian wholesalers and retailers discriminated against U.S. liquor, wine, and beer (Morici 1989). In the case of liquor and wine, these practices will not be addressed by the Canada-U.S. FTA until 1995, and in the case of beer, they will not be addressed. However, modeling these practices as a quota is probably not correct. For this reason, we ignore them.

6. Tobacco

In the case of tobacco, Ten Kate and de Mateo Venturini (1989) reported that 100 percent of Mexican tobacco production was covered by import licenses. We assume an ad valorem equivalent of 10 percent to account for these restrictions. Quota rents are assumed to accrue domestically.

7. Textiles

In the case of textiles, the United States has significan non-tariff barriers. The U.S. International Trade Commission (September 1991) used an estimate of the ad valorem equivalent rate of 10 percent for textiles. We assume this rate applies against Mexico. Textile quota rights are allocated abroad, so we assume that the rents accrue to Mexico.

8. Apparel

In the case of apparel, the United States again has significant non-tariff barriers. The U.S. International Trade Commission (September 1991) used an estimate of the ad valorem equivalent rate of 30 percent for apparel. We assume this rate applies against Mexico. Apparel quota rights are allocated abroad, so we assume that the rents accrue to Mexico. Erzan, Krishna, and Tan (1991) find evidence of rent sharing in the MFA, but it is not clear that this applies to the U.S.-Mexico case.

9. Leather

We have found no evidence of the presence of significant non-tariff barriers against leather product trade in North American.

10. Paper

We have found no evidence of the presence of significant non-tariff barriers against paper product trade in North American.

11. Chemicals

Although Ten Kate and de Mateo Venturini (1989) report a low percent of the Mexican chemical industry being covered by import licenses in 1988, U.S. International Trade Commission (February 1991) report the practice in Mexico of "registration procedures for various specialty chemicals and chemical products viewed as arbitrary and discriminatory toward U.S. exporters" (p. 4-25). For this reason, we set an ad valorem equivalent of 2 percent with rents accruing to U.S. exporters.

12. Rubber

We have found no evidence of the presence of significant non-tariff barriers against rubber and plastic product trade in North American.

13. Nonmetalic Mineral Products

We have found no evidence of the presence of significant non-tariff barriers against nonmetalic mineral product trade in North American.

14. Iron and Steel

Steel quotas are difficult to assess. The U.S. International Trade Commission (1989) found that these quotas were not binding in 1988. Trela and Whalley (1991) argue, however, that "there are... reasons why binding quotas can seem to be non-binding and hence imply difficulties of interpretation of this data" (p. 6). Trela and Whalley assume that the U.S. steel quotas against Mexico are "fully binding". The U.S. International Trade Commission (February 1991) reported: "Mexican steel exports to the United States are subject to a VRA that has imposed a ceiling on the shipments since February 1985. Recent negotiations have more than doubled Mexico's export quota, scheduled to expire in March 1992. In return for agreeing to limit its exports, Mexico was granted a degree of protection of U.S. unfair trade laws while the VRA remained in effect. A number of anitdumping and countervailing duty cases were terminated to bring the VRA into effect" (p. 4-37). In light of this evidence, we assume an ad valorem equivalent rate of 5 percent with the quota rents accruing to Mexican exporters.

15. Nonferrous Metals

We have found no evidence of the presence of significant non-tariff barriers against nonferrous metal product trade in North American.

16. Wood and Metal Products

We have found no evidence of the presence of significant non-tariff barriers against wood and metal product trade in North American.

17. Nonelectrical Machinery

Mexican import licensing in the nonelectrical machinery sector appear to have been reduced significtly and almost completely between 1980 and 1988 (Ten Kate and de Mateo Venturini, 1989). For this reason, we assume that there are no nontariff barriers to trade in nonelectrical machinery in North America.

18. Electrical Machinery

Similarly, Mexican import licensing in the electrical machinery sector appear to have been reduced significtly and almost completely between 1980 and 1988 (Ten Kate and de Mateo Venturini, 1989). For this reason, we assume that there are no nontariff barriers to trade in nonelectrical machinery in North America.

19. Transportation Equipment

The Mexican transportation equipment sector benefits from significant non-tariff protection. Lo'pez-de-Silanes (1991) reports: "Automobile production ranks third after oil and tobacco in an index of import licensing coverage over domestic production.... (T)he auto parts sector became more open to international competition than the average of the economy, obtaining an index of 12.9 percent in 1988. The opposite condition applies to vehicle production, which in 1988 remained closed with 95.1 percent of import licenses over domestic production.... The commercial protection extended to auto makers and the restrictions affecting cost structures create high domestic car prices well above international levels. The price differential has two components: regulation and taxes. Although tax differences are certainly important, some studies have indicated that, after adjusting the tax differential between Mexico and the United States, the price of Mexican passenger cars was about 40 percent above prices of similar cars in the United States." Based on this evidence, we assume an ad valorem equivalent of 40 percent for the transportation equipment sector as a whole. Rents from the licenses are assumed to accrue to domestic importers.

20. Other Manufacturing

We assume that there are no non-tariff barriers on the other manufacturing sector of our model.

Table A4.1: Scale Economy Estimates
(all figures in percentages)

		Canada				Mexico			
		Harris		*RHRS*	*Average*	*Sobarzo*		*RHRS*	*Average*
		1/E	*CDR*	*CDR*	*CDR*	*1/E*	*CDR*	*CDR*	*CDR*
1	Agriculture	0	0	0	0	100	0	0	0
2	Mining	0	0	10	5	100	0	10	5
3	Petroleum	96	4	15	10	0	0	15	8
4	Food Processing	79	21	15	18	85	15	9	12
5	Beverages	79	21	5	13	71	29	6	18
6	Tobacco	91	9	5	7	72	28	19	24
7	Textiles	93	7	10	9	78	22	6	14
8	Apparel	90	10	1	6	84	16	10	13
9	Leather	98	2	1	2	82	18	9	14
10	Paper	89	11	20	16	62	38	5	22
11	Chemical	96	14	10	12	68	32	6	19
12	Rubber	79	21	5	13	71	29	7	18
13	NonMetMinProd	61	39	10	25	75	25	6	16
14	Iron and Steel	76	24	4	14	83	17	8	13
15	NonFer Metals	76	24	4	14	75	25	14	20
16	WoodMetal Prod	92	8	10	9	86	14	13	14
17	NonElec Mach	95	5	10	8	98	2	16	9
18	Electrical Mach	95	5	10	8	55	45	11	28
19	Transport Eqp	66	34	11	23	66	34	10	22
20	Other Manufact	93	7	10	9	85	15	8	12
21	Construction	0	0	0	0	0	0	0	0
22	Electricity	0	0	0	0	0	0	0	0
23	Commerce	0	0	0	0	0	0	0	0
24	TransptCommun	0	0	0	0	0	0	0	0
25	FinInsRlEstate	0	0	0	0	0	0	0	0
26	Other Services	0	0	0	0	0	0	0	0

Notes: E = AC/MC is the elasticity of scale
CDR is the cost disadvantage ratio
CDR = (AC-MC)/MC = 1 - (MC/AC) = 1 - (1/E)
Sources: Harris [1986], Sobarzo [1991]

Table A4.2: Transport Equipment Scale Estimates
(all figures in percentages)

		HMR		*RHRS*	*Average*
		1/E	*CDR*	*CDR*	*CDR*
1	United States	110	9	11	10
2	Canada	120	17	11	14
3	Mexico	175	43	10	27

Source: Hunter, Markusen, and Rutherford [1991]

COMMENTS ON PAPER 10

BY DRUSILLA K. BROWN

North American Trade Liberalization and the Role of Nontariff Barriers

by

David Roland-Holst, Kenneth A. Reinert, and Clinton Shiells

Comments by Drusilla K. Brown

Roland-Holst, Reinert and Shiells have provided us with a new model of the North American Free Trade Area (NAFTA). Their's is a welcome addition to the existing range of models that have been used to evaluate a NAFTA. Having a complete picture of the likely effects of the NAFTA requires extensive sensitivity analysis on both parameters and model structure. Roland-Holst, et al., provide and important piece of information in developing our understanding of modeling choices and outcomes.

The are several aspects of this effort that reflect conventional modeling choices. The three economies of North America, Canada, Mexico and the United States, are each individually represented with internal goods and factors markets.

Goods are aggregated into 26 product categories which can be used for final consumption, intermediate inputs or exports. Production of each good requires intermediate inputs and a primary input aggregate in fixed proportion to output, where the primary input aggregate is a CES function of capital and labor. Like many of these models, goods are differentiated by source and destination. Within each sector of the model, goods produced for the domestic market are differentiated from the goods sold in each of the three export markets. Total industry production is determined as a CES aggregation of production destined for each location. Production, then, in each sector generates both a final supply relation and a demand for intermediate and primary inputs.

Final demand is generated from a Linear Expenditure System (LES). The

LES determines expenditure on each good. Consumers then allocate expenditure on each sector across the individual national varieties in order to maximize a CES utility function of goods differentiated by source of production. That is, the Armington Assumptions are maintained.

The capital market is perfectly competitive and both capital and labor are taken to be freely mobile across sectors. As with some models of the NAFTA, labor is perfectly elastically supplied at an exogenously set real wage. After-tax factor payments, government revenue, and net foreign lending are then used to calculate household income.

Prices are determined in world markets that equate demand and supply for each variety of a good. At this point, the rest of the world is modeled as having elastic supply to and demand from each country. The world markets also determine an exchange rate for each country that fluctuates to hold the trade balance at the base level. Tariff and nontariff barriers are incorporated in the model through their ad valorem equivalents that put a wedge between the seller price and the buyer price.

The distinctive feature of the model concerns the pricing behavior by firms. Three alternatives are explored. First, technology may be characterized by constant returns to scale (CRS), in which case goods markets are perfectly competitive and price (P) equals marginal cost (MC). Second, technology may be increasing returns to scale (IRS) and market structure is contestable. Increasing returns to scale are modeled with a cost-disadvantage ratio which indicates the degree to which average total cost (ATC) exceeds marginal cost. This structure implies that ATC is always downward sloping. Hence, there is only one firm in each country in each sector, but that firm prices at ATC.

Third, technology is again characterized by increasing returns to scale but the market structure is taken to be a Cournot oligopoly with free entry. That is, all firms within a sector and country produce a homogeneous product, have a mark-up of price over marginal cost given by $(P-MC)/P = 1/n\epsilon$ (where n is the number of competitors and ϵ is the market elasticity of demand), but free entry guarantees that P=ATC.

At this point it is worth drawing some comparisons between the market structure adopted here and the market structure of some of the other models used to evaluate the NAFTA. Two other pricing rules are more common. The first is the assumption of "focal pricing" put forth originally by Eastman and Stykolt (1960). Here firms are assumed to set price equal to the landed price of imports but free entry guarantees that price also equals ATC. In this model, tariff liberalization lowers the focal price. If firms are to brake even, they must also lower ATC. Under the assumption of increasing returns to scale technology, firms must move down the ATC curve, raising output. Hence, tariff liberalization gives rise to the realization of economies of scale particularly in those industries most closely protected.

A second popular assumption is to take market structure as monopolistically competitive. Firms each sell a differentiated product and set price as a profit maximizing mark-up over marginal cost taking the price of other firms as given. Here liberalization lowers the price of competing imports, thereby increasing the competitive pressure on domestic firms. The consequent rise in the price-elasticity of demand leads firms to cut the price-cost margin. As with focal pricing, the zero-profits condition also requires surviving firms to raise output, moving down the ATC curve to a point where the gap between MC and ATC is smaller. Again, the realization of economies of scale following liberalization should be most pronounced in the closely protected sectors prior to liberalization.

Now consider the effects of trade liberalization in the contestable markets structure. Here the number of firms is fixed at one. Therefore, economies of scale are realized when industry output rises. That is, when domestic plus export demand rises. Trade liberalization in the protected sectors will generally result in a fall in demand so that industry output declines and scale economies are lost. Rather, scale gains will emerge in the expanding export sectors that were formerly protected by the partner country.

An important caveat here is that the contestable market structure would not normally produce economy-wide scale gains as a result of liberalization. Scale effects will emerge in expanding sectors, but resource constraints will require some sectors to decline. Consequently, scale gains will be lost in the import-competing sectors.

However, Roland-Holst, et al., assume that labor is perfectly elastically supplied at the base-period real wage. This assumption considerably relaxes the resource constraints limiting the realization of scal' economy-wide gains.

There are two reasons to expect that all three countries in the NAFTA might experience increased output in all sectors. First, tariff liberalization lowers the domestic price level, thereby raising the real wage at the current level of prices and production. In order to return the real wage to its pre-specified level, the marginal product of labor must fall. This is accomplished by raising economy-wide employment of labor, thereby lowering the capital per worker. Therefore, the economy moves out along the labor supply curve, expanding production and scale economies in most if not all sectors.

Second, trade diversion will shift demand from third country suppliers to NAFTA countries. This effect should also raise the demand for labor within the NAFTA at the pre-specified wage.

Turn now to consider the mechanics of the Cournot oligopoly. Here, as trade liberalization causes a sector to expand, part of the scale gains will be dissipated by entry. In the contestability case, a rise in demand for a sector would expand firm output. However, here, the expansion in demand will also trigger entry, thus raising n (the number of firms). As n rises, each firm perceives a more elastic demand curve. The more elastic demand leads firms to produce a higher level of output with a smaller price-cost margin. Scale gains are still realized but are not as large as in the case of contestability.

The model was used to evaluate four liberalization scenarios. Experiment 1 assumes CRS technology and trilateral tariff removal. The welfare gains from tariff removal are quite small. Canada gains the most but Canadian welfare rises by only 0.24 percent over the base period. This result is in keeping with that obtained by similar studies. Trilateral tariff barriers are simply not large enough to have much effect on economic welfare.

The surprise shows up in experiment 2. Here, both tariffs and nontariff barriers are removed, retaining the assumption of CRS technology. Now free trade raises Canada's welfare by 4.8 percent, Mexico's welfare by 2.3 percent and U.S. welfare by 1.7 percent! Employment in Mexico rises by nearly nine percent and the return to capital rises by 14.5 percent. Similarly constructed models obtain welfare gains for Mexico of less than one percent from tariff and NTB removal. The only CRS models that find welfare gains for

Mexico in the range reported here assume that domestic and imported products are perfect substitutes. Clearly, there is considerable disagreement on the size and trade effects of nontariff barriers in all three countries.

Turn now to the IRS experiments. Under the assumption that markets are contestable, tariff and NTB removal has an even stronger effect on economic welfare. Canada's welfare rises by 6.75 percent, Mexico by 3.29 percent and the United States by 2.55 percent. Not surprisingly, the welfare gains under the Cournot market structure are somewhat smaller. Canada's welfare gain drops to 4.08 percent, for example. Inefficient entry dampens the gains from liberalization under the Cournot market structure.

The importance of the rigid real wage assumption can be more clearly seen from the sectoral results. In the two IRS experiments, output rises in nearly every sector in all three countries. Also note that output adjustment is about 50 percent higher under the contestability assumption relative to the Cournot market structure, illustrating the negative consequences of inefficient entry.

The modeling effort reported in this paper is distinctive and contributes to our understanding of a NAFTA in several important regards. First and foremost, results from several different model specifications and trade liberalization experiments are reported. As a consequence, we have a very clear idea as to the contribution that each piece of the model structure and data make to the overall evaluation of the NAFTA. In order to make any use of computable models it is absolutely essential that the relationship between assumptions, data and results can be understood. The authors have excelled in this regard. Second, Roland-Holst, et al., illustrate the importance of assumptions concerning labor market function for the intersectoral reallocation effects of trade liberalization. It would be interesting to perform the same experiments under the assumption of a well-functioning labor market. Finally, it is clear that there is very little consensus as to the size of the current nontariff barriers affecting intra-North American trade. Data reported here suggest much larger distortions than reported elsewhere. Many modelers have come to the conclusion that most of the economic benefit to Mexico from liberalization will stem from unilateral domestic reform rather than from changes in border controls on goods. However, if the numbers reported here are correct, there is much to be gained from obtaining negotiated agreements on nontariff barriers.

COMMENTS ON PAPER 10

BY KENNETH HANSON

Comments on the Role of Nontariff Barriers in NAFTA

A Paper by Roland-Holst, Reinert, and Shiells

For the NAFTA Economywide Modeling Conference

USITC, Washington DC, February 24-25, 1992

By

Kenneth Hanson
Economic Research Service, USDA

1. INTRODUCTION

The intent of the paper is to assess the economywide impacts from removal of tariff and nontariff barrier's to trade (NTB's), in a North American Free Trade Aggrement (NAFTA) between the United States, Canada, and Mexico. A straight forward exercise in a CGE model once the tough task of quantifying the NTB's has been accomplished. Tables 3.3-3.5 present empirical evidence that North American trade is significantly impeded by nontariff barriers to trade. The data are qualitative and indicate that barriers to trade exist for a significant share of imports.

2. SAM DATA BASE

The 26 sector, 3 country North American SAM for 1988 is a commendable accomplishment. I have no problem with the data, given the time at which it was constructed. I would like to note that the structure of the input-output accounts are from the U.S. Forest Service, IMPLAN 1982 update of the U.S. Department of Commerce 1977 input output account. The U.S. Department of Commerce 1982 input output accounts were not available at the time that ITC constructed its data base. A comparison of the IMPLAN based IO accounts and the official 1982 IO accounts has not been attempted to determine whether the difference is significant enough to alter results of CGE analysis.

3. BARRIERS TO TRADE

A. Tariffs

Table 3.1 presents tariff rates derived from collections data. It is worth noting for the simulation experiments below that these tariffs are ones which apply prior to the United States - Canada free trade aggrement.

B. Nontariff barriers (NTB's)

Tables 3.3-3.5 indicate the existence and percent of imports covered by NTB's. The tariff equivalents in table 3.2 can be viewed as quantitative specification of the NTB's in tables 3.3-3.5. These latter tables serve as a guide to what needs to be quantified. Comparing the tables there are a number of zero's in the tariff equivalent data where the qualitative data indicates trade barriers exist. In some of these cases the authors determine that no tariff equivalent was appropriate. Appendix 4 presents the arguments for the quantitative tariff equivalent measure for the nontariff barriers. It is a useful presentation and deserves further refinement and expansion.

C. International Price Distortions

The authors introduce additional data which attempts to measure the distortions among domestic prices of the different countries in the model. These price distortions do not quantify NTB's so much as represent domestic price differences among countries which are assumed to disappear from trade liberalization in several experiments of the paper.

I find focussing attention on these unexplained price distortions is a deviation from the explicit quantification of NTB's, though an interesting aside. The policy issue is what impact will the negotiated removal of tariffs and NTB's have on the economies, and these price distortions have not been shown to be a result of the NTB's. Unless the authors can use these price distortions to quantify the NTB's, I would recommend moving this data to an appendix as additional evidence of domestic price distortions among the negotiating countries. In comment on the price distortion data in table 3.6, it is not evident how the percent price distortions in the last three columns are calculated from the domestic price relatives (at least in earlier drafts).

4. **A 3 Country CGE Model with Increasing Returns to Scale.**

The authors have enhanced a standard CGE model by endogenizing the activities of 3 countries relative to a rest of world, and by introducing unrealized increasing returns to scale.

One aspect of the multi-country feature of the model which needs clarification is the clearing of the external account and how changes in the real exchange rate among the endogenous countries effects transactions with the exogenous rest of world. An elaboration of footnote 17 (from page 30) in section 4 on model description will help. A combination of factors seem important for changes in the real exchange rate in the simulation results; relative tariff magnitudes, import and export substitution elasticities, relative trade shares, and the relative magnitudes of increasing returns to scale among sectors in the different countries.

As I understand the workings of increasing returns to scale in the CGE model, industries have "unrealized" scale economies waiting to be exploited from opening markets which occurs by trade liberalization. The induced scale adjustments depend on the extent average total cost exceeds marginal cost (cost disadvantage ratio, CDR). With price set at average cost and average cost greater than marginal cost, it is profitable for the industry to expand production. It is not clear from the model description whether average cost declines with production, resulting in a profit maximizing level of production.

The opportunity to expand production arises when trade liberalization removes tariffs and NTB's to the exports from other countries. Since the same industry in each country has some empirical specification of increasing returns the dominate gainer from opening a market depends on the relative magnitude of increasing returns and changes in the real exchange rate which occur for other reasons. The Armington assumption for the importing country limits the substitution of the newly available commodities from other countries after trade liberalization.

