TRANSPORTATION COSTS OF U.S. IMPORTS

Report on Investigation No. 332-141
Under Section 332 of the
Tariff Act of 1930

USITC PUBLICATION 1375

APRIL 1983

United States International Trade Commission / Washington, D.C. 20436

UNITED STATES INTERNATIONAL TRADE COMMISSION

COMMISSIONERS

Alfred E. Eckes, Chairman
Paula Stern
Veronica A. Haggart

Kenneth R. Mason, Secretary to the Commission

Office of Economics
John Suomela, Director

This report was prepared principally by

Henry McFarland

Address all communications to
Office of the Secretary
United States International Trade Commission
Washington, D.C. 20436

CONTENTS

Tables

Executive Summary

This report examines transportation costs of U.S. imports between 1965 and 1981. The major findings of the report are summarized in the following sections.

Transportation costs as a percent of the value of U.S. imports declined from 1965 to 1981.--Transportation costs fell from 10 percent of the value of U.S. imports in 1965 to 6.2 percent in 1976 and to 4.5 percent in 1981. This decline in transportation costs contributed significantly to the growth of U.S. trade. It is estimated that from 1976 to 1981, declining transportation costs led to a 14-percent increase in U.S. imports, representing 27 percent of the total real growth in imports during this period.

Ocean-shipping-freight rates fell by more than airfreight rates.--From 1976 to 1981, ocean-shipping-freight rates fell between 27.4 percent and 29.8 percent; relative airfreight rates fell between 14.8 percent and 22.6 percent. The decline in ocean-shipping rates was greater because rising fuel prices had a much larger effect on air transport costs than on ocean-shipping costs, and because ocean-shipping capacity grew faster relative to demand than airfreight capacity. (In this report, freight rates are measured by the ratio of the price charged for transportation to the price of the good being shipped.)

Petroleum products experienced the largest decline in their freight rates.--Freight rates for petroleum products declined between 44.8 percent and 50.7 percent from 1976 to 1981. These rates declined because of overcapacity in the world tanker fleet, the increased use of larger more efficient tankers, and the rapid increase in the price of petroleum products.

Freight rates for manufactured products fell more than rates for nonpetroleum raw materials.—Freight rates for manufactured products fell between 20.8 percent and 24.6 percent. These rates for agricultural products fell by from 1.2 percent to 9.6 percent, and from 2.4 percent to 6.2 percent for mining products. Rates for shipping manufactured goods declined because of weak demand for ocean shipping, and because of the wider use of containerization and wide-bodied aircraft.

Domestic transportation costs significantly affect the ability of some major industries to compete with imports.—Domestic transportation costs are likely to be important to import-competing industries when domestic producers must ship over considerable distances to reach many purchasers and when transportation costs over those distances are a significant part of the product's value. Two such industries are steel and autos. Import penetration in these industries shows a distinct geographic pattern; it is highest in States that are farthest from the center of domestic production. This pattern indicates that domestic transportation costs have a significant effect on the ability of these industries' to compete with imports.

International ocean-shipping rates have fallen relative to domestic rail rates.—From 1974 to 1981, oceangoing tanker and charter rates generally declined, and ocean liner rates rose by 69 percent. During this same period, rail rates increased by 119 percent.

Changes in fuel prices since 1973 affected ocean-shipping costs by much less than airfreight costs or trucking costs and by less than rail freight costs.—Energy costs are approximately 7 percent of total costs for ocean shipping, 9 percent of total costs for rail, 31 percent of total costs for trucking, and 41 percent of total costs for airfreight. Furthermore, the price of marine fuel increased by less than the prices of rail, truck, or jet fuel.

Freight rates are larger than duties collected for most U.S. imports.—U.S. imports were disaggregated into 208 product categories, and freight factors and ad valorem duties were determined for each category. In 1981, freight factors were greater than duties collected for 119 of these 208 products. Transportation costs were 4.5 percent of the value of U.S. imports and duties collected were 3.4 percent.

Transport rates have declined by more than tariff rates.--From 1976 to 1981, ad valorem tariff rates fell by 12.8 percent to 19.0 percent, and ad valorem transport rates fell by 25.8 percent to 29.7 percent.

Transportation costs often rise as a share of a product's value as the product receives more processing.--Transportation costs rose as a share of value in slightly over half of the product transformations examined. Transportation costs were more likely to rise in product transformations that started with raw materials than in product transformations that started with intermediate goods.

Changes in International Transportation Costs

Measuring the cost of international transportation

The most common, and probably the most useful, measure of the cost of transporting goods in foreign trade is the freight factor. The freight factor is the cost of shipping a product between countries expressed as a share of the product's free alongside (f.a.s.) value. 1/ It varies directly with changes in transportation costs and inversely with changes in the price of the product being shipped. The freight factor indicates how much transportation costs hinder international trade. Because it expresses these costs as a share of a good's value, it can easily be compared with ad valorem tariff rates. Furthermore, because the freight factor is independent of any units used to measure quantities, the freight factors of different products can be compared.

This study uses data from the U.S. Bureau of the Census on both shipping charges and the f.a.s. value of U.S. imports to compute freight factors. 2/ Previous studies computed s ipping charges by subtracting the f.a.s. values of imports from their cost-insurance-freight (c.i.f.) values. 3/ By definition, shipping charges should be the only difference between the f.a.s. and c.i.f. values of U.S. imports. However, the Bureau of the Census sometimes adjusts the c.i.f. value if parties to the transaction are related to each other.

1/ The f.a.s. value of a U.S. import is its value at the foreign port of exportation. It includes all costs incurred in bringing the product to the side of the ship or plane that will bring the goods to the United States.

2/ The Bureau publishes these data in U.S. Imports for Consumption and General Imports Report FT 246, Washington, D.C., 1980. They are also available on tapes of the IA 245 series.

Shipping charges include all costs incurred from bringing the imports from alongside the ship or plane in the port of exportation to alongside the carrier in the first port of entry in the United States. These costs include both the freight rates and the cost of insuring the goods while they are in transit. Shipping charges do not include U.S. customs duties.

3/ See, for example, A. J. Yeats, "Do International Transport Costs Increase With Fabrication? Some Empirical Evidence," Oxford Economic Papers, November 1977, pp. 458-471.

Census makes these related party adjustments to ensure that the c.i.f. values of imports are the same as those that would be recorded in arm's length transactions. Because Census does not make related party adjustments to f.a.s. values, these adjustments will distort estimates of shipping charges determined by simply subtracting f.a.s. values from c.i.f. values. This study avoids this problem by using data that directly measure shipping costs. 1/

The freight factor for all imports

Since 1965 the cost of international transportation has dropped significantly relative to the value of U.S. imports, as shown in table 1. The freight factor fell sharply from 1965 to 1969, declined at a much slower pace from 1969 to 1976, and again fell sharply from 1976 to 1981. It fell by 55 percent between 1965 and 1981.

The decline in the relative cost of transportation contributed significantly to the growth of U.S. trade. A recent study indicated that a 1 percent decline in the freight factor would stimulate a 0.52 percent increase in the f.a.s. value of U.S. imports. 2/ According to this estimate, the 27-percent decline in the freight factor since 1976 could have caused an increase of approximately 14 percent in the constant-dollar value of U.S. imports, which was approximately 27 percent of the total real growth of U.S. imports. 1/

1/ The effect of related party adjustments on the freight factors computed by comparing c.i.f. and f.a.s. import values may not be significant. In 1981, these adjustments were only 0.1 percent of the f.a.s. value of U.S. imports. However, related party adjustments have declined in recent years. In 1974, they were 1.3 percent of the f.a.s. value of imports. Therefore, they may distort an analysis of recent changes in the freight factor. Furthermore, though not significant relative to total imports, related party adjustments may be a significant part of the value of some imports.

2/ V. Geraci and W. Prewo estimate the elasticity of U.S. imports with respect to transportation costs in "Bilateral Trade Flows and Transport Costs," Review of Economics and Statistics, LIX (1), February 1977, pp. 67-74. They find that this elasticity will decline if the freight factor declines. The 0.52 percent figure is the value of this elasticity if the freight factor is 5.4 percent, its average value from 1976 to 1981.

A similar calculation shows that from 1965 to 1981 declining transportation costs may have caused an 86-percent increase in the value of U.S. imports, representing 9 percent of the total real growth in imports during this period.

Table 1.--The ratio of transportation cost to f.a.s. value for all U.S. imports, 1965-81 1/

Year	Freight factor
	Percent
1965	10.0
1966	9.0
1968 2/	7.4
1969	6.5
1970	6.4
1971	6.7
1972	6.6
1974	6.5
1975	6.3
1976	6.2
1977	5.8
1978	5.6
1979	5.5
1980	4.6
1981	4.5

1/ These data are for imports for consumption, except data for 1968 to 1972, which are for general imports.

2/ For 1968 only, transportation costs were determined at the port of unlading rather than the port of entry. Data for 1969 indicate that the freight factor for 1968 is 0.1 percent higher than if it were computed at the port of entry.

Source: Data for 1974 to 1981 are from U.S. Bureau of the Census, U.S. Imports for Consumption and General Imports Report FT 246, of various years. Census did not collect regular data on shipping charges before 1974. Data from 1965 are from the U.S. Tariff Commission, "C.I.F. Value of U.S. Imports," Wahington, D.C., Feb. 7, 1967. Data from 1966 are from U.S. Bureau of the Census, "C.I.F. Calculations Add 9 Percent to Import Figures," Washington, D.C., Dec. 20, 1966. Data from 1968 to 1972 are from U.S. D partment of Commerce, "Highlights of Export and Import Trade," December 1973, pp. IV-V; December 1972, pp. IV-V; January 1972, pp. IV-V; April 1971, p. III; July 1970, p. IV.

1/ The Producer Price Index was used to adjust import data for inflation. This index increased by 61 percent from 1976 to 1981.

These data indicate that transportation costs have declined significantly, but they say little about the nature of the decline. The overall freight factor measures the aggregate costs of transporting many different products, from different countries using different modes of transportation. This aggregate number does not show how the transportation costs changed for specific products or trading partners.

These data also provide little information about why the freight factor has declined so sharply. The decline in the overall freight factor could result not from a decline in the relative price of transportation services, but from changes in the mode of transportation used, in the commodity composition of imports, or in the relative importance of U.S. trading partners. Determining the causes of the decline in the overall freight factor requires more specific data. This study will first examine changes in transport modes used and in freight factors for specific products and countries between 1976 and 1981. (The starting point is 1976 because data on transportation costs of specific U.S. imports are not available on magnetic tape before that year.) It will then estimate the importance of each of the four influences on the freight factor.

Changes in the mode of transport

Imports are brought to the United States by air, by water, and by land. Air transport is generally the most expensive of the three. Land transport costs are measured as zero because the U.S. Census Bureau measures the cost of international transportation from the point where the import leaves the exporting country, to the point where the import enters the United States. If the import travels through a land border crossing, these points are the same and the cost of transportation is zero. The import uses domestic transportation in each country, but it does not use international transportation.

Between 1976 and 1981, air transport, still the least used mode, showed the largest increase in relative importance, water transport, the most commonly used mode, increased slightly in importance, and the importance of overland transport dropped significantly, as shown in the following tabulation.

(Percent of total)

Year	Water	Air	Overland
1976	66.7	9.0	24.3
1981	68.0	11.5	20.5

1/ Based on the f.a.s. value of general imports.

Water transport increased in importance because the value of petroleum imports, which are usually waterborne, increased faster than the value of all other imports. The share of nonpetroleum imports shipped by water declined slightly; the share shipped by land declined significantly; the share shipped by air rose substantially. Data on imports excluding petroleum are as follows.

(Percent of total)

Year	Water	Air	Overland
1976	57.7	12.1	30.2
1981	56.5	16.1	27.4

1/ Based on the f.a.s. value of general imports, excluding Schedule A category 33.

Changes in freight factors of specific products

Freight factors for large import categories declined from 1976 to 1981. The changes in the freight factors for these categories range from a 5 percentage point decline to a 1.4 percentage point increase. Most freight factors also declined from 1965 to 1976.

For this study commodities are defined by subparts, each of which contains one or more product category from the Tariff Schedule of the United States Annotated (TSUSA). Although import data are available for each 7-digit product category of the TSUSA classification system, the system changed between 1976 and 1981, affecting product categories below the subpart level. By aggregating import data to the subpart level, data from different years can be compared. This aggregation also allows the results of the study to be compared with those of an earlier Commission study of transportation costs, which also used import data aggregated to the level of TSUSA subparts. 1/

Freight factors for 1976 and 1981 for each of 208 U.S. import subparts are shown in appendix A. Freight factors for the 44 highest volume subparts are shown in table 2. 2/ Freight factors vary widely between products. In 1981 international transportation costs were over 10 percent of f.a.s. value for 5 of the 44 largest products: meat, fruit, wood veneers and plywood, vegetable fiber woven fabrics, and metal-bearing ores. International transportation costs were 1 percent or less of f.a.s. value for 3 of the 44 largest products: papermaking materials, gems and gemstones, and aircraft and spacecraft. A product's freight factor depends on its ratio of value to weight, its handling requirements, and its sources. Ores have a high freight factor and gems a low freight factor because of their ratios of value to weight. Fruit and meat often require refrigeration or airfreight because they are perishable. Papermaking materials have a low freight factor because they come almost exclusively from Canada.

The freight factors for most commodities have declined, as shown in table 2. The changes in freight factors for selected commodities are given in table 3. From 1976 to 1981, freight factors rose for 12 commodities, showed almost no change for 3, and fell for 29. 3/ The freight factor for fertilizer showed the largest increase (1.4 percentage points), and for wood veneers and plywood it showed the largest decrease (5.0 percentage points).

1/ U.S. Tariff Commission, "C.I.F. Value of U.S. Imports," Washington, D.C., Feb. 7, 1967.

2/ These 44 subparts accounted for 78 percent of the value of U.S. imports in 1981.

3/ For all 208 commodities, freight factors declined for 165, showed almost no change for 6, and rose for 37. See app. A.

