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U.S.-CANADA BILATERAL TARIFF ELIMINATION: THE ROLE OF PRODUCT DIFFERENTIATION AND MARKET STRUCTURE*

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I. Introduction

Recent empirical literature evaluating the trade and welfare effects of the proposed U.S.-Canada free trade area (FTA) has emphasized the significant gains associated with tariff removal on trade in differentiated products. In this connection, there are two welfare conclusions concerning U.S.-Canada bilateral tariff elimination that tend to dominate the public discussion of the trade initiative. The first conclusion emphasized by the proponents of a U.S.-Canada FTA relates to the mutual gains from capturing scale economies and increased product variety that access to each other's market will make possible. Moreover, the influx of tariff-free imports will improve the competitive environment for firms selling domestically, requiring these firms either to exit or reduce cost. Free trade, then, is expected to rationalize the production process by increasing output per firm and lowering average total cost.

The predicted gains from liberalization draw heavily from the literature that compares autarky and free trade, e.g., Krugman (1979) and Markusen (1981). However, from a theoretical perspective, the question of whether there are gains from liberalization is distinct from the question of whether there are gains from trade. U.S. and Canadian firms already enjoy substantial access to each other's markets. Post-Tokyo Round bilateral tariffs on U.S-Canada trade are quite low, averaging less than two percent. Furthermore, Canadian firms are subjected to the efficiency-stimulating experience of competing with U.S. firms in the U.S. market. Whether small tariff changes lead to rationalization depends on certain characteristics of the input markets, as Flam and Helpman (1987) have shown, as well as the pro-competitive effects emphasized in the gains-from-trade literature.

Secondly, the emphasis on trade in differentiated products in evaluating liberalization leads to the conclusion that increased trade will be primarily intra-industry. Inter-industry resource reallocation necessary under an FTA is therefore presumed to be minimal. On the other hand, the policy debate has tended to downplay the terms-of-trade changes typically associated with tariffs, resource movements due to inter-industry trade, or the second-best nature of bilateral tariff reductions.

Aside from the theoretical welfare issues, there are some basic modeling choices which arise in evaluating the bilateral tariff elimination using computable general equilibrium techniques. In particular, U.S.-Canada bilateral trade flows which are the subject of tariff removal must be identifiable.

There are four basic approaches to this problem. First, there is the textbook model that examines the case in which each good is homogeneous across firms and countries. The implication of this framework is that some bilateral trade flows will cease with bilateral tariff elimination. Typically the smaller country in the FTA will trade within the FTA only.

In order to avoid this particular pattern of trade in which some bilateral trade flows disappear, it is common to adopt some form of product or market differentiation. One popular approach has been to assume that products are differentiated by place of production, embodied in the Armington (1969) assumptions.[1] Alternatively, there are two other modeling approaches that draw upon the behavior of imperfectly competitive firms. The first is to assume that there is product differentiation at the firm level rather than at the national level. The second alternative is to assume that all firms supply a homogeneous product, but that national markets are segmented, as in Venables (1985). Thus, firms make separate price and supply decisions for each national market based on the perceived elasticity of demand.

The purpose of this paper is to analyze some important issues that arise in the modeling of bilateral tariff removal and to assess these issues computationally in the context of the U.S.-Canada FTA. Our paper is structured as follows. The differentiated products models are discussed in the following section, and the theoretical relationship between tariff liberalization and firm output is developed. We also comment on the demand structure adopted in some previous modeling efforts. In particular we will discuss the practice of assuming both firm and national product differentiation and the implications for the debate concerning intra- vs. inter-industry trade, rationalization of the production process, and the gains from trade.

In section III, we present a market segmentation model and discuss the likely welfare implications of bilateral tariff removal. The issues raised are then illustrated using a computational model designed to analyze U.S.-Canada bilateral tariff removal. The model is discussed in section IV and computational results are presented in section V. Conclusions follow.

II. The Differentiated Products Models

The earliest versions of the differentiated products models involved differentiating by country of origin using the Armington assumptions. 'Love of variety' in the utility function guarantees that all bilateral trade flows will continue following the formation of the preferential trading club as long as industries are not eliminated in any country. Models of this type tend to assume that production is characterized by constant returns to scale and firms are perfectly competitive.

There is an important difficulty, however, with the national product differentiation (NPD) model insofar as it means that each country will have a monopoly in the supply of its own characteristic variety.[2] Consequently, optimal tariffs tend to be large, even for small countries. Terms of trade changes, rather than efficiency gains, therefore dominate the welfare predictions of NPD models.

NPD is the approach adopted by Brown and Stern (1987), who find that Canada's welfare declines by 0.3 percent as the result of bilateral tariff removal. This result appears to emerge because removal of the relatively high tariffs currently in place in Canada leads to a deterioration in the terms of trade. On the other hand, Hamilton and Whalley (1985) consider nontariff barrier (NTB) removal as well as bilateral tariff removal and find that Canada enjoys a 0.7 percent increase of GDP from the formation of an FTA presumably because of the relatively high NTBs in the United States.

An alternative is to differentiate products at the firm level, using the Dixit-Stiglitz-Spence form of the utility function. Love of variety will again guarantee the existence of all bilateral trade flows, since no two firms in the world sell the same variety. In this model, firms are typically assumed to have downward sloping average total cost curves and to be monopolistically competitive.

Harris (1984) developed the imperfectly competitive approach, computationally, incorporating a variety of different assumptions concerning a firm's price setting behavior. The Harris approach yielded startling results. Multilateral pre-Tokyo Round tariff removal was shown to increase Canada's welfare by up to 9 percent of GDP, depending on the precise assumptions concerning firm behavior. Increasing firm output, thereby reducing average total cost, is a key source of welfare gain in the imperfectly competitive computational trade models. Subsequent revisions of tariff data and parameters of the model, however, place the welfare gain for Canada in the Harris model closer to 2.5 percent of GDP.[3]

In this section, we will first describe a typical monopolistically competitive (MC) trade model and evaluate the effects of tariff liberalization on firm output. The NPD model and the MC model are then compared in terms of the implications of a tariff for the terms of trade and intra- vs. inter-industry trade.

Assume a model consisting of n traded goods that are produced by m countries. Good j produced by each firm in each of the m countries is aggregated using a linearly homogeneous aggregation function to form a composite good j. Following Spence (1976) and Dixit and Stiglitz (1977), modelers have typically chosen the CES function to aggregate different varieties into a single aggregate. The conditional demand in country i for the product of a representative firm in country r that produces good j for a CES aggregation function is

(1) $$D^r_{ij} = \frac{E_{ij}(P^r_{ij})^{-\sigma}}{\sum_{s=1}^{m} n_{sj}(P^s_{ij})^{1-\sigma}}$$

where P^r_{ij} is the price paid in country i for good j produced by a representative firm in country r, E_{ij} is expenditure in country i on the aggregate good j, n_{sj} is the number of firms in industry j in country s, and $\sigma > 1$ is the elasticity of substitution among the different varieties.

Firms set price as a mark-up over marginal cost according to

(2) $$P^*_{rj} = MC_{rj}(1+1/\eta_{rj})^{-1}$$

where P^*_{rj} is the price received by a representative producer of j in country r, $\eta_{rj} < -1$ is the firm's perceived elasticity of demand, and MC_{rj} is marginal cost. The firm's perceived elasticity of demand is a sales weighted average of the elasticities of demand in each national market. The elasticity of demand in country i for the product of a representative firm in country r is obtained from equation (1) above to be

(3) $$\eta^i_{rj} = -\sigma + (\sigma-1)\,\frac{P^r_{ij}D^r_{ij}}{E_{ij}}$$

or

(3′) $$\eta^i_{rj} = -\sigma + (\sigma-1)\,\frac{\theta^r_{ij}}{n_{rj}}$$

where θ^r_{ij} is country r's share of the market in country i for good j.

The firm's production function requires a fixed input of capital plus variable capital and labor inputs that are characterized by constant returns to scale. Thus, the average total cost (ATC) curve is downward sloping and marginal cost is constant. Entry occurs until profits are eliminated, requiring the firm's price to equal ATC,

$$(4) \qquad P^{*}_{rj} = P^{K}_{r} \left(\frac{K^{F}}{q_{rj}} + a^{K}_{j}\right) + w_{r}a^{L}_{j}$$

where P^{K}_{r} is the price of capital in country r and w_r is the return to labor, a^{K}_{j} is the variable capital unit input requirement in industry j and a^{L}_{j} is the unit labor requirement, K^{F} is the fixed capital requirement, and q_{rj} is output of a typical firm in industry j in country r.

Capital and labor are assumed to be mobile between sectors. The return to each factor is determined to equate demand to a fixed supply.