The magnitude of "unrealized" scale economies are derived in appendix 4. The CDR used in the model are an average of the CDR from Harris (a cited source) and from RHRS the source of which are not cited. If the RHRS numbers are best judgments from the author then I would recommend adding that to the note. As for the CDR of transport equipment the HMR 1/E numbers suggest that average cost is less than marginal cost, unlike all the other sectors, and hence, the CDR should be negative, but they are not in the table, perhaps 1/E is meant to be E in one case or the other (at least in earlier drafts).

5. SIMULATION RESULTS

The comparative static experiments consist of removing tariff and price distortions, with and without increasing returns to scale. I will only comment on the tariff removal experiments, first with constant returns to scale. From an understanding of these results, the effects of increasing returns to scale can better be assessed.

The model is static so the gains from trade liberalization are efficiency gains from a reallocation of factors when the price distortions are removed. These will be small but still of interest for particular sectors. Potential dynamic gains from increased investment are not a part of the analysis.

A word about closure and other model assumptions: a) Labor is mobile among sectors in a country and aggregate employment varies given a fixed aggregate wage; b) The ROW exchange rates adjust to fixed trade balances; and, C) Each trading partner maintains its existing protection with respect to the rest of world.

A. Tariff removal with Constant Returns to Scale

Canada has the greatest change in RGDP and employment, followed by Mexico and the United States. The dramatic difference for Canada is linked to the much larger change (depreciation) in the real exchange rate and the incentive this depreciation has for Canada to export to the rest of world. Two questions are why does Canada depreciate more than the United States and Mexico and do we expect exports to the rest of the world to respond with such a significant magnitude. As for the change in real exchange rate for the Untied States and Mexico being the same, it is somewhat unexpected. Given the relative size of the countires, I would expect that the impact on the real exchange rate for Mexico to be larger.

First a comment on the supply of exports to the rest of world in response to a depreciation in the real exchange rate. The export supply response is detremined by the export supply elasticity, tau, in table 4.2. The elasticities seem small but the changes in exports to the rest of world seem large for Canada and for some sectors in Mexico, from tables 5.3 and 5.4.[1]

The real exchange rate adjustments among the negotiating countries is from changing trade patterns which arise from the removal of trade barriers. As a country removes its tariffs there is an incentive to import, and as other countries remove their tariffs there is an incentive to export to these countries. The resulting change in trade patterns depends on a number of empirical "facts" about the negotiating countries. Of particular importance are the relative tariff magnitudes (as compared among negotiating countries), and the relative magnitude of import demand and export supply elasticities.

Canada has slightly high tariff rates on the average than does the United States and Mexico. If all else were the same, then the removal of the tariffs would result in Canada importing a greater amount than exporting, but this generates a greater depreciation of the real exchange rate. the depreciating real exchange rate stimulates exports with the negotiating countries bring the adjusting trade pattern into equilibrium. The depreciating real exchange rate also stimulates exports to the rest of world. Given the exogenous specification of the rest of world, it can absorb as much exports from the negotiating countries as they offer, that is the endogenous countires do not compete for market share in the rest of world. From this opportunity to sell to the rest of world the country depreciating the most will expnad production the most. Given the aggregate labor supply can adjust, this expansion of exports to the rest of world does not reduce production in other sectors. There is a growth in employment, as seen in the table of results.

Two model features which may bring the results into question. First, the magnitude of export supply to the rest of world in response to a depreciation in the real exchange rate seems large. Second, the endogenous labor supply. This later feature needs to be discussed in the section on model description, in context of existing unemployment and how trade liberalization may expand employment opportunities.

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[1]These table correspond to the increasing returns to scale case, but the constant returns to scale case will be similar but smaller.

Looking at sectoral output and export results, start with agriculture. For the United States there is an ever so slight fall in output while, agriculture in Mexico and Canada increases. Agricultural exports among the negotiating countries increases for all countries. Its difficult to fully accept these results, primarily because of the aggregation of different commodities which are responding in different directions. Mexico will probably lose on grain production (particularly corn), but they will undoubtedly gain in the area of fruits and vegetables. The United States and Canada will share the gains in grain with exports to Mexico. That Canada has a larger increase in agricultural production than the United States seems to trace back to the exchange rate adjustment. I would play down the results on agriculture and recommend the reader to see an agriculture focussed analysis as is done at the Economic Research Service, USDA.

Moving away from agriculture, look at the results for textile, apparel, and leather. Both the United States and Canada have high tariffs on these sectors while Mexico have relatively low tariffs. I am somewhat surprised that both the U.S. and Canada increase production when tariffs are removed. This appears to be partly due to an increase in U.S./Canada trade. Perhaps in doing these NAFTA experiments the U.S./Canadian trade agreement needs to be treated separate from, and prior to, the NAFTA (unless the U.S./Canada. trade agreement did not include these tariffs). Mexico does increase production in these sectors and their exports to the U.S. and Canada, which is no surprise.

Another sector whose results strike me as interesting are for transportation equipment. If nontariff barriers to trade were included in the experiments the results would even be more dramatic, given the protection Mexico has with respect to U.S. and Canadian transportation equipment (see table 3.2). Both the U.S. and Canada have tariffs on transportation equipment from Mexico, while Mexico has a low tariff on U.S. and Canadian transportation equipment. From the results the change in production and exports among the negotiating countries is not surprising but the change in trade with the rest of world is, to me, surprisingly large.

B. <u>Tariff removal with Increasing Returns to Scale</u>

Industries in different countries, which have unrealized increasing returns to scale, compete for the opportunity to export to the trade liberalizing countries. The question I ask is how does increasing returns change the results from constant returns.

With increasing returns, the real exchange rate for the United States appreciates, while the real exchange rate depreciates even more for Canada and Mexico relative to the case of constant returns to scale. It is assumed that real trade balances remain the same. It is possible to infer from the appreciating real exchange rate (less depreciation), that the United States has a greater incentive to export than Mexico or Canada from the unrealized increasing return to scale. that is, the fixed real trade balance requires the appreciation to induce imports to maintain the real trade balance.

Note that all countires gain from the increasing returns. Welfare, RGDP, exports, and employment all increase for each country. It does not seem that these countries are competing for market share so much as expanding the size of markets, which is occurs with the expanding employment.

6. **Summary**

The simulation results support Canada's effort to participate in the NAFTA negotiations. It seems that Canada turns out to be the largest gainer due to the depreciation in the real exchange rate. The impact of the real exchange rate adjustment on trade with the rest of world is the biggest stumbling block I have with the empirical results. The changes in trade with the rest of world are larger than some of the changes with the negotiating countries.

Several suggestions for the simulation experiments. One, introduce a United States - Canadian free trade aggreement separate from the NAFTA, through a series of experiments building on each other. Start with a United States - Canadian free trade aggreement experiment by removing the tariff and NTB's between the United States and Canada. From this result introduce the NAFTA in a second set of experiments.

Two, include both tariff and nontariff trade barriers in the experiment and take out the international price distortion experiments (or put them in an appendix).

Three, bring out the unemployment assumption and expanding labor supply in the model description. Perhaps make a comparison experiment with a fixed aggregate labor supply.

PAPER 11

"A GENERAL EQUILIBRIUM ANALYSIS OF GAINS FROM TRADE FOR THE MEXICAN ECONOMY OF A NORTH AMERICAN FREE TRADE AGREEMENT," BY HORACIO E. SOBARZO

A GENERAL EQUILIBRIUM ANALYSIS OF THE GAINS FROM TRADE FOR THE MEXICAN ECONOMY OF A NORTH AMERICAN FREE TRADE AGREEMENT

Horacio E. Sobarzo
Centro de Estudios Económicos
El Colegio de Mexico

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0 INTRODUCTION

Applied general equilibrium models have become a widely used instrument for analyzing such issues as trade liberalization and fiscal reform since they capture the resulting resource allocation movements. In particular, trade liberalization has increasingly been analyzed in a general equilibrium context.

However, it would appear that it is now a common result that in most Walrasian applied general equilibrium models that address the issue of trade liberalization, welfare effects are very small.1/ As a result of this, there seems to be concern as to whether such models might be misspecified in that, because of the assumption of constant returns to scale, they do not capture an important source of gains from trade arising from the presence of economies of scale and imperfect competition. This concern is reinforced by the increasing empirical evidence that countries with similar factor endowments have large volumes of trade. Moreover, on the theoretical side a growing literature has flourished focussing on the issue of international trade and industrial organization.2/ Although not as fast as the

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1/ See Shoven and Whalley [1984] for a literature survey on applied general equilibrium models.
2/ See Helpman and Krugman [1986].

theory, applied general equilibrium modelers have started to work in that direction.3/

This paper attempts to evaluate the effects that an eventual free trade agreement (FTA) between Mexico, Canada and United States would have on the Mexican economy, in the presence of scale economies and imperfect competition in the Mexican industry. The way of modeling economies of scale follows the lines of the Harris [1984] model for Canada and focuses in detail on the effects within the Mexican economy.

The choice of incorporating economies of scale for analyzing the Mexican economy responds not only to the recent movement away from Walrasian models mentioned above, but also to the fact that the empirical evidence in Mexico seems to confirm the idea that the theory of comparative advantage is not enough to explain the volume and direction of trade.4/

Likewise, it is convenient to mention that the results presented in this document refer to an scenario in which all trade barriers with North America are removed. Nonetheless, the way in which the model has been specified enables us to simulate not only different degrees of removal of trade barriers but also different ways in which the Mexican

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3/ See Harris [1984].
4/ On this point see, for instance, Casar et al [1990].

economy could react, that is, different closure rules. The realism of these different reactions, however, remains open to discussion.

The exposition is organized as follows. Section 1 presents a brief review of trade policy in Mexico and some comments on the structure of industrial organization. Section 2 describes the model used and presents some results. Section 3 comments on possible extensions of the model. Finally, Section 4 contains some concluding remarks.

1 TRADE POLICY AND INDUSTRIAL ORGANIZATION IN MEXICO

1.1 Trade Policy

Mexico's economic modern history is not very long; the country started its industrialization process in the forties, particularly after the second world war when a period of import substitution began. Such period would not end until the eighties. During these five decades economic growth was essentially based on an "inward-oriented" strategy, characterized by a growing public sector intervention and high levels of protection.5/

Unlike other Latin American countries, whose strategy was also to follow an "inward-oriented" policy based on high levels of tariffs, Mexico was to rely more heavily on the use of direct controls, particularly import permits, as opposed to tariffs, although, formally, commercial policy measures were made up of a combination of the two.6/

5/ During this period public sector expenditure increased permanently, particularly after 1970. Thus, for instance, the contribution of the public sector to GDP went from 14.6 percent in 1975 to 25.6 in 1983. As a result, while the public sector deficit as a proportion of GDP was kept at relatively low levels before 1970 (it averaged 1.4 percent from 1966 to 1971), after 1971 it increased sharply; it was 10 percent in 1975 and reached 15.4 percent in 1982. (IMF [1987]).

6/ Note that although trade policy in Mexico was formally based on a combination of tariffs and import permits, the fact that the latter was heavily used made tariffs superfluous, as far as the protection effect is concerned.

Indeed, from the forties direct controls in the form of import permits became the cornerstone of protection policy, and extended throughout the period to cover an increasing number of items. Thus, for instance, while in 1956 33 percent of import categories required import permits (28 percent in value terms), in 1973 the number of categories subject to licensing represented 80 percent (64 percent in value terms), and 100 percent in 1982.

Together with a policy of fix nominal exchange rate for over a period of 23 years and a growing public sector intervention, such a policy, although successful in achieving some degree of industrialization, did not take into consideration efficiency and opportunity costs. Indeed, this strategy led to a very distorted scenario in which prices no longer reflected opportunity costs, and the relative price structure of the economy became a major source of micro and macroeconomic disequilibrium. Many economic imbalances were created during the past decades such as a very marked regional disequilibrium, a very concentrated income in relatively few hands and, more important, to the extent that it became the main obstacle to economic growth in the seventies, the external disequilibrium.

The picture in the eighties changed dramatically. With the second largest foreign debt in the developing world and most oil export revenues going to service this debt, Mexico embarked on a programme of economic reform in an attempt to remove domestic distortions and, more generally to liberalize the economy. Essentially, the purpose has been to remove the many sources of distortions created in the previous years and to expose domestic producers to foreign competition. Such set of reforms included not only changes in trade policy but, more generally, a reduction of the public sector intervention both direct and indirect.7/

Insofar as trade policy is concerned, the Mexican government implemented, after 1983, a deep trade liberalization set of measures that have taken the economy from one of the most protected economies in the seventies, to a one of the most opened economies by the nineties. Such measures were implemented in three stages.

In the first stage, from 1983 to 1985, the de la Madrid administration started to gradually open the market to foreign participation, essentially by a simplification of the tariff schedule, a reduction of the import licensing

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7/ In 1985 the government began a privatization programme to desincorporate its parastatal sector. By the end of July 1990, the number of Government-owned or controlled entities had fallen to 310 from 1,155 in 1982. (USITC [1991]).

requirements 8/ and a reduction of the number of items covered by official prices.9/

The second stage is marked by Mexico joining the GATT in 1986, which strengthened the trade liberalization process by freeing more items from the import licensing requirements, reducing more the tariff level, and phasing out official prices. Indeed, by the end of 1987 the use of official prices was almost nonexistent and import tariffs were reduced from a 0 to 100 percent range in 1985, to a 0 to 20 percent range by the end of December 1987.(USITC [1990]).

As a result of these measures, in only three years the Mexican economy moved from a regime in which almost all imports were subject to import license to a regime in which only a few selected sectors required import permit.

Finally, in a third stage the government has attempted to consolidate these measures by further liberalizing some sectors and further reducing the level of tariffs. Thus, for instance, the trade weighted average tariff fell from 25

8/ In this stage the most significant measure was the removal of the import licensing requirement for a total of 2,000 categories on the Mexican tariff schedule.

9/ Official prices were a widely used instrument of the Mexican government to combat dumping or subsidized import competition. Essentially, this instrument permits the government to determine an "official" price that, usually, differs from the commercial value. In 1986, for instance, duties on approximately 1,000 items were calculated on an official price.

percent in 1985 to 10 percent in 1990. Likewise, whereas in 1986 35 percent of Mexican import value were subject to the licensing requirement, in 1990 only 230 categories (out of nearly 12,000) were subject to this requirement.10/

1.2 Industrial Structure

As it has been mentioned, the industrialization process in Mexico has taken place in a relatively short period and, to a great extent, it was clearly an induced process. An important consequence, as we will try to explain, is that the industrial structure behavior is far from being perfectly competitive, at least for some sectors.

In a very schematic way, it can be said that the Mexican industry concentrates in the production of consumer and some intermediate goods. The production of sophisticated intermediate and capital goods is less developed.

As a whole, the industrial structure was the result of three decades of explosive growth since the volume of production duplicated every ten years.11/ The process,

10/ These 230 controlled categories belong, basically, to a few sectors: agriculture, auto parts, pharmaceutical products, petrochemicals, apparel, wood and wood products.
11/ See Casar et al [1990].

however, resulted, in some cases, in sectors where a few large firms were dominant.12/

Casar et al [1990] characterize the Mexican industry, in 1980, as follows. They identify what they call (a) concentrated oligopolies, (b) concentrated and differentiated oligopolies, (c) differentiated oligopolies, (d) competitive oligopolies, and (d) competitive industries. The so called concentrated oligopolies are responsible for some 20 percent of value added in the manufacturing industry and produce intermediate and, to a lesser extent, capital goods. They characterize by high levels of concentration in the order of 75 percent 13/. The concentrated and differentiated oligopolies participate with 15 percent of value added in the manufacturing industry and produce mainly durable consumer goods and to a less degree, traditional consumer goods. The level of concentration is between 84 and 77 percent. The differentiated oligopolies contribute 12

12/ In the fifties, large public enterprises were set up to produce steel, railroad equipment, and paper. On the other hand, private firms, often associated with foreign firms, started to produce commodities such as electrical machinery, metallic products, and rubber products. By the end of the sixties foreign firms already participated with 30 percent and enjoyed a well established position in the automotive industry, chemicals, electrical and non electrical machinery. Private national firms, in addition to collaborating with foreign firms, consolidated their position in the production of traditional goods, such as food, beverages, textiles, construction and, in a lesser extent, steel and chemicals.

13/ Estimated as the value of the production of the four largest firms in the industry as a proportion of the total value of production in the industry.

percent of value added and have an average level of concentration of 40 percent. They produce mainly non durable consumer goods. The competitive oligopolies generate 30 percent of value added in manufacturing and have also a concentration level of 40 percent, concentrating on the production of light capital and intermediate goods (inputs for the agroindustry, food and textile industries as well as some non standard capital goods) Finally, the competitive industries participate with approximately 25 percent of value added and have a low level of concentration of 14 percent. They concentrate on the production of some intermediate inputs for agroindustries, construction materials as well as some basic consumer goods in the food, apparel, and shoe industries.

In summary, it can be said that the industrialization process in Mexico generated an imperfectly competitive scenario where a few large firms produce the most sophisticated intermediate, capital, and durable consumer goods. It seems that the less sophisticated the commodity produced is, the larger the number of firms in a sector.

2 THE MODEL

2.1 Overview of the Model

The structure of the model is outlined in Table 1. With some exceptions, notably the introduction of economies of scale and imperfect competition, the assumptions of the model resemble very much conventional general equilibrium models and therefore in this section we will provide only a general overview of the model, and then proceed to comment on the question of economies of scale and imperfect competition. The more technical details are shown in Appendix A where the underlying equations of the model are presented.

The model is calibrated around a Social Accounting Matrix (SAM) of the Mexican economy for the year 1985. As mentioned in Table 1, domestic and imported commodities are assumed to be imperfect substitutes and modeled with the Armington assumption.14/ On the export side, domestic production and exports (both to North-America and rest of the world) are modeled with constant elasticity of transformation (CET) functions.15/ That is, we assume that the producer maximizes its income distributing output among the different markets (domestic and foreign). The obvious advantage of this

14/ See Armington [1969].
15/ For a derivation of this CET function see Appendix A.

TABLE 1
General Characteristics of the Model

1.- Level of Aggregation. The model identifies 27 production sectors, each sector producing a single commodity. Of these 27 commodities, 21 belong to the category of the so called traded while the remaining 6 commodities are non traded (see Appendix B).

2.- Dimensions. There are two factors of production, capital and labor, which are mobile between sectors (see Section 2.4 for the different closure rules adopted). It is assumed one consumer and three regions: Mexico, the rest of the world (ROW), and North-America (NA) (which includes US and Canada). It is important to stress that the model is not fully general equilibrium since only the Mexican economy is explicitly modeled (the other regions are modeled only in the sense that we postulate a demand for imports from NA and ROW as well as a demand for Mexican exports in the two regions).

3.- Production. All production activities combine intermediate inputs in fixed proportions but are allowed for some degree of substitution between domestic and foreign commodities. They also combine labor and capital by means of a Cobb-Douglas production function to generate net output which, in turn, combines in fixed proportions with intermediate inputs.

4.- Foreign Trade. Each sector produces a share for domestic markets and export the remaining share to North-America and ROW. Exported commodities face a downward slopping demand curve which depends, among other things, on a price elasticity of demand. Production is split between these three possible destinations according to a constant elasticity of transformation (CET) function, which enables us to differentiate between domestic and exported commodities (in the present version an infinite elasticity of transformation is assumed). On the import side the small country assumption is adopted, and domestic and foreign commodities are assumed to be imperfect substitutes (in the Armington manner). The numeraire is taken to be the consumer price index. (See Section 2.4 for different closure rules regarding balance of payments, exchange rate, and factor markets).

5.- Final Demand. There is a single representative consumer which demands goods according to a Cobb-Douglas utility function. The same assumption is adopted for government and investment expenditures.

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specification is that, by assigning different values to the elasticity of transformation, it is possible to differentiate commodities according to the market of destination. In the present version we assume that commodities sold in domestic markets and commodities exported are the same (infinite elasticity of substitution).16/

Producers buy composite commodities combining them in fixed coefficients while in the factor markets capital and labor combine in a Cobb-Douglas way. At a higher level, intermediates and net output or value added combine in fix proportions.

