FDI, TRADE, AND PRICING IN A BERTRAND DIFFERENTIATED PRODUCTS MODEL

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Abstract

We develop a sector-specific modeling framework that quantifies the effects of foreign direct investment on trade, prices, and employment. We consider three different types of direct investment: a foreign acquisition of a domestic firm without a transfer of production technology, a foreign acquisition with a technology transfer, and a greenfield investment by a foreign firm to establish transplant production in the domestic market. After explaining the equations and data requirements of the model, we report a series of simulations that illustrate the sensitivity of estimated price, trade, and employment changes to the type of foreign direct investment, the initial market shares of market participants, and the levels of tariffs on imports.

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1 Introduction

Foreign direct investment (FDI) is not an anonymous international capital flow. It shifts ownership and alters market concentration. It often involves technology or knowledge transfers that can change a firm's costs of supplying the market.[1] In these ways, FDI can have significant effects on prices in a market, the volume of international trade, and employment. There are many different types of FDI – including a foreign acquisition of a domestic firm without a transfer of production technology, a foreign acquisition with a technology transfer, and a greenfield investment by a foreign firm to establish transplant production in the domestic market – and these types have different economic effects.

In this paper, we develop a sector-specific oligopoly model of horizontal FDI, trade, tariffs, pricing, and employment. The model provides a practical tool for quantifying these effects with a modest amount of sector-specific data. It does not try to predict whether there will be new FDI or what form it will take.[2] Instead, we estimate the impact of the new FDI, its effects rather than its causes.[3]

After explaining the equations and data requirements of the model in Section 2, we report a series of simulations that illustrate the sensitivity of estimated effects to model inputs in Section 3. Section 4 concludes.

[1] Markusen (1995) is a useful introduction to the economics of foreign direct investment and international trade.

[2] In contrast, Norbäck and Persson (2007), Tekin-Koru (2009), and Chakrabarti, Hsieh and Chang (2017) explicitly model the acquisition process and decisions about the magnitude of investment.

[3] An example of a cause of new FDI might be a reduction in foreign ownership restrictions. Tekin-Koru (2009) is an interesting theoretical analysis that is similar to the model in this paper, with an emphasis on technology transfers, oligopoly, international acquisitions, and market concentration. However, Tekin-Koru focuses on the determinants or causes of a firm's choice of entry mode rather than the consequences of this choice.

2 Modeling Framework

The sector-specific model has three firms supplying a market, two domestic producers (firms x and y) and one foreign producer (firm f). The demand for the products of the three firms has a constant elasticity of substitution (CES) structure with elasticity σ. Equation (1) is the sector's CES price index.

$$P = \left((p_x)^{1-\sigma} + b_y\ (p_y)^{1-\sigma} + b_f\ (p_f\ (1+t_f))^{1-\sigma}\right)^{\frac{1}{1-\sigma}} \tag{1}$$

In addition, there are Cobb-Douglas preferences between the products of different sectors, so the price elasticity of total sector demand is equal to -1. Equations (2), (3), and (4) are the consumer demands for the three products.

$$q_x = k\ (P)^{\sigma-1}\ (p_x)^{-\sigma} \tag{2}$$

$$q_y = k\ (P)^{\sigma-1}\ (p_y)^{-\sigma}\ b_y \tag{3}$$

$$q_f = k\ (P)^{\sigma-1}\ (p_f\ (1+t_f))^{-\sigma}\ b_f \tag{4}$$

The variable t_f is an ad valorem tariff on imports.[4] b_y and b_f are model parameters that are calibrated to capture preference symmetries and differences in the quality of the products. k is a demand parameter calibrated to the size of market.

There are constant marginal costs of production (m_x, m_y, and m_f) and fixed costs of production (c_x, c_y, and c_f). Equations (5), (6), and (7) are the profits of the three firms.