Finally, tariff policy serves to link the price received by the seller to the price paid by the buyer. Thus

$$(5) \qquad P^{r}_{ij} = P^{*}_{rj} \, (1 + t^{r}_{ij})$$

where t^{r}_{ij} is the ad valorem tariff that country i imposes on imports of good j from country r.

Rationalization

We now examine the conditions under which tariff liberalization will lead to rationalization of production in this model. That is, will a tariff reduction increase output per firm and lower average total cost? There are several considerations that determine the effect of liberalization on rationalization, such as differing factor intensities across industries and the effect of liberalization on the elasticity of demand.

Turning first to the production side, suppose that there are two industries and industry 1's fixed capital input requirement is zero. Throughout this exercise we will hold the shape of the demand curve fixed so as to focus on technological determinants of firm output.

Equilibrium in the labor market requires that

$$(6) \qquad L = a_1^L\, Q_1 + a_2^L\, n_2 q_2$$

where L is the endowment of labor, Q_1 is output of industry 1, and n_2q_2 is output of industry 2. Proportionate differentiation yields

$$(6') \qquad \lambda_{L1}\hat{Q}_1 + \lambda_{L2}(\hat{q}_2 + \hat{n}_2) = \delta_L(\hat{w} - \hat{P}^K)$$

where $\quad \delta_L = \lambda_{L1}\theta_{K1}\sigma_1 + \lambda_{L2}\theta_{K2}^V\sigma_2,$

λ_{fj} is industry j's share of the employment of factor f, θ_{fj} is factor f's share of total cost in industry j, θ_{fj}^V is variable factor f's share of variable cost in industry j, and σ_j is the elasticity of substitution between capital and labor in industry j.

Similarly, capital market equilibrium requires

$$(7) \qquad K = a_1^K\, Q_1 + a_2^K\, n_2 q_2 + n_2\, K^F$$

which when proportionately differentiated yields

$$\lambda_{K1}\hat{Q}_1 + \lambda_{K2}^{V}(\hat{q}_2 + \hat{n}_2) + \lambda_{K2}^{F}\,\hat{n}_2 = -\delta_K(\hat{w} - \hat{P}^K) \tag{7'}$$

where $\delta_K = \lambda_{K1}\theta_{L1}\sigma_1 + \lambda_{K2}^{V}\theta_{L2}^{V}\sigma_2$,

λ_{K2}^{V} is variable capital in industry 2's share of capital employment, λ_{K2}^{F} is fixed capital in industry 2's share of capital employment, and $\lambda_{K2}^{V} + \lambda_{K2}^{F} = \lambda_{K2}$ is industry 2's share of capital employment.

A tariff reduction will lower demand for the domestically produced good, yielding negative profits for domestic firms. The question is, will output per firm in industry 2 rise or fall as firms exit? Suppose first that q_2 is held constant as n_2 falls so that firms neither rationalize nor de-rationalize. The mark-up pricing rule used by firms requires that the percent change in price be equal to the percent change in marginal cost, if the elasticity of demand is held constant. Therefore

$$\hat{P}_2 = \theta_{L2}^{V}\,\hat{w} + \theta_{K2}^{V}\,\hat{P}^K. \tag{8}$$

On the other hand, the zero-profit condition requires that the percent change in price be equal to the percent change in ATC. Therefore

$$\hat{P}_2 = \theta_{L2}\,\hat{w} + \theta_{K2}\,\hat{P}^K - \theta_{K2}^{F}\,\hat{q}_2. \tag{9}$$

Now, as industry 2 contracts and industry 1 expands, relative factor prices must also be adjusting. As a result, equations (8) and (9) cannot be satisfied simultaneously if output per firm is held constant. This conclusion follows from the assumption that capital is the only fixed factor, which implies that labor's share of variable cost must be greater than labor's share of total cost and capital's share of variable cost must be smaller than capital's share of total cost.

The necessary change in firm output will depend on the relative factor intensity ranking of the two industries. It can be demonstrated using equations (6′) and (7′) that, if industry 2 is the capital intensive industry ranked according to its variable inputs, then $\hat{w} - \hat{P}^K > 0$ as resources are transferred from industry 2 to industry 1. On the other hand, if industry 2 is the labor intensive industry, then $\hat{w} - \hat{P}^K < 0$. That is

$$\hat{w} \gtrless \hat{P}^K \quad \text{as} \quad \lambda_{L1}\,\lambda^V_{K2} \gtrless \lambda_{K1}\,\lambda_{L2}.$$

For the case in which industry 2 is relatively labor intensive, so that $\hat{w} - \hat{P}^K < 0$, marginal cost has fallen relative to ATC, requiring output per firm to rise. However, if industry 2 is relatively capital intensive, then marginal cost has risen relative to ATC, requiring output per firm to fall.

As a general rule, if an industry's intensively used factor has a greater share in variable cost than in total cost, then a policy that lowers price will also lead to rationalization. On the other hand, if an industry's intensive factor has a smaller share in variable cost than in total cost, then de-rationalization will occur.[4] It should also be noted that, if technological considerations are leading to rationalization of the domestic industry, de-rationalization will be occurring in the foreign industry.

There are, of course, several demand side considerations that will also help determine firm output. An increase in the absolute value of the firm's perceived elasticity of demand will lower the mark-up over marginal cost, so that firm output will rise. To the extent that liberalization increases the number of firms in the industry world wide, reducing individual firm market share, the second term on the right hand side of equation (3) will become smaller so that the absolute value of the elasticity will rise.

On the other hand, as noted by Horstmann and Markusen (1986), ad valorem tariff reductions tend to steepen the demand curve facing the foreign firm, lowering the elasticity of demand and lowering output per firm. This point can be seen by differentiating equation (3) with respect to t^{r}_{ij}, using equation (5).

Tariff Liberalization and the Terms of Trade

It is reasonable to presume that a tariff reduction on imports of the monopolistically competitive good 2 will tend to lower the price received by domestic producers, P^d_2, relative to the price paid for imports, P^m_2, thus worsening the terms of trade for the liberalizing country. The terms of trade for the competitive good will also deteriorate. The tariff reduction will shift production in the home country toward good 1 and away from good 2. Thus P_1/P^d_2 will rise. If the home country is a net exporter of good 2 and an importer of good 1, then the increase in P_1/P^d_2 constitutes a fall in the price of exports. The tariff reduction will also shift production in the foreign country toward good 2 and away from good 1. Thus P_1/P^m_2 will fall. If the home country is a net importer of good 2 and an exporter of good 1, then the fall in P_1/P^m_2 also constitutes a deterioration in the home country's terms of trade.

The welfare implications of the relative price changes for the home country should nonetheless be smaller than in the more conventional Armington model in which goods are differentiated at the national level and individual firms are price takers. This will be the case for two reasons.

First, the powerful terms-of-trade gain from a tariff in the NPD model stems from the fact that firms, as price-takers, do not internalize the market power attendant to national product differentiation. Thus, a tariff that reduces national supply to the world market, exploits monopoly power ignored by the firms. However, if product differentiation exists at the firm level rather than at the national level, there is little market power associated with product differentiation that can be perceived by the government that is not already exercised by the firm.

Second, the number of differentiated products in an NPD model equals the number of countries. On the other hand, the number of products in a monopolistically competitive model is significantly larger and equal to the sum over the number of firms in each country. By increasing the number of products, the market power of the seller of an individual product is reduced, leaving less room to increase welfare by reducing supply.

The terms-of-trade loss of the home country may be further mitigated if rationalization occurs in the foreign country. An increase in output per firm is associated with a reduction in the mark-up over marginal cost, offsetting some of the original increase in price by foreign firms.

Increasing Returns to Scale and National Product Differentiation

Implementation of the differentiated products model computationally does not require national product differentiation. Nonetheless, the tendency has been to preserve both national and firm product differentiation. In this context, a third level is added to the utility function. Expenditure on imports is allocated among competing sources following the decision concerning allocation between an import aggregate and a domestic aggregate. For example, Wigle (1988) adopts this approach and finds that bilateral tariff removal would reduce welfare in Canada by 0.1 percent of GDP.

National product differentiation is not necessary to explain cross-hauling in models with <u>firm</u> product differentiation. It may nonetheless seem plausible to retain a preference for the domestically produced good in the utility function. However, if perfect aggregation is used to form separate domestic and import aggregates, then domestic firms are insulated from changes in the composition of the import aggregate with the consequence of introducing a new equilibrating mechanism that has questionable economic content.