The income received by factors of production, in the model, is divided, in fixed shares, between consumption, savings, and payment of taxes (both direct and indirect). There is only one representative consumer who takes two decisions; first, he decides the proportions to consume between domestic and foreign commodities and, as a second decision, he maximizes his utility level consuming composite commodities according to a Cobb-Douglas utility function. The same behavior is assumed for government expenditure. Domestic and foreign savings determine the level of

16/ The opposite extreme is zero, which amounts to assume that commodities sold in different markets are different commodities. Obviously, between these two extremes a whole range of elasticity values can be assumed depending on the degree of differentiation.

investment. Both factors of production, capital and labor, are perfectly mobile between sectors.17/

It is important to mention that, for the purposes of using the present model for analyzing the potential impact of an FTA between Mexico and North- America, the base benchmark equilibrium was calibrated using the level of tariffs of the year 1989 which, as we have seen, were substantially lower than the level of tariffs that prevailed in 1985, year for which the SAM was built.

2.2 Modeling Economies of Scale and Imperfect Competition

In modeling economies of scale we have followed the assumptions of the Harris [1984] model.18/ That is, we have assumed that some firms, in some industrial activities, behave as non competitive. Essentially, we have three types of industries: competitive, regulated, and non competitive. (See Table 2 to identify industry classification). In the competitive industries constant returns to scale are assumed. Insofar as the regulated industries, which in the present enquiry corresponds to the petroleum sector, we assume that the producer determines the price considering elements other than marginal costs which, for the purposes of the model, are exogenous. That is, both the quantity produced and the domestic price are fix and, therefore, the

17/ As it will be explained, in one version it will also be assumed that capital is mobile between countries.
18/ See also Harris [1986].

quantity exported is a residual once the domestic demand has been satisfied. Finally, in the case of non competitive industries we assume that firms, whose number is endogenous, use a fixed bundle of capital and labor, which can be interpreted as the costs involved in setting up a plant. A fixed cost is thus involved and, in the long run, average cost is declining everywhere. Thus, for a given level of output, X, total costs are

$$C = F(w,r) + V(P,w,r,)X \qquad (1)$$

where $F(\cdot)$ is fixed cost, which depends on the prices of labor and capital, and V is variable cost, being a function of prices of intermediates, P, as well as prices of labor and capital. Therefore, average cost is total cost divided by the level of output, X.

$$AC = F/X + V \qquad (2)$$

Thus, as the level of production increases, there is a gain in efficiency since average cost declines. As will be explained later, for each non competitive industry in the model, the degree of unexploited scale economies is measured as the ratio of marginal to average costs.

Following Harris [1984], two pricing behaviors are assumed. First, a modified Cournot-Chamberlain equilibrium at the industry level is assumed, where firms set prices conditional on an elasticity of a perceived demand curve, according to the Lerner rule 19/

$$[(P-MC)/P] = 1/|n| \qquad (1)$$

where the degree of deviation between price and marginal cost is inversely related to the perceived elasticity of demand. Note that for this rule to be valid it is necessary that $|n| > 1$.

Freedom of entry and exit of firms guarantees zero economic profits in all industries so that price equals average cost. Naturally, for this adjustment to take place it is necessary to assume that there are no barriers to entry of firms, other than fix costs.

The second pricing rule attempts to capture the existence of an oligopolistic market which, as we saw, characterizes the industry in Mexico. This rule follows the Eastman-Stykolt model of protected oligopolies.20/ According to this model, domestic firms set prices in a collusive manner around a focal point price, which is determined as the international price plus the tariff. A removal of tariffs,

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19/ Notice that the model is not pure Cournot type since we assume that demand is evenly shared by all firms in the industry.
20/ See Eastman and Stykolt [1960].

therefore, leads to an immediate reduction of the domestic price. Naturally, the degree of collusion will determine the extent to which the domestic price falls. Therefore, as it will be explained, it will be necessary to define a particular value for this parameter. It is important to mention that, for the purposes of the present model, we considered North American prices as reference, rather than the prices of the rest of the world, thus recognizing that United States is, by and large, Mexico's main commercial partner which, no doubt, can be seen as a large economy compared to Mexico.

Together with the assumption of free entry and exit of firms, these two pricing behaviors make the adjustment of the economy very different from Walrasian models when trade liberalization takes place. Indeed, in the context of imperfect competition, an external change that causes the markup to be lower implies that some firms must leave the industry (since profits are negative) with the result that fewer firms serve a larger market at lower unitary costs. Compared to Walrasian models, thus, there is an additional efficiency gain.

2.3 Parameter Values

Four set of parameter values are required to solve the model. They are, elasticities of substitution between domestic and imported commodities (σ), export demand elasticities (β), inverse scale elasticities (δ), and the weight attached to the two pricing rules adopted in the model. Table 2 reports values for the first three sets of elasticities. It is important to mention that the values of σ and β are guess estimates.

TABLE 2
Elasticity Values

	σ	β	δ
Agriculture	3.0	2.0	competitive
Mining	0.5	2.0	competitive
Petroleum	0.5	3.0	regulated
Food	1.125	2.0	0.85
Beverages	1.125	2.0	0.71
Tobacco	-	2.0	0.72
Textiles	1.125	2.0	0.78
Wearing apparel	1.125	3.0	0.84
Leather	1.125	3.0	0.82
Wood	1.125	3.0	0.89
Paper	0.5	3.0	0.62
Chemicals	0.5	3.0	0.68
Rubber	0.5	3.0	0.71
Non-metallic prod	0.5	3.0	0.75
Iron and Steel	0.5	3.0	0.83
Non ferrous met	0.5	3.0	0.75
Metallic prods.	0.5	3.0	0.83
Non elect. mach.	0.375	3.0	0.98
Elect. mach.	0.375	3.0	0.55
Transp. equip.	0.375	3.0	0.66
Other manufac.	0.375	6.0	0.85
Construction	- -	2.0	competitive
Electricity	- -	2.0	competitive
Commerce, Hotels	- -	2.0	competitive
Transp. & comm.	- -	2.0	competitive
Financial serv.	- -	2.0	competitive
Other services	- -	2.0	competitive

σ = Elasticity of substitution (domestic-imported)
β = Export demand elasticity
δ = Inverse scale elasticity

Insofar as the values of inverse scale elasticities they were approached following calculations carried out by Hernandez [1985]. He estimated what he calls net scale economies at the industry level, which measures the extent to which economies of scale are exploited (see Chapter VIII).21/ Finally, a decision had to be taken as to what weight should be given to the two pricing rules. Unfortunately, there is nothing in the literature on this point. Therefore, we shall present results attaching a fifty percent weight to each rule 22/ and, at the end, we shall carry out some sensitivity analysis by changing the weights.

2.4 Results

The results presented in this section correspond to a bilateral 100 percent tariff reduction with North America. Table 3 shows the Mexican tariff levels used in the benchmark equilibrium.

21/ Estimations based on the 1975 industrial census.
22/ As Harris [1986] does.

TABLE 3
Benchmark Equilibrium Tariffs

Commodity	Tariff(%)
Agriculture	3.2
Mining	3.9
Petroleum	2.1
Food	6.5
Beverages	14.5
Textiles	11.6
Wearing apparel	16.5
Leather	15.1
Wood	13.3
Paper	3.5
Chemicals	7.9
Rubber	12.7
Prods. of non metallic minerals	13.4
Iron and steel	6.7
Non ferrous metals	6.7
Metallic products	13.2
Non electrical machinery	10.9
Electrical machinery	12.1
Transport equipment	12.1
Other manufactures	19.5

We present three different versions of the model changing in each version the closure rule. It is important to mention, however, that in all the three versions the assumption of perfect mobility of capital and labor between sectors is maintained. The main features of these three versions are briefly described as follows.

In version one we assume unemployment in the labor market and therefore the real wage is fixed. That is, the level of employment is endogenously determined. On the other hand, the quantity of capital is assumed to be fixed and hence, this factor market clears through movements of the price of capital. Thus, we assume full employment of capital. Insofar as trade balance, the assumption in this first version is that it is fixed and therefore the real exchange rate adjusts to accommodate changes in domestic vs. foreign prices.

Version two is very similar to version one except for the fact that in this second version trade balance is allowed to change and therefore the real exchange rate is fixed. Note that the implicit assumption of this second version is that Mexico can borrow abroad without any restriction in order to finance any resulting deficit.23/

Finally, in version three we assume full employment in the labor market so that now the variable that clears the market is the wage. Insofar as capital is concerned we adopted the assumption that its price is fixed as the world rental rate.24/. Naturally, to justify this scenario it is necessary to assume that capital is mobile not only between sectors but also between countries. Notice that this assumption implies that Mexicans have a fix capital endowment and, therefore, if the level of economic activity expands, the additional capital is assumed to be owned by foreigners. It is important to mention that, in order to run this third version of the model, it was necessary to modify

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23/ Obviously, since the country can borrow abroad, requires that we formulate an intertemporal estimation at present value in the budget constraint.
24/ This assumption was originally adopted by Harris [1984].

the benchmark equilibrium since any surplus (deficit) in the current account balance was interpreted as a reduction (increase) in the capital endowment of Mexicans. To be consistent with this scenario we assumed a variable trade balance and a fix real exchange rate.

In summary, then, we have three different versions of the model. Versions one and two attempt to determine the effects of an FTA in the presence of excess capacity in the labor market and a fix quantity of capital. Insofar as version three, the main purpose is to get an insight as to how an eventual capital inflow would influence the effects of an FTA. A common feature of the three scenarios, however, is the presence of economies of scale and imperfect competition in some industrial activities. Table 4 summarizes the main features of each version.

TABLE 4
CLOSURE RULES ADOPTED IN THE DIFFERENT VERSIONS OF THE MODEL

MODEL ASSUMPTIONS	VERSION ONE	VERSION TWO	VERSION THREE
CAPITAL STOCK	FIXED AND FULLY EMPLOYED		VARIABLE AND MOBILE BETWEEN COUNTRIES
EXCHANGE RATE	VARIABLE	F I X E D	
TRADE BALANCE	F I X E D	V A R I A B L E	
WAGE	F I X E D		VARIABLE

Moving now on to the analysis of results, it can be seen from Table 5 a summary of the main aggregate effects in each of the three versions. To keep the same order in the exposition we shall first make some comments on the results of version one.

TABLE 5
SUMMARY OF RESULTS
(Percent changes)

	VERSION 1	VERSION 2	VERSION 3
WELFARE	2.0	2.3	2.4
GDP	1.7	1.9	8.0
WAGE	0.0	0.0	16.2
EMPLOYMENT	5.1	5.8	0.0
RATE OF PROFITS	6.2	6.6	0.0
TRADE BALANCE	0.0	5.6	18.3
TRADE BALANCE (NA)	0.0	7.1	18.9
TRADE BALANCE (ROW)	0.0	2.1	17.1
EXCHANGE RATE (NA)	3.0	0.0	0.0
EXCHANGE RATE (ROW)	0.3	0.0	0.0

Starting with the first column of Table 5, it can be seen that in version one the welfare gain is 2.0 25/ percent, GDP goes up by 1.7 percent, employment raises 5.1 percent and, finally, the price of capital increases 6.2 percent. Since an initial condition in this version was to maintain the trade balance fixed, the real exchange rate becomes an adjusting variable: it depreciates 3.0 percent with respect to NA and 0.3 percent with ROW.

Table 6 shows much more detailed sectorial results of this first version. Looking at column two, it can be

25/ Welfare changes are computed with the so-called equivalent variation. That is, we compute income and prices in the benchmark equilibrium and calculate the income needed to reach the utility level of the solution equilibrium.

appreciated that, with the exception of petroleum, all production activities expand.

TABLE 6
VERSION ONE
SECTORIAL EFFECTS
(Percent changes)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agriculture	3.4	1.5	3.2	-6.4	10.1	12.1	0.3	6.6
Mining	2.6	1.2	0.6	-5.3	4.5	3.7	-0.6	5.5
Petroleum	0.1	0.0	-2.5	0.7	0.4	0.8	-	0.0
Food	-3.9	2.2	8.5	-4.0	2.7	-2.6	1.2	7.5
Beverages	-7.7	2.4	12.7	-0.3	6.1	-6.9	0.9	7.2
Tobacco	2.7	2.1	21.9	-4.7	0.0	0.0	0.6	6.8
Textiles	-6.4	3.2	22.2	0.5	5.3	-5.0	1.2	7.5
Wearing app.	-6.2	3.5	59.4	2.9	12.5	-5.3	1.8	8.1
Leather	-0.9	2.6	40.6	3.1	6.8	-	0.4	6.7
Wood	-7.7	2.5	9.1	-3.5	6.2	-6.6	1.3	7.6
Paper	-1.6	1.9	13.1	1.5	1.1	0.8	0.3	6.6
Chemicals	-4.0	2.5	16.9	0.9	2.5	-0.1	1.0	7.3
Rubber	-7.5	2.6	38.6	0.2	3.9	-1.7	0.8	7.1
Non met. min.	-7.5	2.8	13.5	-3.9	3.9	-1.7	1.5	7.9
Iron & steel	-3.2	3.7	17.1	1.1	3.5	1.4	1.9	8.3
Non ferr. met.	-0.7	2.7	9.9	-5.0	4.6	2.6	1.3	7.6
Metallic prods	-7.8	2.9	18.6	-0.5	4.3	-1.7	0.9	7.2
Non elec.mach	-5.8	3.7	14.2	-2.2	3.6	0.1	1.9	8.2
Electr. mach	-6.8	5.1	24.9	3.1	3.7	-0.3	2.7	9.1
Transp. equip	-7.0	5.3	16.8	6.0	4.2	0.0	3.4	9.8
Other manuf	-14.8	3.6	14.0	-5.2	5.8	-5.9	2.4	8.8
Construction	-0.6	2.6	0.0	0.0	0.0	0.0	-1.3	4.7
Electricity	2.7	1.6	0.5	0.0	1.6	0.0	-0.4	5.7
Commerce	4.2	1.6	-2.2	0.0	2.1	0.0	0.4	6.7
Transport	3.1	1.7	0.0	0.0	1.9	0.0	0.0	6.2
Financial serv	4.1	1.5	-2.1	0.0	1.6	0.0	0.1	6.3
Other services	2.0	0.1	2.1	0.0	0.1	0.0	-3.1	2.9

Note: Columns are as follows. (1) = composite good price, (2) = gross output, (3) = exports to NA, (4) = exports to ROW, (5) = imports from NA, (6) = imports from ROW, (7) = capital, (8) = employment.

TABLE 7
VERSION TWO
SECTORIAL EFFECTS
(Percent changes)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agriculture	3.4	1.0	-3.0	-7.2	20.7	13.2	-0.1	6.4
Mining	2.4	1.4	-5.4	-5.9	7.6	5.3	-0.5	5.9
Petroleum	-0.1	0.0	-2.2	0.0	2.1	1.1	0.0	0.0
Food	-3.9	2.2	2.1	-4.6	6.4	-2.1	1.1	7.7
Beverages	-7.6	2.6	6.1	-0.8	10.1	-6.3	1.0	7.7
Tobacco	2.7	2.4	14.7	-5.3	0.0	0.0	0.8	7.4
Textiles	-6.4	3.1	15.1	0.0	9.0	-4.6	1.0	7.6
Wearing app.	-6.3	3.3	45.6	2.0	16.7	-4.8	1.6	8.3
Leather	-9.0	2.8	28.4	2.2	10.8	0.0	0.4	7.8
Wood	-7.7	3.7	-0.5	-4.5	11.4	-5.0	2.4	9.1
Paper	-1.8	1.9	3.7	1.0	2.7	1.0	0.2	6.8
Chemicals	-4.2	2.5	7.1	0.3	4.4	0.3	0.9	7.6
Rubber	-7.6	2.8	26.8	-0.4	5.8	-1.2	0.9	7.5
Non met. min.	-7.5	4.1	3.6	-4.9	7.4	0.2	2.7	9.4
Iron & steel	-3.5	5.6	7.5	0.7	7.3	3.7	3.7	10.6
Non ferr. met.	-1.3	3.4	0.7	-5.6	7.1	3.6	1.9	8.6
Metallic prods	-8.1	4.0	8.6	-1.1	7.3	-0.2	1.9	8.6
Non elec.mach	-6.8	5.3	4.6	-2.8	7.6	3.0	3.3	10.1
Electr. mach	-7.1	5.3	14.5	2.7	6.8	1.4	2.9	9.7
Transp. equip	-7.4	5.1	7.4	5.8	7.0	1.6	3.1	9.8
Other manuf	-15.4	2.9	4.0	-6.1	8.3	-5.0	1.6	8.3
Construction	-0.6	6.4	0.0	0.0	0.0	0.0	2.9	8.8
Electricity	2.8	1.9	-5.4	0.0	0.0	0.0	-0.2	6.3
Commerce	4.3	1.4	-8.2	0.0	0.0	0.0	0.2	6.7
Transport	3.0	1.7	-6.0	0.0	0.0	0.0	-0.1	6.4
Financial serv	4.3	1.7	-8.1	0.0	0.0	0.0	0.2	6.8
Other services	2.0	0.2	-4.0	0.0	0.3	0.0	-3.2	3.1

Note: Columns are as follows. (1) = composite good price, (2) = gross output, (3) = exports to NA, (4) = exports to ROW, (5) = imports from NA, (6) = imports from ROW, (7) = capital, (8) = employment.

TABLE 8
VERSION THREE
SECTORIAL EFFECTS
(Percent changes)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agriculture	1.6	3.6	0.5	-3.7	17.0	9.7	6.6	-8.2
Mining	2.7	16.1	-6.1	-6.6	28.0	25.2	21.7	4.7
Petroleum	-0.1	0.0	-8.9	0.0	5.4	4.3	0.0	0.0
Food	-3.9	3.3	5.3	-1.6	7.5	-1.2	5.9	-8.8
Beverages	-7.6	3.5	7.2	0.1	11.1	-5.5	7.3	-7.7
Tobacco	2.0	3.4	16.3	-4.0	0.0	0.0	7.5	-7.5
Textiles	-6.4	5.5	15.3	0.1	11.7	-2.2	10.6	-4.7
Wearing app.	-6.3	4.7	47.0	3.0	18.2	-3.5	9.0	-6.1
Leather	-9.0	4.3	27.1	1.2	12.6	0.0	10.2	-5.1
Wood	-7.7	17.2	3.5	-0.7	26.3	7.6	20.8	3.9
Paper	-1.8	6.9	4.2	1.5	7.8	6.0	11.2	-4.3
Chemicals	-4.2	7.9	8.1	1.2	10.1	5.8	11.8	-3.7
Rubber	-7.6	9.7	27.6	0.2	13.0	5.4	14.6	-1.3
Non met. min.	-7.5	20.5	6.1	-2.6	25.4	16.9	24.4	7.0
Iron & steel	-3.5	30.1	7.6	0.8	33.1	28.6	35.7	16.7
Non ferr. met.	-1.3	19.5	2.0	-4.4	24.2	20.4	23.7	6.4
Metallic prods	-8.1	19.4	8.1	-1.5	23.8	15.1	25.4	7.9
Non elec.mach	-6.8	30.5	4.7	-2.7	36.5	30.6	36.6	17.5
Electr. mach	-7.1	18.9	14.2	2.4	24.0	17.8	25.7	8.2
Transp. equip	-7.4	19.7	7.4	5.8	25.8	19.5	25.3	7.8
Other manuf	-15.4	11.1	8.0	-2.5	17.9	3.3	14.4	-1.5
Construction	2.8	38.4	0.0	0.0	0.0	0.0	52.8	31.4
Electricity	3.4	7.3	-6.6	0.0	0.0	0.0	13.0	-2.7
Commerce	2.8	6.6	-5.5	0.0	0.0	0.0	9.8	-5.5
Transport	3.0	5.6	-6.1	0.0	0.0	0.0	10.3	-5.1
Financial serv	3.5	3.6	-6.7	0.0	0.0	0.0	7.3	-7.6
Other services	6.5	0.0	-11.9	0.0	2.0	0.0	10.4	-4.9

Note: Columns are as follows. (1) = composite good price, (2) = gross output, (3) = exports to NA, (4) = exports to ROW, (5) = imports from NA, (6) = imports from ROW, (7) = capital, (8) = employment.

The intersectorial factor movements are described in columns seven and eight in Table 6. It can be seen that all sectors use more labor, which is explained by the fact that its price is fixed so that a substitution of capital for labor may have taken place. Notice that the increase in the demand for labor is particularly strong in the manufacturing sectors. This is not surprising if we remember that these sectors have the opportunity of realizing economies of scale. Insofar as capital is concerned, although in aggregate the total quantity of capital remains unchanged, some capital shifts between sectors takes place. While in most sectors the demand for capital increases in some of them, such as mining, construction, electricity, and other services, the use of capital diminishes.

