FDI, Price Setting, and Tariff Changes in a Logit Model

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Abstract

In this paper, we present a partial equilibrium model of tariff changes where consumer demand is represented by a multinomial logit system of equations, firms maximize profits through Bertrand-style imperfect competition, and there is foreign ownership of some of the firms in the domestic market. Through a series of illustrative simulations, we show that the simulated economic impacts of a tariff shock are markedly different depending on firm ownership.

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1 Introduction

One of the most common ways to model consumer preferences over differentiated products in a trade policy simulation is with Constant Elasticity of Substitution (CES) utility, where there is a representative consumer with an aggregate utility function that reflects love-of-variety.[1] Another option used more frequently in an industrial organization setting is the multinomial logit model, where consumers choose one variety from a set of discrete choices.[2] Anderson, de Palma, and Thisse (1988) show the equivalence between the two models under certain restrictive assumptions and relate the logit parameters to the CES parameters.[3] While the models often produce similar predictions about changes in prices and trade, logit can offer a better descriptive fit for some industries with differentiated goods where consumers choose one brand and not a love-of-variety basket of goods (e.g., buying a car).

In this paper, we present a partial equilibrium model of tariff changes with consumer demand represented by a multinomial logit system of equations. Firms maximize profits through Bertrand-style imperfect competition, and there is foreign ownership of some of the firms in the domestic market. Through a series of illustrative simulations, we show that the simulated economic effects of a tariff shock are markedly different depending on firm ownership.

In section 2, we present the model with and without joint ownership of foreign and domestic firms. In section 3, we run illustrative simulations to show how the model behaves using different combinations of inputs. In section 4, we conclude.

[1] Dixit and Stiglitz (1977); Helpman and Krugman (1985).

[2] McFadden (1973).

[3] Also see Sheu (2014) for a nice comparison between nested CES and nested logit model formulations.

2 Model

We present three versions of the logit model of tariff changes: one standard three-source trade policy model without joint ownership, one with full joint ownership of two of the three sources of supply, and one where foreign parent firm m has partial ownership over domestic firm a.

2.1 No Joint Ownership

In this model, consumers can choose one of four discrete alternatives: buy from the domestic source d, from domestic source a, from the subject importer m, or choose the outside option o. Denote the decision to buy good i as $d_i \in \{0, 1\}$. Each consumer can choose only one variety or the outside option, implying that $d_d + d_a + d_m + d_o = 1$. The prices of varieties d, a, and m are p_d, p_a, and p_m. Then, using a multinomial logit formulation, the share of consumers who choose option i is:

$$s_i = \frac{e^{\alpha_i + \beta\ p_i}}{\sum_j e^{\alpha_j + \beta\ p_j}} \tag{1}$$

where α_i and β are the parameters of the demand system. β describes the price sensitivity of marginal utility with respect to the price of good i. In this model, β is a user-supplied parameter, and each α_i is calibrated to initial market data. The variable j indexes all of the choices, including the outside option.

This specification has a number of desirable properties. First, the calculated shares are necessarily between zero and one and the sum of the shares across the alternatives will be one. Second, a negative value for β implies that as the price of the variety increases, holding all other prices constant, the share of consumers who buy that variety decreases, consistent with a downward-sloping demand curve.

On the supply side of the market, firms operate under Bertrand-style imperfect competition. Firms maximize profits by choosing their price, taking other prices as given. Denote the marginal cost of production of firm i as c_i. Equation (2) is the profit function for firm i with fixed cost f_i.

$$\pi_i = (p_i - c_i)\ s_i\ -\ f_i \tag{2}$$

The first order condition for the price of firm i is:

$$0 = s_i + (p_i - c_i)\ \beta\ (1 + t_i)\ s_i\ (1 - s_i) \tag{3}$$

The tariff rate t_i is zero unless $i = m$. This first order condition implicitly takes the prices of the other firms into account through the share term, s_i.

The policy experiment adds a tariff on subject imports from source m. To solve for new equilibrium prices and quantities in this model, the user inputs initial market shares for each variety, the initial and new tariff rate on subject imports, initial prices for each variety, and a value for the logit parameter β. Marginal costs c_i and logit parameters α_i are calibrated to the initial market data. Then the post-tariff equilibrium prices are simulated using the first order conditions for the three firms in (3) and the three share equations described by (1).