Table 2.--Transportation costs as a share of value for selected U.S. imports, 1965 and 1976-81

(In percent)

Subpart	Commodity	1965	1976	1977	1978	1979	1980	1981
1-1	Live animals	3	1.8	1.6	1.3	1.4	1.4	1.7
1-2-B	Meat, other than bird meat	7	10.9	11.9	11.0	9.4	9.9	10.7
1-3-A	Fish, fresh, chilled, or frozen	13	7.6	6.7	6.7	6.1	6.0	6.0
1-3-E	Shellfish	7	3.5	3.4	3.3	3.0	3.0	3.3
1-5-A	Hides, skins, and leather	5	4.8	4.5	4.7	3.9	4.1	4.9
1-5-B	Furskins	1	1.5	1.6	1.7	1.6	2.0	1.6
1-9-B	Edible fruits	11	26.7	25.9	25.8	26.3	25.8	27.0
1-10-A	Sugars, sirups, and molasses	9	7.9	10.0	9.9	11.3	6.8	7.7
1-10-B	Cocoa	7	5.9	3.6	3.7	3.5	4.6	6.8
1-12-D	Spirits and spirituous beverages	3	6.9	6.7	6.2	6.1	5.4	4.8
1-13	Tobacco and tobacco products	8	5.6	5.3	5.2	5.6	6.0	6.4
2-1-B	Lumber, floorings, and moldings	41	5.7	5.1	4.5	4.1	3.9	4.1
2-3	Wood veneers and plywood	19	16.1	12.8	11.9	9.6	9.7	11.1
2-4-A	Papermaking materials	12	.8	.9	.9	.9	.7	1.0
2-4-B	Paper and paperboard	8	2.2	2.5	2.7	3.0	2.6	2.2
3-1-A	Cotton	4	5.7	6.7	5.1	4.8	7.3	6.3
3-1-C	Wool	7	9.2	8.3	8.2	7.8	8.3	8.1
3-3-A	Cotton woven fabric	4	6.7	6.1	6.2	5.7	5.4	4.9
3-3-B	Vegetable fiber woven fabric	9	21.9	22.0	19.3	18.4	16.1	20.5
3-3-C	Woolen woven fabric	8	5.7	5.5	4.5	4.5	3.9	3.7
3-6-F	Other wearing apparel	8	8.8	8.4	8.3	7.3	6.8	6.5
4-2-C	Inorganic chemical compounds	13	4.9	5.7	4.5	4.8	5.6	4.6
4-4-B	Rubber	11	8.7	8.7	8.1	7.1	6.9	8.1
4-10	Petroleum, natural gas, and their derivatives	1/	6.9	6.2	6.1	6.2	4.1	3.7
4-11	Fertilizers	60	3.4	3.2	3.6	3.8	5.0	4.8
5-1-H	Gems and gemstones	1	4.9	4.6	4.5	4.4	4.5	4.6
6-1	Metal-bearing ores	1/	15.6	14.5	12.8	12.9	12.3	14.0
6-2-B	Iron or steel	13	9.4	9.5	8.7	8.2	8.6	8.0
6-2-C	Copper	4	3.8	3.3	4.2	3.3	2.6	3.7
6-2-D	Aluminum	4	3.0	1.6	2.3	2.4	.9	1.7
6-2-E	Nickle	1	.6	.9	1.1	1.1	1.1	1.2
6-2-F	Tin	2	1.6	1.3	1.2	1.2	1.3	1.5
6-3-D	Nails, screws, bolts, and other fasteners, locks	11	7.8	7.4	7.1	6.6	6.5	6.6
6-3-F	Miscellaneous metal products	12	6.2	6.0	4.4	4.0	2.8	3.8
6-4-A	Boilers and other general-purpose machinery	5	2.6	2.9	3.0	3.2	2.9	2.7
6-4-C	Agricultural machinery	3	1.9	2.1	2.5	2.3	2.0	2.2
6-4-E	Textile machines	10	3.9	4.2	4.1	4.0	3.8	3.7
6-4-G	Office machines	4	3.0	3.1	2.9	2.8	2.6	2.5
6-5	Electrical machinery	6	3.4	3.2	3.2	2.6	2.6	2.5
6-6-B	Motor vehicles	11	4.4	4.0	4.0	4.1	4.8	4.5

Table 2.--Transportation costs as a share of value for selected U.S. imports, 1965 and 1976-81--Continued

(In percent)

Subpart	Commodity	1965	1976	1977	1978	1979	1980	1981
6-6-C	Aircraft and spacecraft	40	1.0	.7	1.0	.9	.8	.9
7-1-A	Footwear	10	8.7	8.5	8.1	7.2	6.4	6.4
7-2-E	Watches and clocks	1	2.8	2.7	2.8	2.5	2.4	2.3
7-2-F	Photographic equipment and supplies	3	3.1	3.3	2.9	2.8	2.6	2.4
	Total 2/	1/	6.0	5.6	5.4	5.3	4.5	4.3

1/ Not available.
2/ For products in the table only.

Source: Calculated from official statistics of the U.S. D partment of Commerce by the staff of the U.S. International Trade Commission, except data for 1965, which are from U.S. Tariff Commission, "C.I.F. Value of U.S. Imports," Washington, D.C., Feb. 7, 1967.

The behavior of freight factors from 1965 to 1981 can be examined by combining the data gathered for this study with data from an earlier Commission study. Over this period, freight factors rose for 9 commodities showed almost no change for 4, and fell for 29. These changes are shown in table 3. Fruit showed the largest increase, (16 percentage points); fertilizer showed the largest decrease (55 percentage points). These data indicate that from 1965 to 1981 the cost of transportation generally has fallen relative to the cost of U.S. imports.

Changes in freight factors of specific countries

Freight factors can be defined on a country-specific basis as well as a product-specific basis. Freight factors fell for almost every major U.S. trading partner. Countries where petroleum is the primary export to the United States were among those whose freight factors fell the most. The Asian countries also saw large declines in their freight factors. West European and Latin American countries generally saw only small declines in their freight factors.

Table 3.—Decline in freight factors of selected commodities, 1965-81

Subpart	Commodity	1965 to 1981		1965 to 1976		1976 to 1981	
		Percent	Actual	Percent	Actual	Percent	Actual
2-3	Wood veneers and plywood	42	8	6	3	31.1	5.0
4-10	Petroleum, natural gas, and their derivatives	1/	1/	1/	1/	46.9	3.2
6-3-F	Miscellaneous metal products	68	8	48	6	38.9	2.4
3-6-F	Miscellaneous wearing apparel	19	2	-10	-1	26.1	2.3
7-1-A	Footwear	36	4	13	1	25.6	2.2
1-12-D	Spirits and spirituous beverages	-59	-2	-129	-4	30.9	2.1
3-3-C	Woolen woven fabric	54	4	29	2	35.9	2.0
3-3-A	Cotton woven fabric	-23	-1	-67	-3	25.9	1.7
2-1-B	Lumber, floorings, and moldings	90	37	86	35	29.0	1.7
1-3-A	Fish, fresh, chilled, or frozen	54	7	42	5	21.1	1.6
6-1	Metal-bearing ores	1/	1/	1/	1/	9.9	1.5
6-2-B	Iron or steel	39	5	27	4	15.6	1.5
3-3-B	Vegetable fiber woven fabrics	-127	-12	-143	-13	6.5	1.4
6-2-D	Aluminum	59	2	26	1	44.1	1.3
6-3-D	Nails, screws, bolts, and other fasteners, locks	40	4	29	3	16.0	1.3
3-1-C	Wool	-16	-1	-31	-2	11.2	1.0
6-5	Electrical machinery and equipment	59	4	43	3	27.8	.9
7-2-F	Photographic equipment and supplies	21	1	2/	2/	22.9	.7
4-4-B	Rubber	27	3	21	2	7.6	.7
6-4-G	Office machines	37	2	25	1	15.3	.5
7-2-E	Watches and clocks	-134	-1	-177	-2	15.5	.4
1-10-A	Sugars, sirups, and molasses	15	1	13	1	2.7	.2
4-2-C	Inorganic chemical compounds	64	8	63	8	4.3	.2
6-4-E	Textile machines	63	6	61	6	4.5	.2
6-6-C	Aircraft and spacecraft	98	39	98	39	16.0	.2
1-3-E	Shellfish	52	4	50	4	4.1	.1
1-2-B	Meat, other than bird meat	-53	-4	-56	-4	1.3	.1
6-2-F	Tin	25	1	-	-	8.5	.1
1-1	Live animals	42	1	39	1	4.3	.1
6-2-C	Copper	2/	2/	2/	2/	1.1	2/
2-4-B	Paper and paperboard	73	6	73	6	1.4	2/
5-1-H	Gems and gemstones	54	1	51	1	5.7	2/
1-5-B	Furskins	-61	-1	-55	-	-4.1	-.1
6-4-A	Boilers and other general-purpose machinery	46	2	47	2	-3.2	-.1
1-5-A	Hides, skins and leather	2/	2/	2/	2/	-1.9	-.1
6-6-B	Motor vehicles	59	7	60	7	-3.3	-.1
2-4-A	Papermaking materials	92	11	93	11	-18.9	-.2
6-4-C	Agricultural machinery	2	1	38	1	-15.7	-.3
1-9-B	Edible fruits	-146	-16	-142	-16	-1.2	-.3
6-2-E	Nickle	2/	2/	2/	2/	-93.8	-.6
3-1-A	Cotton	-58	-2	-43	-2	-11.0	-.6
1-13	Tobacco and tobacco products	20	2	30	2	-14.3	-.8
1-10-B	Cocoa	-	-	15	1	-14.5	-.9
4-11	Fertilizers	92	55	94	57	-41.5	-1.4

1/ Not available
2/ Less than 0.05 percent.

Source: Calculated from official statistics of the U.S. Department of Commerce by the staff of the U.S. International Trade Commission.

In 1981, freight factors for 17 countries that each supplied over 1 percent of U.S. imports are shown in table 4. They range in value from 0.8 percent for Canada to 8.4 percent for Brazil. Distance obviously has an important effect on these freight factors. Another important determinant of each country's freight factor is the commodity composition of its exports. For example, Saudi Arabia's freight factor is lower than Italy's even though Italy is closer to the United States because Saudi Arabia's exports are dominated by petroleum products, which have a below average freight factor. Other things that affect a country's freight factor include the quality of port facilities and the volume and directional balance of cargo on a route. 1/

The freight factors of all major U.S. trading partners except one declined from 1976 to 1981. The exception was Mexico, whose freight factor rose by 0.5 percentage points. Mexico's freight factor increased because the share of its exports shipped to U.S. overland fell, whereas the share shipped by water rose dramatically. In 1976, 17.5 percent of Mexico's exports to the United States were shipped by water; in 1981, 48.3 percent were. 2/ The increasing importance of petroleum products in Mexico's exports to the United States caused this shift. In 1976, 6.0 percent of Mexico's nonpetroleum exports to the United States were shipped by water; in 1981, 5.1 percent.

Major petroleum exporters generally did well. Saudi Arabia had the largest decline in its freight factor, Libya was second, and Nigeria was fourth. These countries' freight factors probably declined by relatively

---

1/ Reasons for different countries to have different freight factors are discussed by G. P. Sampson, in "An Analysis of the Sources of Inter-Country Differences in International Transportation Costs," Economia Internazionale 31(3), August-November 1978, pp. 234-47; J. Binkley and B. Harrer, "Major Determinants of Ocean Freight Rates for Grain: An Econometric Analysis," American Journal of Agricultural Economics, 63(1), February 1981, pp. 47-57; C. Moneta, "The Estimation of Transportation Costs in International Trade," Journal of Political Economy, 47(1), February 1959, pp. 41-58.

2/ In 1976, 3.4 percent of Mexico's exports to the United States were shipped by air; in 1981, 4.6 percent were shipped this way.

Table 4.--Freight factors by trading partner, 1981, and decline in freight factors, 1976-81

Country	Value	Decline
	Percent	Percentage points
Saudi Arabia	5.9	6.3
Libya	3.3	3.9
Republic of Korea	6.4	3.6
Nigeria	3.3	3.1
Taiwan	7.2	3.0
Hong Kong	6.0	2.9
Algeria	3.4	2.7
Indonesia	6.6	2.3
Japan	5.9	2.2
United Kingdom	3.7	1.9
Venezuela	4.2	1.6
West Germany	4.5	.9
France	4.9	.9
Italy	6.9	.9
Brazil	8.4	.3
Canada	.8	.1
Mexico	1.3	-.5

Source: Calculated from official statistics of the U.S. Department of Commerce by the staff of the U.S. International Trade Commission.

large amounts because of the large decline in the freight factor for petroleum products. Asian countries' freight factors also declined significantly. Western European and Latin American countries' freight factors declined by much less.

The reason for the decline in the overall freight factor

The decline in the freight factor can be attributed to four different causes: (1) changes in the relative rates charged for transportation, (2) changes in the commodity composition of imports, (3) changes in the sources of imports, and (4) changes in the modes used to transport imports.

Of these four causes, the decline in transport rates was by far the most important. From 1976 to 1981, the rates charged for transporting U.S. imports fell between 25.8 percent and 29.2 percent. For ocean shipping, rates fell between 27.4 percent and 29.8 percent. For airfreight, rates fell between 16.4 percent and 22.6 percent. The total decline in the freight factor was 27.4 percent; therefore, the combined effect of influences besides transport rates on the freight factor is relatively small and may have been either positive or negative.

The extent to which other influences have each affected the freight factor can also be estimated. Changes in the commodity composition of imports reduced the freight factor between 0 and 4.8 percent. Changes in the relative importance of various U.S. trading partners reduced the freight factor between -3.2 percent and 1.6 percent. Changes in the modes used increased the freight factor between 0 and 4.7 percent.

Methodology.--The methods used to derive these estimates are fully discussed in appendix B, so they will only be briefly discussed here.

These estimates are based on data for all U.S. imports in 1976 and 1981. These data are disaggregated to the level of TSUSA subparts and individual countries.

The effect of changes in the relative price of transportation can be separated from the effects of other changes using the same methodology commonly used to create price indexes. A constant-weight freight factor for 1981 is constructed. That freight factor would have existed in 1981, if the United States had imported the same products, from the same countries, using the same modes as in 1976. The difference between the constant-weight freight factor for 1981 and the actual freight factor for 1976 can only be due to changes in transportation costs, because products, sources, and modes are held constant.

This methodology can be used in reverse. The freight factor that would have existed in 1976, if the United States had imported the same products, from the same countries, using the same modes as in 1981 can be constructed and compared with the actual freight factor for 1981. These two methods give slightly different results, which is why the change in transportation costs is expressed as a range.

The estimates of the separate effects of changes in products imported, sources of imports, and modes used are prepared in a similar way. To see the effects of price changes, a system of weights is used to hold commodity composition, sources, and modes constant. To estimate the effects of changes in commodity composition, a set of weights is used that allows products imported to vary while sources and modes are held constant. The result is an estimate of the joint effect of changes in commodity composition and transport rates. Because the effect of transport rates has already been identified, the separate effect of product changes can easily be estimated. This method can be extended to determine the effects of changes in sources and modes.

Changes in transport rates by sector.--Between 1976 and 1981, the weighted average of transportation rates declined by a range of 25.8 percent to 29.2 percent, depending on whether 1976 or 1981 weights were used for measurement. The decline in transport rates for major product categories is listed in descending order: for petroleum products the decline ranged from 44.8 to 50.7 percent; for manufacturing, from 20.8 to 24.6 percent;for mining, from 2.4 to 6.2 percent; and for agriculture, from 1.2 to 9.6 percent. 1/

Estimates of the decline in transport rates for each sector were found by applying the methodology described in the previous section to specific categories of imports rather than total imports. The results are summarized as follows in table 5.

The decline in transport rates for these product categories on each mode can also be determined for each mode of transportation. These estimates are shown as follows. For waterborne shipments, the decline in rates was largest

---

1/ Unprocessed wood and fish are included in this agricultural sector.

Table 5.--Estimated decline in freight factors and transport rates, by product categories 1976-81

(In percent)

Category	Freight factor		Decline in freight factor	Decline in transport rates	
	1976	1981		Minimum	Maximum
Manufacturing	5.3	4.3	18.9	20.8	24.6
Agricultural	8.2	8.5	-3.7	1.2	9.6
Mining	12.7	12.2	3.9	2.4	6.2
Petroleum	6.9	3.7	46.4	44.8	50.7
Total	6.2	4.5	27.4	25.8	29.2

Source: Estimated by the staff of the U.S. International Trade Commission.

for petroleum products, and second largest for manufactured products. For airborne shipments, the decline in rates was much greater for manufactured goods than for agricultural products. Mining and petroleum products are rarely shipped by air (table 6).

Table 6.--Estimated decline in transport rates, by modes of travel and by product categories, 1976 and 1981

(In percent)

Category	Air		Water	
	Minimum	Maximum	Minimum	Maximum
Manufacturing	16.9	23.5	21.8	24.3
Agricultural	-6.4	8.7	1.1	9.6
Mining	1/	1/	2.3	7.8
Petroleum	1/	1/	45.9	50.6
Total	14.8	22.6	27.4	29.8

1/ Air transport is only very infrequently used to ship products in these categories.

Source: Estimated by the staff of the U.S. International Trade Commission.

Transport rates are affected by both the price of transportation and the price of the good being shipped. A major reason petroleum transport rates declined the most is the large increase in the price of these products. Transport rates on manufactured goods fell by more than transport rates on raw materials in part because prices of manufactured goods rose faster than prices of raw materials. 1/ Factors affecting the price of transportation are discussed later in this report.

1/ Data on petroleum product prices are in table C-1. From 1976 to 1981, the producer price index for manufactured goods rose by 124 percent, while the producer price index for crude materials rose by 62 percent.

Domestic Transportation Costs In International Trade

Why domestic transportation costs affect foreign trade

Domestic transportation costs may significantly affect the international competitiveness of domestic industries. These effects depend on such factors as the relative importance of transportation costs in U.S. export and import-competing industries, the cost of U.S. goods relative to the cost of imports at the port of entry, the geographic locations of U.S. producers and domestic consumers, and price elasticities of demand.