The evolution of trade is described in columns three to six in Table 6. Exports to North America are shown in column three whereas exports to the rest of the world appear in column four. As can be seen, in almost all of the so called traded commodities exports go up and, in particular, the increase in exports to North America in sectors such as leather, wearing apparel, electrical machinery, and rubber is very strong. With the exception of food processing and wood, in the remaining manufacturing activities the increases are of two digits. Exports to the rest of the world, although less pronounced, also register increases of considerable magnitude. It would appear that an important element explaining the behavior of exports is the possibility of realizing economies of scale in the foreign markets.

The changes in the level of imports are less pronounced. The results may be suggesting some trade diversion in favor of North America. This could explain the fact that in some cases imports from the rest of the world fall. Obviously, in those cases where the elasticity of substitution between domestic and imported commodities is high, the substitution in favor of North America is higher. That seems to be the case of commodities such as food processing, beverages, textiles, wearing apparel, and some others.

Finally, column one of Table 6 shows the price changes of composite commodities, which, are the prices consumers face. It can be seen that price reductions, especially in the manufacturing sectors, are significant whereas in the case of the so called non traded commodities and in general in the competitive industries, prices go up.

The summary of results of version two are shown in column two of Table 5. This second version, as already explained, is very similar to version one, the only difference being that in this second version the trade balance is variable whereas the real exchange rate is assumed to be fixed. The results are, therefore, not very different. Welfare increases by 2.3 percent while GDP goes up 1.9 percent. The level of employment rises 5.8 percent and the price of capital increases 6.6 percent. Thus, in general, the results are in the same direction as in version one although slightly greater in this second version.

Perhaps the only significant difference is that now the trade balance deteriorates 5.6 percent, which seems a reasonable result if we keep in mind that the average tariff level in Mexico is higher than North American tariffs on Mexican exports.

The sectorial results are shown in Table 7. It can be seen that the results are also very similar to version one although in this second version the increases in exports are less pronounced. Nonetheless, they still are of considerable magnitude.

The adjustment of the economy in the third version is, undoubtedly, of very different nature. This is so because of the specifications adopted in the factor markets. Indeed, looking at the third column of Table 5 it can be appreciated that whereas the welfare gain is close to the two previous versions (2.4%), the raise in GDP is considerably greater (8.0%).

The reason behind this result lies, obviously, on the assumption that the capital endowment of Mexicans is fixed so that, although the economy can easily expand because of the fact that the price of capital is fixed, the income generated by the use of additional capital goes to foreigners. Therefore, although Mexicans benefit from the expansion of the level of the economic activity, the additional income is not received by them.

Another interesting result is that the wage rate increases 16.2 percent whereas the trade balance registers a 18.3 percent deterioration.

The sectorial adjustment is also of very different nature when compared with the two previous versions. They are shown in Table 8. Several points deserve to be mentioned. First, as can be seen from column two, the expansion of the level of economic activity of the production sectors is stronger, particularly in the sectors where the capital-labor ratio is higher. This is the case, for instance, of sectors such as iron and steel, non electrical machinery, and construction.26/

26/ It is likely that these results may be overestimated because of data deficiencies. This is so because a common practice in collecting data for Mexican National Accounts is that, whenever a small business is run by a family whose members are not receiving an explicit salary, the implicit salary is registered as operating surplus. Unfortunately we have no empirical evidence of the magnitude of error.

The second point to notice is that, in the factor markets, the allocation of resources is also different. Labor, for instance, experiences strong intersectorial shifts whereas, on the other hand, the use of capital raises in all sectors. Naturally, given that the price of capital is fixed, some substitution of labor for capital takes place.

Finally, in relation to foreign trade, it can be seen that the evolution of exports follows a similar pattern to the behavior of exports in version two, where trade balance is also variable. In this third version, however, the increase in exports in most sectors is stronger.

In summary, depending on the assumptions adopted in regard to the behavior of factor markets, the adjustment of the economy can be very different. A common feature of the three versions, however, is that, as a result of trade liberalization, a fewer number of firms serve a larger market and use factors of production more efficiently. It would appear that sectors that do better are precisely those where the potential for realizing economies of scale is greater, particularly in the export markets.

2.4.3 Sensitivity Analysis

As it has already been mentioned, the results of the model are not very sensitive to the values of the elasticities of substitution between domestic and imported goods neither to the export demand elasticities. Although not reported here, we conducted the same set of experiments doubling the value of these parameters, and the results were not very different. A parameter which seems to influence the results considerably, however, is the weight attached to the Eastman-Stykolt pricing rule.

To get an idea of how sensible to this parameter the results are, we conducted some sensitivity analysis changing its value. A summary of these results is shown in Table 9. It should be mentioned that these results correspond to our third version and refer to four possible weights of the Eastman-Stykolt rule: 1.0, 0.5, 0.25 and 0.0.

TABLE 9
EASTMAN-STYKOLT WEIGHT
(Percent changes)

Eastman-Stykolt	GDP	Welfare
100	15.5	3.5
50	8.1	2.3
25	4.6	1.6
0	1.1	0.7

It can be seen that the results of the model are extremely sensible to the value of this parameter. For instance, when the weight is 1 GDP raises 15.5 percent and the welfare gain is 3.5 percent. In the opposite extreme, when the Eastman-Stykolt rule is not present GDP raises 1.1 percent and the corresponding welfare gain is 0.7 percent.

3. EXTENSIONS AND LIMITATIONS OF THE MODEL

Extensions to the present model are both, possible and desirable. Perhaps the most relevant extension is to incorporate the effects of non tariff barriers. Indeed, to the extent that the model is used to get some insight into the potential effects of an FTA, this extension becomes crucial, given the already low current level of tariffs on the three regions. It seems very likely that an FTA, if successful, will move in the direction of removing these trade barriers.

In terms of the model, a usual way out of it is to estimate the tariff equivalent level and then model the effects through the price mechanism. This option has the appeal that, once the tariff equivalent level has been estimated, it is very straightforward to model it. The obvious disadvantage is that, strictly speaking, non tariff barriers are essentially quantity rationing mechanisms. The other possibility is to explicitly incorporate this quantity rationing mechanism, thus recognizing that in the presence of QRs, a rent is generated, whose final destination is private producers.27/ This second option is not difficult to model as long as we keep the assumption that there is only one consumer in the model because, in this case, the problem

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27/ See Grais et al [1986] for an attempt to model QRs.

of allocation of rents does not exist. The only difficulty is then to estimate the tariff equivalent.

Another point is to get reliable values of parameters. Although the results do not seem to be very sensitive to these values, it nevertheless the task remains of running the model with elasticities estimated in the particular context to which the model is applied.

Finally, an intrinsic limitation of our approach is the static nature of the model. This, however, should not be seen as a limitation but, instead, as a delimitation of the analysis. That is, the main purpose of the present enquiry is to evaluate the static effects of an FTA in the presence of economies of scale and imperfect competition. No doubt a model that incorporated dynamic effects could produce very different results.

Insofar as the limitations of the model, there are many. We shall not, however, comment on the limitations of the general equilibrium approach since they are widely known in the literature. It will suffice to recognize that, on the issue of imperfect competition and scale economies, while the assumption of free entry and exit of firms may be appropriate for some industries, it is clearly not so in those industries where high entry barriers exist. Tha automotive industry provides a very good example of an industry for which this assumption is not appropriate. In building highly disaggregated sectorial models, however, some realism has to be sacrificed. Whether or not the loss of realism is too much for the results to be reliable is an issue that ultimately has to be resolved on empirical grounds. Compared to a Walrasian model, however, it would appear that the present approach constitutes an step forward.

4 CONCLUDING REMARKS

The model presented here has attempted to incorporate a form of imperfect competition. The results suggest that, compared with the Walrasian general equilibrium models, additional gains from trade are present. We have seen that the magnitude of the results are, in some cases, very high.

The decision of incorporating economies of scale and imperfect competition obeys not only the recent theoretical approach focussing on these issues but also to the empirical evidence in Mexico, which suggests that the industrial sector is far from behaving as perfectly competitive.

Unfortunately the results of the model are quite sensitive to the weight attached to the two pricing rules adopted, but even in the case in which the Eastman-Stykolt assumption is not incorporated, the gains from trade are higher than the traditional general equilibrium model estimates.

Surely more sensitivity analysis is required both on issue of parameter values as well as model specification. That would give us more certainty as to how "accurate" the results are.

Perhaps the most general and important conclusion of the present study is that economies of scale matter. Indeed, a common result in all the versions presented is that, as a result of trade liberalization, a fewer number of firms will end up serving a larger market and using factors of production more efficiently.

Finally, it is important to mention that the simulations carried out here are quite arbitrary since we assumed a total removal of tariffs. No doubt the results will be very different once we get an idea of the possible direction of an FTA both in terms of which sectors are going to be liberalized as well as the magnitude of such liberalization. That will provide us with better information in order to carry out more sensible simulations.

Appendix A
Model Equations

A) PRICES

-Prices of Imports from North America (NA).

$$PMEU_i = PEU_i\ (1+t_{meui})\ TCEU \tag{1}$$

where PEU_i is the price of commodity i in dollars imported from NA, t_{meui} is the tariff rate on commodity i imported from NA, and TCEU is the exchange rate between pesos and dollars.

-Prices of Imports from the Rest of the World (ROW).

$$PMRM_i = PRM_i\ (1+t_{mrmi})\ TCRM \tag{2}$$

where PRM_i is the price in foreign currency of commodity i imported from ROW, t_{mrmi} is the corresponding tariff rate, and TCRM is the exchange rate between pesos and the currencies from ROW.

-Price of Exports to NA

$$PWEEU_i = PD_i/(1+t_{eeui})\ TCEU \tag{3}$$

where PD_i is the price of domestic commodity i and t_{eeui} is the corresponding subsidy on exports to NA.

-Price of Exports to ROW.

$$PWERM_i = PD_i/(1+t_{ermi})\ TCRM \tag{4}$$

where t_{ermi} is the subsidy on exports to ROW.

-Price of the Composite Commodity.

$$\begin{aligned} P_i=\delta_i^{-1/\sigma}\ (& PD_i[\alpha_i+\beta_i(\alpha_i\cdot PMEU_i/\beta_i\cdot PD_i)^{\sigma/(\sigma-1)} + \\ & + \tau_i(\alpha_i\cdot PMEU_i/\tau_i\cdot PD_i)^{\sigma/(\sigma-1)}]^{-1/\sigma} + \\ & + PMEU_i[\alpha_i(\beta_i\cdot PD_i/\alpha_i\cdot PMEU_i)^{\sigma/(\sigma-1)} + \beta_i + \\ & + \tau_i(\beta_i\cdot PMRM_i/\tau_i\cdot PMEU_i)^{\sigma/(\sigma-1)}]^{-1/\sigma} + \\ & + PMRM_i[\alpha_i(\tau_i\cdot PD_i/\alpha_i\cdot PMRM_i)^{\sigma/(\sigma-1)} + \\ & + \beta_i(\tau_i\cdot PMEU_i/\beta_i\cdot PMRM_i)^{\sigma/(\sigma-1)} + \tau_i]^{-1/\sigma}\ ) \end{aligned} \tag{5}$$

where δ_i is the scale parameter associated to a CES function from which the last equation is obtained, and σ_i is defined as

$$\sigma_i = (1+ces_i)/ces_i \qquad (6)$$

where ces_i is the elasticity of substitution, α_i, β_i and τ_i are the parameters associated with the commodities domestic, imported from NA and imported from ROW, respectively, in the CES function.

-Price Level

$$P = \Sigma\, \Omega_i P_i \qquad (7)$$

-Net Price Equations (PN)

$$PN_i = PD_i(1-td_i) - \Sigma a_{ij} P_j \qquad (8)$$

where td_i is the tax rate on the production of commodity i and a_{ij} is the input-output coefficient.

B) PRODUCTION

-Value Added Functions

$$X_i = \phi_i[\pi_i L_i^{\epsilon i} + (1-\pi_i) K_i^{\epsilon i}]^{1/\epsilon i} \qquad (9)$$

where L_i and K_i are the quantities of labor and capital respectively used in sector i, and ϵ_i is defined as

$$\epsilon_i = (\tau_i - 1)/\tau_i \qquad (10)$$

where τ_i is the elasticity of substitution between capital and labor in sector i.

-Intermediate Input Demands

$$II_{ij} = a_{ij}\ XO_i \qquad (11)$$

where XO_i is the gross domestic product of sector i.

-Functions for Aggregation of Inputs.

$$AI_j = \min\ (II_{ij}/a_{ij}) \qquad (12)$$

-Gross Output Functions

$$XO_i = \min\ (AI_i\ ,\ X_i/v_i) \qquad (13)$$

where v_i is a value added coefficient indicating the value added requirements by unit of production of commodity i.

C) FACTOR MARKETS

-Labor Demand

$$L_i=(X_i/\phi_i)(\pi_i+[1-\pi_i][\pi_i r/(w-w\pi_i)]^{\epsilon/(\epsilon-1)})^{-1/\epsilon} \quad (14)$$

where r and w are the prices of capital and labor respectively.

-Labor Supply

$$L = L \quad (15)$$

-Demand for Capital by Sector

$$K_i=(X_i/\phi_i)((1-\pi_i)+\pi_i[(w-w\pi_i)/r\pi_i]^{\epsilon/(\epsilon-1)})^{-1/\epsilon} \quad (16)$$

-Supply of Capital

$$K = K \quad (17)$$

D) INCOME EQUATIONS

-Net Private Income

$$RP = (\Sigma\, L_i \cdot w + \Sigma\, K_i \cdot r)(1-dir) \quad (18)$$

where -dir- is the income tax rate.

-Net Government Income

$$\begin{aligned} RG = {} & (\Sigma L_i \cdot w + \Sigma K_i \cdot r)\cdot dir + \Sigma PEU_i \cdot t_{meui} \cdot TCEU \cdot MEU_i + \\ & + \Sigma PRM_i \cdot t_{mrmi} \cdot TCRM \cdot MRM_i - \Sigma PD_i \cdot t_{eeui} \cdot TCEU \cdot EEU_i - \\ & - \Sigma PD_i \cdot t_{ermi} \cdot TCRM \cdot ERM_i + \Sigma PD_i \cdot td_i \cdot XO_i \end{aligned} \quad (19)$$

where MEU_i and MRM_i are imports of commodity i from NA and ROW respectively, and EEU_i and ERM_i are exports to NA and ROW.

E) INVESTMENT EQUATIONS

-Savings – Investment equality.

$$TINV = sp \cdot RP + sg \cdot RG + FEU \cdot TCEU + FRM \cdot TCRM \quad (20)$$

where sp and sg are the private and public income proportions devoted to savings, and FEU and FRM are foreign savings from NA and ROW respectively, expressed in dollars.

-Investment by Sector of Destination

$$Y_i = par_i \cdot TINV \quad (21)$$

where par_i is the share of sector i on total investment demand.

F) CONSUMPTION EQUATIONS

-Private Consumption of Commodity i.

$$CP_i = parp_i \cdot (1-sp) \cdot RP/P_i \tag{22}$$

where $parp_i$ is the parameter associated to commodity i in the Cobb-Douglas utility function.

-Government Consumption of Commodity i.

$$CG_i = parg_i \cdot (1-sg) \cdot RG/P_i \tag{23}$$

where $parg_i$ is the parameter associated to commodity i in the Cobb-Douglas utility function.

G) INTERMEDIATE DEMAND

-Intermediate Demand.

$$V_i = \Sigma\, a_{ij} \cdot XO_j \tag{24}$$

H) EXTERNAL SECTOR

-Function for Exports to NA

$$EEU_i = EEUF_i\ (PEU_i/PWEEU)^{elaeui} \tag{25}$$

where $EEUF_i$ is the demand in NA for the domestically produced commodity i when prices in NA equal the prices of Mexican exports, $elaeu_i$ is the price elasticity of demand for exports to NA.

-Function for Exports to ROW

$$ERM_i = ERMF_i\ (PRM_i/PWERM_i)^{elarmi} \tag{26}$$

where $ERMF_i$ is the demand of the ROW for commodity i when the prices of our Mexican exports equal the prices in ROW.

-Functions for Imports from NA

$$MEU_i = [(\beta_i \cdot PD_i)/(\alpha_i \cdot PMEU_i)]^{\sigma-1} \cdot D_i \tag{27}$$

where D_i is the internal demand for domestic commodities.

-Functions for Imports from ROW.

$$MRM_i = [(\gamma_i \cdot PD_i)/(\alpha_i \cdot PMRM_i)]^{\sigma-1} \cdot D_i \tag{28}$$

I) DEMAND EQUATIONS

-Demand for Domestic Commodities

$$D_i = RU_i(Y_i + CP_i + CG_i + V_i) \tag{29}$$

where RU_i is the ratio of domestic use to total demand for composite commodity i. It is obtained from

$$RU_i = \delta_i^{-1/\sigma}[\alpha_i + \beta_i(\alpha_i \cdot PMEU_i/\beta_i \cdot PD_i)^{\sigma/(\sigma-1)} + \\ + \tau_i(\alpha_i \cdot PMRM_i/\tau_i \cdot PD_i)^{\sigma i/(\sigma i-1)}]^{-1/\sigma i} \tag{30}$$

-Total Demand for Domestic Commodities

$$XD_i = D_i + EEU_i + ERM_i \tag{31}$$

J) EQUILIBRIUM CONDITIONS

-Equilibrium in the Labor Market

$$L = \Sigma L_i \tag{32}$$

-Equilibrium in the Capital Market

$$K = \Sigma K_i \tag{33}$$

-Equilibrium in the Commodity Markets

$$XO_i = XD_i \tag{34}$$

-External Equilibrium with NA

$$FEU = \Sigma PEU_i \cdot MEU_i - \Sigma PWEEU_i \cdot EEU_i \tag{35}$$

-External Equilibrium with ROW

$$FRM = \Sigma PRM_i \cdot MRM_i - \Sigma PWERM_i \cdot ERM_i \tag{36}$$

DERIVATION OF THE CET FUNCTION

Formally, it will be assumed that producers distribute their output in three markets, i, (i = 1,2,3) corresponding to the domestic, NA, and ROW markets respectively, according to a constant elasticity of transformation (CET) function, of the following form

$$Q_j^{\phi} = \Sigma\ \theta\ Q_{ji} \qquad (37)$$

where θ is a distribution parameter which represents the proportions in which the commodity i is distributed within the different markets i, and the elasticity of transformation, E, is given by $[1/(1-\phi_j)]$. Thus, the problem for the producer of commodity i is to maximize its total income, $\Sigma P_i Q_{ji}$, subject to (37). That is, the problem is to maximize

$$\Sigma\ P_i Q_{ji} + \mu[Q_j^{\phi} - \Sigma\theta Q_{ji}^{\phi}\ ] \qquad (38)$$

differentiating with respect to Q_{ji} gives

$$P_i = \mu\phi\theta_i\ Q_{ji}^{(\phi-1)} \qquad (39)$$

and multiplying by Q_{ji}, and remembering that total income of the producer is $P_j Q_j$

$$\Sigma\ Q_{ji} P_j = \mu\phi\Sigma\theta_i Q_{ji}^{\phi} = \mu\phi Q_j^{\phi} = P_j Q_j \qquad (40)$$

then, from (39)

$$P_i = (P_j Q_j / Q_j^{\phi})\ \theta_i Q_{ji}^{(\phi-1)} \qquad (41)$$

and

$$P_i = \theta_i P_j (Q_{ji}/Q_j)^{(\phi-1)} \qquad (42)$$

hence,

$$\Sigma\theta_i [P_i / P_j \theta_i]^{[\phi/(\phi-1)]} = \Sigma\theta_i (Q_{ji}/Q_j)^{\phi} = 1 \qquad (43)$$

finally, solving for P_j and remembering that $E=1/(1-\phi)$

$$P_j^{(1-E)} = \Sigma\ \theta_i^{E}\ P_i^{(1-E)} \qquad (44)$$

Note that if E tends to infinite the price is independent of the market in which the commodity is sold.