2.2 Full Joint Ownership

In this section, we consider a modification to the model where domestic source a and subject import source m are jointly owned.[4] In this full joint ownership case, a and m have completely overlapping financial interests, and also have joint control over the pricing of both products. For example, this would be the case if a foreign firm that supplies the market through exports

[4]Note that the model provides a practical tool for quantifying the effects of joint ownership but does not attempt to predict whether there will be new FDI.

is acquired by a foreign firm that supplies the domestic market through FDI, or vice versa. The share equations presented in the previous section remain the same, as does the profit function and pricing first order condition for the domestic source d. For the subject imports source m and affiliate domestic source a, the joint firm profit function and pricing first order conditions are:

$$\pi_{a+m} = (p_a - c_a)\ s_a + (p_m - c_m)\ s_m\ - f_a - f_m \tag{4}$$

$$0 = s_a + (p_a - c_a)\ (\beta\ s_a\ (1 - s_a)) - (p_m - c_m)\ (\beta\ (1 + t)\ s_a\ s_m) \tag{5}$$

$$0 = s_m + (p_m - c_m)\ (\beta\ (1 + t)\ s_m\ (1 - s_m)) - (p_a - c_a)\ (\beta\ (1 + t)\ s_a\ s_m) \tag{6}$$

Similar to the model without joint ownership in section 2.1, the policy experiment is to add a tariff on the subject import variety m and solve for post-tariff prices and shares using the first order conditions described above.

2.3 Partial Ownership

In this version of the model, the foreign firm m has a minority (non-controlling) stake in the domestic firm a. This means that foreign firm m has a financial interest in the profitability of a but does not control the pricing of a's product. In this case, the equilibrium conditions for the d and a firm remain the same as the case with no joint ownership. For the foreign parent m firm, with the minority stake in the domestic affiliate firm, they set their own price taking into account the financial impact on the affiliate. Then the first order condition for

p_m is:

$$0 = s_m + (p_m - c_m)\ (\beta\ (1+t)\ s_m\ (1-s_m)) - z\ (p_a - c_a)\ (\beta\ (1+t)\ s_a\ s_m) \tag{7}$$

where z is m's ownership share of a. The parameter z is a model input and could be any value between zero and 0.5 for a minority (non-controlling) stake. Similar to the sections above, the model solves for post-tariff prices and shares using the first order conditions for each firm.

3 Illustrative Simulations

In this section, we present a series of simulations that illustrate how the model works. In the first simulation, we compare modeling results under different ownership structures. In all simulations, we assume that the initial volume shares of the domestic variety, imported variety, and affiliated variety are 50%, 20% and 20% respectively. The probability of choosing none of the varieties, or the outside option, is the remaining 10%. We set all initial prices to 1 for both simulations. In the partial ownership simulation below, firm m's ownership share of a is 20%.

Results from the first simulation are presented in Table 1. We make several observations. First, the increase in the price and change in market share of the unaffiliated domestic producer is lowest when there is full joint ownership between the m and a firms. We also see that the change in market share is largest for the affiliate firm in the full joint ownership case, and smallest in the no joint ownership case, and the change in market share of the importer is most negative in the full joint ownership case, and less in the no joint ownership case. Also, the percent change in price of the affiliated firm is positive in the no and partial ownership case and negative in the full joint ownership case. When there is no joint ownership, an

Table 1: Simulation Results under Different Ownership Structures

	1: No Joint Ownership	2: Full Joint Ownership	3: Partial Ownership
Model Inputs:			
Policy change: % increase in the power of the tariff	10%	10%	10%
β price coefficient	-20	-20	-20
Calibrated Parameters:			
α_d logit parameter	21.6	21.6	21.6
α_m logit parameter	20.7	20.7	20.7
α_a logit parameter	20.7	20.7	20.7
Markup of unaffiliated firm	10%	10%	10%
Markup of importer	6.25%	8.33%	6.95%
Markup of potential affiliate	6.25%	8.33%	6.25%
Outcomes:			
% Change in price of unaffiliated firm	1.18%	0.78%	1.18%
% Change in consumer price of imports	8.4%	8.6%	8.45%
% Change in producer price of imports	-1.45%	-1.26%	-1.40%
% Change in price of potential affiliate	0.46%	-0.80%	0.46
Change in market share of unaffiliated firm (in share points)	8.57	5.8	8.6
Change in market share of imports (in share points)	-15.74	-16.7	-15.79
Change in market share of potential affiliate (in share points)	7.17	10.91	7.19

increase in the tariff causes the price for the imported variety to rise. Demand for d and a varieties increases, so the price of the d and a varieties increases. In the case of full joint ownership, an increase in the tariff causes the price for the imported good to rise, and production of the imported good transfers to the affiliated firm to avoid paying a tariff on imports. This increase leads a profit maximizing firm to lower the price of the good produced by the affiliated firm and increase market share domestically.