In the absence of exchange rate adjustments, a decrease in domestic transportation costs will always improve the foreign competitiveness of U.S. exports. U.S. exporters' costs will be reduced, whereas the costs of competing foreign producers will not be affected. The effect on imports is more complex. This effect depends on whether or not imports at the port of entry enjoy a cost advantage over U.S. import-competing products at the plant, and whether U.S. consumers are closer to U.S. producers or to the port of entry of the imports. 1/ Domestic transportation costs can affect the competitiveness of imports in two ways. 2/ First, if U.S. consumers are nearer to ports of entry than to U.S. producers and if imports at the ports are more expensive than U.S. products at the plant, then imports are competitive only because of domestic transportation costs. In this case, a decline in transportation costs may enable U.S. producers to drive imports back into the sea.

1/ This discussion considers only the direct effects of transportation costs; these costs may also have a large indirect effect on domestic industries' ability to compete in foreign trade. If these costs fall, then domestic industries generally will have to pay less to bring inputs to their factories. Thus, their costs of production will fall and they will be better able to compete with foreign producers. Because the available data are limited, this study cannot measure the importance of this indirect effect.

2/ In two cases domestic transportation costs will not affect the competitiveness of imports. First, when U.S. consumers are closer to U.S. producers and imports are more expensive than U.S. goods, imports will not be competitive regardless of domestic transportation costs. Second, when U.S. consumers are closer to ports of entry than to potential U.S. producers and the cost of imports is less than U.S. production costs, U.S. products will be uncompetitive regardless of domestic transportation costs.

Second, if U.S. consumers are nearer to U.S. producers than to ports and if the cost of imports at the port is less than the cost of U.S. goods at the plant, then U.S. products can compete only because of favorable domestic transportation costs. A decline in domestic transportation costs would enable imports to penetrate farther inland in U.S. markets. Thus the effect of a decline in domestic transportation costs on the competitiveness of U.S. import-competing industries is ambiguous and depends upon costs of production and geographic location. 1/

The situation is more complicated if exchange rates can adjust. For example, suppose that a decline in domestic transportation costs enhances the competitiveness of U.S. exports. The rise in exports will tend to cause the exchange rate to appreciate, reducing the international competitiveness of U.S. industries. Because the exchange-rate change affects both exports and imports, the dollar appreciation will only partially offset the improvement in the competitiveness of exports caused by the decline in transportation costs. The net effect of the change in transportation costs is to increase both U.S. exports and U.S. imports. The balance of trade is unchanged. Similarly, an improvement in the competitiveness of U.S. import-competing goods leads to an appreciation of the dollar and a deterioration in the competitiveness of U.S. exports. A deterioration in the competitiveness of U.S. import-competing goods will lead to a depreciation and will enhance the competitiveness of U.S. exports.

1/ For a technical discussion of these points see app. C.

Thus, although a fall in domestic transportation costs may improve the competitiveness of certain industries in foreign trade that improvement will tend to cause an appreciation of the dollar that will adversely affect the competitiveness of all U.S. producers of traded goods. On balance, the domestic producers who gained the most from the fall in transportation costs may become more competitive, but domestic producers who gained little from the fall in transportation costs will very likely become less competitive.

Empirical evidence on domestic transportation costs in U.S. foreign trade

To determine how domestic transportation costs affect foreign trade, one must know the size of these costs and what modes are used to ship U.S imports, exports, and import substitutes. This section examines the available empirical evidence on the structure of domestic transportation costs for goods involved in foreign trade.

Choice of modes.--The best available data on the domestic transport modes used by traded goods are from a 1976 survey done by the Department of Commerce. Tables 7 and 8 summarize these data for imports and exports, respectively. Data are not available on transport modes used by domestic goods competing with imports.

These data indicate that trucking dominates the domestic transportation of nonbulk imports and exports. Bulk exports travel by rail and truck. Water is the domestic mode most frequently used for bulk imports, but bulk imports generally do not use domestic transportation.

Several factors influence the domestic transport mode chosen for imports and exports. One such factor is the product's value. Trucking and air freight are advantageous because their speed allows shippers to carry lower inventories. The cost of having a good in inventory increases with its value. Therefore, shippers of higher valued goods are more likely to use faster, higher cost trucking and air freight. Shippers of low-valued, bulk

Table 7.--Domestic mode of transportation for U.S. imports, by international modes of transportation, 1/ 1976

(In percent)

Mode	General vessel: share of total		Bulk vessel share of total		Air share of total		Total share of total	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Rail	11.8	11.5	8.0	6.5	.9	.5	8.6	9.1
Truck	73.8	77.3	6.1	11.2	86.3	82.3	17.1	65.8
Air	.1	.3	2/	2/	9.2	10.9	2/	1.7
Water	5.9	2.5	22.8	21.9	2/	2/	20.1	5.7
Other	1.9	3.9	4.1	5.0	.8	2.2	3.8	3.8
None	6.5	4.6	59.0	55.4	2.8	4.1	50.5	13.9

1/ Refers to transportation from port of entry to destination.
2/ Less than 0.05 percent.

Source: U.S. Department of Commerce, "Domestic and International Transportation of U.S. Foreign Trade: 1976;" part B, Washington, D.C., 1979.

Table 8.--Domestic mode of transportation for U.S. exports, by international mode of transportation, 1/ 1976

(In percent)

Mode	General vessel: share of total		Bulk vessel share of total		Air share of total		Total share of total	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Rail	28.8	21.7	53.0	40.0	1.3	.4	48.9	20.4
Truck	56.8	71.2	16.0	27.9	81.3	69.4	22.7	62.3
Air	2/	.2	2/	2/	16.1	27.1	.1	6.4
Water	4.7	3.0	11.8	13.6	2/	2/	10.6	4.4
Other	2.2	1.4	3.5	7.3	.5	2.3	3.3	2.7
None	7.5	2.5	15.8	11.3	.8	.8	14.4	3.8

1/ Refers to transportation from place of acquisition to port of export.
2/ Less than 0.05 percent.

Source: U.S. Department of Commerce, "Domestic and International Transportation of U.S. Foreign Trade: 1976;" part A, Washington, D.C., 1979.

products are more likely to use rail or water, which are the slower cheaper modes. 1/

Low-valued, bulk products are also more likely not to use any domestic transportation. Recipients and shippers of bulk products often move large volumes of materials, and the cost of transferring their products from a domestic carrier to an ocean-going vessel may be substantial. Furthermore, any cost of domestic transport costs may be significant compared with the total delivered cost of these products. Therefore, shippers and recipients of these products have a strong incentive to seek a dockside location.

The length of haul also significantly influences the choice of domestic mode. The cost of transportation includes loading and line-haul costs. Water's loading cost is the highest, rail's cost is lower, and truck's cost is the lowest. The ranking of their line-haul costs is the opposite. Water transport's line-haul cost is usually the lowest, rail cost is higher, and truck cost is the highest. Therefore, shippers are more likely to select water and rail transport than truck transport the longer the distance to be traveled, because on the longer hauls their line-haul cost advantage outweighs trucking's loading cost advantage. Long hauls also favor air transport. Although air transport's line-haul costs are high, speed can make it attractive for long-distance movements. 2/

1/ A comparison of the various modes' share of weight and value in tables 6 and 7 provides evidence that value influences mode choice. Water and none have higher shares of weight than value for both imports and exports, rail has a higher share of weight than value for exports and only a slightly lower share of weight than value for imports. Air and truck have higher shares of value than weight.

The effect of value on mode choice is the reason the mode chosen for domestic transportation varies with the mode used in international transportation. Higher valued goods that are more likely to travel by truck or air within the country are more likely to enter or leave the country by air.

2/ Data on the average length of haul for all modes in domestic transportation are given in Transportation Association of America, Transport Facts and Trends, Washington, D.C., 1980, p. 14. These data indicate that shipments traveling by air, rail, and water travel over longer distances than truck shipments. U.S. D artment of Commerce, "Domestic and International Transportation of U.S. Foreign Trade: 1976," part A, pp. 228-252 and part B, pp. 104-131, presents data confirming that domestic shipments of exports and imports traveling by air, rail, and water travel over longer distances than truck shipments.

Shipment size may also influence the choice of mode. Transport costs increase dramatically if the shipment does not fill the vehicle used. The capacity of a truck is generally smaller than the capacity of a railcar or vessel, therefore, shippers with smaller shipments are more likely to use truck than rail or water transport, so they can fill the vehicle. 1/ However, while shipment size affects the choice of mode, choice of mode also affects shipment size. For example, a shipper that wants to use rail may be able to combine several small shipments to fill the railcar.

The size of domestic transportation costs of traded goods.--Domestic transportation costs are affected by distance, shipment size, the volume-weight ratio, and value. The unit cost of transportation usually falls with shipment size, and rises with the product's volume per unit of weight, and value. 2/

Shipment size, the volume-weight ratio, and value also affect international transportation costs. However, shipment size generally affects ocean-shipping charges only when very large volumes, enough to fill an oceangoing vessel, are reached. The volume-weight ratio and value usually affect ocean transportation costs more than domestic transportation costs. 3/

1/ U.S. Department of Commerce, Ibid., shows that average size of shipments is higher on rail or water transport than on trucks.

The cost of rail transport may decline with shipment size even after a single railcar has been filled. Shippers are often able to realize further savings by shipping several railcars at once, and still greater savings by filling a train.

2/ Value tends to increase transportation costs because as a good's value increases the volume of shipments generally becomes less sensitive to the rate charged. Therefore, carriers tend to increase rates on higher valued shipments. For empirical evidence that value increases most truck and rail rates, see Kenneth D. Boyer, "Equalizing Discrimination and Cartel Pricing in Transport Rat^ Regulation," Journal of Political Economy, 89(2), April 1981, pp. 270-286.

3/ For example, an ocean carrier's rate for carrying a container usually increases with the value of its contents, but a railroad's rate is usually the same for all containers. For further evidence concerning the effect of value and the volume-weight ratio on oceanborne international transportation costs, see Organization for Economic Cooperation and Development, "Ocean Freight Rates as Part of Total Transport Costs," Paris, 1968.

Data on the relative size of domestic transportation costs in foreign trade are scarce. These costs vary depending on the commodity shipped, the route traveled, and the mode used. The great variation in these costs makes it difficult to gather enough data to give a valid picture of their overall size.

Two previous studies attempted to measure the significance of domestic transportation costs in foreign trade. The Organization for Economic Cooperation and Development (OECD) did a study based on a sample of oceanborne shipments traveling between Noth America and Western Europe in 1966 and 1967. All but 9 percent of these shipments originated or terminated in the United States. The study found that domestic transportation costs were approximately 1.6 percent of the shipments' f.o.b. costs. 1/ The OECD sample includes only liner shipments. Liners usually carry cargoes with higher value to weight ratios than other ocean carriers; they rarely carry bulk products.

A later study used a sample of U.S. oceanborne exports and imports from 1976 to measure transportation costs within the United States. 2/ The study determined that for shipments traveling between 500 and 1,000 miles within the United States domestic transportation costs ranged from 30 percent to 65 percent of international transportation costs. Most shipments in that study traveled less than 500 inland miles and so probably had lower domestic transportation costs. 3/ The study indicates that domestic transportation costs for goods in foreign trade are usually substantially less than international transportation costs.

1/ OECD, Ibid. Ocean freight costs averaged 3.9 percent of f.o.b. price for shipments in the sample.

2/ J. A. Binkley et. al., Fleet Management Technology Performance Evaluation, Report to the Maritime Administration, U.S. Department of Commerce, 1979, ch. 4.

3/ Domestic transportation costs were not measured for these shorter shipment.

Domestic transportation costs and import-competing industries.--Data on the importance of domestic transportation costs to import-competing industries are unavailable. Domestic transportation costs are likely to be important to these industries when domestic producers must ship over considerable distances to reach purchasers and when transportation costs over those distances are a significant part of the product's value. Two such industries are steel and autos. The experience of these industries supports the finding of the last section. 1/ Domestic transportation costs will significantly affect certain U.S. producers' competitiveness in international trade.

Production in both the steel and auto industries is geographically highly concentrated. Steel production is concentrated in Illinois, Indiana, Ohio, and Pennsylvania. 2/ Auto production is concentrated in Michigan, Ohio, and Illinois. 3/ In both industries, import penetration is much higher in areas that are further from the center of domestic production. The USITC has found this geographic pattern to steel import penetration in several earlier investigations. 4/ Data on automobile import penetration show the same pattern. Foreign cars' share of new car sales is largest in States bordering the Pacific Ocean and smallest in States bordering the Great Lakes. 5/ The

---

1/ Although this section focuses on the steel and automobile industries because of their size and the availability of data, other import-competing industries are also affected by domestic transportation costs. For an example, see U.S. International Trade Commission, Unrefined Montan Wax From East Germany, Report to the President on investigation No. TA-406-7 . . ., USITC Publication 1214, January 1982, pp. A-48-A-50.

2/ In 1980, mills in these 4 States produced 61 percent of the U.S. output of steel. U.S. Bureau of the Census, Current Industrial Reports: Steel mill products, September 1981, p. 11.

3/ In 1979, plants in these States produced 43.8 percent of U.S. made automobiles. Ward's Automotive Yearbook, 1979, p. 107.

4/ Conditions of Competition In the Western U.S. Steel Market Between Certain Domestic and Foreign Steel Producers, Report to the President on investigation No. 332-87, March 1979; Hot-Rolled Carbon Steel Sheet From France, Report on in investigation 701-TA-85 (Preliminary), and Hot-Rolled Carbon Steel Plate from Belgium Brazil and Romania, Report to the President on investigations Nos. 701-TA-83, 701-TA-84, and 731-TA-51, January 1982.

5/ Ward's Automotive Yearbook, op. cit.

geographic pattern of import penetration in these two industries indicates that domestic transportation costs have a significant effect on their competitiveness with imports.

Comparing trends in domestic and international transportation costs

International transport costs have declined significantly relative to domestic transport costs. This change in the relative cost of different types of transportation may make producers in the interior of the United States less competitive with imports near the coasts.

Trends in the costs of different modes should be compared using rate indexes. Reliable rate indexes are only available for international waterborne transport and for domestic rail transport. These indexes are presented in table 9, for 1974-81.

Of the indexes for waterborne transport, the tanker index shows the largest decline. Of the dry cargo indexes, the largest decline is shown by the index for time charters of 2 years or less. The index for voyage charters also declines, but the index for time charters of 1 year or less rises. The only maritime rate index that increased steadily throughout this period is the liner freight index. Liners adhere to a regular schedule; they generally carry higher valued cargo than other ships. The liner freight index increased by 69 percent from 1974 to 1981. The rail rate index increased by 119 percent over this same period.

Factors influencing domestic and international transportation costs

In recent years, weak demand and technological change have reduced international transportation costs while rising fuel prices have increased these costs. Demand has been weaker for ocean shipping than for air freight, and rising fuel prices affected air freight much more than ocean shipping.

Table 9.--Rate indexes for domestic rail transport and international maritime transport

(1974=100)

Year	Tankers	Maritime dry cargo				Railroad
		Voyage charter	Time charters		Liner	
			Up to 1 year	Up to 2 years		
1974	100	100	100	100	100	100
1975	53	65	57	43	110	113
1976	53	61	58	45	116	125
1977	52	61	54	29	123	133
1978	70	64	65	39	130	142
1979	119	82	92	68	144	163
1980	83	98	127	94	154	190
1981	62	90	111	70	169	219

Source: Railroad rate index from official statistics of the U.S. Bureau of Labor Statistics. Other indexes from OECD Maritime Transport, various issues.

Rising fuel prices also significantly affected domestic transportation costs. These prices increased both rail and truck costs by more than they increased ocean shipping costs. Changes in government regulation may also have affected the relative costs of domestic transportation.