APPENDIX B

1. AGRICULTURE

   Agriculture
   Livestock
   Forestry
   Fishing and hunting

2. MINING

   Coal products
   Metal ore mining
   Other mining
   Quarrying
   Other metal ore mining

3. PETROLEUM

   Petroleum extraction & natural gas
   Petroleum products
   Basic petrochemicals

4. FOOD PROCESSING

   Meat and dairy products
   Processed fruits and vegetables
   Milling of wheat and their products
   Milling of corn and their products
   Processing of coffee
   Sugar and products
   Oils and fats
   Food for animals
   Other processed food

5. BEVERAGES

   Alcoholic beverages
   Beer
   Soft beverages

6. TOBACCO

   Tobacco and products

7. TEXTILES

   Soft fiber textiles
   Hard fiber textiles
   Other textiles

8. WEARING APPAREL

Wearing apparel

9. LEATHER

Leather and products

10. WOOD

Manufacturing wood
Other wood industries

11. PAPER

Paper products
Printing and publishing

12. CHEMICALS

Basic chemicals
Fertilizers
Synthetic fibers
Drugs and medicines
Soaps and detergents
Other chemical industries

13. RUBBER

Rubber products
Plastic products

14. NON METALLIC MINERAL PRODUCTS

Glass products
Cement
Other non metallic mineral products

15. IRON AND STEEL

Steel mills

16. NON FERROUS METALS

Non ferrous basic industries

17. METALLIC PRODUCTS

Metallic furniture
Metallic structures
Other metallic products

18. NON ELECTRICAL MACHINERY

Machinery and non electrical equipment

19. ELECTRICAL MACHINERY

Electrical machinery
Electrical appliances
Electronic equipment
Other electrical products

20. TRANSPORT EQUIPMENT

Motor vehicles
Motor parts
Other transport equipment

21. OTHER MANUFACTURES

Other manufacturing industries

22. CONSTRUCTION

Construction

23. ELECTRICITY

Electricity, gas and water

24. COMMERCE, RESTAURANTS AND HOTELS

Commerce
Restaurants and hotels

25. TRANSPORT AND COMMUNICATIONS

Transport
Communications

26. FINANCIAL SERVICES AND INSURANCE SERVICES

Financial services
Dwellings

27. OTHER SERVICES

Professional services
Educational services
Medical services
Recreational and cultural services
Other services.

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COMMENTS ON PAPER 11

BY ROBERT K. MCCLEERY

Comments on Horacio E. Sobrazo's paper:

A General Equilibrium Analysis of the Gains from Trade for the Mexican Economy of a North American Free Trade Agreement

Robert K. McCleery, Institute for Economic Development and Policy, East-West Center

The paper on the whole appears to be a solid effort in the tradition of Harris [1984,1986] and Cox and Harris [1985]. As in the case of those pioneering works, his model is an attempt to go beyond the traditional competitive markets paradigm to consider how a trade agreement would impact Mexico given the oligopolistic structure and pricing patterns as well as increasing returns to scale in certain key industries. The third version of the model also considers the effects of capital mobility between countries, although the model cannot identify capital inflows by sending country.

I will divide my comments into two sections. The first deals with the Cox and Harris model itself, particularly the validity of its application to the Mexican industrial sector. The second will raise some questions and ask for some clarifications about the parameters, equations, and results of Sobrazo's application of the model.

The Applicability of the Cox and Harris Model to Mexico

I have no disagreement with his portrayal of many sectors of Mexican industry as being organized oligopolistically. But the model is predicated on the ability of these oligopolies to effectively collude in restricting output and raising product prices. One element not studied which might affect the ability of firms in a sector to collude in price setting is ownership differences. In other words, it is plausible to assume that domestic firms or foreign firms based in a single country could more easily collude than a heterogeneous mix of firms. But the way economies of scale are measured in the model is somewhat questionable in the U.S.-Canada context and may not be supportable in the U.S.-Mexico situation.

The measurement of economies of scale is a tricky issue. The author appears to contend that economies of scale are present in all industries in which marginal costs are lower than average costs, and that point estimates of the ratio of marginal to average costs provide parameters for scale economies that hold for production increases in the range of 15 to 38 percent, in some sectors and scenarios. There are two distinct possibilities. First, the cost curves may be U-shaped rather than declining forever, and the large increases predicted here could actually move firms up the other side of the U. Secondly, if costs are decreasing throughout, the industries are what is known as natural monopolies. This should be testable in data for OECD countries. The burden of proof in that case would be on the author to show why, in the integrated North American market, any production at all takes place in Mexico. I suggest that the first interpretation is more likely, and furthermore the author may well be measuring excess capacity from some optimal scale in the recessionary base year of 1985, and that marginal costs would be rising instead of constant as output approaches capacity.

Excess capacity in a time of trade liberalization can mean one of several things. First, it can be an indication of extreme shortages of imported intermediate goods. Secondly, it can be an indication of poor or constrained management--an unwillingness or inability to cut back on expenses, particularly labor, in bad times. Thirdly, it could be a result of import penetration, indicating that the domestic firms are inefficient and unable to compete with imports. Only in the first instance is it conceivable that industries with a large spread between marginal and average cost would be the big gainers from trade liberalization. In fact, it can be said that Sobrazo's results are almost the exact opposite of what would have been projected from so-called revealed comparative advantage calculations or from a Heckscher-Ohlin model based on factor endowments. In contrast,in one of their original articles (JPE 1985), Harris and Cox state "The model has much in common with the traditional Heckscher-Ohlin trade model, in which comparative advantage plays the key role. The comparative advantage effects are present in the model, but in addition there is scope for intraindustry rationalization." In the Sobrazo model, this balance appears to have been lost.

In discussing the results, I will focus on table 8 (version 3), although the comments are applicable to the other versions as well. In some of the more labor-intensive sectors (agriculture[1] and food through leather), gross output increases are quite modest, in the range of 3.3 to 5.5 percent. By contrast, capital-intensive sectors (non-metallic minerals through other manufacturing) enjoy double digit growth from 11 percent to over 30 percent in perhaps the two most unlikely sectors-Iron and Steel, where no developing country since Korea has been successful, and non-electric machinery, i.e. the production of capital goods. Part of the problem may be attributable to the decision to hold employment constant in this version, despite the inflow of capital into a labor-surplus economy. The structure of the production functions would therefore require an outflow of labor from labor-intensive sectors in order to equilibrate at the higher level of capital, contributing to their slow growth. With only one type of labor specified, peasant farmers can readily and costlessly move into the capital-goods producing sectors.

Some mildly distressing policy implications come out of this work, as well. In general, there seems to be a prescription for a return to the bias toward heavy industry and capital intensive growth that characterized the late 1970s, however this time under a liberal trade environment and in the guise of pursuing economies of scale instead of self-reliance through import substitution. If those gains prove to be more modest that predicted, it could be a recipe for urban unemployment, balance of payments crisis, and, in general, a return to the lost decade of the 1980s.

It should also be pointed out that in a number of other instances, with perhaps the case of Indonesian trade liberalization in 1983-87 being the most relevant comparison, tariff reductions in developing countries have led to changes in the pattern of production, employment and trade entirely consistent with the H-O approach. Indonesia's tremendous

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[1] As was pointed out by Tim Kehoe, agriculture is <u>not</u> labor intensive in terms of labor costs, but it is in terms of labor usage in person-years.

spurt of manufacturing exports came in the traditional areas of garments, textiles, and consumer electronics. Early indications from Mexico's experience do not contradict this pattern, nor does the product mix in Mexico's "free trade areas" along the border, the maquiladoras.

Policy makers might also be unduly reassured by some of the model's predictions. We would all agree that a drop in price and an increase from the profit maximizing monopoly or oligopoly sales level should be noted in some formerly concentrated sectors. But the reassurance that a reduction in the number of domestic firms in many industries is both normal and desirable on efficiency grounds ignores the conclusions of another branch of the growing trade and industrial organization literature. In those works, an expanding market increases the number of monopolistically competitive firms, increasing the welfare of consumers who value product diversity and selection. It seems more likely that a contraction in the number of firms as a result of trade liberalization in industries which are already highly concentrated should be taken as evidence of weakness, rather than of potential strength.

Yet another possibility is that free trade might lead to a "rationalization" in which a heterogeneous batch of producers, say, multinational from several different countries and representative of one or two Mexican "Grupos" is reduced to a smaller, more homogeneous group. This very reduction in size and diversity could lead to oligopolistic pricing behavior in the free trade scenario when such an agreement could not be maintained before. Equilibrium price could even rise (given the extremely low elasticities between imports and domestic production mentioned below) in some instances, moving the economy farther away from the competitive equilibrium.

Particular Comments on the Model

It is almost traditional to include a critique of the modeler's elasticities and a call for sensitivity analysis on values that seem extreme. Mexico's exports face a downward-sloping demand curve, but imports, which are said to be imperfect substitutes for Mexican domestic production, are obtained at a fixed price in the model (page 12). No explanation is given for why the small country assumption holds in one direction and not the other. Furthermore, it would seem that these assumption would introduce a bias lowering the trade increases resulting from liberalization, and that free trade would tend to lead to a deterioration in the terms of trade for Mexico.

A more fundamental problem is the size of the import and export elasticities. I have seen generous elasticities of 2 used for Mexican exports in the past, but to use 2, 3, and even 6 at this point, after the large increases already registered in the past five years, it at the optimistic limit of credulity. In some ways, the import elasticities in the key capital-intensive sectors are even more surprising. Given that the largest producers of autos in Mexico are Ford-Mexico and VW-Mexico, how is the extremely low elasticity between imports and domestic production of .375 in transportation justified?

A couple of minor points on production. On page 13 of the text, you say capital and labor combine in a Cobb-Douglas way, and I was prepared to make a small point that production function estimates across both developed and developing countries yield elasticities of substitution of less than one in manufacturing activities. Then I looked at the equation list and the relationship is actually CES, although no parameter values are given for these functions. Also, equation 12 I think should be a summation rather than a MIN function. But I'll be delighted if there are only two discrepancies in my own equation list and exposition.

The model simulates a bilateral elimination of tariffs (although page 2 incorrectly states that "all trade barriers with North America are removed"). Nowhere in the paper are the somewhat suspect weighted "North American" tariffs on Mexican exports explained or listed. Incidentally, many variables in the model are identified with the letters EU (Estados Unidos), rather than NA (Norteamericano). Without a more complete data set, the reader cannot tell which data and parameters are truly North American and which may apply only to the U.S., perhaps remnants of an earlier U.S.-Mexico model. Also, no source and particularly no date is given for the table of benchmark Mexican tariffs used. I would guess that they are no more recent than as of 1990. The unweighted average of 13.7% seems a bit high for the purpose of modeling tariff reductions, but considerably lower than the level in the 1985 base year, and tobacco is missing from the table.

The exchange rate and trade balance lead to some confusion in interpreting the results on page 23. The author states on page 23 "the real exchange rate ... depreciates 5.1 percent on average." This assertion is seemingly at odds with the figure in Table 5. Also, Table 5 on page 23 presents percentage changes, with no signs. For instance, the trade balance deteriorates, but that is not made clear until page 29. The base year trade balance is not specified, thus the dollar value of the change cannot be computed.

In conclusion, this paper is the result of a competent technical modeling exercise, but I would not put much weight on its conclusions. The inapplicability of the Cox-Harris structure to Mexico, the failure to disaggregate labor or the agricultural sector, the inability of the model to capture most dynamic elements of the regional relationship, and the questionable choices of elasticities combine to outweigh the numerous good points of the modeling effort, resulting in predictions that are contrary to experiences elsewhere in addition to being counterintuitive.

COMMENTS ON PAPER 11

BY WILLIAM E. SPRIGGS

Comments
on Horacio E. Sobarzo's "A General Equilibrium Analysis of the Gains From Trade for the Mexican Economy of a North American Free Trade Agreement"

prepared by

William E. Spriggs*
Economist
Economic Policy Institute
Suite 200
1730 Rhode Island Ave., NW
Washington, DC 20036

for the

United States International Trade Commission
Conference on Economy-Wide Modeling
of the Economic Implications of an FTA
with Mexico and a NAFTA with Canada and Mexico

This paper argues that if the results of computable general equilibrium models are meant for policy debates they must show their application to real data on Mexican trade liberalization (1986-1991) and the U.S.-Canada Free Trade Area (1989-1991) before leaping into the future. Models also must take into account that 42 percent of North American trade is related to shipments by U.S. owned affiliates operating in Mexico and Canada. Because of trade among multinational production units, models must incorporate the production location choice corporations will make (as opposed to disembodied capital movement) that a North American Free Trade Agreement would imply. The first two sections of this paper present comments that apply to Professor Sobarzo's paper and all the other models presented. The third section has comments specific to Professor Sobarzo's paper.

I. General Comments on the Presentation of Results

Viewed in proper perspective, computable general equilibrium models are not "crystal ball" visions of the future under a free trade agreement. To his credit, Professor Sobarzo does not pretend that his model presents a forecast of

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*Thea Lee provided help in editing these comments.

the future. The principal use of general equilibrium models is to help us understand complex causal relationships that are too difficult to model with statistical techniques--that is, using only observed data, and estimating the relationship of the observed data. The important contribution that these models can make is to help show which assumptions may matter in understanding trade theory.

Computable general equilibrium (CGE) models provide the theoretician with a numerical analysis to further flesh out pure equations. This allows the theoretician to understand better which variable among many that may have positive (negative) derivatives is likely to have the most positive (negative) impact; and to find plausible causal implications for variables that have indeterminate signs. For a trade theorist, this is an important step in trying to make the transition from theory to policy implications.

So, theorists have long been accustomed to the use of sensitivity analysis in presenting CGE model results. By changing parameter values, the theorists can see how sensitive the numerical analysis is to the choice of parameter values. If the results of the CGE model vary widely because of small changes in parameter values, this alerts the theorists that either the model is misspecified, or that very reliable estimates of the parameter are needed to understand the policy implications of theory.

At their current level of development then, CGE models help theorists understand what is likely to matter in formulating a trade policy. But, CGE models must go further to have relevance in real trade policy debates. This is highlighted by the outcome of Professor Sobarzo's work.

As Professor Sobarzo says, and as others have shown, static Walrasian models with constant returns to scale show no appreciable gains from trade liberalization. (Deardorff and Stern, 1981 is an example.) Proponents of free trade agreements cannot argue that the proposed NAFTA would generate any statistically detectable gains unless they make some additional assumptions (Spriggs, 1991). But different assumptions yield widely different model results.

In Professor Sobarzo's paper, GDP growth in Mexico could be as low as 1.1 percent, or as high as 15.5 percent. For a theorist, this is sufficient. For a policy maker this makes the models useless unless additional information is provided so that the policy maker can understand which formulation yields the most realistic outcome.

Often, when debating trade liberalization, there are no actual data to measure the more liberal regime. In those cases, it is necessary to rely on the judgement of theorists as to which assumptions yield the most realistic outcome. But this is not so for the proposed U.S.-Mexico free trade agreement (FTA), or a North American Free Trade Agreement (NAFTA) that would include Canada. In 1986, when Mexico joined GATT, there was a unilateral opening of the Mexican market. Between 1985 and 1989, Mexico lowered most of its tariffs so that the trade weighted average tariff fell by half. In 1989, the U.S. and Canada entered their FTA. Actual data exist for measuring the outcomes of those trade liberalizations.

Instead of sensitivity analysis economists need to present policy makers with goodness-of-fit statistics. CGE trade models purport to show the effects of trade liberalization. Too often, because the models are part of the theoretical debate about trade, economists choose between the models based on consistency with theory and not reality. The "backcast" of the model to cover two important trade liberalizations in North America would move the discussion away from economists and toward policy makers. I propose that economists must present as the results of their model the following:

1. The model's prediction of the Mexican trade liberalization, 1986-1991.
   a. If the model has an analysis by economic sector then:
      i. a weighted correlation between actual 1986-1991 data and the models predicted percentage change for the sectors.
      ii. the regression coefficient of the predicted percentage change for the sectors on the actual change, and a test of whether the coefficient is equal to one.

b. For the growth of GDP or GNP, wages, trade flows or currency evaluation--a goodness-of-fit statistic.

2. The model's prediction of the U.S.-Canada FTA: 1989-1991.
   a. If the model has an analysis by economic sector, then:
      i. A weighted correlation between actual 1989-1991 data and the models predicted percentage change for the sectors.
      ii. The regression coefficient of the predicted percentage change for the sectors on the actual change, and a test of whether the coefficient is equal to one.
   b. For the growth of GDP or GNP, wages, trade flows or currency evaluation--a goodness-of-fit statistic.

This is not an unreasonable request. Timothy Kehoe, Clemente Polo and Ferran Sancho (1992) have done this for a model of fiscal reform for the Spanish economy.

This exercise has already been carried out in the context of the U.S.-Canada free trade area by Ricardo Grinspun (1992). Table I shows projections from various models of the U.S.-Canada FTA for employment in Canada. It shows two things. First, the models do not give consistent projections of the likely outcomes of an FTA. Therefore, from the policy analyst's perspective, understanding which model is best is not possible unless some check with real data is provided. Here, the 1989 Brown and Stern model appears to have come closest to forecasting the negative impact for many sectors. Second, while the 1989 Brown and Stern model has more of the direction of the results correct than the other models, none of the models is very good at forecasting the absolute results.

Other statistics that all models should report come from the calibrating done to develop the benchmark case. First, the economist should make clear how many parameters are predetermined before the benchmark calibration and how many are fixed by the calibration process. Here, a parameter is any number used in the model that is not endogenous, and is not part of the social

accounting matrix (SAM). If the parameters are predetermined by assumptions, then the author should make this clear to the reader--as, to his credit, Professor Sobarzo did in his model with the elasticities of substitution. Parameters obtained from empirical research should be reported with their standard errors. A statistic should appear with the model showing the proportion of parameters that fit in the three categories.

Second, the economist should present benchmark results, with a comparison to the actual data for the benchmark. The economist should present a goodness-of-fit statistic between the calibrated data and the actual benchmark. Santiago Levy and Sweder van Wijnbergen present such figures in their paper, "Transition Problems in Economic Reform: Agriculture in the Mexico-U.S. Free Trade Agreement."

Professor Sobarzo's presentation would be much stronger if he followed these guidelines. His paper presents alternate regimes that model the price-setting behavior in the economy. Each alternative yields very different implications for the impact of a NAFTA. To prevent a policy analyst from dismissing the whole exercise, it is better to guide the analyst to understand which formulation is most reliable in predicting known outcomes.

Because the models presented in the conference all yield such different results, it would be best if they also accepted the responsibility to the policy community of showing how well the models perform with respect to the past trade liberalization. Without such an approach, policy makers must remain skeptical toward an approach that can yield almost any result desirable. Responding to reality, and to policy makers, will--I think--make the modelling exercise more relevant.

II. Comments on Multinational Firms and Modelling Trade

The scenario labelled Version 3 of Professor Sobarzo's is the most intriguing. Like other papers that are presented at this conference--but, unlike many prominent models cited in past debates, he acknowledges that capital can move across borders. Still, this is loosely modeled. A significant portion of

Table III

North American Trade, 1989
All Trade and Trade by U.S. Foreign Affiliates in Mexico and Canada (In U.S. $billions)

	All Imports From			Imports from U.S. Multinationals		
	U.S.A.	Canada	Mexico	U.S.A.	Canada	Mexico
U.S.A.	...	87.95	27.16	...	40.14	7.27
Canada	78.81	...	1.43	38.18	...	...
Mexico	24.98	.52	...	7.59	...	...
Totals	103.79	88.37	28.59	45.77	40.14	7.27

Source: U.S. Dept. of Commerce, *Survey of Current Business*, Vol. 71 (October, 1991): Table 19, page 51 and S-16, S-17 for all U.S. trade; and IMF, *Direction of Trade Statistics, Yearbook 1991*, page 156 for Canada-Mexico trade statistics.

North American trade is the result of U.S. based multinational activity. Table II presents some data to this effect.

Looking at all North American trade, 42 percent ($93.18/220.75) can be accounted for by the movement of goods among U.S. owned affiliates operating in Canada and Mexico. Now, much of the trade by U.S. multinationals is in the U.S.-Canada free trade area. Still, of the almost $25 billion that the U.S. exports to Mexico, $7.6 billion is shipments to U.S. multinationals operating in Mexico--roughly thirty percent of U.S. exports. A similar proportion of U.S. imports are from U.S. multinationals operating in Mexico. So, a large portion of U.S.-Mexico trade is about the decision where to produce an item. Thus, to assess the impact of an FTA, it is difficult to argue that one does not have to model the behavior of U.S. multinational firms.