Adding a third stage to the budgeting process will have three implications for the computational results. First, the model will be predisposed toward the conclusion that free trade will stimulate intra-industry trade, thus minimizing the necessary inter-sectoral adjustment. To see this point, consider the extreme case in which consumers distinguish between the import and the domestic variety of good j, D_j, but all firms within a country produce perfect substitutes. That is

$$D_j = [(D_j^d)^\rho + (D_j^m)^\rho]^{1/\rho} \tag{10}$$

where the domestic variety, D_j^d, and the imported variety, D_j^m, are given by

$$(11) \qquad D_j^d = \sum_{i=1}^{n_{dj}} X_{ij}^d \quad \text{and} \quad D_j^m = \sum_{i=1}^{n_{mj}} X_{ij}^m$$

where n_{dj} is the number of domestic firms, n_{mj} is the number of foreign firms in industry j, and X_i denotes the output of the i^{th} firm. This is the case analyzed by Horstmann and Markusen (1986).[5] A key assumption in this framework is that the number of firms in the domestic industry does not affect demand facing an individual foreign firm, nor does the number of firms in the foreign industry affect the demand facing an individual domestic firm.

A tariff on imports will stimulate demand for the domestic variety and reduce demand for the foreign variety, leaving domestic firms with positive profits and foreign firms with negative profits. To restore the zero-profit condition, entry occurs domestically while foreign firms exit. Since domestic firm demand does not depend on the number of foreign firms, entry in the domestic industry reduces individual firm demand until profits are once again zero. The opposite occurs for foreign firms. The essential equilibrating mechanism here is that <u>local</u> entry dissipates positive profits by dividing the market among a larger number of firms, thereby reducing firm output and raising average fixed cost. Indeed, Horstmann and Markusen conclude that the tariff change has no effect on domestic firm output.[6]

In comparison, consider the model outlined above, in which consumers distinguish between the output of different firms but not between imports and the domestic good. In this case, the level of firm demand depends not on whether there is local entry or exit, but rather on whether there is global entry or exit. If the increase in the number of domestic firms is smaller than the fall in the number of foreign firms, then all firms in the industry, both domestic and foreign, will experience an increase in demand. As a result, positive profits for domestic firms will increase even further.

Entry in the domestic industry restores the zero-profit condition by raising the return to the factor used intensively in the expanding sector, which raises total cost. The effect of local entry on firm demand, which occurs in the Horstmann-Markusen model, is absent here. Thus, restoring the zero-profit condition depends entirely on inter-sectoral factor movements.

The second implication of adding a third stage to the budgeting process is that reducing the change in factor prices necessary to restore equilibrium will also weaken the forces leading to rationalization or de-rationalization associated with differing factor intensities. The third implication is that reintroducing national product differentiation increases national market power which is not perceived by firms, thus raising the optimal tariff.

Summary

There are a few lessons that we can draw in comparing the likely welfare and trade conclusions of each approach for a U.S.-Canada bilateral tariff elimination which will be relevant for the computational results presented below. Welfare conclusions from a model assuming perfect competition and national product differentiation will be dominated by changes in the terms of trade. The average level of tariffs currently in place in Canada is somewhat higher than in the United States. This implies that tariff elimination will tend to worsen Canada's terms of trade, resulting in a welfare loss. In addition, the inter-sectoral trade pattern will not be particularly affected by tariff liberalization. Rather, increased trade will be primarily intra-industry.

In contrast, if industries are monopolistically competitive, then product differentiation is removed to the firm and firms incorporate market power associated with product differentiation into their pricing decisions. Therefore, welfare-reducing changes in the terms of trade as the result of liberalization will be confined primarily to large countries and are not likely to play a dominant role in the welfare conclusions of bilateral tariff removal. Consequently, welfare gains for Canada are more likely than in the NPD model. Further, more distinctive changes in the inter-sectoral pattern of specialization will emerge in view of the fact that each variety of a good is not nationally specific. Production can be relocated in the country where the cost of production is lowest.

Rationalization of the production process will depend on the general equilibrium effects of tariff liberalization on the return to capital, which in turn depends on the relative factor-intensity ranking of industries. If the protected sector is labor intensive, so that liberalization causes the return to capital to rise, output per firm will tend to rise. However, if the protected sector is capital intensive, then the return to capital is likely to fall. Consequently, firm output may fall, as well.

III. A Market Segmentation Model

Another alternative to modeling bilateral tariff elimination is to assume that all firms sell a homogeneous product but that national markets are segmented. Thus, all firms selling to a single national market must charge the same price, but price may vary across countries. This approach has not been used previously in the context of U.S.-Canada bilateral tariff removal, but has been applied to the European Community by Smith and Venables (1988).

Here we extend the model of Venables (1985) to three countries.

The market demand in country j is

$$D_j = S_j(D - p_j) \qquad j=1,2,3 \tag{12}$$

where p_j is the price paid by consumers in country j and S_j is a parameter indicating the size of market j. Firms are assumed to behave as Cournot followers, so that the perceived demand is the market demand net of supply by other firms. Therefore, a typical firm in country i perceives the demand for its exports to country j to be

$$x_i^j = S_j(D - p_j) - Q_j \qquad j \neq i \tag{13}$$

where Q_j is supply by other firms, and demand in the local market to be

$$y_i = S_i(D - p_i) - Q_i. \tag{14}$$

As above, each firm in country i faces a fixed cost, f_i, and constant marginal cost, c_i, yielding profits of

$$\pi_i = \sum_{j \neq i}(p_j - c_i - t_j)x_i^j + (p_i - c_i)y_i - f_i \tag{15}$$

where t_j is the tariff imposed by country j on imports. The first order conditions for profit maximization are

$$x_i^j = S_j(p_j - c_i - t_j) \qquad i \neq j \tag{16}$$

and

(17) $$y_i = S_i(p_i - c_i).$$

Free entry guarantees that profits will be zero, which when making use of the first-order conditions for profit maximization, equations (16) and (17), implies that

(18) $$\sum_{j \neq i} (p_j - c_i - t_j)^2 S_j + (p_i - c_i)^2 S_i - f_i = 0.$$

Consider now the effect of a tariff change by country 2 on imports from country 1. Totally differentiating equation (18) for each i yields

(19) $$\begin{bmatrix} y_1 & x_1^2 & x_1^3 \\ x_2^1 & y_2 & x_2^3 \\ x_3^1 & x_3^2 & y_3 \end{bmatrix} \begin{bmatrix} dp_1 \\ dp_2 \\ dp_3 \end{bmatrix} = \begin{bmatrix} x_1^2 \, dt_2 \\ 0 \\ 0 \end{bmatrix}.$$

Solving for the equilibrium price changes yields

(20) $$\begin{bmatrix} dp_1 \\ dp_2 \\ dp_3 \end{bmatrix} = \frac{-x_1^2 \, dt_2}{A} \begin{bmatrix} -y_2 y_3 + x_3^2 x_2^3 \\ y_3 x_2^1 - x_3^1 x_2^3 \\ y_2 x_3^1 - x_2^1 x_3^2 \end{bmatrix}$$

where $A = y_1(y_2 y_3 - x_3^2 x_2^3) - x_1^2(y_3 x_2^1 - x_3^1 x_2^3) - x_1^3(y_2 x_3^1 - x_2^1 x_3^2)$.

If A is positive[7] and $c_i < c_j+t_i$, then it can be shown that $dp_1/dt_2 > 0$. The restriction on marginal cost implies that a typical domestic firm sells more to the domestic market than a typical foreign firm. In this case, the tariff imposed by country 2 raises the price paid by consumers in country 1, thus lowering welfare in country 1. If, in addition, $y_3x_2^1 > x_3^1x_2^3$, then it follows that $dp_2/dt_2 < 0$. The tariff lowers the price to consumers in country 2, raising welfare in country 2.[8]

The impact of a tariff imposed by country 2 in this model is to lower the price net of tariff that country 1 firms receive for their exports to country 2. In order to restore the zero-profit condition, country 1 firms must increase price in other markets, such as in the domestic market. However, the higher price in country 1's market raises profitability for country 2 firms, leading to a reduction in price on sales to domestic consumers. The price increase to country 1 consumers lowers welfare in country 1 and the price reduction in country 2 raises consumer welfare in country 2.

This outcome, of course, is not inevitable. Negative profits for country 1 firms are eliminated by raising the price in countries in which country 1 firms have a relatively large market share. The change in relative price, then, will depend closely on the pattern of trade and pre-existing market share.

In the U.S.-Canada case, the volume of trade between the United States and Canada is large, while trade between Canada and the rest of the world is comparatively small. A tariff reduction by Canada will raise the profitability of U.S. firms. A price reduction in the United States which lowers profits of U.S. firms, and a price increase in Canada and the rest of the world which offsets the price reduction in the U.S. market are likely.