D and.--Ocean shipping rates have been held down because the demand for ocean shipping has grown slowly relative to the growth of capacity. From 1976 to 1981, ton-miles of dry cargo shipped in oceanborne trade rose by 27 percent, and the capacity of the world's ocean-going dry cargo fleet rose by 28 percent. Ton-miles of tanker cargo shipped fell by 26 percent, while the capacity of the world tanker fleet rose by 5 percent. 1/

The demand for all ocean shipping has been limited by the worldwide recession. The demand for tanker shipping has also been limited by the large increase in petroleum prices that has reduced shipments of petroleum products. Furthermore, several major petroleum importers have increased the

1/ Data on ton-miles shipped are from OECD, Maritime Transport 1981, (Paris, 1982), p. 29. Data on capacity are from Maritime Transport, 1981, p. 146 and OECD, Maritime Transport, 1976, Paris, 1977, p. 123. Capacity is measured in deadweight tons.

share of their imports from relatively nearby sources. For example, the share of U.S. petroleum imports that came from Mexico and the share of European petroleum imports that came frm the North Sea both increased. As a result, the average length of haul of crude oil in oceanborne trade has fallen from 6,649 miles in 1976 to 5,730 miles in 1981. 1/ This change in the pattern of traffic has reduced the demand for tankers.

The demand for airfreight services rose more rapidly from 1976 to 1981 than the demand for ocean shipping. Although the worldwide recession reduced the demand for airfreight, high interest rates increased that demand. By using faster modes of transport shippers can reduce inventories. Because higher interest rates raise the cost of holding inventories, they encourage shippers to use air transport. From 1976 to 1981, airline traffic increased by 33 percent. At the same time, total airline capacity increased by 23 percent. 2/

Air freight capacity has grown sharply on the U.S. North Atlantic routes. In 1977, the United States concluded a new international aviation agreement with the United Kingdom that made it easier for airlines to increase capacity on these routes. As a result, capacity on these routes grew significantly and this growth in capacity tended to reduce rates. 3/

1/ Based on data in Maritime Transport 1981, p. 29.

2/ Separate capacity figures for airfreight are unavailable. Total airline freight traffic increased by 42 percent. Capacity estimates are based on data in International Air Transport Association, World Air Transport Statistics, 1979 and 1981. Traffic data are also from this source. Traffic is measured in ton-kilometers, and capacity is measured in plane-tons. These data are only for IATA members; in 1976, IATA members carried 74 percent of total world airline traffic. Traffic data refer only to scheduled services; in 1976, 95 percent of IATA traffic travelled on scheduled flights.

3/ Bruce Barnard, "Europeans Fear Tigers Move Will Spur New Air Rate War," Journal of Commerce, Tuedsay, October 13, 1981, p. 1A, 5A.

Energy.--The large increases in fuel prices that have taken place in recent years have significantly increased the cost of transportation. As shown in appendix C, the long-run effect of a change in fuel prices on the rates charged by a transportation mode can be found by multiplying the percentage change in fuel prices by the ratio of that mode's energy costs to total costs.

The effect of fuel price increases from 1973 to 1981 on the costs of various modes of transportation are shown in table 10. This period was selected because fuel prices began rising rapidly in 1973. Air freight had the largest cost increase; its costs almost qradrupled. Air freight has both the largest energy cost ratio and the largest fuel price increase of the modes considered. Containerships had the smallest cost increase, 39 percent. Of the domestic modes, truck had a 199 percent cost increase; rail costs increased by 63 percent.

Table 10.--The effects of fuel price increases on the costs of various transport modes, 1973-81

(In percent)

Item	Fuel cost as a share of total cost	Increase per unit of fuel cost	Increase in total cost due to increased fuel cost
International transport:			
Airfreight	41	724	297
Containership	7	551	39
Domestic transport:			
Airfreight	40	724	290
Truck	31	643	199
Rail	9	704	63

Source: The derivation of these data is described in app. D.

The data in table 10 show the long-run effect of changes in fuel prices on transport rates. It is not possible to determine the extent to which the increased fuel prices are already reflected in transport rates.

Technological change.--The four major technological innovations that caused transportation costs to fall between 1976 and 1981 were wide-bodied jets, containerization, large-scale tankers, and large dry bulk carriers. All four innovations existed in 1976, but their use expanded after that year.

The use of larger aircraft significantly reduced the cost of airfreight. The cost per revenue freight ton-mile of a wide-bodied aircraft is 34 percent below the cost of a regular-bodied aircraft. 1/ From 1976 to 1981, the average size of aircraft in the world fleet grew by 23 percent. 2/

Containerization reduces costs by decreasing the time spent loading and unloading and by reducing pilferage and damage to cargo. Containerization was introduced in U.S. foreign trade in the mid-1960's. Since then its use has steadily expanded. In 1976, 24 percent of containerizable oceanborne trade was shipped in containers, in 1981, 27 percent was shipped in containers. 3/

The use of larger tankers can significantly reduce the cost of hauling oil. For example, the cost per ton of hauling oil in an 87,700 deadweight-ton tanker is 11 percent less than the cost per ton in a 75,000 deadweight-ton

---

1/ This figure is based on a comparison of 747 and DC-8 freighters flown by Flying Tiger Airlines on domestic routes. See Civil Aeronautics Board, Aircraft Operating Cost and Performance Report 1981, Washington, D.C., 1982, p. 68.

2/ Based on data for IATA members only, from IATA, World Air Transport Statistics 1981, Paris, 1982, and World Air Transport Statistics 1979, Paris, 1977.

3/ Data on the volume of oceanborne container trade are from U.S. Maritime Administration, Containerized Cargo Statistics, 1976, Washington, D.C., 1979, and Containerized Cargo Statistics, 1981, Washington, D.C., forthcoming. Data from the forthcoming report were provided by the staff of the Maritime Administration. Containerizable cargo is all assumed to be cargo excluding crude materials, fuels and related materials, and live animals.

tanker. 1/ The average size of the world tanker fleet has grown rapidly in order to take advantage of these efficiencies. From January 1, 1976, to January 1, 1982, the average size of tankers increased by 24 percent. 2/

Significant cost savings can also be realized by increasing the size of large bulk carriers. The cost per ton of hauling ore in a 60,000 deadweight-ton bulk carrier is about 54 percent less than the cost per ton in a 12,000 ton bulk carrier. 3/ The average size of bulk carriers in the world fleet grew by 8 percent from January 1, 1976, to January 1, 1982. 4/

Deregulation of domestic transport.--Recent legislation has substantially reduced the power of the Interstate Commerce Commission (ICC) to regulate trucks and railroads, the domestic transportation modes most commonly used by goods traveling in foreign trade. 5/

The Motor Carrier Act of 1980 gives truckers significantly greater freedom to raise or lower their rates. Rates charged on truck movements that are incidental to airborne shipments are no longer regulated. Furthermore, truckers may raise or lower any rate by 10 percent a year without the ICC's approval.

1/ See John A. Binkley, Fleet Management Technology Performance Evaluation, report done by Simat, Helleisen, and Eichner for the U.S. Department of Commerce, Maritime Administration, Washington, D.C., 1979, p. 288.

2/ Data on the average size of tankers are available in OECD, Maritime Transport 1981, Paris 1982, p. 78 and Maritime Transport 1976, Paris, 1977, p. 76.

3/ See A. J. Yeats, Shipping and Development Policy, New York City, Praeger, 1981, p. 156.

4/ OECD, Maritime Transport, 1981.

5/ For a discussion of recent deregulation of railroads and trucks, see John Guandolo, "The Role of the Interstate Commerce Commission in the 1980's," American Economic Review, 71(2), May 1981, pp. 116-121, and "Congress Passes Rail Deregulation Bill, Sends It to President Carter," Traffic World, Oct. 6, 1980, pp. 27-28, 128-140. Domestic airfreight transportation has also been deregulated, but because few U.S. exports or imports travel domestically by air that mode will not be discussed in this section.

Besides these provisions relating directly to rates, the Motor Carrier Act makes it harder for truckers to maintain rates above competitive levels. After 1984, rate bureaus (organizations of truckers that meet to set rates) will no longer be able to discuss rates on movements that involve only one trucking firm. Furthermore, the act reduces regulatory obstacles to starting a trucking firm. If trucking rates rise too high, new firms can now enter the industry and that added capacity will tend to reduce rates.

Railroads also now have more freedom to adjust their own rates. If the ICC finds that competition from other transport modes prevents railroads from dominating the market for a particular type of traffic, it will not regulate that traffic's rate. 1/ Furthermore, railroads can change any rate by as much as 6 percent a year until 1984 without regulatory interference, and the ICC may permit even greater increases. 2/

D~regulation will probably tend to reduce truck rates. Trucking regulation has reduced competition and has probably increased rates over the levels that would prevail in an uncontrolled market. 3/ Because of the nature of trucking, unregulated markets for truck transportation will be competitively structured with many small firms and little to prevent new firms from entering. Thus, trucking deregulation will probably lower rates.

1/ For example, the ICC has deregulated rates on Trailer on Flat Car and Container on Flat Car (TOFC/COFC) traffic. Soon after this action two railroads substantially reduced rates on containers and trailers shipped from the Midwest to be exported from the ports of New York, N.Y.; Philadelphia, Pa.; and Baltimore, Md. The railroads reduced rates by approximately 22 percent. See "Conrail Announces Sharp Cut in Marine Container Rates," Journal of Commerce, Apr. 8, 1981, p. 1A.

2/ Traffic World op. cit. After 1984 railroads that the ICC finds to have inadequate revenues can increase rates by 4 percent without regulatory interference.

3/ See T. G. Moore, "The Beneficiaries of Trucking Regulation," The Journal of Law and Economics, 21 (2), October 1978, pp. 327-344 and Kenneth D. Boyer, "Equalizing Discrimination and Cartel Pricing in Transport Rate Regulation," Journal of Political Economy, 89(2), April 1981, pp. 270-286.

Deregulation may either raise or lower railroad rates. 1/ In general, only a few railroads will be able to profitably provide service on a given route, and starting railroad service is very difficult. Therefore, markets for railroad services are unlikely to be competitively structured, and competition may not effectively control rates. The effectiveness of competition will depend on the number of railroads serving the route involved and the amount of competition from truck and barge operators. 2/ Competition from barges will limit rates on shipments of bulk commodities on routes that are parallel to waterways. Competition from trucks will limit rates on manufactured articles. Regulation seems to have increased rates on traffic where railroads face strong competition from other modes. Therefore, deregulation will probably tend to decrease rates on some manufactured products and on bulk products with strong waterborne competition. However, given the low profitability of the nation's railroads, the general level of rates will probably have to increase. 3/

A complete analysis of the effects of transport deregulation on U.S. foreign trade would be a full project in and of itself. However, this brief discussion suggests that deregulation will stimulate foreign trade. Deregulation may increase most rail rates, but it will lower some. Furthermore, deregulation will lower rates on truck transport, the domestic transportation mode most often used by goods traveling in U.S. foreign trade.

1/ For studies of the effect of rail deregulation, see Boyer, op. cit. and R.C. Levin, "Railroad Rates, Profitability, and Welfare Under Deregulation," The Bell Journal of Economics, 12(1), spring 1981, pp. 1-26.

2/ Competition between railroads on different routes sometimes may be important. For example, two railroads might compete if they take the same product to the same destination from two different origins.

3/ Deregulation has increased railroads' ability to abandon low density lines. Abandoning such lines can improve railroad profits and reduce the pressure on the ICC to allow railroads to charge high rates to offset the losses suffered on these lines. Thus, the need to increase rail profits will be met in part by abandonments and not just higher rates.

Tariffs and Transportation Costs

The cost of international transportation is larger than the cost of tariffs for most U.S. imports. Both these costs have declined from 1976 to 1981; the decline in tariffs has been smaller than the decline in transportation costs. The cost of transporting a product and the rate of duty on that product do not seem to be related.

Comparing transportation costs and tariffs

Transportation costs were greater than duties collected for U.S. imports in 1965 and in every year from 1974 to 1981, as shown in table 11.

Table 11.--Ad valorem duties and transportation costs for U.S. imports for consumption, 1965 and 1974-81

(In percent)

Year	Duty	Transportation cost
1965	7.6	10.0
1974	3.8	6.5
1975	3.9	6.3
1976	3.9	6.2
1977	3.7	5.8
1978	4.0	5.6
1979	3.5	5.5
1980	3.1	4.6
1981	3.4	4.5

Source: Compiled from official statistics of the U.S. Department of Commerce.

Freight factors and ad valorem duties in 1981 were determined for 208 products that correspond to subparts of the TSUSA. These data are in appendix A. Freight factors are greater than duties collected for 119, or 57 percent, of these 208 products.

Two previous studies compare tariffs and transportation costs in 1965 and 1974. Yeats and Finger found that in 1965 ad valorem transportation costs were slightly larger than ad valorem tariffs 1/. They also presented some

1/ "Effective Protection By Transportation Costs and Tariffs: A Comparison of Magnitudes," Quarterly Journal of Economics, February 1976, pp. 169-176.

evidence that in the late 1960's and mid-1970's, tariffs fell by more than transportation costs. This suggestion was supported by D. P. Clark, who found that in 1974 transportation costs were substantially larger than tariffs, 1/ and by the data in table 11. Such data show that from 1965 to 1974 ad valorem duties fell by half, whereas ad valorem transportation costs fell by 35 percent.

Between 1974 and 1981, tariff rates have fallen for several reasons: (1) the start of the Generalized System of Preferences (GSP); (2) the extension of most-favored-nation status to the People's Republic of China, Czechoslovakia, Hungary, and Romania; (3) the start of preferential rates for imports from least developed developing countries; and (4) the negotiation of duty reductions during the Tokyo round. 2/ Furthermore, some tariffs are wholly or partially in terms of specific dollar amounts. Rising import prices will cause these tariffs to decline relative to the value of imports. Despite these changes, ad valorem transportation costs have fallen by more than ad valorem duties. From 1974 to 1981, ad valorem transportation costs fell by 30.8 percent, ad valorem duties fell by 10.5 percent.

Data on tariffs and transportation costs for specific products are only available on magnetic tape from 1976 to 1981. Of the major changes in tariff structure that took place between 1974 and 1981, only the extension of most-favored-nation status to Romania and the GSP were in effect in 1976. 3/ From 1976 to 1981, freight factors fell by more than ad valorem duties for 114 of the 208 products imported, or 55 percent of all products.

1/ D. P. Clark also finds that tariff and nontariff barriers to trade combined are larger than transportation costs. "On the Relative Importance of International Transport Charges as a Barrier to Trade," Quarterly Review of Economics and Business, winter 1981, pp. 127-135.

2/ The duty reductions negotiated during the Tokyo round will not be completely effective until 1991.

3/ The number of products and the number of countries involved in the GSP increased from 1976 to 1981.

The decline in tariff rates.--Overall ad valorem duties may change for several reasons: (1) tariff rates may decline, (2) the commodity composition of imports may change, and (3) the relative importance of U.S. trading partners may change. The effect of changes in tariff rates on overall ad valorem duties is separately identified using the methodology described in appendix B. The results show that from 1976 to 1981, ad valorem tariff rates fell between 12.8 percent and 19.0 percent. This decline in rates was from 1 to 1.6 times as great as the total decline in overall ad valorem duties. These estimates indicate that transportation rates declined by much more than tariff rates. From 1976 to 1981, transport rates fell between 25.8 percent and 29.2 percent.

Changes in tariff rates for major product categories are shown in table 12. Petroleum products have the largest decline in rates. Because duties on petroleum products are usually in terms of dollars per unit of quantity, the large increase in the price of these products would lower their ad valorem equivalent tariff rates. Tariff rates fell by more on fuel and raw materials than on manufactured goods. Tariff rates fell by more than transport rates on fuel and raw materials and by less than transport rates on manufactured goods.

Table 12.--Estimated decline in transport rates and tariff rates, by product categories 1976-81

(In percent)

Category	Ad valorem duties collected 1981	Decline in transport rates		Decline in tariff rates	
		Minimum	Maximum	Minimum	Maximum
Manufacturing	5.4	20.8	24.6	8.6	11.5
Agriculture	3.0	1.2	9.6	40.0	43.4
Mining	.8	2.4	6.2	.0	27.3
Petroleum	.2	44.8	50.7	75.0	75.0
Total	3.4	25.8	29.2	12.8	19.0

Source: Estimated by the staff of the U.S. International Trade Commission.