Linda Hunter, James Markusen and Thomas Rutherford attempt to model multinational firm behavior in their conference paper, "Trade Liberalization in a Multinational-Dominated Industry: A Theoretical and Applied General Equilibrium Analysis." Because of the presence of large trade flows among multinationals, they recognize that the Armington assumption is inappropriate. Without the Armington assumption, models of a NAFTA predict greater shifts in sector shares. The key contribution that Hunter, Markusen and Rutherford make is that moving capital in response to an FTA is best modelled as a problem of coordinating "production, pricing and sales decisions across multiple plants and markets."

With the presence of multinational firms, the concern is not the movement of disembodied capital, but the movement of production. An FTA reduces the barriers posed by national boundaries to production location decisions. This is different from lowering tariffs. An FTA provides an assurance that production can be shifted about without government interference, thus reducing the cost and more importantly the *risk* of shifting production. Lower tariffs--without an FTA--reduce the cost, but not the risk, of shifting production.

For Professor Sobarzo's work the distinction is important. He argues for the importance of dynamic gains from capital investment and scale economies. Magnus Blomstrom and Edward Wolff (1989) have shown that for Mexico, labor "productivity growth in local firms and productivity convergence between local and foreign firms are faster in industries with a greater share of employment accounted for by multinationals." The process technology transfer that takes place through foreign direct investment is important to the spurt in Mexico's growth that Professor Sobarzo's work says could take place. Celso Garrido (1989) has shown that 80 percent of Mexico's early export growth after joining GATT can be accounted for by ten companies. Only two of those companies are Mexican. But, under an FTA this shift in production could take place at the cost of production in the U.S.--and therefore at the cost of employment for U.S. based workers.

It is surprising that none of the presentations mentioned the size of trade flows in North America that are directly related to U.S. multinational shipments. Further, it is surprising that despite discussing productivity gains in the abstract, none discussed the evidence available on the impact of direct foreign investment on Canada and Mexico. This lack of attention to such details only invites cynicism from knowledgeable policy makers and non-trade economists. It gives the impression that the modelling exercise is part of a discussion for trade theorists only. I think that it is important that the current modelling exercises reflect these realities of current North American trade and investment flows.

III. Comments Specific to Professor Sobarzo's Model

Professor Sobarzo has set out to model the Mexican economy. He looks at how his model would be affected if trade with North America is liberalized. The free trade regime is characterized as lowering tariffs from their 1989 levels to zero. Non-tariff trade barriers are not included in his model. Though his model is not a general equilibrium model of North America, there are still important contributions possible from this approach. Professor Sobarzo says that his model's contribution is that he shows how removing the assumption of constant returns to scale can significantly alter the results of general equilibrium models. He shows that results can differ because of assumptions about the pricing rule when increasing returns to scale and imperfect competition are allowed. Further, assumptions about the pricing rule dominate the results so that typical discussion on the elasticities of substitution of imported goods are moot. These are not unique finds. They are similar to Richard Harris' (1984) findings for Canada.

Professor Sobarzo is to be commended for the great detail of his work. This paper includes some of the most detailed data for the Mexican economy of any of the models presented at the conference. The detail he has provided is obviously appreciated by the other modelers, some of whom depended on his work.

Professor Sobarzo's main hypothesis is that current models overlook the increased efficiency that will occur when tariffs are lowered. His SAM however is drawn from 1985, when tariffs in Mexico were higher than 1989. If

Professor Sobarzo is correct, the SAM reflects an economy that contains less efficient production than the Mexico of today. For purposes of understanding potential gains to the Mexican economy of a NAFTA then, the changes he reports will be bigger than should be expected if we looked at his model starting with the Mexico of today. Much of the gains in efficiency from lower tariffs should have already occurred and so the SAM based on 1989 data should reflect those changes--if his main hypothesis is correct.

As with other CGE models, Professor Sobarzo allows the movement of workers among economic sectors to be free. This ignores barriers that workers face in making such moves. In version 3 of his paper, where the labor supply is fixed and the wage is variable, the cost-free movement among sectors is an important assumption. Version 3 yields the greatest gains to the Mexican GDP and welfare. But these gains rely on shifts of workers out of agriculture and other low productivity sectors. Of course such shifts cannot take place easily. A more reasonable approach is to include a cost function for switching from one sector to another.

Further, Professor Sobarzo's approach at modelling capital flows in version 3 of his paper may be inadequate. He ignores the unique nature of multinational corporations changing production processes in their new locale. So, in one sense, he may not include all the effects of technology transfers. In another sense, he ignores the impact that shifts in production may have on all North America. In particular, if there are sufficient shifts in production facilities away from the U.S. then less gain will come from trade.

Choices of what to report as the output of a CGE model depend on the policy maker's concerns. Professor Sobarzo identifies three major areas of concern. He says that Mexico's "inward-oriented" development policy that dominated the post-World War II era:

> . . .led to a very distorted scenario in which . . .Many economic imbalances were created . . .such as [1] a very marked regional disequilibrium, [2] a very concentrated income in relatively few hands and, [3] more important . . .the external disequilibrium.

The results he reports as output from his model however, do not help us understand his concerns very much. For instance, the number of firms in his model is endogenously determined. If he is concerned with the concentration of income it would be helpful to see what happens to the number of firms. We are told that there are fewer firms, but not shown how many fewer. Mexican critics of the current development policies claim that the concentration of income and wealth has become worse, not better.* While the number of firms does not necessarily tell us what has happened to income distribution, it is a strong clue of how economic power is concentrated. After all, Professor Sobarzo's sensitivity analysis suggests that more collusive pricing behavior increases the benefits of trade.

Second, while we are given an industry-sector breakdown, we are not given a regional breakdown. The concerns about industrial organization that Professor Sobarzo models make the intra-and inter-industry trade patterns crucial. Still, his policy concern lies in a regional breakdown. It is possible that increased foreign investment in northern Mexico would close, some regional income disparities. Supporters of the maquiladora plan claim that regional disparities in wages are shrinking as investment in northern Mexico maquiladora plants matures.** Allowing the labor supply to be fixed, and wages to adjust, increased investment would lead to big wage gains in Professor Sobarzo's model. Does this imply the closing of regional wage gaps? Professor Sobarzo does not say.

Third, while Professor Sobarzo does show a worsening of Mexico's trade balance--in those scenarios where it can vary--he does not give us information

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* See for example, Carols Fernández-Vega, "Concentración y poder: La élite del empresariado mexicano," *Perill de LaJornada*, April 2 and 15, 1991.

** See for example: Jorge Carrillo V. (ed.), *Mercados de Trabajo en la Industria Maquiladora de Exportación: Síntesis del Reporte de Investigación* (Secretaría del Trabajo y Previsión Social y El Colegio de la Frontera Norte, 1991).

on Mexico's current account balance. This is important to both versions 2 and 3 of his model. In version 2, Mexico is allowed to borrow to address a trade deficit, and in version 3 Mexico is allowed to have foreign direct investment to address Mexico's capital account balance. Already there is some concern with Mexico's current account deficit. At the current rate of growth, the current account deficit could soon reach the same level as in 1981 that caused Mexico's debt crisis. Does the model support those who are sanguine about this trend?*

IV. Conclusion

CGE modelers still have work to do to make their results accessible for policy makers. For non-trade economists, the reliance on a single year for calibrating several parameters and the assumption that a particular year is an equilibrium are troubling--particularly for labor economists. While most models now incorporate imperfect competition in product markets, there is little effort shown to include the complexities of the labor market. These are shortcomings of Professor Sobarzo's paper as well. Still, he should be commended for the detail of his work. The flaws in his model could be corrected in future versions.

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* See for example: Roberto Salinas-Leon, "Don't Cry for Mexico's Current Account Deficit," *The Wall Street Journal* (Friday, February 21, 1992) p. A15.

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PAPER 12

"STEADY GROWTH AND TRANSITION IN A DYNAMIC DUAL MODEL OF THE NORTH AMERICAN FREE TRADE AGREEMENT,"
BY LESLIE YOUNG AND JOSÉ ROMERO

STEADY GROWTH AND TRANSITION IN A DYNAMIC DUAL MODEL OF THE NORTH AMERICAN FREE TRADE AGREEMENT:

Leslie Young and Jose Romero
University of Texas at Austin and El Colegio de Mexico

2/21/92

Abstract

This paper develops a multi-period, general equilibrium model of the impact of the North American Free Trade Agreement (NAFTA) on Mexico. The model has 9 consumption goods sectors and 3 capital goods sectors. At current real interest rates of 10%, the long-run effect of NAFTA is a 2.6% increase in Mexican gross domestic product at world prices. These benefits are substantially higher if NAFTA reduces real interest rates: if the real rate falls to 7.5%, then gross domestic product increases by 8.1% in the long run.

The tentative results reported in this paper should not be quoted without the authors' permission.

1. INTRODUCTION

This paper uses a multi-period, general equilibrium model of the Mexican economy to estimate the effects of the proposed North American Free Trade Agreement (NAFTA). In line with the classification in the Sistema de Cuentas Nacionales de Mexico, the model has 3 capital goods sectors (machines, buildings and vehicles) and 9 consumption/intermediate goods sectors. In each period, production uses labor, capital and intermediate goods. The capital in each sector depreciates at the empirically-observed rates, while investment is determined endogenously by profit maximization as part of the general equilibrium conditions of the dynamic model. We find that, at the current real interest rates of 10%, the long run effect of NAFTA is a 2.6% increase in Mexican gross domestic product at world prices. The gains are significantly greater if NAFTA reduces real interest rates. If these fall to 7.5%, then gross domestic product increases by 8.1% in the long run.

Our estimates of the benefits from NAFTA are higher than estimates from existing static models. The reason could be as follows. The recent economic liberalization of Mexico has already led to a substantial reduction in tariffs. Since existing nominal rates of protection are quite low, removing these distortions leads only to minor gains in a model where both consumption and production losses from tariffs are essentially proportional to nominal rates of protection. In our model, the consumption losses from tariffs are likewise quite small (of the order of 0.25% of GDP). However, the richer structure of inter-sectoral flows in our model captures more of the distortionary impact of the existing tariff structure on the value added in various sectors. We therefore obtain higher estimates of the production losses arising from inter-sectoral discrepancies in effective rates of protection (Corden (1966, 1975)). As explained in Section 9, the high real interest rates prevailing in Mexico imply that tariffs on capital goods lead to particularly severe inter-sectoral discrepancies in effective rates of protection. Our model also captures additional gains from the NAFTA from improved efficiency in input use within sectors and in the intertemporal allocation of resources within and across sectors.

2. THE DUAL APPROACH TO POLICY MODELLING

The key innovation in our modelling is the consistent use of duality in a dynamic open economy model which extends the model of Young and Romero (1990). The monograph of Dixit and Norman (1980) established the dual approach as the standard method of presenting theoretical issues in international economics because of the clarity and economy that results when the first-order conditions for consumer and producer choice are impounded in the dual functions specifying their behavior. Duality also facilitates clarity and economy in empirical modelling of international issues. The dual approach to estimating a sector's production function and determining its factor demands via the cost function is well-known. We go further by stating all the equilibrium conditions of the model in terms of the estimated cost functions. Since these cost functions build in the optimal intra-period input choices of firms, this obviates the first-order conditions for these choices. In calculating the steady growth path of the economy, we also bypass the first-order conditions for output and investment by exploiting the intertemporal relationship between the price of capital and the stream of future rentals from the capital. In calculating the transition to steady growth, we can again bypass the first-order conditions for output and investment by using the Second Fundamental Theorem of Welfare Economics and the maximization procedures built into the GAMS computational package to duplicate market outcomes.

These techniques mean that our dynamic general equilibrium model does not require explicit computation of <u>any</u> first-order conditions. This sharply reduces the number of equations, yielding a compact, yet transparent, model which is readily computable.

3. Estimation of Cost Functions

For each sector, we have price indices both for the broad categories of labor, capital and intermediate goods and for the outputs of each of the 12 sectors, including individual intermediate and capital goods. Labor and intermediate inputs are used up in one period, but capital goods depreciate over time, while receiving a rental from the profits of that sector. Of course, there is no way to impute rentals separately to the individual capital goods: machines m, buildings b (which includes all construction) and vehicles v. Nor do we have individual depreciation rates for these goods.

Given the form in which the data is available, it is natural to view production as taking place in two stages. In stage I, the representative sector i firm produces :

(a) a composite capital good K_i using machines, buildings and vehicles;

(b) a composite intermediate good M_i using various intermediate goods.

In stage II, the firm produces good i using K_i, M_i and labor L_i. The time t mix of capital goods m,b,v used to produce K_i is that minimizing the cost of production, given the time t prices p_{mt}, p_{bt}, p_{vt} of the three capital goods. The depreciation rate d_i of K_i comes directly from the data. The time t rental r_{it} on a unit of K_i equals the time t profits in sector i, divided by the amount of K_i — which equals the time t value of sector i capital, divided by its price p_{iKt}. Thus:

$$r_{it} = \frac{\text{time t profits} \,.\, p_{iKt}}{\text{time t value of capital}} \qquad (1)$$

All production functions are assumed to exhibit constant returns to scale.

The unit cost function for K_i is assumed to be a translog function $C_{iK}(p_m,p_b,p_v)$ of the prices of the individual capital goods. The production function for M_i is assumed to be Cobb-Douglas, so that its unit cost is a Cobb-Douglas function of the vector $p = (p_1,..,p_n)$ of intermediate goods prices:

(2) $$C_{iM}(p) = \gamma_i p_1^{s_{i1}} p_2^{s_{i2}} \dots p_n^{s_{in}}$$

where s_{ij} is the share of intermediate good j in the total cost of the intermediate goods used in the production of good i. These shares are obtained from the Input-Output Matrix published by INEGI. The constant γ_i is chosen so that the price that emerges from (2) equals the price of the composite intermediate good q_i observed in 1988. Finally, the stage II production function of sector i is estimated indirectly from its cost function $C_i(w_i,r_i,q_i)$, which is assumed to be a translog function of the wage w_i, the rental r_i and the price q_i of M_i.

4. Input Demands

The unit cost function for good i as a function of the sector i wage and rental rate and the prices of individual intermediate goods can be obtained by substituting the unit cost function for intermediates estimated in stage Ib for the intermediate goods price q_i in the cost function $C_i(w_i,r_i,q_i)$ estimated in stage II:

$$c_i(w_i,r_i,p) = C_i(w_i,r_i,C_{iM}(p))$$

By the Shephard-Samuelson relations, the sector i demand for labor a_{iL}, the composite capital good a_{iK} and the individual intermediate goods is obtained by differentiating c_i with respect to the corresponding price (or rental in the case of the capital good). The demand A_{ik} for capital good k (= m,b,v) per unit of the composite capital good K_i is obtained by differentiating C_{iK} with respect to p_{ik}. Thus, the sector i demand for capital good k per unit of output is:

$$a_{ik}(w_i,r_i,p) = a_{iK}(w_i,r_i,p)A_{ik}(p_m,p_b,p_v).$$

5. Steady Growth

All models with a finite horizon T encounter the problem of modelling investment in capital goods which would be fully depreciated only beyond T. Our approach is to suppose that the time T capital stock and investment rates are at the levels corresponding to a steady growth path, where goods prices are steady while every sector's output, labor force and capital stock expands at a fixed rate g, so that factor returns and capital goods prices are steady also.

The steady growth rental r_i on a unit of capital in sector i satisfies:

(1) $$p_i = c_i(w_i,r_i,p) \qquad i = 1,..,12$$

In equilibrium, the price of new sector i capital equals the unit cost of capital $c_{iK}(p_m,p_b,p_v)$; it also equals the present value of the rentals from that unit, future rentals being discounted at the real rate of interest i plus the empirically-observed depreciation rate d_i:

(2) $$c_{iK}(p_m,p_b,p_v) = \sum_{t=1}^{\infty} r_i \frac{(1-d_i)^{t-1}}{(1+i)^t} = \frac{r_i}{i+d_i}$$

The equilibrium condition for sector i labor is:

(3) $a_{iL}(w_i, r_i, c_{iI}(p))y_i = L_i$

where L_i is the labor force in sector i.

All goods except buildings are traded and therefore have their prices determined internationally, once the trade policy is specified. The price of buildings, however, is determined by internal market-clearing conditions. Buildings are demanded by industry, by individuals and by the government. In principle, it would be desirable to estimate private demand for buildings as a function of private income and to include this in the market-clearing conditions. However, there are insurmountable data problems since private housing demand responds to considerations which have fluctuated widely over the estimation period, such as the anticipated rate of inflation, the availability and the terms of finance and the desire to hold wealth in a nontaxable form. Moreover, the government provides a significant portion of the housing stock, as well as all infrastructure — which is included in the category "buildings". Since industrial demand for construction has been a relatively stable proportion of the output of the construction industry, we shall suppose that, as a matter of social policy, the government targets the proportion of construction available to meet private and government demands. Our simulation sets this equal to the proportion that obtained in 1988, when the value of output in the construction industry was 82,481 million pesos while industrial usage was 51,337 million pesos. Thus, we set total demand for construction equal to industry demand multiplied by $F = 82{,}481/51{,}337 = 1.61$. Of course, we could explore the implications of other values of F.

The steady growth stock of buildings in sector i is that implied by steady growth output:

$$a_{ib}(w_i, r_i, p)y_i$$

Steady growth investment in sector i buildings is that required to ensure that the stock of buildings grows at a rate g after depreciation d_i:

$$(g+d_i)a_{ib}(w_i, r_i, p)y_i$$

Thus, industry demand is $\sum_i(g+d_i)a_{ib}(w_i, r_i, p)y_i$, while total demand for buildings is assumed to be larger by a factor F. Thus, equilibrium in the market for new buildings requires that:

(4) $F\sum_i (g+d_i)a_{ib}(w_i, r_i, p)y_i = y_b$

There is no corresponding constraint on machines or vehicles since they are traded.

Our model has 12 sectors, including the 3 capital goods sectors. We assume that all goods (apart from buildings) are traded so that (1) and (2) comprise 24 equations in 25 unknowns: w_i, r_i for $i = 1,..,12$, plus p_b (which is endogenously determined since buildings are nontraded). (3) comprises 12 equations and (4) comprises 1 equation, so we have 37 equations in 37 unknowns. Thus, with exogenously-given labor forces, the model could be solved for steady growth outputs and factor returns.

However, we expect NAFTA to lead to substantial changes in the sectoral allocation of labor. Hence, instead of requiring all the sectoral labor forces to grow at the rate g of population growth during the transition to steady growth, we admit deviations within specified bounds $(g-f_i, g+h_i)$ while constraining the total labor force to grow at rate g. Thus, in solving for a steady growth path which starts T periods after the current period 0, we impose the constraints:

$$(1+g-f_i)^T < L_{iT}/L_{i0} < (1+g+h_i)^T \text{ and } \sum_i L_{iT} = (1+g)^T L_{i0}$$

and choose the L_{iT} to maximize steady growth gross domestic output valued at domestic prices in order to duplicate the effect of market choices in face of domestic prices. We then compare the steady growth value of gross domestic output (GDP) at world prices under free trade and under current tariffs. The next section provides a rigorous welfare interpretation of our empirical results.

6. Production and Consumption Gains from NAFTA

If a country practices free trade at world prices π and its GDP is $r(\pi)$, then its welfare u^f is given by the income-expenditure identity:

(1) $$e(\pi, u^f) = r(\pi)$$

where e(.,.) is the country's expenditure function (Dixit and Norman (1980)). If the country imposes a vector T of ad valorem tariffs and therefore faces internal prices $p_i = \pi_i(1+T_i)$ for good i, and its GDP at these prices is r(p) while its tariff revenue is R, then its welfare u^T is given by the income-expenditure identity:

(2) $$e(p, u^T) = r(p) + R.$$

Suppose that the expenditure function is multiplicatively separable (i.e., consumer preferences are homothetic) with the form:

$$e(p,u) = I(p)f(u)$$

where I(p) is the exact consumer price index and f(u) is "real income". Then the expenditure required to ensure free trade utility u^f at internal prices p is:

(3) $$e(p,u^f) = e(\pi,u^f)I(p)/I(\pi) = r(\pi)I(p)/I(\pi) \text{ by (1)}$$

Thus, a GDP of $r(\pi)$ in face of world prices π yields the same welfare as a GDP of $r(\pi)I(p)/I(\pi)$ in face of tariff-ridden prices p. Thus, NAFTA increases domestic real income by the factor:

(4) $$\frac{f(u^f)}{f(u^T)} = \frac{e(p,u^f)}{e(p,u^T)} = \frac{r(\pi)}{r(p)+R}\frac{I(p)}{I(\pi)} = \frac{r(\pi)}{\sum_i \pi_i y_i(p)}\frac{\sum_i \pi_i y_i(p)}{r(p)+R}\frac{I(p)}{I(\pi)}$$

For example, if this equals 1.09, then without NAFTA, a 9% increase in income would be needed to achieve the welfare level attainable under NAFTA.