IV. The Computational Model

Sections III and IV leave us with a set of propositions concerning the implications of modeling choices which we would like to illustrate computationally. There are three variants of the model. The perfect competition (PC) version is characterized by national product differentiation, perfect competition, and constant returns to scale. The monopolistic competition (MC) version differs in that product differentiation exists only at the firm level, there are increasing returns to scale, and firms set price as a mark-up over marginal cost. In the market segmentation (MS) version there are economies of scale as well, but each product is homogeneous across firms and countries. Firms behave as Cournot followers and perceive national markets as segmented.[9]

Canada, the United States, and a group of thirty-two other countries are modeled explicitly, and the rest of the world constitutes an abbreviated fourth region. Our sectoral coverage includes twenty-two tradable product categories based on three-digit ISIC industries and seven nontradable categories based on one-digit ISIC industries.[10]

In all three models, consumers initially allocate final demand and producers allocate intermediate demand across sectors without regard to the location of production. Bilateral trade flows are identified in the PC model by assuming that consumers and producers aggregate the variety produced by each country using a CES aggregation function. Thus, the demand in country i for the output of country r's production of good j, conditional on expenditure on the aggregate good j, E_{ij}, is

$$(21) \qquad D^r_{ij} = \frac{E_{ij}(P^r_{ij})^{-\sigma}}{\sum_{s=1}^{m}(P^s_{ij})^{1-\sigma}}$$

where P^r_{ij} is the price consumers in i pay for good j produced in country r. This price differs from the price received by the seller in country r by any tariffs imposed by country i.

Bilateral trade flows in the MC model are similarly identified, though product differentiation exists at the firm level only. Monopolistically competitive firms set price as a mark-up over marginal cost according to equation (2) and the firm's perceived elasticity of demand is given by equation (3).

In the MS model consumers do not distinguish between the output of various firms or countries. Rather, firms perceive national markets as segmented. The firm sets price and supply in each market to maximize firm profits. That is

$$\max_{\{P^1_{rj},\ldots,P^m_{rj}\}} \sum_{i=1}^{m} D^r_{ij}\,[P^i_{rj} - MC_{rj}] - FC_{rj}$$

where MC and FC are marginal and fixed costs, and P^i_{rj} is the price a typical firm in country r receives for sales in country i. This price differs from the price paid by consumers in country i by any tariffs imposed. Firms behave as Cournot followers. Therefore, the firm's perceived demand, D^r_{ij}, is the market demand in country i for good j, D_{ij}, less output by other firms, Q. The underlying utility function determining industry demand is Cobb-Douglas. Under this assumption it can be shown that the supply to country i by a representative firm in country r is

$$S^i_{rj} = D_{ij}\frac{(P^i_{rj} - MC_{rj})}{P^i_{rj}}. \tag{22}$$

The production function in all three models requires intermediate and primary inputs. Intermediate inputs and a primary input aggregate are employed in fixed proportion to output. The primary input aggregate is a CES function of capital and labor employed. Capital and labor demand are determined by minimizing the cost of attaining the level of the primary input aggregate required by the upper level of the production function. In addition to variable capital and labor inputs, a fixed input of capital is necessary in the MC and MS models.

Capital and labor are mobile between sectors but not countries. The return to capital is determined to equate demand to a fixed supply of capital. The return to labor is held constant. National income is adjusted to maintain total employment at the base level.

Freedom of entry is assumed and, therefore, firm profits are zero. This implies that PC firms must set price equal to marginal cost, MC firms must set price equal to average total cost, and MS firms must set average price to average total cost.

Equilibrium prices are determined in global markets to equate supply and demand. In the PC model one price is determined for each national variety of each good. In the MC model one price is determined for each firm. However, firms within each country face identical costs and technology and demand is symmetric. Therefore, all firms within an industry and country charge the same price. In the MS model one price is determined for each national market.

Thus, all firms selling in a single market must charge the same price.

The base year for data on production, employment, and trade for the United States, Canada, and other countries and the rest of the world is 1976. Input-output coefficients for the production function were derived from the U.S. input-output table for 1972 and the Canadian table for 1976.

The key parameters in the base period for the MC model are obtained in the following manner.[11] The firm's perceived demand in the base period is calculated according to equation (3), assuming that the elasticity of substitution among varieties of each good is 15.0.

Once the elasticity of demand is determined, it is straightforward to calculate the variable input share of total cost. The variable cost share is equal to the ratio of marginal cost and average total cost, $\theta^{VC} = MC/ATC$. Since profits are zero, average total cost is equal to price. The ratio of marginal cost and price is determined by the mark-up pricing rule in equation (2). Therefore, $\theta^{VC} = 1 + 1/\eta$.

The share of total capital that is variable is implied by the variable cost share, capital's primary input cost share, θ^K, and the primary input share of total cost, b_0. Capital is assumed to be the only fixed factor. Therefore, the share of capital which is fixed is equal to the ratio of fixed cost's share of total cost to capital's share of total cost. That is

$$(23) \qquad \frac{1 - \theta^{VC}}{\theta^K\ b_0} = \frac{P^K\ K^F/TC}{P^K\ (K^F + K^V)/TC} = \frac{K^F}{K^F + K^V}.$$

The distribution of primary input cost between capital and labor is available from industry data and primary input share of total cost is obtainable from input-output data.

The relationship between fixed capital's share of total capital and the elasticity of substitution in the aggregation function places restrictions on the size of the elasticity of substitution. A small value for σ can imply a fixed capital share which does not lie between zero and one. Setting σ=15 was the smallest value for this parameter consistent with the restrictions on the fixed capital share.

Structural equations of the MS model also imply base period values for the parameters. The mark-up over marginal cost, (P-MC)/MC, for each of the three national markets are derived from equation (22) to be

$$(24) \qquad M_r^i = \frac{\theta_i^r/n_r}{1 - \theta_i^r/n_r}$$

where M_r^i is the mark-up over marginal cost by producers in country r on their sales to country i and θ_i^r is country r's share of the market in country i.

This procedure tended to lead to very small mark-ups for many industries which caused instability in the computational model. Therefore, the mark-ups are bounded from below by 5 percent. Utility functions other than Cobb-Douglas may produce larger mark-ups. However, it may also be the case that this model is unsuitable for modeling sectors which are not highly concentrated.

The variable cost share for the MS model can be obtained in a manner similar to the method employed with the MC model. Variable cost share is equal to the ratio of marginal cost to average cost. The zero-profit condition implies that the average price received by the firm for its sales in each market must equal ATC. Therefore

$$(25) \qquad \theta_r^{VC} = \frac{MC_r}{\sum_i \delta_r^i P_r^i}$$

where δ_r^i is the share of country r's output which is sold to country i. Equation (22) can be used to find that

$$(26) \qquad \theta_r^{VC} = \left[\sum_i \frac{\delta_r^i}{1 - \theta_i^r/n_r} \right]^{-1}.$$

V. <u>Computational Results of U.S.-Canada Bilateral Tariff Elimination</u>

The models described in section IV have been used to analyze computationally the effects of bilateral tariff removal by the United States and Canada. Our purpose here is to illustrate the implications of various modeling choices for the trade and welfare conclusions of U.S.-Canada bilateral tariff removal. The model was run three times, employing each of the three different market structures in all industries: perfect competition, monopolistic competition, and market segmentation. It is of course more plausible to assume that market structure will vary across industries. Results reflecting our best judgement concerning the proper market structure for each industry can be found in Brown and Stern (1988).

Tariffs removed are those prevailing in both countries subsequent to full implementation of the Tokyo Round tariff reductions that was completed in 1987. The last column of each of Tables 2 and 3 list the bilateral trade weighted ad valorem tariff equivalents on U.S.-Canada trade. Notice that U.S. tariffs on Canadian exports are somewhat lower than Canadian tariffs on the United States. Nevertheless, U.S. tariffs on Canadian exports on some products such as clothing and footwear remain quite high.

The results for imports, exports, the exchange rate, terms of trade, and welfare are summarized in Table 1. Section A of Table 1 reports the change in trade and welfare under perfect competition. U.S. and Canadian trade increases by close to $7 billion, while ROW trade falls by nearly $2 billion. The welfare and terms of trade changes are similar to those obtained elsewhere using such a model[12] and the role of national product differentiation is clearly evident. The comparatively deep tariff reductions by Canada worsen its terms of trade by 0.7 percent, leading to a trivial decline in welfare. U.S. terms of trade, on the other hand, improve by 0.3 percent, raising U.S. welfare by $781 million based on 1976 trade. ROW welfare declines as well.

The outcome is somewhat different if industry structure is taken to be monopolistically competitive. These results are presented in section B of Table 1. U.S. and Canadian trade increases by about $9 billion. The U.S. terms-of-trade gain is now only one-third as large (0.1%) and Canada's terms of trade loss is about 30 percent smaller (-0.5%). This result was expected. The move from products differentiated at the national level to products differentiated at the firm level significantly increases the number of products, thereby increasing the elasticity of demand for each individual variety. In addition, rationalization occurs in the United States as a result of liberalization, forcing U.S. firms to reduce the mark-up over marginal cost.