Comparing the structure of transportation costs and tariffs.--It has been suggested that goods with high transportation costs will have low tariffs, because if high transportation costs protect domestic industries from imports, there will be less reason to protect the industry with a high tariff. 1/ The available data, however, do not support this hypothesis.

To test the hypothesis that the pattern of tariffs and the pattern of transportation costs are related, freight factors and ad valorem duty equivalents were determined for subparts of the TSUSA. Pearson and Spearman correlation coefficients then were computed for those two variables. The Pearson correlation coefficient was -.08; the Spearman correlation coefficient was .09. Neither coefficient is significantly different from zero at the 10 percent confidence level. 2/ This result is similar to an earlier finding of W. G. Waters, who also could not support the hypothesis that freight factors were related to tariffs. 3/

1/ One reason that was traditionally given for expecting a negative relationship between tariffs and transportation costs is that tariffs usually are higher on more processed goods whereas freight factors were thought to be lower. Freight factors, however, are as likely to increase with processing as to decrease. The relationship between processing and the freight factor is discussed at length later in this report.

2/ A correlation coefficient measures the relationship between two variables. The Spearman correlation coefficient is computed by ranking observations and then finding the Pearson correlation coefficient of the ranks of each variable. The advantage of the Spearman coefficient is that it is not as sensitive to observations with extreme values.

3/ W. G. Waters "Transport Costs, Tariffs, and the Pattern of Industrial Protection," American Economic Review, December 1970, pp. 1013-1020.

Transportation Costs and Processing

Freight factors often rise as products receive more processing. The most important reason freight factors sometimes are higher for more processed goods is that such products are more likely to use air transport. When freight factors rise with processing, their effect is reinforced by the tariff structure, because tariffs also tend to rise with processing. The cost of importing, therefore, can be much higher for goods after they have received additional processing.

Methodology and results

Transportation costs were once expected to decline, as a share of a product's value, as the product received additional processing. Processing increases the price of a good, but it has no clear relationship to transportation costs. However, using data from 1974, A. J. Yeats found that transportation costs often rose as a percent of value as goods received more processing. 1/

This study uses 1981 data to examine the structure of transportation costs. The results indicate that freight factors are somewhat more likely to increase than to decrease with processing. Freight factors generally decrease in the first stage of processing but increase in later stages. These results are similar to those of Yeats. The methodology used is also similar to that used by Yeats. Eighteen processing chains are identified; the products included in each chain are shown in table 13. These products constituted 14.6 percent of U.S. imports

---

1/ A. J. Yeats, "Do International Transport Costs Increase With Fabrication? Some Empirical Evidence," Oxford Economic Papers, November 1977, pp. 458-471, and Yeats, "A Comparative Analysis of the Incidence of Tariffs and Transportation Costs on India's Exports," Journal of Development Studies, October 1977, pp. 97-107.

in 1981. Of these processing chains, 12 involved three stages of processing, and six involved two stages. Bureau of the Census data on transportation costs and f.a.s. values of U.S. imports are used to determine the freight factors.

Table 13.--Products and stages of processing for each processing chain

Chain	Stage of processing		
	1	2	3
Aluminum	Bauxite	Unwrought	Wrought
Cocoa	Beans	Powder and butter	Chocolate
Coffee	Crude	Roasted or ground	Soluble or instant
Copper	Ore	Unwrought	Wrought
Cotton	Raw	Yarn	Fabric
Fish	Fresh, chilled or frozen	1/	Products
Fruit	Fresh or preserved	1/	Preparations
Iron and steel	Iron ore	Ingots, blooms, and billets	Rolling mill products
Lead	Ore	Unwrought	Wrought
Leather	Hides	Leather	Shoes and other leather articles
Meat	Fresh	1/	Products
Nails	Wire rod	Wire	Nails
Pulp and paper	Paper making materials	Paper and paperboard	Printed matter
Tobacco	Leaf, wrapper, filler, scrap and stems	1/	Manufactures
Vegetable fibers	Raw	1/	Fabric
Vegetable oil	Oil bearing materials	1/	Crude or refined
Wood	Lumber, rough and primary wood	Simply worked	Wood products
Wool	Raw	Yarn	Fabric

1/ Not available.

No consistent relationship exists between transportation costs and processing, as the data in table 14 show. As these 18 products move from the first to the third stage of processing, freight factors increase 9 times and decrease 9 times. Freight factors are more likely to increase at the later

Table 14.--Transportation costs as a percent of value, by stages in the processing chains, 1981

(In percent)

Chain	Stage of processing		
	1	2	3
Aluminum	24.9	.8	4.4
Cocoa	7.5	6.0	5.6
Coffee	5.6	2.2	5.8
Copper	4.4	2.8	5.8
Cotton	3.9	8.5	4.9
Fish	6.0	1/	4.2
Fruit	27.0	1/	12.6
Iron and steel	18.1	3.7	8.3
Lead	5.7	1.7	3.1
Leather	4.8	4.9	5.6
Meat	12.6	1/	6.2
Nails	7.7	7.8	10.0
Pulp and paper	1.0	2.2	5.5
Tobacco	6.8	1/	5.8
Vegetable fiber	20.4	1/	20.5
Vegetable oil	1.7	1/	9.3
Wood	3.9	8.9	9.6
Wool	8.7	6.5	3.7

1/ Not available.

Source: Estimated by the staff of the U.S. International Trade Commission.

stages of processing. Of the 30 transformations included in these 18 processing chains, 17 involve raw materials. 1/ Freight factors increase in 6 of these 17 transformations. However, freight factors increase in 10 of the 13 transformations that start with intermediate goods.

Reasons for increasing freight factors

Freight factors are higher for more processed goods in part because these goods are more likely to be shipped by air. The major advantage of air freight is that its speed allows importers to hold lower inventories. The cost of holding a good in inventory increases with its value. The attractiveness of airfreight, therefore, increases with the value of the good being shipped.

1/ All products in the first stage of processing are raw materials except wire rod, the first product in the nails chain.

To eliminate the effects of differences in mode of transport, freight factors were calculated solely for imports shipped by water. The results are shown in table 15. Freight factors are much less likely to increase with processing for waterborne imports than for total imports. Freight factors for waterborne imports decrease with processing for all but 3 of the 18 processing chains included in this study. The exceptions are vegetable fibers, nails, and copper. Freight factors increase in only 2 of the 17 transformations involving raw materials, but they increase in 6 of the 13 transformations that start with intermediate products.

Table 15.--Transportation costs as a percent of value for waterborne imports, by stages in the processing chain, 1981

(In percent)

Product	Stage of processing		
	1	2	3
Aluminum	24.9	2.6	5.2
Cocoa	7.5	6.1	6.4
Coffee	6.2	3.4	5.9
Copper	6.5	3.9	6.8
Cotton	13.7	8.7	4.7
Fish	8.6	1/	6.0
Fruit	31.6	1/	16.1
Iron and steel	18.2	11.6	9.4
Lead	8.8	8.2	7.8
Leather	7.7	4.5	4.8
Meat	15.3	1/	6.3
Nails	10.7	9.5	13.3
Pulp and paper	9.6	10.8	5.7
Tobacco	6.9	1/	6.8
Vegetable fiber	21.1	1/	21.7
Vegetable oil	13.2	1/	9.4
Wood	23.6	13.5	12.1
Wool	8.8	6.4	2.1

1/ Not available.

Source: Estimated by the staff of the U.S. International Trade Commission.

These data indicate that the greater use of air transport for more processed products is an important reason why freight factors increase with processing. It is not, however, the only reason, because in the later stages of processing freight factors for waterborne imports frequently increase.

Freight factors may be different for different products because these products may be shipped from different countries. Therefore, a weighted average of the freight factors from specific countries was determined with that country's share of U.S. imports of the first product in the processing chain used as the weights. Data from countries that did not export each product in the chain were not used in calculating these weighted freight factors. To eliminate the effect of the use of air freight, only data on waterborne imports were used to calculate these freight factors.

The weighted freight factors shown in table 16 follow approximately the same pattern as the unweighted freight factors. In the 17 transformations that start with a raw material, freight factors increase 3 times. In the 12 transformations that start with an intermediate product, freight factors increase 4 times. Thus differences in the country of origin do not significantly affect the pattern of freight factors.

Besides the use of airfreight and differences in country of origin, freight factors might rise with processing for other reasons. Processing increases a product's value and transportation charges generally rise with value. Insurance costs, which are part of total transport charges, almost always increase with value. Insurance costs, however, are only a small part of total transportation costs. 1/ A more important reason for transportation costs to increase with value is the rate setting behavior of ocean liner conferences. These conferences generally charge higher rates on higher valued commodities, because the demand for transportation is usually less elastic for higher valued commodities. The effect of value on transportation costs, however, is not a sufficient reason for freight factors to increase with

---

1/ In 1972, insurance costs were 4 percent of total transportation costs. See Phillip M. Ritz, "The Input-Output Structure of the U.S. Economy, 1972," Survey of Current Business, February 1979, p. 41.

Table 16.--Transportation costs, as a percent of value, for waterborne imports by stages in the processing chain, using stage 1 weights, 1981

(In percent)

Product	Stage of processing		
	1	2	3
Aluminum	36.2	6.7	9.9
Cocoa	7.6	7.1	8.1
Coffee	5.3	3.6	5.5
Copper	11.5	4.0	6.1
Cotton	7.3	6.7	4.5
Fish	6.6	1/	8.0
Fruit	31.6	1/	13.9
Iron and steel	34.8	18.1	9.9
Lead	13.7	11.9	1/
Leather	9.6	8.6	4.9
Meat	12.8	1/	9.2
Nails	10.7	10.4	9.9
Pulp and paper	13.6	19.3	6.4
Tobacco	8.3	1/	7.0
Vegetable fiber	17.5	1/	14.6
Vegetable oil	7.5	1/	4.1
Wood	27.4	16.8	15.9
Wool	6.7	8.6	4.2

1/ Not available.

Source: Estimated by the staff of the U.S. International Trade Commission.

processing. For the freight factor to increase when value increases, the elasticity of transportation charges with respect to value must be greater than one. R. Lipsey and L. Weiss, however, found that this elasticity for U.S. waterborne imports in 1966 was 0.52. 1/

Freight factors may also increase with processing because carriers have higher costs to move more processed goods. Processing can increase handling costs because more highly processed goods may be more vulnerable to pilferage and breakage. Processing also often increases a products' ratio of volume to weight, the stowage factor. Increases in the stowage factor may significantly increase both handling costs in port and line-haul costs. 2/ The effect of

1/ "The Structure of Ocean Transport Charges," Explorations in Economic Research, summer 1974, pp. 162-193.

2/ For a discussion of the effect of the stowage factor on transportation costs, see D. Shneerson, "The Structure of Liner Freight Rates," Journal of Transport Economics and Policy, vol. 10, January 1976, pp. 52-67.

value on liner conference rates combined with the higher cost of transporting more processed goods may make freight factors increase with processing.

Freight factors tariffs and processing

The structure of freight factors can be compared with the structure of tariffs; ad valorem equivalent tariffs for the products included in this study are shown in table 17. These tariff rates increase with processing for sixteen of the eighteen processing chains. One exception is coffee; the products included in that chain all have zero tariff rates. Tariff rates only decline with processing in four cases, between the second and third steps of the lead, and iron and steel, and nails processing chains and in the vegetable oil chain.

Table 17.--Tariffs, as a percent of value by stages in the processing chains, 1981

(In percent)

Product	Stage of processing		
	1	2	3
Aluminum	1/	1.0	2.4
Cocoa	1/	.1	1.1
Coffee	1/	1/	1/
Copper	1/	.8	2.1
Cotton	1.6	7.6	11.4
Fish	.5	2/	4.5
Fruit	2.5	2/	5.1
Iron and steel	1/	6.1	5.6
Lead	.3	2.3	2.2
Leather	1/	2.5	8.2
Meat	1.7	2/	2.3
Nails	2.5	6.2	.6
Pulp and paper	1/	.2	2.2
Tobacco	8.1	2/	13.3
Vegetable fiber	1.2	2/	1.3
Vegetable oil	1.2	2/	.5
Wood	1/	.3	4.2
Wool	5.2	9.6	36.7

1/ Less than .05 percent.
2/ Not available.

Source: Estimated by the staff of the U.S. International Trade Commission.

The freight factors and ad valorem tariff rates are combined into ad valorem importing costs, as shown in table 18. Because transportation costs are significantly larger than tariffs for most of the products considered, the combined costs behave in about the same way as do transportation costs. Ad valorem importing costs are somewhat more likely to rise than to decline with processing. These costs decline for 7 of the 18 processing chains and increase for 11 of the chains. Ad valorem importing costs rise in 8 of the seventeen transformations that start with raw materials and in twelve of the thirteen transformations that start with intermediate goods. The structure of these costs may explain why goods in international trade are generally either raw materials or intermediate goods. 1/

Table 18.--Tariffs and transportation costs, as a percent of value by stages in the processing chains, 1981

(In percent)

Product	Stage of processing		
	1	2	3
Aluminum	24.9	1.8	6.9
Cocoa	7.5	6.1	6.7
Coffee	5.6	2.2	5.8
Copper	4.4	3.5	8.0
Cotton	5.5	16.1	16.3
Fish	6.5	1/	8.7
Fruit	29.5	1/	17.7
Iron and steel	18.1	9.8	13.9
Lead	6.0	4.0	5.3
Leather	4.8	7.4	13.8
Meat	14.3	1/	8.6
Nails	10.1	14.0	10.6
Pulp and paper	1.0	2.4	7.7
Tobacco	11.9	1/	20.0
Vegetable fiber	21.6	1/	21.7
Vegetable oil	12.9	1/	9.8
Wood	3.9	9.3	13.8
Wool	13.9	16.2	40.4

1/ Not available.

Source: Estimated by the staff of the U.S. International Trade Commission.

1/ This observation concerning the composition of trade is made by K. K. Sanyal and R. W. Jones, in "The Theory of Trade in Middle Products," American Economic Review, vol. 72, March 1982, p. 16.