[4]Alternatively, it could represent a transport cost or any factor that increases the cost of delivering the foreign product to the domestic market.

$$\pi_x = (p_x \ - \ m_x) \ q_x \ - \ c_x \tag{5}$$

$$\pi_y = (p_y \ - \ m_y) \ q_y \ - \ c_y \tag{6}$$

$$\pi_f = (p_f \ - \ m_f) \ q_f \ - c_f \tag{7}$$

Equations (8), (9), and (10) are the first order conditions for the firms' profit-maximizing pricing.[5]

$$\frac{d\pi_x}{dp_x} = (p_x \ - \ m_x) \ \frac{dq_x}{dp_x} \ + q_x \ = \ 0 \tag{8}$$

$$\frac{d\pi_y}{dp_y} = (p_y \ - \ m_y) \ \frac{dq_y}{dp_y} \ + q_y \ = \ 0 \tag{9}$$

$$\frac{d\pi_f}{dp_f} = (p_f \ - \ m_f) \ \frac{dq_f}{dp_f} \ + q_f \ = \ 0 \tag{10}$$

The data requirements of the model are initial prices and market shares, as well as an estimate of the elasticity of substitution σ. The demand parameters (k, b_f, and b_y) are calibrated to the initial equilibrium using (1), (2), (3), and (4). The initial marginal costs of the three firms (m_x, m_y, and m_f) are calibrated to the initial equilibrium using the first order conditions in (8), (9), and (10).[6]

[5]The Appendix translates these first-order conditions into a system of linear equations in the prices.

[6]The specific formulas for both of these calibrations are listed in the Appendix.

3 Illustrative Simulations

We consider three groups of simulations that vary in the type of FDI: a foreign acquisition of a domestic firm without a transfer of production technology, a foreign acquisition with a technology transfer, and a greenfield investment by a foreign firm to establish transplant production in the domestic market. In all three cases, we assume that the firms continue to supply the three distinct varieties to the market, even if ownership changes due to a merge.[7]

The first group of simulations involves a merger of firms x and f with no technology transfer and no changes in the costs of production.[8] These simulations replace two of the first order conditions from the initial equilibrium to reflect joint profit-maximizing pricing in the new equilibrium after firm x acquires firm f.[9] Equations (8) and (9) are replaced by (11) and (12).

$$\frac{d\ (\pi_x + \pi_f)}{dp_x} = (p_x\ -\ m_x)\ \frac{dq_x}{dp_x}\ + q_x + \ (p_f\ -\ m_f)\ \frac{dq_f}{dp_x} =\ 0 \tag{11}$$

$$\frac{d\ (\pi_x + \pi_f)}{dp_f} = (p_f\ -\ m_f)\ \frac{dq_f}{dp_f}\ + q_f + \ (p_x\ -\ m_x)\ \frac{dq_x}{dp_f} =\ 0 \tag{12}$$

In this first group of simulations, the merger increases market concentration: firms x and f continue to sell distinct products, but they price less competitively when maximizing their joint profits after the merger.[10] Table 1 reports the simulated effects for three alternative sets of initial market shares. All prices rise in the simulations. There is an increase in the sector price index in all three simulations, and it is larger when f or x has the largest initial

[7] This is more likely if consumers view the products as highly differentiated.

[8] This merger, an acquisition of x by f, would be inbound FDI in the domestic economy. We assume that firm f continues to produce in the foreign country after the merger. This is more likely if there were significant investments in production capacity in the foreign country.

[9] The first condition for firm y in (9) remains the same, and marginal costs of production remain unchanged.

[10] The pricing decision for each of their products takes into account the effects on the demands for the other, jointly owned products.

market share. There is a decline in the quantity of imports in all three simulations, with the largest percentage change when the initial market share of imports is largest. Domestic employment declines in two of the three simulations. The largest percentage decline in domestic employment occurs when imports have the largest initial market share.

The second group of simulation is similar, again a merger of x and f, but now there is technology transfer that lowers m_x or m_f to the minimum of the initial marginal costs of the two firms, reflecting an assumption that they adopt the most efficient practices of the two, but there is no change in the location of production.[11] Again the model uses the first order conditions with joint profit-maximizing pricing, (11) and (12), but now m_x or m_f is reduced. In this second group of simulations, there is an increase in market concentration, with joint pricing of x and f after the merger, but also a reduction in the marginal costs of some production, and this mitigates the upward pressure on prices. Table 2 reports the simulated effects for the three alternative sets of initial market shares. The signs and magnitudes of the percentage changes in prices depend on the relative competitiveness of the firms, which is indicated in their initial market shares. When the initial market share of imports is relatively high, firm f is relatively competitive, and there is a significant reduction in the marginal costs of its merger partner, m_x. In these simulations, the sector price index increases, imports decline since the foreign firm loses its cost advantage, and domestic employment increases due to the expansion of firm x as its costs decline. When the initial market share of firm x is relatively high, firm x has a cost advantage, and m_f declines due to the technology transfer associated with the merger. Imports increase, domestic employment falls, and the sector price index rises. The increase in market concentration dominates the reduction in costs.