The U.S. welfare gain is accordingly reduced to $476 million, but Canada's welfare gain rises to $2.3 billion, which is 1.2 percent of Canadian GDP in 1976. There are several possible explanations for the welfare improvement for Canada. First, a smaller deterioration in Canada's terms of trade will reduce the welfare loss. Second, as discussed above, internalizing market power by differentiating products at the firm level, rather than at the national level, lowers Canada's optimal tariff. Thus, despite the deterioration in the terms of trade, Canadian welfare still rises due to efficiency gains. Third, Canada may be gaining from rationalizing production.

In order to illustrate the sensitivity of the model to the choice of the elasticity of substitution, the PC and MC versions of the model were rerun after increasing the elasticity of substitution. Values for this parameter ranged from 17 to 45 across industries, compared to 15 in the base run. These results are summarized in sections D and E of Table 1.

In the case of perfect competition, the most notable effect of increasing the elasticity of substitution is to increase the change in the volume of trade. The impacts on the terms of trade and welfare are trivial. This is not the case, however, if firms are monopolistically competitive. The terms-of-trade changes are further weakened as the elasticity of substitution increases. In particular, Canada's terms of trade deteriorate by only 0.3 percent, as compared to 0.5 percent in the base run and 0.7 percent under national product differentiation. Canada's welfare gain rises to 1.4 percent of GDP.

Section C of Table 1 summarizes the effects of liberalization in the market segmentation model. The trade impact is significantly larger than for the other two market structures, with U.S. and Canadian trade increasing by about $11 - $13 billion. The terms of trade effects are similar to those which obtained in the MC model, but welfare for all three country groups declines. It should be noted at the outset that the market segmentation model is a poor approximation of firm behavior in unconcentrated industries.

Results presented for this version of the model should therefore be considered illustrative only. Little weight should be attached accordingly to the aggregate measures such as the terms of trade and welfare.

Sectoral Results: Perfect Competition and Monopolistic Competition

Sectoral results for each experiment are presented in Tables 2 to 7. Tables 2 and 3 report the percent change in exports, imports, bilateral trade, output, capital employment, the return to capital, and labor employment due to bilateral liberalization under perfect competition for the United States and Canada, respectively. Tables 4 and 5 report similar values for the monopolistic competition model. The percent changes in the number of firms and in the firm's perceived elasticity of demand are also included.

The most notable feature of the PC model is the strong tendency toward increased intra-industry trade. Bilateral trade increases in virtually every sector. The only exception is that Canadian imports of transportation equipment from the United States fall by 3.2 percent. Total trade for both countries generally increases as well. U.S. imports increase in every sector and Canada's imports decline only in petroleum products and transportation equipment.

Employment effects are equally small. The largest decline in employment in the United States is 1.3 percent in nonferrous metals. Significantly more labor adjustment is required in Canada. For example, employment in textiles falls by 25.0 percent.

In comparison, the inter-industry impact of liberalization is much more pronounced under monopolistic competition. While liberalization causes U.S. imports from Canada to rise in every sector in the PC model, U.S. imports from

Canada in the MC model fall in wood products (-9.2%), paper products (-23.3%), printing and publishing (-6.7%), chemicals (-48.3%), petroleum products (-12.0%), nonmetallic mineral products (-8.9%), and miscellaneous manufactures (-1.3%).

Inter-industry specialization in production, particularly for Canada, follows a similar pattern. Under MC, output in Canada declines in sixteen of the 22 tradable sectors, as compared to eight sectors that decline in the PC model. The expanding sectors are leather products (37.2%), footwear (2.8%), rubber products (18.7%), iron and steel (27.4%), nonferrous metals (68.1%), and transportation equipment (85.1%). On the other hand, U.S. output declines in several of these sectors, such as leather products (-0.5%), rubber products (-0.7%), iron and steel (-1.6%), nonferrous metals (-6.5%), and transportation equipment (-7.6%).

The degree to which firms rationalize or de-rationalize can be determined by comparing industry output to the number of firms. If the percent change in industry output exceeds the percent change in the number of firms, then output per firm must have risen. In the case of the United States, rationalization occurs in every sector except miscellaneous manufactures. In that industry, output rises by 2.0 percent but the number of firms increases by 2.3 percent.

This is not a particularly surprising result. The return to capital in the United States rises by 0.1 percent, causing ATC to increase. Firms return to the zero-profit position by increasing output.

On the demand side, the reduction in Canada's tariffs was expected to reduce the perceived demand elasticity of U.S. firms, while the fall in the U.S. tariff should have raised the firm's perceived elasticity of demand. Overall, the demand elasticity increased, reducing mark-up over marginal cost and further raising firm output. Miscellaneous manufactures is the only industry in the United States for which the firm's perceived elasticity of demand falls. The increased market power attendant to a fall in elasticity induces profit maximizing firms to reduce output and increase the mark-up of price over marginal cost. Thus, as noted above, output per firm in the industry also falls.

Rationalization effects for Canada are mixed. The comparatively deep tariff reductions by Canada would have been expected to increase the elasticity of demand and increase firm output. However, the return to capital fell in Canada by 1.1 percent, which tends to lower firm output. Rationalization occurred in 15 of the 22 tradable industries in Canada, but de-rationalization occurred in all of the nontradable industries.

The tradable industries in which firm output declined are agriculture, wood products, paper products, printing and publishing, chemicals, and nonmetallic mineral products. These tend to be the industries in which Canadian tariffs are already quite low. (Canadian average tariffs on U.S. exports of agricultural products is 2.2%, wood products 2.5%, printing and publishing 1.1%, and nonmetallic mineral products 4.4%.) Consequently, tariff reductions did little to increase the perceived elasticity of demand of Canadian firms.

We conclude then that the relatively large increase in welfare for Canada may in part be due to realized economies of scale. However, the U.S. welfare gain is distinctly smaller even though rationalization occurs much more consistently across all U.S. industries. Therefore, it is likely that inter-sectoral specialization is playing an important role as well.

Sectoral Results: Market Segmentation Model

Sectoral results for U.S.-Canada bilateral tariff removal in the market segmentation model are presented in Table 6 for the United States and Table 7 for Canada. The special characteristics of the market segmentation model are most readily apparent when examining the production and price changes in the United States. The reduction in Canadian tariffs on U.S. exports raises the after-tariff price received by U.S. exporters, thus increasing firm profits. The zero-profit condition is restored by a reduction in the price received for sales to the domestic market. As can be seen from column 7 of Table 6, the price paid by U.S. consumers for tradable goods generally declines. The only exceptions are leather products, iron and steel, and transportation equipment.

In addition, entry occurs in most U.S. industries. The number of U.S. firms declines only in leather products (-42.2%), petroleum products (-4.4%), rubber products (-0.4%), iron and steel (-1.8%), metal products (-0.1%), and transportation equipment (-18.0%).

The tariff reductions by the United States increase the profits of Canadian firms, as well. However, the adjustment is dominated by inter-sectoral resource shifts. Interestingly, sectoral specialization in Canada in the MS model occurs in many of the same industries as in the MC model. Output in Canada increases in only six tradable sectors: leather products, footwear, petroleum products, rubber products, nonelectrical machinery, and transport equipment. Due to increased specialization in Canada, U.S. imports from Canada decline in several sectors, such as wood products (-17.2%), paper products (-43.1%), printing and publishing (-6.0%), chemicals (-62.9%), nonmetallic mineral products (-5.1%), nonferrous metals (-185.9%), and miscellaneous manufactures (-68.1%). On the other hand, Canada's imports from the United States increase in all categories except leather products (-73.2%) and transportation equipment (-42.2%).

Exit accompanies the decline in output in most Canadian industries. The number of Canadian firms increases only in leather products (1094.5%), footwear (15.6%), petroleum products (72.0%), rubber products (14.0%), nonelectrical machinery (2.5%), and transportation equipment (153.3%).

Though the MS and MC models yield similar inter-sectoral results, the two models differ in one important respect. Rationalization is much more prevalent for Canadian firms and much less prevalent for U.S. firms in the MS model than in the MC model. A comparison of the percent change in industry output and number of firms in Canada shows that output per firm rises in 16 of the 22 tradable sectors. This result is similar to that obtained with the MC model. However, rationalization also occurs in five of the seven nontradable sectors, whereas all of the nontradable Canadian industries de-rationalized in the MC model.

In the United States, de-rationalization occurs in furniture and fixtures, petroleum products, rubber products, nonmetallic mineral products, glass products, iron and steel, metal products, nonelectrical machinery, and electrical machinery. In comparison, all U.S. industries increase output per firm in the MC model, except miscellaneous manufactures. In the nontradable industries, six of seven sectors de-rationalize in the MS model, compared to none in the MC model.