Both production and consumption gains are included in this calculation. In (4), the term $\frac{r(\pi)}{\sum_i \pi_i y_i(p)}$ is the factor by which GDP increases as a result of NAFTA, when output is evaluated at world prices. This measures the production gain from NAFTA, i.e., the increased value at world prices π of the country's output when internal producer choices are made facing world prices rather than the distorted prices obtaining under a tariff. The term $\frac{\Sigma_i \pi_i y_i(p)}{r(p)+R} \frac{I(p)}{I(\pi)}$ in (4) measures the consumption gain from NAFTA, i.e., the gain arising when internal consumer choices are made facing world prices rather than the distorted prices obtaining under a tariff, so that consumer needs are met at a lower foreign exchange cost. Exploiting the homotheticity of consumer preferences, an elementary calculation (Appendix A) shows that:

$$\frac{\sum_i \pi_i y_i(p)}{r(p)+R} = 1 - \sum_i \frac{s_i T_i}{1+T_i} \tag{5}$$

where s_i is the share of consumer expenditure on good i. (5) gives the impact of a unit increase in domestic expenditure on the foreign exchange cost of the goods consumed. This is less than 1 because some the expenditure increase is returned to the domestic economy as tariff revenue. Thus, the consumption gain from NAFTA increases welfare by the factor:

$$\left\{ 1 - \sum_i \frac{s_i T_i}{1+T_i} \right\} \frac{I(p)}{I(\pi)}$$

i.e., the percentage consumption gain from NAFTA equals the percentage increase in the cost of living due to the tariffs minus the percentage of domestic expenditure that would be returned to the domestic economy as tariff revenue.

Cobb-Douglas preferences imply that the expenditure share s_i on each good i is fixed and that the expenditure function has the form:

$$e(p,u) = u p_1^{s_1} p_2^{s_2} \ldots p_n^{s_n}$$

so the tariffs T_i increase the consumer price index by the factor:

$$\frac{I(p)}{I(\pi)} = (1+T_1)^{s_1} (1+T_1)^{s_2} \ldots (1+T_n)^{s_n}$$

Estimating Mexican demand parameters assuming Cobb-Douglas preferences, we find that NAFTA would reduce the cost of living by 3.59% while 3.36% of domestic expenditure is returned to the Mexican economy as tariff revenue. Thus, the consumption gain from NAFTA is about 0.23%. This is very small compared to the production gains reported below, indicating that it is hardly worthwhile making more sophisticated estimates, e.g., with more flexible functional forms or non-homothetic preferences. Thus, we henceforth focus on production gains.

7. STEADY GROWTH OUTCOMES

The following results were obtained for the effects of NAFTA on steady growth gross domestic product at world prices.

Table 1: Effects of NAFTA on Steady Growth Mexican Gross Domestic Product

A: Tariffs $i = 10\%$	B:Free Trade $i = 10\%$	C:Free Trade $i = 7.5\%$	$\frac{B-A}{A}\%$	$\frac{C-A}{A}\%$	$\frac{C-B}{B}\%$
418,365,060	429,208,531	452,406,021	2.6%	8.1%	5.5%

Thus, the long-run effect of NAFTA is a substantial increase in Mexican gross domestic product, even at current real interest rates. The gains are even greater if NAFTA reduces Mexican real interest rates, as we would expect for the reasons given below in Section 9.4. Our analysis indicates that this could well be one of the most significant benefits of NAFTA to Mexico.

The above results assume that each sector's share of the labor force can deviate from its current share by 20% either way. Earlier models assumed perfect labor mobility, yet estimated much smaller gains from NAFTA. In general, we found that the gains from NAFTA are greater, the greater the deviations allowed in the structure of employment. Thus, the benefits from NAFTA to Mexico would be substantially enhanced by government policies which facilitate labor mobility, such as an expansion of educational opportunities.

8. THE TRANSITION TO STEADY GROWTH

This section sets out the equations governing the transition to steady growth beginning at time T. At transition times $t = 0,..T-1$, the rental r_{it} on sector i capital satisfies:

(1) $$p_{it} = c_i(w_{it}, r_{it}, p_t).$$

The equilibrium condition for sector i labor is:

(2) $$a_{iL}(w_{it}, r_{it}, p_t)y_{it} = L_{it}$$

The equilibrium condition for sector i physical capital is:

(3) $$a_{iK}(w_{it}, r_{it}, p_t)y_{it} = K_{it}$$

The equilibrium condition for buildings is:

(4) $$\Sigma_i\, a_{ib}(w_i, r_i, p)I_{it} = y_{bt}$$

where I_{it} is the time t physical investment in sector i.

Time 0 (=1988) physical capital in sector i, K_{i0}, is taken from the data. Its value at $t = 1,..,T-1$ equals the depreciated value of time t-1 physical capital plus the time t-1 value of physical investment:

(5) $$K_{it} = (1-d_i)K_{it-1} + I_{it-1}$$

Thus, if we know sectoral physical investment at $t = 0,..,T-1$, then we can deduce the capital stocks for $t = 0,..,T$. Given also the sectoral labor forces during the transition, at any $t = 0,..,T-1$, (1) - (4) comprise 37 equations in 37 unknowns $(w_{it}, r_{it}, y_{it}, p_{bt})$.

We suppose that the total labor force grows at the population growth rate g but in each period, we allow deviations f_i in the growth rate of the labor force in each sector i. Thus, during the transition, we impose the constraints:

$$1 + g - f_i < L_{it}/L_{it-1} < 1 + g + h_i \text{ and } \sum_i L_{it} = (1+g)L_{it-1}$$

We then set GAMS to choose the L_{it} and sectoral physical investments $(I_{it} \geq 0)$ during the transition to maximize the value of domestic output valued at domestic prices in order to duplicate the effect of market choices while constraining the time T capital stocks to equal the levels required to begin steady growth at time T with the population exogenously specified for time T.

The Second Fundamental Theorem of Welfare Economics indicates that this maximization duplicates the market outcome when investors can sell their time T sectoral capital stocks at prices equal to the Kuhn-Tucker multipliers λ_{iKT} associated with the constraints on these capital stocks. Investment at times $t < T$ would then satisfy the following market equilibrium conditions for time t positive investment [with complementary slackness]:

$$c_{iK}(p_{mt}, p_{bt}, p_{vt}) \geq \sum_{\tau=t+1}^{T-1} r_{i\tau} \frac{(1-d_i)^{\tau-t-1}}{(1+i)^{\tau-t}} + \lambda_{iKT} \frac{(1-d_i)^{T-t-1}}{(1+i)^{T-t}} \quad [I_{it} \geq 0]$$

i.e., time t investment in sector i is positive only if the time t price of a unit of new sector i capital equals the time t present value of the rentals which that unit would earn up until time T (when steady growth commences) plus the time T value of the depreciated capital.

Von Neumann's Theorem on the optimality of balanced growth indicates that if the transition and the steady growth phases comprise an optimal program, then λ_{iKT} equals the price p_{iKT} of sector i capital emerging from the steady growth solution. Thus, the discrepancy between λ_{iKT} and p_{iKT} indicates whether the transition phase has been set long enough that the above procedure is close to maximizing the present value of domestic output at domestic prices - thereby duplicating the market outcome.

Our simulation used 11 periods, leading to discrepancies between the values of λ_{iKT} and p_{iKT} which were always less than 0.5% and averaged less than 0.3%. This suggests that little accuracy would be gained by increasing T.

Table 2: Mexican Gross Domestic Product Over the Transition.

Year	Tariffs i=10%	Free Trade i=10%	Free Trade i=7.5%	$\frac{C-B}{B}\%$	$\frac{D-B}{B}\%$	$\frac{D-C}{C}\%$
1992	333802200	339930098	328871800	1.84	-1.48	-3.25
1993	321518800	327917979	340259100	1.99	5.83	3.76
1994	334465000	338264787	360055300	1.14	7.65	6.44
1995	340757000	346711719	359717000	1.75	5.56	3.75
1996	347093700	357586226	374264900	3.02	7.83	4.66
1997	354867900	364020006	385389800	2.58	8.60	5.87
1998	363286900	374074495	395261900	2.97	8.80	5.66
1999	374159000	385323841	405042100	2.98	8.25	5.12
2000	386333300	398850036	417573300	3.24	8.09	4.69
2001	401200900	414268495	426663100	3.26	6.35	2.99
2002	417530000	431365358	444406700	3.31	6.44	3.02

At real interest rates of 10%, NAFTA increases the present value of national income over the transition and growth phases by 2.5%. The comparison between the present values of national income at different interest rates is dominated by the effects of discounting at these different interest rates, but the last column of Table 2 shows that the drop in the interest rate from 10% to 7.5% leads to substantial increases in GDP in all periods except in first.

9. The Economic Gains from NAFTA

This section provides an intuitive idea of the economic gains from NAFTA that are captured in our model, contrasting them with the gains captured in earlier models.

9.1. Equalization of Effective Rates of Protection: Static Gains

Consider three sectors A, B and C, each protected by a nominal 5% tariff. If each sector used only Mexican inputs which are themselves unprotected, then their effective rates of protection would be the same and there would be no misallocation of resources across the three sectors, although there would be a misallocation between these sectors and sectors producing nontraded goods. The latter misallocation would be small because of the low level of the nominal tariffs. By contrast, suppose that the free trade percentage of the final product price representing value added from Mexican sources is 90% in A, 50% in B and 50% in C. Suppose also that A and B use inputs which are imported freely, while C uses inputs which are subject to a 20% tariff. The standard formula for effective protection then implies that the tariff structure has increased the value added from Mexican sources by +5.55% in A, +10% in B and - 5% in C, severely distorting the allocation of these resources between these sectors, even though all enjoy the same nominal protection. Moreover, relative to nontradeables, the value added in sector B has increased by 10% while that in sector C has fallen by 5%, suggesting that NAFTA would move resources from B into nontradeables and from nontradeables into C. Thus, removing modest nominal tariffs can significantly improve the efficiency of resource use. The gains from eliminating a complex tariff structure can be estimated only within a CGE which captures all inter-sectoral resource flows: there can be no presumption that low nominal tariff rates imply low gains. Indeed, as the above examples illustrate, *low* nominal rates of protection of a final good sector tends to imply *high* negative effective protection when combined with moderate tariffs on inputs. Thus, models with highly aggregated input structures which fail to capture the impact of NAFTA on traded input prices could bypass important efficiency gains.

9.2. Equalization of Effective Rates of Protection: Dynamic Effects

Machinery and other capital goods are currently subject to substantial nominal tariffs of the order of 16% - 20%. We pointed out above that a sector whose inputs are highly protected suffers negative effective protection and ends up too small relative to sectors enjoying positive effective protection. This effect is stronger, the greater the share of the final product price absorbed by inputs which are subject to tariffs. For goods whose production requires substantial investment, the relevant "final product price" is the present value of the future revenue generated. The very high real rates of interest currently obtaining in Mexico imply that, in highly capital-intensive sectors, the cost of capital goods is particularly high relative to the present value of the revenue stream generated from investment in those goods. Thus, highly capital-intensive sectors suffer particularly high negative levels of effective protection. The tariffs on capital inputs act like a tax on capital accumulation, slowing economic growth by raising the perceived cost of producing for future periods and cutting off investment projects which would enhance labor productivity. The efficiency losses imposed by the tariffs on capital inputs are cumulative, reducing the rate of economic growth.

9.3. Efficient Input Use Within a Sector

Tariffs not only misallocate resources across sectors, but also prevent each sector from using the input combination with the lowest foreign exchange cost. Models with highly aggregated input structures could bypass the potential gains from NAFTA arising from the more efficient use of inputs within a sector. For example, within a broad category such as "materials", the removal of tariffs on different types of materials will lead sectors to choose combinations of materials which cost the country less foreign exchange, but these cost savings will not be captured in a model which treats all "materials" as an aggregate. Indeed, unless the model captures the full impact of the removal of tariffs on the internal prices of the aggregative inputs, it will not even fully capture the gains from the use of more efficient combinations of these inputs.

The detailed modelling of intersectoral flows in our model should capture more of the gains from more efficient input use within each sector. The prevailing high interest real rates imply that these gains will be particularly great since they exacerbate the inefficiencies in input use within a sector that result from tariffs on capital goods. Faced with high rates, an entrepreneur will economize sharply on capital goods whose prices have been raised by tariffs, resulting in production techniques which are inefficient for the country as a whole, given their actual opportunity cost.

9.4. A Fall in Real Interest Rates

If the current high real rates in Mexico arise from a high degree of uncertainty about future monetary policy and about the economy generally, and such uncertainty would be substantially reduced by NAFTA, then significant reductions in the real interest rates can be expected. Static models cannot take account of the impact of the fall in Mexican real interest rates that is likely to accompany NAFTA. Our analysis indicates that this will be one of its most important benefits, contributing a 5.5% increase in gross domestic product. As real interest rates fall, industries switch to more capital intensive techniques, increasing the productivity of the existing labor force and raising GDP.

Appendix A. Derivation of Equation (7.5).

Tariff revenue R satisfies:

(a1) $$R = \sum_i \frac{p_i T_i}{1+T_i}\{d_i(p,r(p)+R) - y_i(p)\}$$

Given homothetic preferences, the share s_i of expenditure on good i is independent of income so:

$$d_i(p,r(p)+R) = \frac{\{r(p)+R\}s_i}{p_i}$$

and (a1) becomes:

$$R = \sum_i \frac{p_i T_i}{1+T_i}\frac{\{r(p)+R\}s_i}{p_i} - \sum_i \frac{T_i p_i y_i(p)}{1+T_i}$$

Therefore:

$$r(p)+R = r(p) + \{r(p)+R\}\sum_i \frac{s_i T_i}{1+T_i} - \sum_i \frac{T_i p_i y_i(p)}{1+T_i}$$

and:

$$\{r(p)+R\}\left\{1 - \sum_i \frac{s_i T_i}{1+T_i}\right\} = r(p) - \sum_i \frac{T_i p_i y_i(p)}{1+T_i}$$

$$= \sum_i \pi_i(1+T_i)y_i(p) - \sum_i \pi_i T_i y_i(p)$$

$$= \sum_i \pi_i y_i(p)$$

(7.5) follows immediately.

COMMENTS ON PAPER 12

BY A. HUGHES HALLETT

Comments on the paper by Young and Romero:

I have to congratulate the authors on a very interesting and illuminating paper and one in which their estimates of the trading gains from a NAFTA regime are concisely and cleverly executed. It is important that these issues should be, systematically and independently analysed before the design of a possible NAFTA deal is finally agreed. In that respect this paper, and the conference as a whole, performs an important public service. I only wish the EC commission had gone about its 1992 and Monetary Union programmes in the same way! Instead we got a great deal of scattered and incredibly detailed analysis of different parts of those programmes - for example the 17 volume of the Cecchini report - most of it without solid academic foundations and all of it contributed by the EC commission itself or those selected by the Commission.

The crucial element in all this is that the costs and benefits of the regime change should be analysed rigorously, independently (i.e. using the different paradigms available) and systematically, in a way that leaves the various assumptions and model specifications clear and open to inspection. That is the only way to make the judgements finally reached accountable to all the interested parties. It also makes it much easier to reach an informal judgement. Secondly it is essential to check that the gains to be expected from NAFTA are large enough to warrant the change and well enough distributed to ensure that there is something in it for everyone. That will make it incentive compatible. Thirdly, it is perhaps easy to say that the change is on average beneficial and to discuss what has to happen to make that change, but it is also important to consider what policies need to be put in place in order to realise those benefits once the new regime has been created. Reasearch is needed not only to identify the necessary conditions for an improvement, but also the sufficient conditions for it to be a success.

Against this background the Young and Romero paper looks very good - at least from the Mexican side of the border. The discussant's role however is to play Devils Advocate: to argue whether the results and methodology produce reliable and significant conclusions, and to consider what those results do not show. In that regard I have few comments about the details of their particular model, but I do have 4 general points which I think must be taken into account when evaluating the benefits of a NAFTA regime empirically:

1. The authors make a strong claim that you have to use a CGE modelling approach because, unless you are able to see the effects of removing different effective protection rates in different sectors, you will miss many of the efficiency gains that a NAFTA would generate. Their illustration suggests that removing effective protection in the input and intermediate goods markets on the production side is <u>the</u> key gain from NAFTA. They go on to show how effective protection rates can vary widely over sectors even when the nominal rates of protection are much the same. That is an important insight and makes their point. They then encourage the reader to walk away with the numerical estimates of the gains that this implies. It is important to emphasise, however, that these calculations do not imply a full equilibrium - but just an equilibrium over the set of productive sectors. Further adjustments over the rest of the economy (e.g. investment expenditures, fiscal reactions etc.) or over the NAFTA area (e.g. trade responses, capital flows) could invalidate the calculations, implying either bigger or smaller benefits and that the key gains come from elsewhere. To illustrate:

   a) Because expenditure categories are not explicit in this model, I cannot be sure if savings and investment are in equilibrium, or (if they are not) what the impact of increased capital flows might be. NAFTA will create and divert investment and one might expect that to have major effects on the Mexican economy. (Some other papers in the conference suggest this may actually be a major part of the gains for Mexico). As it is, investment is assumed to be hold a constant share to GDP in the long run and to chosen to maximise domestic output in the transition periods. That may seem artificial, and it would be helpful to be able to see the investment creation and investment diversion effects explicitly.

   b) For the same reason, it would also be helpful to see the employment consequences of NAFTA explicitly. Traditional CGE modelling has the awkward feature that it <u>assumes</u> full employment. Not only is that hard to justify in the Mexican case; it automatically assumes away all migration problems. Migration must be one of the most important aspects which need investigation.

c) All calculations of this kind have to be conditioned on some sort of fiscal and monetary policy trajectories, even if they represent "no change" policies. Different trajectories would imply different equilibria and hence different gains. This paper is silent on what policies the Mexican government is assumed to follow (or the policy conditions in the US for that matter), and on whether changes in the policy trajectories would make much difference. In principle I would like to be sure the results correspond to a policy equilibrium as well as a market equilibrium. The crucial element here is monetary policy, and that opens a Pandora's box of questions about the exchange rate regime and monetary coordination that Maxico might adopt. It will be very hard to answer those questions in a CGE context, but they could be very important (compare the importance attached to the ERM and monetary union in Europe)

d) These calculations contain no feedback from the US or Canadian within NAFTA. If Mexico develops faster, it will affect US growth and price levels even if there are no behavioural or policy changes. For example cheaper imports into the US would raise US output or lower its prices, implying yet greater demand for Mexican output and Mexican growth rises further. On the other hand, if US production is already efficient, NAFTA may present US producers with greater consumption and services markets which reduces the growth impulse in Mexico. Similarly as Mexican tariffs fall, so to US tariffs reducing US prices as well as Mexican. The relative improvement in Mexican competitiveness may therefore be smaller than these calculations suggest. All these cases imply the trade diversion effects may be important and certainly should be set against the trade creation effects highlighted in the Young and Romero paper.

e) There is also a possible problem in that these calculations assume the Rest of the World (ROW) to be unchanged - there are neither active nor passive feedbacks from the ROW to NAFTA (and Mexico) in trade, capital flows or prices. Yet the NAFTA is no more "small" as a trading bloc than is the EC. Indeed it is an interesting question whether the ROW effects on NAFTA would actually be reasonably small. To check that out, one has to compare whether the gains from multilateral (or cooperative) free trade within each bloc are large compared to the costs to protectionism between the blocs in a retreat from the GATT system. The game theory foundation for this is to compare a fully cooperative (GATT) solution, against trading blocs as coalitions or unrestricted cooperation. None of this can easily be done in a CGE framework but it is important to take it into account (in separate calculations if need be). And all of it has to be set in the context of possible retaliations by the EC or Pacific areas, which would magnify any feedbacks onto NAFTA.