The third group of simulations focuses on greenfield FDI by firm f that transplants its production to the domestic economy. There is an increase in m_f if it is more costly to operate

[11] This case is more likely if there are significant investments in production capacity in the foreign country. Branstetter, Fisman and Foley (2006) provides evidence of technology transfers from parents to foreign affiliates, especially in markets with strong protection of intellectual property rights.

transplant production, but firm f's sales to the market are no longer subject to the tariff t_f. We assume that the increase in cost is less than the avoided tariff, resulting in a net reduction in firm f's delivered costs.[12] In these simulations, there is no merger, so the first order conditions revert back to (8), (9) and (10), but there is a change in marginal costs. In this group of simulations, there is no increase in market concentration, and there is no technology transfer. Table 3 reports the simulated effects for the three sets of initial market shares. In all of these simulations, imports are eliminated, though firm f continues to supply the domestic market through transplant production. Domestic employment increases, with the largest percentage change when imports have the largest initial market share. All prices decline in these simulations, because there is no increase in market concentration and there is a net reduction in the delivered costs of firm f.

Table 4 reports additional simulations that illustrate the sensitivity of the price and employment effects to the tariff rate on imports. Each column of Table 4 illustrates the sensitivity of the estimated price and employment effects to the magnitude of the tariff rate on imports. The effects within each column of the table illustrate the sensitivity to the type of FDI.[13] The effects within each row of the table, on the other hand, illustrates the sensitivity of the price and employment effects to the magnitude of tariff rate. A higher tariff rate does not change the signs of the price or employment effects, but it amplifies the effects in some cases and mitigates the the effects in other cases. When the FDI involves a merger with no technology transfer, a higher tariff rate amplifies the increase in the sector price index but mitigates the reduction in domestic employment. When the FDI involves a merger and technology transfer, a higher tariff rate mitigates the increase in the sector price index and amplifies the increase in domestic employment. Finally, when the FDI involves greenfield investments, a higher tariff rate amplifies the price reduction but mitigates the

[12] Otherwise, firm f would prefer to import.

[13] They repeat the estimates reported in Tables 1, 2, and 3.

increase in domestic employment.

4 Conclusions

The signs and magnitudes of the changes in prices, trade, and employment depend on the type of FDI, the initial expenditure shares of market participants, and the tariff rate on imports. There are no general conclusions about the economic effects of FDI; the effects need to be evaluated case-by-case using data for a specific sector and market and a structural model that fits the type of FDI at issue. The modeling framework in this paper, with its modest data requirements, provides a practical tool for this evaluation.

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Table 1: Simulations For A Merger without a Technology Transfer

Model Inputs			
Elasticity of Substitution	4	4	4
Price Elasticity of Total Industry Demand	-1	-1	-1
Initial Market Share of Domestic Firm X	25%	50%	25%
Initial Market Share of Domestic Firm Y	25%	25%	50%
Initial Market Share of Imports from Firm F	50%	25%	25%
Initial Tariff Rate on Imports	20%	20%	20%
Economic Impact			
Change in the Prices of Domestic Firm X	28.19%	15.44%	9.47%
Change in the Prices of Domestic Firm Y	4.72%	4.71%	4.38%
Change in the Prices of Imports from Firm F	20.47%	46.15%	13.70%
Change in the Industry Price Index	17.12%	17.10%	7.71%
Change in the Quantity of Imports	-23.70%	-64.81%	-25.24%
Change in Domestic Employment	-3.45%	4.79%	-0.83%

Table 2: Simulations For A Merger with a Cost-Reducing Technology Transfer

Model Inputs			
Elasticity of Substitution	4	4	4
Price Elasticity of Total Industry Demand	-1	-1	-1
Initial Market Share of Domestic Firm X	25%	50%	25%
Initial Market Share of Domestic Firm Y	25%	25%	50%
Initial Market Share of Imports from Firm F	50%	25%	25%
Initial Tariff Rate on Imports from Firm F	20%	20%	20%
Economic Impact			
Change in the Prices of Domestic Firm X	13.13%	14.60%	9.47%
Change in the Prices of Domestic Firm Y	3.41%	3.75%	4.38%
Change in the Prices of Imports from Firm F	18.89%	28.01%	13.70%
Change in the Industry Price Index	12.82%	13.99%	7.71%
Change in the Quantity of Imports	-28.12%	-44.85%	-25.24%
Change in Domestic Employment	6.65%	-0.16%	-0.83%