The relative return to capital in Canada increases by 1.3 percent, raising firm fixed costs. In order to maintain zero profits, firm output in Canada tends to rise. The return to capital in the U.S. increases as well, but by a much smaller 0.1%. This result suggests that the rationalization effects in the model may be quite sensitive to the method used for calculating the variable cost share, though demand side considerations are also affecting firm behavior.

VI. Summary and Conclusions

Our purpose in this paper has been to review the important modeling issues involved in analyzing the economic effects of bilateral tariff removal between the United States and Canada. The major modeling issues identified include (1) improving modeling techniques for identifying the bilateral trade which will be subject to tariff removal, (2) whether liberalization would lead firms to increase output and capture scale economies in production, (3) whether the gains from the agreement would stem from increased intra-industry trade or inter-industry trade, and (4) whether terms-of-trade effects or efficiency gains would dominate the welfare outcome of liberalization.

Three classes of models were identified as suitable for studying bilateral tariff removal. These are models in which products are differentiated at the national level, models in which products are differentiated at the firm level, and models in which markets are segmented at the national level.

In all three cases, markets may be imperfectly competitive as the result of increasing returns to scale in production. Reaping economies of scale provides an additional source of potential gain from trade liberalization, which is thought to be especially important in the Canadian case because of the small size of its national market. The determination of the scale of production for each firm in a monopolistically competitive market was shown theoretically to depend on the factor-intensity ranking of the industries most heavily protected. If liberalization raises the return to capital, thereby increasing average total cost relative to marginal cost, firm output must rise to satisfy the zero-profit and maximum-profit conditions. The opposite occurs if the return to capital falls. Though the power of rationalization effects may depend on country size, the direction does not.

Previous studies of the U.S.-Canada FTA have exhibited a strong tendency toward the conclusions that increased trade will be primarily intra-industry, rationalization will occur in most Canadian industries, but that Canada's terms of trade will deteriorate. These results were shown in section II to be influenced by the assumption of national product differentiation. In particular, national product differentiation and strong terms-of-trade effects appear to lie behind most negative welfare conclusions found for Canada.

Differentiating products by place of production is a convenient and popular procedure for identifying bilateral trade flows. However, the development of computational models with imperfectly competitive firms offers an attractive alternative. We have not provided empirical evidence that product differentiation is more likely to exist at the firm level than at the national level. However, given the artificial nature of the assumption of national product differentiation and its strong welfare, trade, and terms-of-trade implications, it should be used sparingly and only on the condition that this assumption is convincingly justified in each case. This is especially the case, in view of the fact that differentiating products at the firm level side steps many of the problems associated with differentiation at the national level.

The theoretical results were illustrated using a general equilibrium computational model. Three market structures were adopted: perfect competition with national product differentiation; monopolistic competition with firm product differentiation; and a national market segmentation model with homogeneous products.

The computational results from the monopolistic computation model without national product differentiation indicate that rationalization depends on the change in the return to capital, with the United States more likely to experience rationalization than Canada. Strong inter-industry specialization occurs, particularly in Canada, with output in Canada declining in 16 of the 22 tradable sectors and exports declining in 8 tradable sectors. Inter-sectoral specialization gains are in part responsible for an increase in Canadian welfare by 1.2 percent of GDP, despite the deterioration in Canada's terms of trade. The U.S. welfare gain is also positive but smaller in absolute terms.

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ENDNOTES

1. The Armington assumptions are that the utility function is weakly separable in goods and that the function used to aggregate the import and the domestically produced good is linearly homogeneous. That is, the utility function can be written as a function of the n goods, $U=U(X_1,\ldots,X_n)$, and each good is an aggregate of the domestic and imported varieties, $X_i=f(X_i^H,X_i^M)$. These are simply the assumptions necessary for perfect aggregation as demonstrated by Green (1964).

2. National product differentiation and the terms of trade effects of a tariff are discussed in detail in Hamilton and Whalley (1983) and Brown (1987).

3. See Brown and Stern (1988) for a summary and analysis of the various studies of the U.S. Canada FTA.

4. Flam and Helpman (1987, p. 87) explore a similar model but cast their results somewhat differently. They conclude that the utilization rate in industry 2 depends on whether the absolute value of the elasticity of supply of 2 with respect to the price of 1 is larger or smaller than the absolute value of the elasticity of R & D with respect to the price of 1.

5. Horstmann and Markusen make the additional assumption that there is a single factor of production.

6. This strong result depends on two assumptions. First, there is only one factor of production. As a result, the industry can expand without changing relative factor prices. This implies that the slope of the ATC curve does not change during the adjustment. Second, the demand for the domestic good is assumed to shift in a parallel fashion in response to changes in the price of imports. Thus, the slope of the demand curve is also unaffected. Together, these two assumptions imply that the point of tangency between the ATC curve and domestic demand will always occur at the same level of output.

7. Sufficient conditions for $A>0$ are that all countries of the model are identical and that all countries impose a positive tariff. This implies that $y_i = y_j$, $x_i^j = x_i^k$, and that $y_i > x_j^i$. An alternative is that $y_i > x_i^j + x_i^k$ and that $y_i > x_j^i$. That is, a typical firm sells more domestically than it exports, and a domestic firm sells more to the domestic market than a foreign firm.

8. This condition requires that a country 3 firm's sales to the domestic market add more to profits than exports to country 1 as compared to a typical firm in country 2. As a result, an increase in p_1 and a fall in p_3 that hold country 3 firm profits at zero will imply positive profits for country 2 firms. Thus dp_2 must be less than zero.

9. See the appendix to Brown and Stern (1988) for the proportionately differentiated equations of the model.

10. The thirty-two countries are sixteen industrialized countries: Australia, Austria, Belgium-Luxembourg, Denmark, Federal Republic of Germany, Finland, France, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, and the United Kingdom; and sixteen newly industrializing countries: Argentina, Brazil, Chile, Colombia, Greece, Hong Kong, India,

Israel, Mexico, Portugal, Singapore, South Korea, Spain, Taiwan, Turkey, and Yugoslavia.

11. Values for these parameters can be obtained from the authors on request.

12. See Brown and Stern (1987) and Boadway and Treddenick (1978).

TABLE 1

SUMMARY RESULTS OF A U.S.-CANADA FREE TRADE AREA:
CHANGES IN COUNTRY IMPORTS, EXPORTS, EXCHANGE RATES,
TERMS OF TRADE, AND WELFARE
(Trade and Welfare in Millions of U.S. Dollars)

COUNTRY	IMPORTS*	EXPORTS*	EXCHANGE RATE**	TERMS OF TRADE PERCENT CHANGE	EQUIVALENT VARIATION
A. PERFECT COMPETITION: NATIONAL PRODUCT DIFFERENTIATION					
United States	6981.3	6643.4	0.0	0.3	780.9
Other	-1758.1	-1611.2	0.2	-0.1	-145.4
Canada	6254.8	6546.8	0.6	-0.7	-28.5
B. MONOPOLISTIC COMPETITION: FIRM PRODUCT DIFFERENTIATION					
United States	9194.2	9051.7	0.0	0.1	476.1
Other	-1882.1	-1762.7	0.1	-0.1	-116.1
Canada	9366.3	9557.0	-1.0	-0.5	2304.0
C. MARKET SEGMENTATION MODEL: HOMOGENEOUS PRODUCTS					
United States	12947.9	12624.5	-0.0	0.2	-1175.3
Other	-1547.3	-1620.2	-0.0	-0.1	-240.0
Canada	10668.0	10754.2	0.0	-0.3	-1389.1
D. SENSITIVITY ANALYSIS***: PERFECT COMPETITION					
United States	14689.2	14372.4	-0.0	0.2	657.1
Other	-2991.2	-2871.0	0.2	-0.1	-267.8
Canada	13190.4	13462.4	0.6	-0.7	-163.9
E. SENSITIVITY ANALYSIS***: MONOPOLISTIC COMPETITION					
United States	19107.9	19024.4	0.0	0.1	-1002.8
Other	-3181.4	-3101.0	0.0	-0.0	-55.9
Canada	18875.5	18980.3	-1.4	-0.3	2797.2

*Dollar value of change in trade volume.
**(+) indicates depreciation of currency.
***Elasticity of substitution between varieties increased above base run.