2. One point does concern me - although it is a cheap criticism - and that is the sensitivity of the results to the calibration of the model. The change of regime may have long lasting effects. It is important to check that sensitivity rather carefully since we cannot be very confident of true parameter values. Perhaps it is more important to check the sensitivity of the results to alternative possible model specifications. Before drawing firm conclusions I would want to be sure that those conclusions would not be affected much had alternative parameters or equation specifications been used, or, failing that, that I had at least identified the crucial parameters and assumptions so that I could investigate them further before reaching any decisions. Moreover I cannot tell if 1988 was a reasonable year for calibrating the model. Was it a very representative (i.e. steady state) year? Does the model actually fit well during other representative years for which we do have data? Might NAFTA not itself induce changes in behaviour? The authors may have captured that on the supply side with the choice between capital and labour intensive technologies. But what about consumer demand patterns, capital flows, migration, and trade with ROW? Capital and migration flows might be substantially affected if NAFTA promises to be a success.

3. A more serious criticism, because it may have a strong bearing on why the gains to NAFTA appear to be rather small here, is that all (factor as well as product) markets are assumed to be perfectly competitive and all production functions to have constant returns to scale. It is hard to believe that the markets for capital, materials and intermediate goods are perfectly competitive in Mexico (consider PEMEX for example), as assumed in the derivation of factor demands from marginal productivity conditions. The authors note, in section 9.1, that removing nominal tariffs can significantly increase the efficiency of resource use. By the same token it may be that removing market barriers/uncompetitive structures would also produce such gains. In that case a major benefit of NAFTA would be the removal of imperfect competition by competitive pressure from outside, rather than from tariff reduction per se. But that aspect is ignored in this model. Another big source of gains could be the freedom to invest where there is greatest comparative advantage within NAFTA or where the scale economies are greatest. Those gains too are missed since they are not modelled. I would have thought they need to be investigated, if only because the EC has cited them as the real motivation behind its 1992 programme. Maybe they would move the calculated gains of 1%-2% of GNP over 5 years to around the 5% figure which the EC quotes.

4. Perhaps the most striking result of the paper is that simple reductions in the (real) interest rate produces gains which are 2 to 3 times larger than going to a free trade regime. This underlies my point that investment and capital flows are the things to concentrate on in evaluating NAFTA. The sensitivity of these gains to reductions in interest rates is also a remarkable result, all the more perhaps because the bankers Salamon Bros estimate the real rate of interest (in $ terms) at 16% for 1991, and about 25% in the 1990, just when growth returned to Mexico. That emphasises just how important this mechanism is. Similarly European real interest rates have doubled or tripled over the past year while the start of the 1992 programme have been greeted with renewed and prolonged recession - now said take the worst since the 1930s. All of this suggests that design of monetary and fiscal policies is crucially important in these trading zones. A free trade agreement's contribution may actually be comparatively small unless the underlying macro policies are made more effective.

In other words NAFTA is probably necessary but not sufficient for generating economic gains. In particular:

(a) It is clear that real interest rates have fallen in Mexico, but will they continue to do so? How do we force them down further, without releasing inflation?

(b) Is there a sizeable risk premium which still remains on Mexican interest rates? Does that prevent the real benefits of NAFTA being realised? Will it fall further as the probability of financial collapse recedes, as Mexico commits itself to freer trade with more disciplined fiscal and monetary policies? Will that produce pressure for convergence in monetary policies?

(c) If the gains come from ending high interst rates, so that firms switch to capital intensive production (section 9.4), it will be crucial to look at investment creation vs. investment diversion again. May the result not be unemployment (or migration) or a Mezzogiorno problem as the US tries to help stem those difficulties? The demand side may still be important. and the full employment implications of CGE modelling may overestimate the welfare gains.

(d) What then of a decreasing wage gap as markets become more integrated?

Ref: March 92/001

COMMENTS ON PAPER 12

BY TIMOTHY J. KEHOE

Comments on

Steady Growth and Transition in a Dynamic Dual Model of the North American Free Trade Agreement

by Leslie Young and Jose Romero

Timothy J. Kehoe
February 1992

This paper is interesting in that it raises a number of important issues. In it Young and Romero make at least four significant contributions: First, they attempt to quantify in a structural model the dynamic impact of a North American Free Trade Agreement on the Mexican economy. Second, imports of intermediate goods and capital goods play an important role in their model, as they undoubtedly will in Mexican economic development over the next decade. Third, they focus on the gains that Mexico will reap from increased efficiency on the production side of the economy rather than on the consumption side, and it is here where the potentially large gains are. Fourth, they illustrate numerically the importance of capital flows into Mexico.

I will not say much now about the first contribution that Young and Romero make. As my own paper presented here illustrates, I think that modeling the dynamic impact of a NAFTA, both on the balanced growth path and on the transition path to it, is essential. The dynamic impact that Young and Romero analyze is significant. As I point out in my paper, however, I think that the most important potential dynamic impact of a NAFTA on Mexico is the impact on growth rates, which Young and Romero do not model.

The second contribution of this paper is to emphasize imports of intermediate goods and capital goods. In modeling trade flows, the authors specify thirteen goods: the nine goods that can serve as final or intermediate goods; labor; and three types of capital goods - machines, buildings, and vehicles. All of the goods except buildings and labor are tradeable. The other goods are homogeneous both domestically and internationally: U.S. automobiles are perfect substitutes for Mexican automobiles, are perfect substitutes for Canadian automobiles, are perfect substitutes for automobiles from the rest of the world. The price of an automobile in Mexico is equal to the international price times one plus the tariff,

$$P^* = P(1+T).$$

A NAFTA is modeled as lowering tariffs with the U.S. to zero so that the domestic price is equal to the international price. Given that domestic prices are fixed by international prices both before and after a NAFTA, the authors can model the dynamic equilibrium by analyzing alternative profit maximizing production decisions at these different prices without analyzing the consumption side of the model. Any excess of supply over demand is implicitly exported; any shortfall is imported.

One problem with this specification is that it does not allow simultaneous importing and exporting of goods in the same product category: Mexico either imports automobiles or exports then, but not both. When we look at figures on North American trade, however, we see significant amounts of cross-hauling, the simultaneous importing and exporting of goods in the same product category. The table for U.S. merchandise trade with Canada and Mexico in 1989 shows cross-hauling even at the two-digit SITC level, a disaggregation much finer than the authors', that dwarfs net trade flows. Notice, for example, that the biggest export of the U.S. to Canada is road vehicles, which is also the biggest import to the U.S. from Canada; the biggest export of the U.S. to Canada is road vehicles, which is also the biggest import to U.S. from Canada; the biggest export of the U.S. to Mexico is electrical machinery, which is also the second biggest import to the U.S. from Mexico, after petroleum. The approach adopted by the authors rejects whatever is causing this phenomena and

UNITED STATES MERCHANDISE TRADE BY COMMODITY 1989

(Millions of 1989 U.S. Dollars)

	EXPORTS			IMPORTS		
SITC Code*	World	Canada	Mexico	World	Canada	Mexico
0 Food and Live Animals	29,425	1,903	1,990	22,497	3,567	2,446
03 Fish Related Products	2,299	198	22	5,711	1,226	397
04 Cereals	15,457	209	976	1,017	417	27
05 Vegetables and Fruit	3,808	738	140	5,686	260	1,095
1 Beverages and Tobacco	5,510	83	19	4,690	583	258
2 Crude Materials Except Fuels	26,947	2,288	1,493	16,524	8,339	675
22 Oil Seeds	4,362	127	358	186	122	27
24 Cork and Wood	4,965	439	143	3,733	3,333	103
25 Pulp and Waste Paper	4,343	184	362	3,164	2,748	8
28 Metal Ores and Scrap	5,313	819	225	4,205	1,257	178
3 Mineral Fuels, Related Products	9,865	1,678	712	56,094	8,053	4,457
33 Petroleum, Related Products	4,828	656	518	52,411	5,126	4,359
4 Animal and Vegetable Fats, Oils	1,350	47	143	785	91	21
5 Chemicals, Related Products	36,485	4,210	2,195	21,768	4,087	600
51 Organic Chemicals	10,609	941	680	7,330	625	162
52 Inorganic Chemicals	4,323	483	206	3,464	1,284	215
6 Manufacturing by Material	27,243	5,865	2,961	65,055	16,989	2,769
64 Paper, Related Products	4,195	738	616	8,926	6,391	380
65 Textiles, Related Products	3,897	696	387	6,417	372	186
67 Iron and Steel	3,278	633	451	11,376	1,678	315
68 Nonferrous Metals	4,699	1,068	308	11,042	4,782	710
7 Machinery, Transport Equipment	148,800	33,194	10,813	210,810	39,293	12,213
71 Power Generating Machinery	14,166	2,915	852	14,488	2,865	1,214
72 Specialized Machinery	13,644	2,446	711	13,390	1,564	151
74 General Industrial Machinery	13,095	2,745	1,228	14,974	1,742	728
75 Office Machines, Computers	2,318	2,572	691	26,251	1,704	776
76 Telecommunications	7,669	803	1,161	23,607	953	2,675
77 Electrical Machinery	23,921	3,572	3,477	33,034	2,453	4,211
78 Road Vehicles	25,480	15,891	2,080	73,843	25,830	2,405
79 Other Transport Equipment	25,038	1,669	406	7,217	1,920	45
8 Miscellaneous Manufacturing	32,637	4,326	2,469	80,470	3,637	2,766
82 Furniture	1,006	277	236	5,278	1,187	533
84 Apparel, Clothing	2,087	109	375	26,026	262	596
87 Scientific Instruments	10,924	1,201	656	5,964	472	471
9 Not Classified Elsewhere	28,388	21,011	1,222	12,820	3,909	1,237
TOTAL	**346,650**	**74,605**	**24,017**	**491,513**	**88,548**	**27,442**

*Standard International Trade Classification (Revision 3), one-digit and selected two-digit.

Source: OECD, *Foreign Trade by Commodities*, Series C.

ignores the impact of a NAFTA on expanding this type of trade even further.

One way to account for cross-hauling would be to model imported goods as close, but not perfect, substitutes for domestic goods, the Armington specification. Specifying demands for intermediate imports in this way is meant to capture the observation that, even at a fairly disaggregated level, any product category is made up of a variety of goods that are not perfect substitutes. Admittedly this specification far from a perfect solution to how to model trade flows, and it would complicate the analysis in this paper considerably. It would, however, have the advantage of eliminating one unfortunate implication of the current specification: if the tariff on imports of U.S. machinery in Mexico falls, but that on imports of Japanese machinery does not, then there can be no imports of Japanese machinery into Mexico.

The third contribution made by this paper is to focus on dynamic efficiency gains on the production side of the economy. The authors claim that potential gains on the consumption side of the economy are negligble. While I agree that increased production efficiency is the major source of potential gains for Mexico, I disagree with the way that the authors have specified the impact of a NAFTA on consumption. The problem is that, before NAFTA, $P^* = P_I(1+T)$, whether or not Mexico imports or exports the good. The more natural way to model the relation between foreign and domestic prices is that depicted in a suggestive way in the partial equilibrium diagram in Figure 1: There $P^* = P_I(1+T)$ if the good is being imported, but $P^* = P_I$ if the good is being exported: unless Mexican exporters of automobiles receive a subsidy equal to what the tariff would be on imports of automobiles, they receive the international price for their product on world markets. Furthermore, there is even a range of outputs, as depicted in Figure 1, for which the domestic price is between the two limits fixed by the international price, $P_I < P^* < P_I(1+T)$.

Distortionary Effect of Tariffs

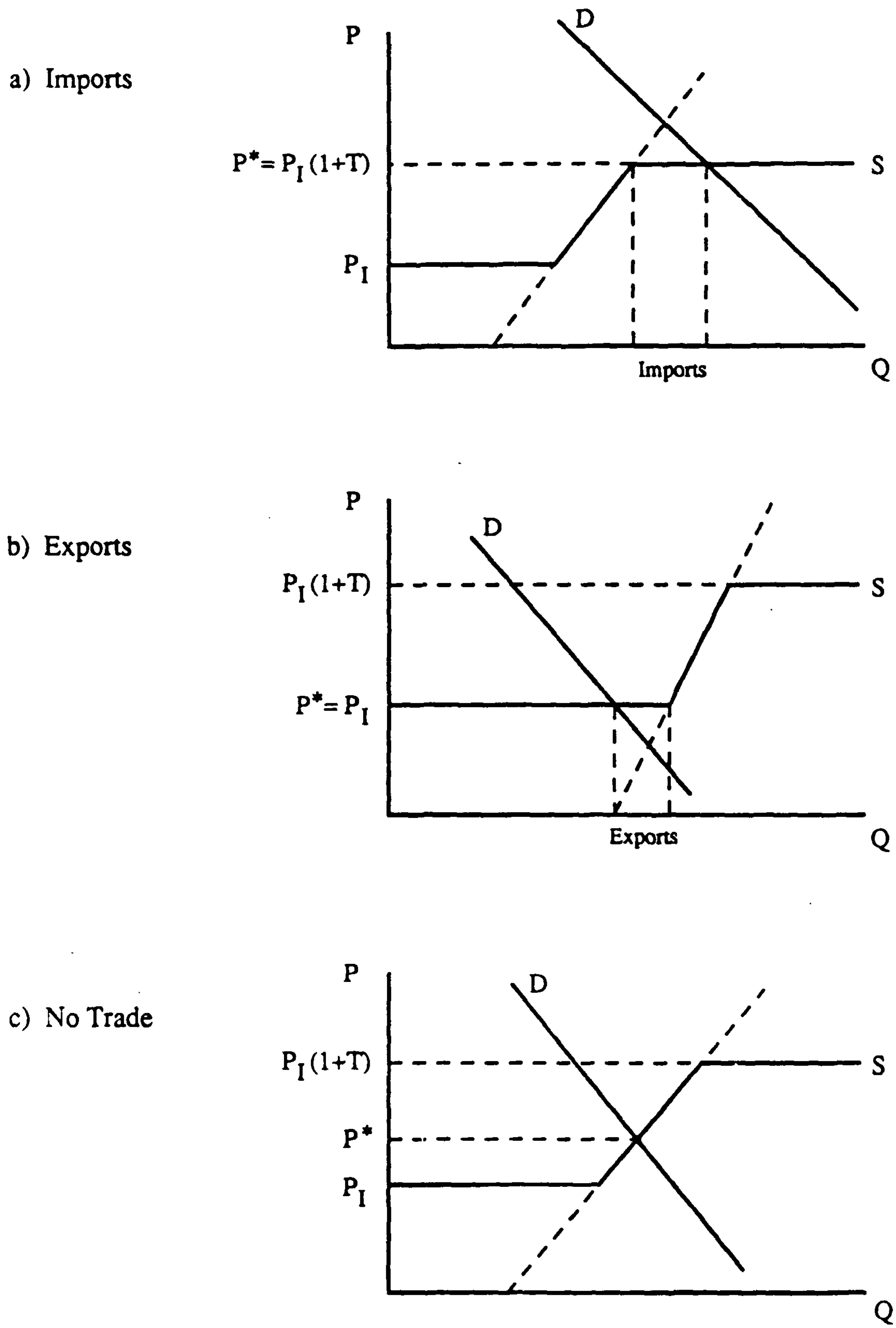


Figure 1

In this range, domestic producers move along the ordinary supply curve and there are no imports or exports.

Partial equilibrium analysis like that embodied in Figure 2 is not suitable for measuring the gains or losses resulting from a NAFTA. It can, however, point us towards the sources of these gains or losses. In Figure 2 a fall in the domestic price from $P_I(1+T)$ to P_I results in a rise in demand from Q_D to Q'_D and a fall in supply from Q_S to Q'_S. Imports rise from $Q_D - Q_S$ to $Q'_D - Q'_S$. The triangle A represents the increase in consumer surplus; the rectangle B tariff revenues; and the rectangle C is the decrease in consumer surplus. If Mexico exports the good before the NAFTA, however, as in Figure 1b, reducing the tariff to zero changes nothing. This partial equilibrium analysis neglects the effects that changes in different markets have on each other in terms of both supply and demand. These effects are, of course, crucial, and this is why we use general equilibrium models. What is worth noticing, however, is that the impact of a tariff reduction is drastically different if Mexico starts off being an importer of the good than it is if Mexico starts off being an exporter. This distinction is, unfortunately, ignored in the authors' analysis.

The fourth contribution made by this paper is to stress the potential role of capital flows into Mexico in raising output per worker. A dynamic model such as this is the ideal tool for analyzing such capital flows. In this model the interest rate is exogenously fixed both before and after the NAFTA. The authors achieve a substantial increase in capital flows by lowering the interest rate as a result of the NAFTA. This specification leaves us to wonder, if the post-NAFTA interest rate is the world interest rate, what is the pre-NAFTA interest rate? One possible answer is that a high interest rate in Mexico is the result of closed capital markets and of inefficient, oligopolistic financial intermediaries. If this is the case, we

Consumption Gain from Tariff Reduction

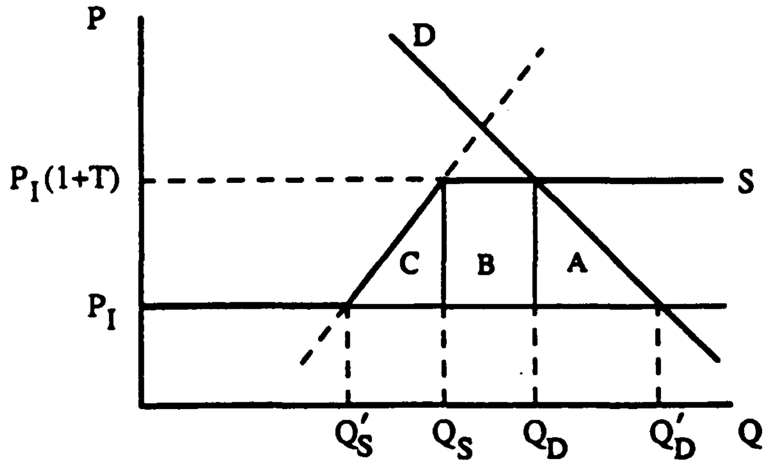
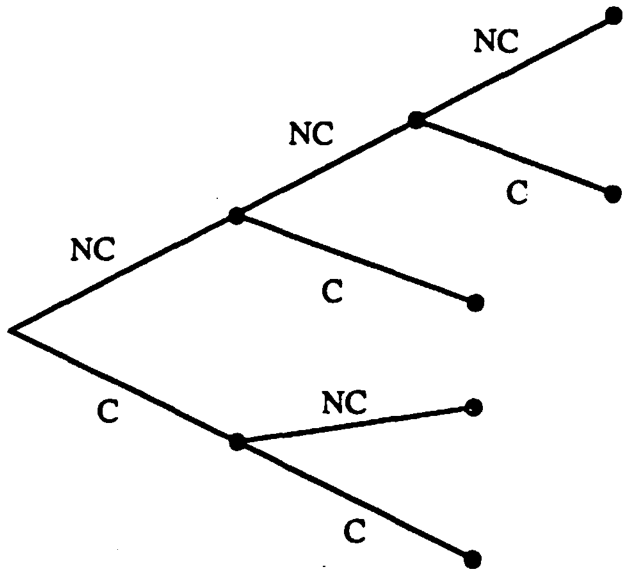


Figure 2

would want to model the pre-NAFTA interest rate as endogenous and also explicitly model the way in which the NAFTA would lower this interest rate.

Another potential answer is that the gap between the pre-NAFTA interest rate in Mexico and the world interest rate represents a risk premium: international investors demand a higher rate of return in Mexico because they fear that a financial collapse and maxi-devaluation like that which occurred in 1982 would wipe out much of their investment. By locking Mexico and its two northern neighbors into policies that would help guarantee economic stability in Mexico, the NAFTA would lower this risk premium and thereby lower the interest rate.

It may be possible to model the process by which the NAFTA would lower the premium in a simple way. Figure 3 depicts an event tree for a dynamic, stochastic general equilibrium model in which there is a probability π_{ct} of a financial collapse in period t and a probability $1-\pi_{ct}$ of no financial collapse. In simulations, we could concentrate on the path in which no financial collapse actually occurs. Even so, in principle, we would have to model what would occur at every node of this event tree. This would subject us to the "curse of dimensionality" associated with an expanding state space typical in this type of model. To simplify the analysis, however, we could model what happens if a financial collapse occurs in a simple enough way so that we do not have to move further out on branches in which a financial collapse occurs to compute the equilibrium outcomes. Even though we would not need to model in great detail what happens if a financial collapse occurs, lowering its probability π_{ct} could have a significant impact on equilibrium outcomes along the branch of the tree where there is no collapse. To make this approach useful, we would need to model the interaction of π_{ct} and the NAFTA in a way that is tractable but also captures the impact of a NAFTA on economic stability in Mexico.



C = Financial Collapse
NC = No Collapse

Figure 3