Table 3: Simulations For Greenfield Investment with a 10% Increase in Cost

Model Inputs			
Elasticity of Substitution	4	4	4
Price Elasticity of Total Industry Demand	-1	-1	-1
Initial Market Share of Domestic Firm X	25%	50%	25%
Initial Market Share of Domestic Firm Y	25%	25%	50%
Initial Market Share of Imports from Firm F	50%	25%	25%
Initial Tariff Rate on Imports	20%	20%	20%
Economic Impact			
Change in the Prices of Domestic Firm X	-0.73%	-1.49%	-0.64%
Change in the Prices of Domestic Firm Y	-0.73%	-0.64%	-1.49%
Change in the Prices of Imports from Firm F	-5.45%	-6.95%	-6.95%
Change in the Industry Price Index	-3.20%	-2.78%	-2.78%
Change in the Quantity of Imports	-100.00%	-100.00%	-100.00%
Change in Domestic Employment	87.95%	30.53%	30.53%

Table 4: Sensitivity of Price and Employment Effects to the Tariff Rate

Model Inputs			
Elasticity of Substitution	4	4	4
Price Elasticity of Total Industry Demand	-1	-1	-1
Initial Market Share of Domestic Firm X	25%	25%	25%
Initial Market Share of Domestic Firm Y	25%	25%	25%
Initial Market Share of Imports from Firm F	50%	50%	50%
Initial Tariff Rate on Imports	15%	20%	25%
Scenario with Merger but no Technology Transfer			
Change in the Industry Price Index	17.00%	17.12%	17.28%
Change in Domestic Employment	-5.00%	-3.45%	-1.93%
Scenario with Merger and Technology Transfer			
Change in the Industry Price Index	12.84%	12.82%	12.84%
Change in Domestic Employment	4.83%	6.65%	8.41%
Scenario with Greenfield Foreign Investment, No Merger			
Change in the Industry Price Index	-1.65%	-3.20%	-4.68%
Change in Domestic Employment	89.48%	87.95%	86.34%

APPENDIX

Equations (13), (14) and (15) calibrate the demand parameters of the model based on data for the initial market equilibrium.

$$k = q_x \ (P)^{1-\sigma} \ (p_x)^{\sigma} \tag{13}$$

$$b_y = q_y \frac{1}{k} \ (P)^{1-\sigma} \ (p_y)^{\sigma} \tag{14}$$

$$b_f = q_f \frac{1}{k} \ (P)^{1-\sigma} \ (p_f \ (1+t_f))^{\sigma} \tag{15}$$

Equations (16) and (17) are the own-price and cross-price elasticity of demand.

$$\epsilon_{jj} = \frac{dq_j}{dp_j} \ \frac{p_j}{q_j} = (\sigma - 1) \ s_j - \sigma \tag{16}$$

$$\epsilon_{kj} = \frac{dq_k}{dp_j} \ \frac{p_j}{q_k} = (\sigma - 1) \ s_j \tag{17}$$

These two equations imply equations (18) and (19).

$$\frac{dq_j}{dp_j} = ((\sigma - 1) \ s_j - \sigma) \ \frac{q_j}{p_j} \tag{18}$$

$$\frac{dq_k}{dp_j} = ((\sigma - 1) \ s_j) \ \frac{q_k}{p_j} \tag{19}$$

Substituting (18) into (8), (9), and (10) results in (20) as the first order condition without joint ownership of j and k, for $j \in \{x, y, f\}$.

$$p_j = (p_j \ - \ m_j) \ (\sigma \ - \ (\sigma - 1) \ s_j) \tag{20}$$

The variable s_j is the market share of product j. Substituting (18) and (19) into (11) and (12) results in (21) as the first order condition with joint ownership of j and k, for $j \in \{x, f\},\ k \neq j$.

$$p_j = (p_j - m_j)\ (\sigma - (\sigma - 1)\ s_j)\ - (p_k - m_k)\,(\sigma - 1)\ s_j \left(\frac{q_k}{q_j}\right) \tag{21}$$