TABLE 2
SECTORAL EFFECTS ON THE UNITED STATES OF U.S.-CANADA FREE TRADE, TARIFFS ONLY, POST-TOKYO ROUND
PERFECT COMPETITION
PERCENT CHANGE

SECTOR	EXPORTS	IMPORTS FROM		OUTPUT	CAPITAL	RENTAL RATE	EMPLOYMENT	TARIFF ON CANADA EXPORTS
		WORLD	CANADA					
Agriculture	-0.2	4.2	30.9	-0.3	-0.3	-0.1	-0.4	1.6
Food	7.0	7.5	64.4	-0.0	0.0	-0.1	-0.1	3.8
Textiles	30.7	5.8	125.0	3.4	3.4	-0.1	3.3	7.2
Clothing	47.8	3.8	255.8	0.6	0.7	-0.1	0.6	18.4
Leather Prod.	2.7	4.8	49.7	-0.3	-0.3	-0.1	-0.4	2.5
Footwear	80.5	3.0	141.3	-0.1	0.0	-0.1	-0.1	9.0
Wood Prod.	2.0	8.7	12.4	-0.7	-0.7	-0.1	-0.8	0.2
Furniture, Fixtures	77.4	31.8	80.0	0.2	0.3	-0.1	0.2	4.6
Paper Prod.	11.6	10.2	10.9	0.1	0.2	-0.1	0.1	0.0
Printing, Publishing	2.2	5.2	15.0	0.0	0.1	-0.1	0.0	0.3
Chemicals	9.4	7.4	23.5	1.0	1.1	-0.1	1.0	0.6
Petrol. Prod.	-0.9	1.2	6.4	-0.6	-0.5	-0.1	-0.7	0.0
Rubber Prod.	22.5	13.2	62.3	-0.2	-0.1	-0.1	-0.2	3.2
Nonmetal Mineral Prod.	11.2	5.5	14.7	0.2	0.2	-0.1	0.2	0.3
Glass Prod.	22.0	18.9	93.1	0.6	0.6	-0.1	0.5	5.7
Iron & Steel	8.7	6.9	48.4	-0.3	-0.3	-0.1	-0.4	2.7
Nonferr. Metals	4.6	7.4	19.3	-1.3	-1.2	-0.1	-1.3	0.5
Metal Prod.	25.1	14.2	69.7	0.4	0.4	-0.1	0.4	4.0
Nonelectrical Machinery	4.2	13.2	45.1	-0.2	-0.1	-0.1	-0.2	2.2
Electrical Mach.	11.3	5.9	81.3	0.7	0.7	-0.1	0.7	4.5
Transport Equip.	-2.1	5.7	10.8	-1.1	-1.1	-0.1	-1.1	0.0
Misc. Mfrs.	5.4	4.5	29.2	0.1	0.1	-0.1	0.0	0.9
Mining & Quarrying				-0.4	-0.3	-0.1	-0.4	
Utilities				0.0	0.0	-0.1	-0.1	
Construction				0.0	0.1	-0.1	-0.0	
Wholesale Trade				0.0	0.1	-0.1	-0.1	
Transportation				0.0	0.1	-0.1	-0.0	
Financial Services				0.0	0.0	-0.1	-0.1	
Personal Services				-0.0	0.0	-0.1	-0.0	

TABLE 3
SECTORAL EFFECTS ON CANADA OF U.S.-CANADA FREE TRADE, TARIFFS ONLY, POST-TOKYO ROUND
PERFECT COMPETITION
PERCENT CHANGE

SECTOR	EXPORTS	IMPORTS FROM		OUTPUT	CAPITAL	RENTAL RATE	EMPLOYMENT	TARIFF ON U.S. EXPORTS
		WORLD	U.S.					
Agriculture	8.0	13.3	23.6	0.5	0.5	0.4	0.8	2.2
Food	31.8	22.2	65.4	-0.3	-0.5	0.4	-0.1	5.4
Textiles	34.7	67.9	165.5	-25.1	-25.4	0.4	-25.0	16.9
Clothing	99.9	15.3	260.7	-1.5	-2.0	0.4	-1.3	23.7
Leather Prod.	22.9	4.5	27.8	17.3	16.9	0.4	17.4	4.0
Footwear	99.1	4.6	245.7	4.4	4.0	0.4	4.5	21.5
Wood Prod.	11.2	17.7	24.2	3.4	3.2	0.4	3.5	2.5
Furniture, Fixtures	79.0	99.7	160.6	0.8	0.5	0.4	0.9	14.3
Paper Prod.	9.8	68.1	74.3	0.9	0.7	0.4	1.0	6.6
Printing, Publishing	13.8	3.9	6.4	0.9	0.6	0.4	1.0	1.1
Chemicals	20.8	48.9	72.9	-13.3	-13.7	0.4	-13.1	7.9
Petrol. Prod.	6.1	-0.7	3.4	5.7	5.1	0.4	6.4	0.4
Rubber Prod.	58.7	36.6	76.4	3.6	1.9	0.4	4.0	7.3
Nonmetal Mineral Prod.	9.5	24.6	46.8	-0.4	-0.7	0.4	-0.2	4.4
Glass Prod.	73.8	40.4	60.6	-6.5	-6.9	0.4	-6.4	6.9
Iron & Steel	33.9	26.8	63.3	5.7	5.6	0.4	5.8	5.1
Nonferr. Metals	14.0	4.3	25.8	18.7	18.6	0.4	18.8	3.3
Metal Prod.	45.2	66.2	97.3	-4.6	-4.8	0.4	-4.5	8.6
Nonelectrical Machinery	34.5	12.2	22.9	7.3	6.8	0.4	7.5	4.6
Electrical Mach.	47.4	40.9	75.1	-6.5	-6.6	0.4	-6.4	7.5
Transport Equip.	10.0	-3.0	-3.2	9.1	9.0	0.4	9.2	0.0
Misc. Mfrs.	27.1	12.4	38.6	3.4	3.0	0.4	3.6	5.0
Mining & Quarrying				3.5	3.3	0.4	4.0	
Utilities				-0.4	-0.7	0.4	0.3	
Construction				-0.1	-0.4	0.4	0.1	
Wholesale Trade				-0.3	-1.0	0.4	0.0	
Transportation				-0.1	-0.6	0.4	0.1	
Financial Services				-0.3	-0.5	0.4	0.2	
Personal Services				-0.5	-0.8	0.4	-0.3	

TABLE 4
SECTORAL EFFECTS ON THE UNITED STATES OF U.S.-CANADA FREE TRADE, TARIFFS ONLY, POST-TOKYO ROUND
MONOPOLISTIC COMPETITION
PERCENT CHANGE

SECTOR	EXPORTS	IMPORTS FROM		OUTPUT	NO. FIRMS		ELASTICITY	CAPITAL	RENTAL RATE	EMPLOYMENT
		WORLD	CANADA		U.S.	WORLD				
Agriculture	0.4	3.2	17.7	-0.1	-0.1	-0.2	0.0	-0.1	0.1	-0.0
Food	8.8	5.7	50.5	0.0	-0.1	-0.1	0.0	-0.1	0.1	0.0
Textiles	43.7	-1.0	72.0	5.0	4.8	4.6	0.1	4.8	0.1	5.0
Clothing	52.1	1.9	234.2	0.9	0.7	0.6	0.0	0.8	0.1	0.9
Leather Prod.	2.7	5.8	72.2	-0.5	-0.6	0.3	0.0	-0.7	0.1	-0.5
Footwear	84.1	1.9	131.6	0.2	-0.1	-0.1	0.2	-0.0	0.1	0.2
Wood Prod.	6.6	-5.8	-9.2	1.5	0.7	0.2	0.7	1.1	0.1	1.5
Furniture, Fixtures	85.9	24.5	63.4	0.5	-0.8	-1.0	1.1	-0.6	0.1	0.5
Paper Prod.	19.4	-21.3	-23.3	3.5	2.0	0.8	1.3	2.5	0.1	3.5
Printing, Publishing	11.6	-0.2	-6.7	0.2	0.0	0.0	0.1	0.0	0.1	0.2
Chemicals	19.6	-11.5	-48.3	3.9	1.0	0.5	2.6	2.8	0.1	3.9
Petrol. Prod.	1.6	-1.0	-12.0	0.7	0.5	0.0	0.1	0.5	0.1	0.7
Rubber Prod.	27.6	12.4	63.8	-0.7	-0.8	-0.4	0.0	-0.8	0.1	-0.6
Nonmetal Mineral Prod.	17.7	-1.3	-8.9	0.7	0.6	0.5	0.0	0.6	0.1	0.7
Glass Prod.	32.6	10.6	57.9	1.1	1.0	0.8	0.0	1.0	0.1	1.1
Iron & Steel	9.3	7.8	63.8	-1.6	-1.7	-1.5	0.0	-1.8	0.1	-1.6
Nonferr. Metals	5.2	28.4	76.9	-6.5	-6.6	-2.9	0.0	-6.6	0.1	-6.5
Metal Prod.	30.6	9.8	52.6	-0.1	-0.2	-0.2	0.0	-0.2	0.1	-0.1
Nonelectrical Machinery	7.4	5.8	22.6	0.7	0.6	0.2	0.0	0.6	0.1	0.7
Electrical Mach.	15.9	2.5	60.1	1.2	-0.2	-0.3	1.2	0.1	0.1	1.2
Transport Equip.	-11.0	44.6	96.0	-7.6	-15.8	-11.3	7.5	-13.1	0.1	-7.5
Misc. Mfrs.	10.0	-0.3	-1.3	2.0	2.3	1.1	-0.4	2.1	0.1	2.0
Mining & Quarrying				0.1	0.1		0.0	0.1	0.1	0.2
Utilities				0.0	-0.0		-0.0	-0.0	0.1	0.1
Construction				-0.1	-0.1		-0.0	-0.2	0.1	-0.1
Wholesale Trade				-0.1	-0.2		-0.0	-0.2	0.1	-0.1
Transportation				0.0	-0.1		-0.0	-0.1	0.1	0.0
Financial Services				-0.0	-0.0		-0.0	-0.1	0.1	0.0
Personal Services				-0.1	-0.2		-0.0	-0.2	0.1	-0.1