APPENDIX A

Freight Factors and Ad Valorem Duties for Specific U.S. Imports, 1976 and 1981

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981

Part	Description	Duty equivalents		Freight factors	
		1976	1981	1976	1981
		Percent			
	Schedule 1.				
Part 1:	Live animals	4.7	1.1	1.8	1.8
Part 2:					
A.	Bird meat	1.6	2.1	3.1	4.6
B.	Meats other than bird meat	4.0	1.9	10.9	10.7
Part 3:					
A.	Fish, fresh, chilled, or frozen	.7	.5	7.6	6.0
B.	Fish, dried, salted, pickled, smoked, or kippered	.2	.2	1.6	1.0
C.	Fish in airtight containers	6.5	6.6	6.6	5.3
D.	Other fish products	3.0	2.5	9.4	5.6
E.	Shellfish	.2	.4	3.5	3.3
Part 4:					
A.	Milk and cream	5.4	3.8	23.7	17.1
B.	Butter, oleomargarine, and butter substitutes	8.6	1.7	15.4	13.1
C.	Cheeses	10.4	9.8	9.2	9.2
D.	Other milk products	19.7	6.5	16.8	15.4
E.	Poultry and other birds' eggs	3.0	3.5	13.4	3.3
Part 5:					
A.	Hides, skins, and leather	3.6	1.9	4.8	4.9
B.	Furskins	.6	.6	1.5	1.6
Part 6:					
A.	Live plants	3.9	2.8	12.4	10.4
B.	Seeds	1.0	.4	5.7	4.4
Part 7:					
A.	Grains	2.0	1.0	5.0	5.0
B.	Milled grain products	4.5	2.7	15.4	9.6
C.	Malts and starches	3.6	1.6	22.0	16.4
Part 8					
A.	Vegetables, fresh, chilled, or frozen	16.7	6.8	3.5	2.4
B.	Vegetables, dried, desiccated, or dehydrated	9.0	4.7	11.1	9.1
C.	Vegetables, packed in salt, in brine, pickled, or otherwise prepared or preserved	13.7	11.1	14.6	12.5
D.	Mushrooms and truffles	13.5	28.3	8.4	8.0

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 1.--Continued				
Part 9:					
A.	Edible nuts	1.4	1.9	10.7	6.7
B.	Edible fruits	3.4	2.5	26.7	27.0
C.	Fruit flours, peels, pastes, pulps, jellies, jams, marmalades, and butters	9.7	5.1	14.3	12.6
D.	Glace nuts, fruits, and other vegetable substances	10.5	7.1	6.9	6.7
Part 10:					
A.	Sugars, sirups, and molasses	5.1	.0	7.9	7.7
B.	Cocoa	.3	.2	5.9	6.8
C.	Confectionery	6.3	6.0	8.7	7.3
Part 11:					
A.	Coffee and coffee substitutes,tea, mate	.0	.0	4.6	6.0
B.	Spices and spice seeds	1.6	1.2	10.0	12.6
Part 12:					
A.	Fruit juices	35.6	27.9	19.8	13.6
B.	Nonalcoholic beverages	.7	.6	22.2	19.2
C.	Fermented alcoholic beverages	6.3	5.1	15.5	14.4
D.	Spirits, spirituous beverages and beverage preparations	10.3	5.4	6.9	4.8
Part 13:	Tobacco and tobacco products	15.0	11.6	5.6	6.4
Part 14:					
A.	Oil-bearing vegetable materials	2.0	1.2	4.1	1.7
B.	Vegetable oils, crude or refined	1.7	.5	7.7	9.3
C.	Animal oils, fats, and greases, crude or refined	5.5	4.2	11.2	11.4
D.	Hardened oils, fats, and greases; mixtures	12.5	10.4	10.8	11.0
Part 15:					
A.	Products of American fisheries	.0	.0	.0	.0
B.	Edible preparations	5.0	3.5	9.9	8.0
C.	Animal feeds	1.1	1.1	5.0	4.5

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 1.--Continued				
Part 15--Cont.					
D.	Feathers, downs, bristles, and hair	.5	.6	5.1	3.8
E.	Shellac and other lacs; natural gums, gum resins, resins, and balsams; turpentine and rosin	.2	.2	14.0	11.5
F.	Miscellaneous animal products	.5	.1	17.4	14.5
G.	Miscellaneous vegetable products	3.7	4.0	10.0	12.5
	Schedule 2.				
Part 1:					
A.	Rough and primary wood products; wood waste	.04	.06	3.5	3.5
B.	Lumber, flooring, and moldings	.08	.07	5.7	4.1
C.	Densified wood and articles thereof	10.5	8.9	6.1	7.0
D.	Wooden containers	6.2	4.3	15.1	9.7
E.	Miscellaneous products of wood	4.3	4.2	13.5	9.6
F.	Articles not specially provided for, of wood	4.6	3.7	13.3	7.7
Part 2:					
A.	Cork and cork products	4.6	1.8	17.9	12.0
B.	Bamboo, rattan, willow, and chip; basketwork, wickerwork and related products of fibrous vegetables substances	11.9	5.0	27.4	20.2
Part 3:	Wood veneers, plywood and other wood-veneer assemblies, and building boards	13.3	8.7	16.1	11.1
Part 4:					
A.	Papermaking materials	.0	.0	.8	1.0
B.	Paper and paperboard, in rolls and sheets, not cut to size or shape	.3	.2	2.2	2.2
C.	Paper and paperboard cut to size or shape; articles of paper or paperboard	6.0	4.7	7.6	4.1

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 2.--Continued				
Part 5.	Books, pamphlets, and other, printed and manuscript material	1.0	.7	5.6	5.3
	Schedule 3.				
Part 1:					
A.	Cotton	5.5	7.2	5.7	6.3
B.	Vegetable fibers, except cotton	2.7	1.2	24.5	20.4
C.	Wool and related animal hair	10.5	6.4	9.2	8.1
D.	Silk	.7	1.1	5.6	4.1
E.	Manmade fibers	13.0	12.2	8.5	6.0
F.	Miscellaneous textile materials	6.9	8.2	7.3	5.6
Part 2:	Cordage	5.1	2.4	13.4	8.2
Part 3:					
A.	Woven fabrics, of cotton	11.5	11.4	6.7	4.9
B.	Woven fabrics, of vegetable fibers (except cotton)	1.0	1.3	21.9	20.5
C.	Woven fabrics, of wool	43.3	36.7	5.2	3.7
D.	Woven fabrics, of silk	12.3	7.0	3.8	4.1
E.	Woven fabrics, of manmade fibers	25.3	22.8	6.0	5.4
F.	Woven fabrics, of other textile materials	8.5	4.7	10.7	2.4
Part 4:					
A.	Knit, pile, tufted, and narrow fabrics; braids, and elastic fabrics	24.3	18.8	7.2	6.0
B.	Lace, netting, and ornamented fabrics	24.7	25.8	7.6	5.9
C.	Wadding, felts, and articles thereof; fish netting andnets; artists' canvas; coated or filled fabrics; hose; machine clothing; other special fabrics	12.6	12.5	6.8	5.3
Part 5:					
A.	Textile floor coverings	13.6	8.5	8.3	6.1
B.	Bedding	20.0	16.3	10.1	7.0
C.	Tapestries, linens, and other furnishings	17.0	14.8	9.8	7.2

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 3.--Continued				
Part 6:					
A.	Handkerchiefs	18.9	15.7	4.4	3.6
B.	Mufflers, scarves, shawls, and veils; men's and boys' neckties	18.2	20.1	5.0	5.1
C.	Hosiery	23.9	23.3	10.5	6.3
D.	Garters and suspenders; body-supporting garments; rainwear	23.4	25.2	5.1	3.8
E.	Underwear	34.5	30.0	5.9	3.7
F.	Other wearing apparel	29.1	26.4	8.8	6.5
Part 7:					
A.	Miscellaneous textile products	15.4	14.6	8.4	7.7
B.	Textile articles not speciallyprovided for	20.1	10.6	7.8	7.7
C.	Rags and scrap cordage	4.0	2.7	19.2	8.1
	Schedule 4.				
Part 1:					
A.	Organic chemical crudes	.0	.0	5.8	6.3
B.	Industrial organic chemicals	16.4	13.5	4.1	4.7
C.	Finished organic chemical products	14.3	13.9	3.9	2.7
Part 2:					
A.	Chemical elements	.7	.4	4.2	2.1
B.	Inorganic acids	.7	.3	4.2	2.1
C.	Inorganic chemical compounds	.6	.8	4.9	4.6
D.	Organic chemical compounds	5.5	4.4	8.0	5.9
E.	Chemical mixtures	5.1	4.8	4.9	4.2
Part 3:					
A.	Natural drugs, crude or advanced	.2	.0	5.5	4.0
B.	Alkaloids, antibiotics barbiturates, hormones, vitamins, and other drugs and related products	3.7	3.5	2.7	2.6
C.	Other drugs	2.4	2.5	4.0	4.6
Part 4:					
A.	Synthetic resins and plastics materials	9.9	9.5	8.8	5.6
B.	Rubber	.5	.5	8.7	8.1

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 4.--Continued				
Part 5:					
A.	Flavoring extracts, and fruit flavors, essences, esters, and oils	5.2	5.4	3.4	4.4
B.	Essential oils	1.4	1.4	3.5	3.4
Part 6:	Glue, gelatin, and related products	5.3	4.8	6.8	6.1
Part 7:					
A.	Aromatic or odoriferous substances	7.0	6.4	3.3	3.0
B.	Perfumery, cosmetics, and toilet preparations	7.8	6.6	6.7	5.1
Part 8:					
A.	Surface-active agents	7.2	6.6	8.0	6.5
B.	Soap and synthetic detergents	5.1	3.7	8.3	8.2
Part 9:					
A.	Dyeing and tanning products	.4	.3	18.7	15.1
B.	Pigments and pigment-like materials	4.8	4.2	12.8	17.3
C.	Inks, paints, and related products	4.5	3.3	6.1	5.0
Part 10:	Petroleum, natural gas, and products derived therefrom	.7	.2	6.9	3.7
Part 11:	Fertilizers and fertilizer materials	.0	.0	3.4	4.8
Part 12:	Explosives	5.6	4.9	2.1	1.4
Part 13:					
A.	Fatty substances	6.0	5.4	11.9	9.6
B.	Camphor, chars and carbons, isotopes, waxes and other products	2.4	1.1	9.9	6.4
C.	Miscellaneous medical supplies	6.8	5.0	1.4	2.0
	Schedule 5.				
Part 1:					
A.	Hydraulic cement; concrete; concrete products	.8	.7	15.6	13.3
B.	Lime, gypsum, and plaster products	.3	.2	47.5	53.7
C.	Stone and stone products	5.2	4.7	29.6	19.7
D.	Mica and mica products	5.7	2.8	11.8	13.4

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 5.--Continued				
Part 1--Cont.					
E.	Graphite and related products	6.0	4.9	8.1	7.3
F.	Asbestos and asbestos products	.4	.3	2.7	3.0
G.	Abrasives and abrasive article	1.7	1.6	2.5	3.0
H.	Gems, gemstones, and articles thereof; industrial diamonds	2.2	.1	.5	.5
J.	Miscellaneous nonmetallic minerals and products	1.6	1.8	14.4	15.2
Part 2:					
A.	Refractory and heat-insulating articles	3.0	2.6	8.9	9.1
B.	Ceramic construction articles	18.9	20.1	15.3	15.6
C.	Table, kitchen, household art and ornamental pottery	15.2	13.5	11.8	9.0
D.	Industrial ceramics	11.1	8.5	4.9	4.6
E.	Ceramic articles not specially provided for	19.3	15.5	7.7	3.0
Part 3:					
A.	Glass in the mass; glass in balls, tubes, rods and certain other forms; foam glass; optical glass, and glass fibers and products thereof	11.0	8.8	7.6	4.6
B.	Flat glass and products thereof	7.0	4.6	10.9	8.5
C.	Glassware and other glass products	17.4	13.6	10.0	7.4
D.	Glass articles not specially provided for	11.5	9.4	8.2	5.7
	Schedule 6.				
Part 1:	Metal-bearing ores and other metal-bearing materials	.2	.1	15.6	14.0

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 6.--Continued				
Part 2:					
A.	Precious metals	.0	.0	.5	.5
B.	Iron or steel	6.0	5.4	9.4	8.0
C.	Copper	.8	1.3	3.8	3.7
D.	Aluminum	2.5	1.3	3.0	1.7
E.	Nickel	.2	.3	.6	1.2
F.	Tin	.0	.0	1.6	1.5
G.	Lead	5.0	2.3	3.7	1.7
H.	Zinc	2.0	1.9	2.6	3.1
J.	Beryllium, columbium, germanium, hafnium, indium, magnesium, molybdenum, rhenium, tantalum, titanium, tungsten, uranium, and zirconium	12.9	11.0	3.5	2.2
K.	Other base metals	2.0	1.8	2.5	2.0
Part 3:					
A.	Metallic containers	5.4	3.8	6.2	7.2
B.	Wire cordage; wire screen, netting and fencing; bale ties	5.5	5.2	7.5	6.8
C.	Metal leaf and foil; metallics	3.8	4.6	4.6	4.0
D.	Nails, screws, bolts, and other fasteners; locks; builders; hardware; furniture, luggage, and saddlery hardware	3.5	7.4	7.8	6.6
E.	Tools, cutlery, forks and spoons	9.3	7.8	5.5	4.0
F.	Miscellaneous metal products	3.3	2.0	6.2	3.8
G.	Metal products not specially provided for	7.0	5.4	6.6	5.4
Part 4:					
A.	Boilers, nonelectric motorsand engines, and other general-purpose machinery	3.2	2.7	2.6	2.7
B.	Elevators, winches, cranes, and related machinery; earth-moving and mining machinery	4.8	4.1	5.2	3.5

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 6.--Continued				
Part 4--Cont.					
C.	Agricultural and horticultural machinery; bookbinding machinery; printing machinery	.5	.8	1.9	2.2
D.	Pulp and paper machinery; bookbinding machinery; printing machinery	5.8	4.7	3.8	3.3
E.	Textile machines; laundry and dry-cleaning machines;sewing machines	7.3	5.7	3.9	3.7
F.	Machines for working metal, stone, and other materials	6.6	5.7	4.3	3.9
G.	Office machines	4.5	4.2	3.0	2.5
H.	Other machines	4.7	4.5	4.3	3.0
J.	Parts of machines	8.0	7.1	3.2	3.0
Part 5:	Electrical machinery and equipment	6.1	5.6	3.7	2.5
Part 6:					
A.	Rail locomotives and rolling stock	5.3	4.4	7.2	5.5
B.	Motor vehicles	1.8	3.5	4.4	4.5
C.	Aircraft and spacecraft	2.1	.2	1.0	.9
D.	Pleasure boats; floating structures	3.5	4.0	7.3	6.7
	Schedule 7.				
Part 1:					
A.	Footwear	10.6	12.2	8.7	6.4
B.	Headwear and hat braids	15.7	12.5	10.3	6.9
C.	Gloves	20.1	18.1	7.8	5.5
D.	Luggage; women's and children' handbags; and billfolds, card cases, coin purses, and similar flat goods	15.8	16.3	11.0	7.7
Part 2.					
A.	Optical elements, spectacles microscopes, and telescopes; optical goods not elsewhere provided for	13.4	9.4	3.9	3.3

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	D scription	Duty equivalents		Freight factors	
		1976	1981	1976	1981
		Percent			
	Schedule 7.--Continued				
Part 2--Cont.					
B.	Medical and surgical instruments and apparatus; X-ray apparatus	7.0	6.6	2.8	2.5
C.	Surveying, navigational, meteorological, drawing, and mathematical calculatinginstruments; measuring andchecking instruments notspecially provided for	9.0	7.0	3.9	3.2
D.	Measuring, testing, and controlling instruments	8.0	6.3	2.9	2.0
E.	Watches, clocks, and timing apparatus	12.4	4.1	2.8	2.3
F.	Photographic equipment and supplies	6.3	5.5	3.1	2.4
G.	Motion pictures; tape recordings, phonograph records,and other recordings; recording media; scrap andwaste photographic film	5.0	4.6	4.0	2.8
Part 3:					
A.	Musical instruments	10.1	7.2	8.5	6.3
B.	Musical instrument parts and accessories	8.5	6.5	4.4	3.6
Part 4:					
A.	Furniture, pillows, cushions,and mattresses	4.1	3.8	10.0	9.4
B.	Nontextile floor coverings	7.0	4.9	9.9	6.7
Part 5:					
A.	Arms and ammunition	6.6	6.5	2.5	2.2
B.	Fishing tackle	10.7	9.4	5.6	3.6
C.	Wheel goods	9.5	7.1	11.6	7.0
D.	Games and sporting goods	6.3	4.8	8.2	5.8
E.	Models; dolls, toys, tricks,party favors	13.2	9.7	13.7	9.6
Part 6:					
A.	Jewelry and related articles	11.6	9.8	3.8	2.1

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents 1976	Duty equivalents 1981	Freight factors 1976	Freight factors 1981
		Percent			
	Schedule 7.--Continued				
Part 6--Cont.					
B.	Cameos; natural, cultured, and imitation pearls; imitation gemstones; beads and articles of beads	4.9	3.2	5.6	1.6
Part 7:					
A.	Buttons, buckles, pins, hooks and eyes, and slide fasteners	15.0	10.4	7.3	6.3
B.	Artificial and preserved flowers and foliage; millinery ornaments; trimmings; and feather products	8.3	4.4	9.4	6.3
Part 8:					
A.	Combs, hair ornaments, brooms and brushes, paint rollers	7.4	4.0	8.9	8.7
B.	Umbrellas, walking sticks, whips, riding crops, and parts thereof	15.7	10.7	7.1	6.2
Part 9:					
A.	Matches, pyrotechnics, candles, blasting caps	10.7	8.2	15.9	11.0
B.	Cigar and cigarette lighters and holders; tobacco pipes	19.2	13.3	5.1	4.2
Part 10:	Pens, pencils, leads, crayons, and chalks	16.2	12.3	5.0	4.0
Part 11:					
A.	Works of art	.0	.0	1.5	.9
B.	Antiques	.0	.0	4.3	2.8
Part 12:					
A.	Reinforced or laminated plastics; foam or sponge rubber and plastics	9.9	6.4	6.8	5.5
B.	Rubber and plastics waste and scrap; rubber and plastics film, strips, sheets, plates, slabs, blocks, filaments, rods, tubing and other profile shapes	5.4	4.5	8.3	6.6

Table A-1.--Freight factors and ad valorem duty equivalents for TSUSA subparts, 1976 and 1981--Continued

Part	Description	Duty equivalents		Freight factors	
		1976	1981	1976	1981
		Percent			
	Schedule 7.--Continued				
Part 12--Cont.					
C.	Specified rubber and plastics products	6.0	4.1	7.8	6.6
D.	Articles not specially provided for, of rubber or plastics	7.0	5.7	11.8	7.3
Part 13.					
A.	Miscellaneous products	7.1	5.2	9.3	6.7
B.	Articles of fur and of leather	3.7	4.1	5.6	4.4
C.	Articles of gelatin, glue, gut, wax, bone, hair, horn, hoof, whalebone, quill, shell, ivory, or sponge	6.7	3.8	12.4	7.1
D.	Waste and scrap	.0	.0	3.0	3.4
Part 14:	Nonenumerated products	5.5	4.2	6.3	4.8

Appendix B

Analyzing Changes in the Overall Freight Factor

Real transportation costs for U.S. imports fell sharply from 1976 to 1981. The ratio of transportation costs to the f.a.s. value of U.S. imports, the freight factor, fell from 6.2 percent in 1976 to 4.5 percent in 1981. This fall could have been caused by a decline in the rates charged for transportation, a change in the commodity composition of imports, an increase in the share of imports coming from nearer trading partners, and an increase in the importance of cheaper modes of transport. The data indicate, however, that most of the fall in the overall freight factor was due to declining transportation rates. Changes in the mix of products, of countries, and of transport modes together had little effect on the overall freight factor, and this effect could have been positive or negative. Changes in transportation rates reduced the freight factor between 25.8 percent and 29.2 percent. Changes in other factors reduced the freight factor between -3.1 percent and 1.6 percent.