The results are different under each of the ownership structure specifications because of several effects. First, the calibrated marginal costs depend on the ownership structure. Full m ownership of a leads to lower marginal costs and higher markup than no joint ownership. Lower marginal costs impacts the firm's first order conditions and changes the optimal price in the new equilibrium. Second, under partial or full ownership, m now has a financial interest in the profits of a, which is a function of m's price. This change in first order condition changes the optimal price chosen by m directly, and a and d indirectly. This leads to different price reactions and different pass-through of tariffs on consumer prices. In the full joint ownership case, there is greater pass-through in the consumer price of the imports, since lost sales are diverted in large part to the domestic affiliate.

Table 2: Simulation Results under Different β Price Parameters

	1: Low β, No Joint	2. Low β, Full Joint	3. High β, No Joint	4. High β, Full Joint
Model Inputs:				
Policy change: % increase in the power of the tariff	10%	10%	10%	10%
β price coefficient	-5	-5	-30	-30
Calibrated Parameters:				
α_d logit parameter	6.6	6.6	31.6	31.6
α_m logit parameter	5.7	5.7	30.7	30.7
α_a logit parameter	5.7	5.7	30.7	30.7
Markup of unaffiliated firm	40%	40%	6.7%	6.7%
Markup of importer	25%	33.3%	4.2%	5.6%
Markup of potential affiliate	25%	33.3%	4.2%	5.6%
Outcomes:				
% Change in price of unaffiliated firm	1.3%	0.9%	1.0%	0.6%
% Change in consumer price of imports	6.3%	6.5%	8.8%	9.0%
% Change in producer price of imports	-3.4%	-3.2%	-1.1%	-0.9%
% Change in price of potential affiliate	0.5%	-1.4%	0.4%	-0.6%
Change in market share of unaffiliated firm (in share points)	1.9	1.4	10.6	6.9
Change in market share of imports (in share points)	-3.5	-4.1	-19.5	-20.0
Change in market share of potential affiliate (in share points)	1.5	2.7	9.0	13.2

In the second set of simulations, we vary the β price parameter, which represents how strongly prices affect market shares. We focus on the cases of no joint ownership and full joint ownership. We keep the same inputs as simulation 1 except for the β parameter. Table 2 shows that a larger β leads to larger changes in market shares after the tariff shock and smaller price changes. Because the marginal costs are calibrated to initial market share data, a larger β implies higher marginal costs and smaller mark-ups for all varieties.

4 Conclusion

This paper presents a partial equilibrium tariff model with logit preferences, Bertrand-style imperfect competition, and foreign affiliated entities that can serve as a practical tool for modeling tariff changes in industries where logit is a better descriptive fit. We presented the model with and without joint ownership of the imported variety and one of the domestic varieties. We then ran illustrative simulations to understand how affiliation across varieties impacts the results. We found that the affiliate firm lowers its prices after a tariff increase as production is shifted domestically to avoid tariff impacts. This model could be extended to include nested logit demand, or to estimate the logit price parameter β rather than requiring the user of the model to supply a value.

References

Anderson, S. P., de Palma, A. and Thisse, J.-F. (1988). The CES and the Logit: Two Related Models of Heterogeneity, *Regional Science and Urban Economics* **18**: 155–164.

Dixit, A. K. and Stiglitz, J. E. (1977). Monopolistic Competition and Optimum Product Diversity, *American Economic Review* **67**: 297–308.

Helpman, E. and Krugman, P. (1985). Market Structure and Foreign Trade, *MIT Press, Cambridge, MA* .

McFadden, D. (1973). Conditional Logit Analysis of Qualitative Choice Behavior, *Frontiers in Econometrics (Academic Press, New York)* pp. 105–142.

Sheu, G. (2014). Price, Quality, and Variety: Measuring the Gains from Trade in Differentiated Products, *American Economic Journal: Applied Economics* **6**: 66–89.