Determining the effects of changes in rates

One measure of the change in the freight factor caused solely by changes in transportation rates is the difference between the freight factor for 1976 and the constant weight freight factor for 1981. The constant weight freight factor for 1981 is the freight factor that would have existed if the United States had imported the same products from the same countries using the same modes in 1981 as it did in 1976. Therefore, the difference between these freight factors is due solely to changes in transportation costs. In equation form, this difference is

$$CTC1 = FF76 - CFF81 = \sum_i \sum_i \sum_k W'_{ijk} F_{ijk} - \sum \sum \sum W'_{ijk} F_{ijk} \quad (1)$$

where CTC1 is the change in transport rates FF76 is the freight factor for 1976

CFF81 is the constant weight freight factor for 1981, Where

F_{ijk} is the freight factor for commodity i from country j on mode k in 1981, F'_{ijk} is the freight factor for product i from country j on mode k in 1976, and

W'_{ijk} is the share of product i from country j on mode k of total U.S. imports in 1976.

Another measure of the effects of the change in transportation rates is given by the equation

$$CTC2 = CFF76 - FF81 = \sum_i \sum_j \sum_k W'_{ijk} F'_{ijk} - \sum_i \sum_j \sum_k W_{ijk} F'_{ijk} \quad (2)$$

Where CTC2 is the change in transport rates, CFF76 is the constant weight freight factor for 1976, FF81 is the freight factor for 1981, and W_{ijk} is the share of product i from country j on mode k of total U.S. imports in 1981.

The constant weight freight factor for 1976 is the freight factor that would have existed if the United States had imported the same products from the same countries using the same modes in 1976 as it did in 1981. Therefore, CTC2 also measures the change in the freight factor caused solely by changes in transportation costs.

Both CTC1 and CTC2 are weighted averages of the changes in specific freight factors. CTC1 uses 1976 weights, and CTC2 uses 1981 weights. Because CTC1 generally will not equal CTC2, the measure of the change in transportation cost is ambiguous. 1/

The conflict between measures of price change based on weights from different years is a common problem in measuring price changes over time. The difficulty arises because purchasers change the composition of goods they buy as prices change. A price index based on a single year's weights cannot show the benefits or costs of these changes in purchaser behavior. Therefore, no

1/ CTC1 and CTC2 would be equal if the relative importance of products, countries, and modes did not change between 1976 and 1981, or if the change in the specific freight factor is the same for every i, j, and k.

price index perfectly reflects the full effect of price changes. Allen shows, however, that a price index that does perfectly reflect these effects generally will lie between the index based on weights from the end of the period and the index based on weights from the beginning of the period. 1/ This study, therefore, presents data based on weights from both years.

The values of CTC1 and CTC2 were calculated using data on all U.S. imports. Comparing CTC1 and CTC2 is easier if each is expressed as a percent of the corresponding estimated freight factor for 1976. Using weights from 1976, the freight factor for U.S. imports declined by 25.8 percent. Using weights from 1981, the freight factor for U.S. imports declined by 29.2 percent.

These estimates indicate that changes in the relative cost of transportation caused almost all of the changes in the freight factor. From 1976 to 1981, the freight factor fell by 27.4 percent. Estimates based on 1976 weights indicate that changes in transportation costs caused 94 percent of this decline. Estimates based on 1981 weights indicate that changes in transportation costs caused 112 percent of this decline.

Decomposing the residual change

The change in the freight factor that is not caused by changes in transportation cost can be broken down into three components: changes in product mix, changes in source, and changes in mode. The effect of each of these three factors can be separately estimated. Changes in the products imported reduced the freight factor by from 0 to 4.8 percent. Changes in the

1/ R. G. D. Allen, Index Numbers in Theory and Practice, Chicago, Aldine Publishing Co., 1975, pp. 65-75.

countries imported from reduced the freight factor by from -3.2 percent to 1.6 percent. Changes in modes used increased the freight factor by from 0 to 4.7 percent.

Let P be the effect of product changes on the freight factor, C, the effect of changes in source, M, the effect of changes in mode, and R, the effect of changes in relative transportation costs. The total change in the freight factor, T, is

$$T = FF76 - FF81 = P+C+M+R \qquad (3)$$

The change in the freight factor due to all changes other than product mix can be found as

$$M+C+R = FF76 - \overleftarrow{Z}\, W'_t \; F_i$$

Where W'_i is the share of product i in U.S. imports in 1976 F_i is the freight factor for product i in 1981.

The expression $\overleftarrow{Z}\, W'_i\, F_i$ is the freight factor that would have been seen in 1981 if the commodity composition of imports did not change between 1976 and 1981 but mode, sources, and transportation costs did change.

From equation 8

$$P = T - (M+C+R)$$

$$\text{So } P = (FF76-FF81) - (FF76 - \overleftarrow{Z}_i\, W'_i\, F_i)$$

$$P = \overleftarrow{Z} = W_i F_i - FF81$$

A similar method will find C

$$M+R = \quad FF76 - \overleftarrow{Z}\,\overleftarrow{Z}\, W'_{ij}\; F_{ij}$$

The expression $\overleftarrow{Z}\,\overleftarrow{Z}\, W'_{ij}\; F_{ij}$ is the freight factor that would have been seen in 1981 if the commodity composition and sources of imports were the same as in 1976 but transport modes and transportation costs changes.

$$C = T - (M+R) - P$$

From equations 10 and 11

$$C = FF76 - FF81 - [FF76 - \Sigma\,\Sigma\, W_{ij}F_{ij}]$$

$$- [\Sigma\, W'_i\, F_i - FF81]$$

$$C = \Sigma\,\Sigma\, W'_{ij}F_{ij} - \Sigma\, W'_i\, F_i$$

Finally, to find the effect of changes in mode

$$M = T - R - P - C$$

$$M = FF76 - FF81 - (FF76 - \Sigma\,\Sigma\,\Sigma\, W'_{ijk}\, F_{ijk})$$

$$- (\Sigma\, W_iF_i - FF81)$$

$$- (\Sigma\,\Sigma\, W_{ij}F_{ij} - \Sigma\, W_iF_i)$$

$$M = \Sigma\,\Sigma\,\Sigma\, W'_{ijk}\, F_{ijk} - \Sigma\,\Sigma\, W_{ij}F_{ij}$$

The order in which the three effects were separated out was arbitrary. Furthermore, this order does affect the estimates of the different effects. Suppose instead of first separating out P, then C, then M, one were to separate out M, then C, then P.

$$M = T - (P+C+R)$$

$$P+C+R = FF76 - \Sigma\, W'_k\, F_k$$

So

$$M = \Sigma\, W'_kF_k - FF81 \qquad (7)$$

$$C = T - (P+R) - M$$

$$P+R = FF76 - \Sigma\,\Sigma\, W'_{kj}F_{kj}$$

$$C = FF76 - FF81 = [FF76 - \Sigma\,\Sigma\, W'_{kj}F_{kj}]$$

$$- [\Sigma\, W'_k\, F_k - FF81]$$

$$C = \Sigma\,\Sigma\, W'_{kj}\, F_{kj} - \Sigma\, W'_kF_k \qquad (8)$$

$$P = T - R - C - M$$

$$P = FF76 - FF81 = (FF76 - \Sigma\,\Sigma\,\Sigma\, W'_{ikj}F_{ikj}]$$

$$- (\Sigma\, W_iF_i - FF81)$$

$$- (\Sigma\,\Sigma\, W_{ij}F_{ij} - \Sigma\, W_iF_i)$$

$$P = \Sigma\,\Sigma\,\Sigma\, W'_{ikj}\, F_{ikj} - \Sigma\,\Sigma\, W'_{ij}F_{ij} \qquad (9)$$

Comparing equations 4, 5, and 6 to equations 7, 8, and 9 show that estimates of the three separate effects will depend on the order these effects are considered. Furthermore, there is no theoretical reason to prefer one set of estimates to another. Therefore, the measurements of these effects are ambiguous.

Table B-1.--Alternative formulas for determining product, country, and mode effects by order of considering each effect, 1976 weights

Order	Effect		
	Product	Country	Mode
Product-country-mode---	$\Sigma W'_i F_i - FF81$	$\Sigma \Sigma W'_{ij} F_{ij} - \Sigma W'_i F_i$	$CFF81 - \Sigma \Sigma W'_{ij} F_{ij}$
Product-mode-country---	$\Sigma W'_i F_i - FF81$	$CFF81 - \Sigma \Sigma W'_{ik} F$	$\Sigma \Sigma W'_{ik} F_{ik} - \Sigma W'_i F_i$
Country-product-mode---	$\Sigma \Sigma W_{ij} F_{ij} - \Sigma W_j F_j$	$\Sigma W'_j F_j - FF81$	$CFF81 - \Sigma \Sigma W'_{ij} F_{ij}$
Country-mode-product---	$CFF81 - \Sigma \Sigma W'_{jk} F_{jk}$	$\Sigma W'_j F_j - FF81$	$\Sigma \Sigma W'_{jk} F_{jk} - \Sigma W'_j F_j$
Mode-country-product---	$CFF81 - \Sigma \Sigma W'_{jk} F_{jk}$	$\Sigma \Sigma W'_{jk} F_{jk} - \Sigma W'_k F_k$	$\Sigma W'_k F_k - FF81$
Mode-product-country---	$\Sigma \Sigma W_{ik} F_{ik} - \Sigma W_k F_k$	$CFF8_j1_j - \Sigma \Sigma W'_{ik} F_{ik}$	$\Sigma W'_k F_k - FF81$

The derivation of separate product, source, and mode effects can be done six different ways, because these effects can be ordered in six different ways. The formulas derived from these six different methods are shown in table B-1. Each of these formulas will be used to estimate these effects. 1/ These estimates are in table B-2 and B-3.

1/ This ambiguity is very similar to problems encountered in the constant market share analysis of export growth. See E. Leamer and R. Stern, Quantitative International Economics, Boston Mass., Allyn and Bacon Inc., 1970, Ch. 7, and J. D. Richardson, "Constant-Market-Shares Analysis of Export Growth," Journal of International Economics, vol. 1, 1971, pp. 227-239.

Table B-2.--Estimates of the decline in the freight factor due to product, country, and mode effects, by order of formular derivation, 1976 weights

(Percentage points)

Order	Effect		
	Product	Country	Mode
Product-country-mode	.3	-.2	0
Product-mode-country	.3	0	-.2
Country-product-mode	.1	0	0
Country-mode-product	.1	0	0
Mode-country-product	.1	.1	-.1
Mode-product-country	.2	0	-.1

Source: Estimated by the staff of the U.S. International Trade Commission.

Table B-3.--Estimates of the decline in the freight factor due to product, country, and mode effects, as a percent of the 1976 freight factor, by order of formula derivation, 1976 weights

Order	Effect		
	Product	Country	Mode
Product-country-mode	4.8	-3.2	0
Product-mode-country	4.8	0	-3.2
Country-product-mode	1.6	0	0
Country-mode-product	1.6	0	0
Mode-country-product	1.6	1.6	-1.6
Mode-product-country	3.2	0	-1.6

Source: Estimated by the staff of the U.S. International Trade Commission.

These estimates indicate that changes in the products imported reduced the freight factor by from 1.6 percent to 4.8 percent. Changes in the sources of imports reduced the freight factor by from -3.2 percent to 1.6 percent. Changes in the modes used increased the freight factor by from 0 to 3.2 percent.

The preceeding estimates of product, country, and mode effects are based on 1976 weights. Alternative estimates can be developed using 1981 weights. Formulas for these estimates are shown in table B-4. The estimates themselves are shown in table A-5. These estimates are expressed as shares of the constant weight freight factor for 1976 in table B-6.

Table B-4.—Alternative formulas for determining product, country, and mode effects, by order of considering each effect, 1981 weights

Order	Effect		
	Product	Country	Mode
Product-country-mode----	$FF76 - \overleftarrow{Z}_i W_i F'_i$	$\overleftarrow{Z} W'_i F_i - \overleftarrow{Z}\,\overleftarrow{Z} W'_{ij} F'_{ij}$	$\overleftarrow{Z}\,\overleftarrow{Z} W_{ij} F_{ij} - CFF76$
Product-mode-country----	$FF76 - \overleftarrow{Z} W_i F'_i$	$\overleftarrow{Z}\,\overleftarrow{Z} W_{ik} F'_{ik} - CFF76$	$\overleftarrow{Z} W'_i F'_i - \overleftarrow{Z}\,\overleftarrow{Z} W'_{ik} F'_{ik}$
Country-product-mode----	$\overleftarrow{Z} W_j F'_j - \overleftarrow{Z}\,\overleftarrow{Z} W_{ij} F'_{ij}$	$FF76 - \overleftarrow{Z} W'_j F'_j$	$\overleftarrow{Z}\,\overleftarrow{Z}_i W_{ji} F'_{jij}$ CFF76
Country-mode-product----	$\overleftarrow{Z}\,\overleftarrow{Z} W_{jk} F'_{jk} - CFF76$	$FF76 - \overleftarrow{Z} W_j F'_j$	$\overleftarrow{Z} W'_j F'_j - \overleftarrow{Z}\,\overleftarrow{Z} W_{jk} F'_{jk}$
Mode-country-product----	$\overleftarrow{Z}\,\overleftarrow{Z} W_{jk} F'_{jk} - CFF76$	$\overleftarrow{Z} W'_k F'_k - \overleftarrow{Z}\,\overleftarrow{Z} W_{jk} F'_{jk}$	$FF76_j - \overleftarrow{Z}_j W_k F'_k$
Mode-product-country----	$\overleftarrow{Z} W_k F'_k - \overleftarrow{Z}\,\overleftarrow{Z} W_{ik} F'$	$\overleftarrow{Z}\,\overleftarrow{Z} W_{ik} F'_{ik} - CFF76$	$FF76 - \overleftarrow{Z} W_k F'_k$

Table B-5.—Estimates of the decline in the freight factor due to product, country, and mode effects, by order of formula derivation, 1981 weights

(Percent of import's value)

Order	Effect		
	Product	Country	Mode
Product-country-mode----------------	0	-.2	0
Product-mode-country----------------	0	-.1	-.1
Country-product-mode----------------	0	-.2	0
Country-mode-product----------------	0	-.2	0
Mode-country-product----------------	0	.1	-.3
Mode-product-country----------------	.2	-.1	-.3

Source: Estimated by the staff of the U.S. International Trade Commission.

Table B-6.--Estimates of the product, country, and mode effects, as a percent of the total decline in the constant weight, 1976 freight factors, by order of formula derivation, 1981 weights

(In percent)

Order	Effect		
	Product	Country	Mode
Product-country-mode	0	-3.1	0
Product-mode-country	0	-1.6	-1.6
Country-product-mode	0	-3.1	0
Country-mode-product	0	-3.1	0
Mode-country-product	0	1.6	-4.7
Mode-product-country	3.1	-1.6	-4.7

Source: Estimated by the staff of the U.S. International Trade Commission.

These estimates indicate that changes in the products imported reduced the freight factor between 0 and 3.1 percent. Changes in the sources of imports reduced the freight factor between -3.1 percent and 1.6 percent. Changes in the modes used increased the freight factor between 1.6 percent and 4.7 percent.

Appendix C

The Effect of Domestic Transportation Costs on Import Competition

A decline in domestic transportation costs may increase the competitiveness of either domestic producers or importers depending on which one uses more domestic transportation. The relative distance shipped by importers and foreign producers will depend in large part on the relationship between the importer's cost at the port of entry and the domestic producer's cost at the plant. How relative costs influence the effect of changes in domestic transportation costs on import competitiveness can be shown using a simple model of spatial competition.

Suppose an importer's unit cost at the port of entry is C_F. This cost includes both international transportation costs and production costs. All domestic production takes place in one location at a per unit production cost of C_H and all purchasers of the product are on a line between the domestic producers and the importers' port of entry. The distance from the domestic producers to the port of entry is D_T. The importers' and domestic producers' products are identical, so all purchasers buy the product with the lowest delivered price. For a purchaser at distance D from the domestic producers, the importers' delivered price is $C_F + t\,(D_T - D)$ (1)
the domestic producers' delivered cost is $C_H + tD$ (2)
where t is the cost of transporting the good one unit of distance within the United States.

If both imports and domestic output are sold, the domestic producers and importers will have the same delivered cost for purchasers at some distance D* from the domestic producer's location. From equations (1) and (2) we have

$$D^* = (C_F - C_H + tD_T)/_{2t} \qquad (3)$$

The domestic producers will sell to any purchaser closer to them than D*, and importers will sell to all other purchasers.

To determine how changes in t affect D*, first rearrange equation 3.

$$D^* = (C_F - C_H)/_{2t} + D_T/_2 \qquad (4)$$

Differentiating equation 4 with respect to t.

$$\frac{dD^*}{dt} = \frac{-(C_F - C_H)}{2t^2} \qquad (5)$$

A decrease in domestic transportation costs will increase the domestic producers' market share if it increases D*. Therefore, a decrease in t will increase the domestic market share if

$$\frac{dD^*}{dt} < 0 \text{ or } C_H < C_F \qquad (6)$$

Thus, if the per unit production cost of the U.S. producers is lower than the importers' delivered cost at the port of entry, a decrease in domestic transportation costs will increase the domestic producers' market share. If the domestic producers' production cost is higher than the importers' delivered cost at the port of entry, a decrease in transportation costs will decrease the domestic producers' market share.

To focus on the influence of relative efficiency on the way domestic transportation costs affect import competitiveness, this model has assumed imports and the domestic product are perfect substitutes. If they are not perfect substitutes, the effect of a fall in domestic transportation costs will also depend on their relative elasticities of demand. The more sensitive sales of a product are to changes in its price the more those sales will increase when domestic transportation costs fall. For example, if the domestic product is more price elastic than the import, then the decline in delivered prices caused by the decline in transportation costs will have a greater effect on domestic producer sales than on importer sales.

So far this appendix has only considered the direct effect of changes in domestic transportation costs on the costs of domestic producers and importers. Domestic transportation costs, however, also may have an indirect effect on domestic producers' costs, because the cost of transporting their imports will fall. This indirect effect may be large enough to outweigh the direct effect, so that declining domestic transportation costs increase domestic producers' competitiveness with imports even if the importers' costs at the port of entry are lower than the domestic producers' costs at the plant.

Appendix D

The Effects of Changes in Energy Costs on the Cost of Different Transportation Modes

This appendix presents a simple formula to measure the effect of changes in fuel prices on the rate charged for transportation and discusses the data the formula uses. Changes in fuel prices since 1973 affected airfreight costs significantly, but they affected ocean-shipping costs by much less than they affected air, rail, or truck freight costs.

The effect of energy prices on cost and price

For an industry in long-run-competitive equilibrium, price will equal long-run-marginal cost.

$$p = C'(y, e, q) \qquad (1)$$

Where long-run-marginal cost, C', is a function of the vector of outputs produced by the industry, y, the price of energy, e, and a vector of prices of other inputs, q. Assume that the cost function is multiplicatively separable.

$$C'(y,e,q) = K'(y)\ c(q, e) \qquad (2)$$

The percentage change in C' caused by a percentage change in e is

$$\frac{e}{c'}\frac{\partial C'}{\partial e} = \frac{eK'}{K'c}\frac{\partial c}{\partial e} = \frac{e}{c}\frac{\partial c}{\partial e} \qquad (3)$$

Now by Shepard's lemma 1/

$$X = K\ \frac{\partial c}{\partial e}$$

where X is the total amount of energy consumed by the industry. Substituting

$$\frac{e}{p}\frac{p}{e} = \frac{e}{C'}\frac{C'}{e} = \frac{eX}{C} \qquad (4)$$

Equation 4 shows that the ratio of the percentage change in the price charged for transportation to the percentage change in the price of its fuel is equal to the ratio of energy costs to total costs, the energy cost ratio.

This formula strictly applies only to small changes in energy prices, because for large changes, the energy cost ratio itself will change. Because fuel prices made very large increases during the period considered, this formula provides only an approximation. The best approximation would be

1/ R. W. Shephard, Cost and Production Functions, Princeton, 1953.

gotten by multiplying the energy cost ratio for each year by the change in fuel prices for that year. However, energy cost ratios are not available for every year. Therefore, ratios from 1977, the midpoint of the period, will be used. 1/

Another problem with using equation 4 is that it refers to the long-run-cost function, and in any given year an industry may not be on its long-run cost function. This problem does not affect the data on ocean shipping, because these data are from an engineering study of the long-run-cost function. This problem, however, does affect the data for rail, truck, and air transport, because these data are based on the actual costs of each mode. Data from a year in which an industry experienced an unusual volume of traffic or a large increase in energy prices might not represent the structure of its long-run costs. Data from 1977, however, probably approximate long-run costs reasonably well, because transport modes had time to adjust to the large jump in energy prices between 1973 and 1974. Furthermore, air, truck, and rail carriers did not experience a particularly high or low volume of traffic in 1977.

Transportation industries often set prices collusively and are regulated by governments, so they may never be in competitive equilibrium. Equation 4, however, holds even if the industry is not competitive, if the industry sets prices equal to a constant multiple of long-run-marginal cost. A noncompetitive industry is likely to behave in this fashion if the demand for its services is of constant elasticity.

1/ For ocean shipping only 1978 data were available.

Energy cost ratios of particular modes

Maritime.--The energy cost ratio in ocean shipping depends on the type of ship used and the route serviced. Energy cost ratios for containerships on three major routes are shown in percent as follows. In 1978, 63 percent of U.S. international marine container traffic traveled on one of these routes. 1/

Route	Energy Cost Ratio 1/ U.S. carriers	Other
U.S. North Atlantic - United Kingdom and Continent	9	4
U.S. Atlantic - Far East	14	12
U.S. Pacific - Far East	9	5
Weighted Average 2/	10	6

1/ Ratios for each route are from Binkley, John A. et al., Fleet Management Technology Performance Evalutation, report done by Simat, Helleisen, and Eichner for the Maritime Administration, Washington D.C., 1979.

2/ This average shown is found by weighting each route's energy cost ratio by that route's share of traffic on all 3 routes.

U.S. carriers have higher energy cost ratios because U.S. flag ships usually are steam powered whereas foreign ships usually are diesel powered. U.S. flag vessels carry 22 percent of the containerized traffic on these routes. The total weighted average energy cost ratio for all vessels is 7 percent.

Air.--Energy cost ratios for air depend on the type of aircraft used and the route flown. Energy cost ratios for several different aircraft types for major U.S. airlines are shown as follows: 2/

1/ Data on traffic on these routes are from U.S. Department of Commerce, Maritime Administration, "Containerized Cargo Statistics 1979," Washington D.C., 1981.

2/ These ratios are based on data in Civil Aeronautics Board, Aircraft Operating Cost and Performance Report 1977, Washington D.C., 1978.

Route	Number of engines	Airframe	
		wide-bodied	regular-bodied
Domestic	4	42	40
	3	37	40
International	4	44	40
	3	36	42

The energy cost ratios are for combination planes, those carrying both passengers and freight. These ratios are used because most freight is carried on combination planes. 1/ Data for planes that carry only freight indicate that the energy cost ratios for all freight service are approximately the same as for combination service.

The weighted average energy cost ratio is 40 percent for domestic routes and 41 percent for international routes. 2/

Truck and Rail.--The energy cost ratio for tractor trailer trucks is 31 percent. The energy cost ratio for U.S. railroad freight service is 9 percent. 3/

Fuel price changes by mode

Different transport modes use different fuels and the prices of these fuels have increased at different rates. The behavior of the prices of these fuels is shown in table D-1.

1/ In 1981, 71 percent of all freight carried by IATA members was carried in combination aircraft.

2/ The relative revenue ton-miles of each aircraft type are used as the weights. Data on revenue ton-miles are from Civil Aeronautics Board, Aircraft Operating Cost and Performance Report 1977, Washington, D.C., 1978.

3/ These ratios both are for U.S. carriers and are based on data from 1977. G. Kulp et al. Transportation Energy Conservation Data Book, ed. 4, Oak Ridge National Labratory, 1980.

Table D-1.--Fuels prices: Indexes of fuel prices for various transport modes, 1973-81

Period	Mode			
	Railroads	Air 1/	Truck 2/	Containership 3/
1973	100	100	100	100
1974	199	172	196	255
1975	236	224	221	260
1976	257	246	241	237
1977	285	282	272	274
1978	298	312	281	262
1979	444	423	404	360
1980	666	690	608	505
1981	804	824	743	651

1/ Index for kerosene based jet fuel.
2/ Index for diesel fuel.
3/ Index for residual fuel.

Source: Data on railroad fuel prices are from the Association of American Railroads. Other data are official statistics of the U.S. Department of Labor.

Bibliography

Allen, R. G. D. Index Numbers in Theory and Practice, Chicago, Aldine Publishing Co., 1975.

Barnard, Bruce, "Europeans Fear Tigers Move Will Spur New Air Rate War," Journal of Commerce, October 13, 1981, pp. 1A, 5A.

Binkley, John et al. Fleet Management Technology Performance Evaluation, report done by Simat, Helleisen, and Eichner for the U.S. Maritime Administration, Washington, D.C., 1979.

Binkley John and Harrer B. "Major Determinants of Ocean Freight Rates for Grain: An Econometric Analysis," American Journal of Agricultural Economics, vol. 63, February 1981, pp. 47-57.

Boyer, Kenneth D. "Equalizing Discrimination and Cartel Pricing in Transport Rate Regulation," Journal of Political Economy, vol. 89, April 1981, pp. 270-286.

Clark, D. P. "On the Relative Importance of International Transport Charges as a Barrier to Trade," Quarterly Review of Economics and Business, vol 21, pp. 127-135.

"Congress Passes Rail Deregulation Bill, Sends it to President Carter," Traffic World, Oct. 6, 1980, pp. 27-28, 128-140.

"Conrail Announces Sharp Cut in Marine Container Rates," Journal of Commerce, April 8, 1981, p. 1A.

Finger, M., and Yeats, A.J. "Effective Protection By Transportation Costs and Magnitudes," Quarterly Journal of Economics, vol. 90, February 1976, pp. 169-176.

Geraci, V. and Prewo, W. "Bilateral Trade Flows and Transport Costs," Review of Economics and Statistics, vol. 59, February 1977, pp. 67-74.

Guandolo, John "The Role of the Interstate Commerce Commission in the 1980's," American Economic Review, vol. 71, May 1981, pp. 116-121.

International Air Transport Association, World Air Transport Statistics 1979 and 1981, 1980 and 1982.

Kulp, G. et al. Transportation Energy Conservation Data Book, ed. 4, Oak Ridge National Labratory, 1980.

Leamer, E. and Stern, R. Quantitative International Economics, Boston, Mass., Allyn and Bacon Inc., 1970.

Levin, R.C. "Railroad Rates, Profitability, and Welfare Under Deregulation," The Bell Journal of Economics, vol. 12, spring 1981, pp. 1-26.

Lipsey, R. and Weiss, L. "The Structure of Ocean Transport Charges," Explorations in Economic Research, vol. 1, summer 1974, pp. 162-193.

Moneta, C. "The Estimation of Transportation Costs in International Trade," Journal of Political Economy, vol. 67, February 1959, pp. 41-58.

Moore, T. G. "The Beneficiaries of Trucking Regulation," The Journal of Law and Economics, vol. 21, October 1978, pp. 327-344.

OECD, "Maritime Transport," Paris, various issues.

OECD, "Ocean Freight Rates as a Part of Total Transport Costs," Paris, 1968.

Richardson, J. D. "Constant-Market-Shares Analysis of Export Growth," Journal of International Economics, vol. 1, 1971, pp. 227-239.

Ritz, Philip M. "The Input-Output Structure of the U.S. Economy," Survey of Current Business, vol. 59, February 1979, pp. 34-72.

Sampson, G. P. and Yeats, A. J. "Tariff and Transport Barriers Facing Australian Exports," Journal of Transport Economics and Policy, vol. 11, May 1977, pp. 141-154.

———. and ———. "The Incidence of Transport Costs on Exports from the United Kingdom," Journal of Transport Economics and Policy, vol. 12, May 1978, pp. 196-201.

———. "An Analysis of the Sources of Inter-Country Differences in International Transportation Costs," Economia Internazionale, vol. 31, August-November 1978, pp. 234-47.

Sanyal, K. K. and Jones, R. W. "The Theory of Trade in Middle Products," American Economic Review, vol. 72, March 1982, pp. 16-31.

Shephard, R. W., Cost and Production Functions, Princeton, 1953.

Shneerson, Dan. "The Structure of Liner Freight Rates," Journal of Transport Economics and Policy, vol. 10, January 1976, pp. 52-67.

Transportation Association of America, Transport Facts and Trends, Washington, D.C., 1980.

U.S. Bureau of the Census, "C.I.F. Calculations add 9 percent to Import Figures," Washington, D.C., Dec. 20, 1966.

U.S. Civil Aeronautics Board, Aircraft Operating Cost and Performance Report 1981, Washington, D.C. 1982.

U.S. Department of Commerce, "Domestic and International Transportation of U.S. Foreign Trade: 1976," Washington, D.C., 1979.

U.S. Department of Commerce, Highlights of Export and Import Trade, Washington, D.C., various issues.

U.S. Maritime Administration, Containerized Cargo Statistics, 1976, and 1981 Washington, D.C., 1979 and forthcoming.

U.S. Tariff Commission, "C.I.F. Value of U.S. Imports," Washington, D.C., 1967.

Waters, W. G., "Transport Costs, Tariffs, and the Pattern of Industrial Protection," American Economic Review, vol. 60, pp. 1013-1020.

Yeats, A. J. "Do International Transport Costs Increase With Fabrication? Some Empirical Evidence," Oxford Economic Papers, vol. 29, November 1977, pp. 458-471.

--------. "A Comparative Analysis of the Incidence of Tariffs and Transportation Costs on India's Exports," Journal of Development Studies, vol. 14, October 1977, pp. 97-107.

--------. Shipping and Development Policy, New York City, Praeger, 1981.