TABLE 5
SECTORAL EFFECTS ON CANADA OF U.S.-CANADA FREE TRADE, TARIFFS ONLY, POST-TOKYO ROUND
MONOPOLISTIC COMPETITION
PERCENT CHANGE

SECTOR	EXPORTS	IMPORTS FROM		OUTPUT	NO. FIRMS		ELASTICITY	CAPITAL	RENTAL RATE	EMPLOYMENT
		WORLD	U.S.		CANADA	WORLD				
Agriculture	-1.2	22.1	32.4	-4.8	-4.6	-4.2	-0.1	-4.5	-1.1	-5.4
Food	20.8	34.7	78.1	-1.8	-1.8	-1.7	0.2	-0.9	-1.1	-2.0
Textiles	5.1	112.3	212.9	-32.5	-33.6	-24.6	0.5	-32.8	-1.1	-32.6
Clothing	86.5	31.9	279.0	-5.1	-6.0	-4.8	0.4	-4.5	-1.1	-5.1
Leather Prod.	42.8	1.7	25.4	37.2	36.1	4.0	1.0	37.4	-1.1	37.2
Footwear	91.6	12.2	254.4	2.8	0.9	0.6	1.3	3.2	-1.1	2.7
Wood Prod.	-10.4	34.8	41.7	-9.0	-6.5	-5.5	-2.2	-6.8	-1.1	-9.1
Furniture, Fixtures	62.4	116.2	177.6	-1.2	-13.1	-11.7	11.1	-9.1	-1.1	-1.3
Paper Prod.	-22.6	93.9	100.4	-20.4	-19.3	-17.4	-0.9	-19.4	-1.1	-20.5
Printing, Publishing	-7.2	20.0	22.7	-4.9	-3.0	-2.6	-1.4	-3.0	-1.1	-5.1
Chemicals	-50.4	91.0	116.1	-52.4	-38.2	-27.4	-13.1	-44.0	-1.1	-52.7
Petrol. Prod.	-12.0	12.1	17.2	-9.6	-9.9	-2.5	0.5	-6.9	-1.1	-9.7
Rubber Prod.	60.2	52.1	92.2	18.7	18.1	13.9	0.5	23.1	-1.1	18.4
Nonmetal Mineral Prod.	-11.8	44.0	66.6	-10.6	-10.4	-8.2	-0.0	-9.7	-1.1	-10.9
Glass Prod.	39.1	65.8	86.5	-20.1	-22.3	-14.0	2.1	-20.2	-1.1	-20.3
Iron & Steel	48.3	33.5	69.7	27.4	27.0	22.6	0.6	27.5	-1.1	27.4
Nonferr. Metals	68.0	24.6	44.7	68.1	67.7	-4.1	0.2	68.2	-1.1	68.1
Metal Prod.	32.7	85.3	116.6	-3.0	-3.8	-3.3	0.8	-2.8	-1.1	-3.0
Nonelectrical Machinery	15.1	21.1	32.2	-9.6	-13.1	-3.1	3.1	-11.2	-1.1	-9.7
Electrical Mach.	31.5	58.6	93.6	-10.4	-16.7	-12.7	5.4	-15.1	-1.1	-10.5
Transport Equip.	89.4	-20.7	-21.4	85.1	48.6	18.3	33.2	50.1	-1.1	85.1
Misc. Mfrs.	-3.2	27.5	55.0	-18.8	-33.5	-12.8	13.3	-27.4	-1.1	-18.9
Mining & Quarrying				-2.2	-2.0		-0.1	-1.6	-1.1	-3.3
Utilities				-1.5	-1.0		-0.1	-0.4	-1.1	-2.9
Construction				0.7	0.8		0.1	1.6	-1.1	0.4
Wholesale Trade				0.9	1.4		0.2	3.0	-1.1	0.4
Transportation				0.6	1.0		0.1	2.0	-1.1	0.3
Financial Services				1.1	1.3		0.1	1.9	-1.1	0.1
Personal Services				0.3	0.9		0.1	1.2	-1.1	-0.1

TABLE 6
SECTORAL EFFECTS ON THE UNITED STATES OF U.S.-CANADA FREE TRADE, TARIFFS ONLY, POST-TOKYO ROUND
MARKET SEGMENTATION MODEL
PERCENT CHANGE

SECTOR	EXPORTS	IMPORTS FROM		OUTPUT	FIRMS U.S.	PRICE	MARGINAL COST	CAPITAL	RENTAL RATE	EMPLOYMENT
		WORLD	CANADA							
Agriculture	5.3	0.6	13.2	1.2	1.0	-0.0	-0.0	1.1	0.1	1.3
Food	15.3	4.5	59.6	0.2	0.1	-0.0	-0.0	0.0	0.1	0.2
Textiles	67.9	-7.1	81.6	8.1	6.9	-0.5	-0.2	7.2	0.1	8.1
Clothing	77.3	-4.2	303.0	2.5	2.1	-0.3	-0.2	2.3	0.1	2.5
Leather Prod.	-45.8	92.9	1150.9	-42.1	-42.2	0.2	-0.0	-42.3	0.1	-42.1
Footwear	104.4	-1.4	219.4	1.4	1.4	-0.1	-0.0	1.2	0.1	1.4
Wood Prod.	12.1	-11.8	-17.2	2.9	2.4	-0.1	-0.0	2.8	0.1	3.0
Furniture, Fixtures	114.5	27.4	76.6	0.4	0.5	-0.2	-0.1	0.4	0.1	0.4
Paper Prod.	31.9	-39.6	-43.1	6.2	5.3	-0.2	-0.1	5.5	0.1	6.3
Printing, Publishing	17.0	-2.0	-6.0	0.4	0.3	-0.0	-0.0	0.3	0.1	0.4
Chemicals	30.8	-17.3	-62.9	6.3	5.5	-0.3	-0.0	5.8	0.1	6.3
Petrol. Prod.	-1.1	10.4	72.2	-4.5	-4.4	0.0	0.0	-4.6	0.1	-4.3
Rubber Prod.	45.3	11.1	69.1	-0.8	-0.4	-0.1	-0.1	-0.8	0.1	-0.8
Nonmetal Mineral Prod.	24.2	-2.3	-5.1	0.8	0.9	-0.0	0.0	0.7	0.1	0.8
Glass Prod.	39.3	12.4	81.7	0.6	0.9	-0.1	-0.0	0.6	0.1	0.6
Iron & Steel	12.2	3.1	40.9	-3.0	-1.8	0.1	0.0	-2.2	0.1	-3.0
Nonferr. Metals	21.2	-67.0	-185.9	14.7	10.8	-0.1	-0.0	14.1	0.1	14.7
Metal Prod.	42.4	9.8	64.7	-0.9	-0.1	-0.0	0.0	-0.5	0.1	-0.9
Nonelectrical Machinery	10.2	10.8	48.4	0.5	0.6	-0.1	-0.0	0.5	0.1	0.5
Electrical Mach.	24.5	0.2	72.6	1.8	2.0	-0.1	-0.0	1.9	0.1	1.8
Transport Equip.	-28.6	88.3	185.6	-17.6	-18.0	0.3	0.0	-17.9	0.1	-17.6
Misc. Mfrs.	25.0	-11.8	-68.1	7.4	7.2	-0.2	-0.0	7.3	0.1	7.5
Mining & Quarrying				-2.0	-0.2	0.1	0.0	-2.0	0.1	-1.9
Utilities				0.1	0.0	0.1	0.1	0.0	0.1	0.2
Construction				-0.2	-0.0	-0.0	-0.0	-0.2	0.1	-0.1
Wholesale Trade				-0.2	-0.0	0.0	0.0	-0.4	0.1	-0.1
Transportation				-0.1	-0.0	0.0	0.0	-0.2	0.1	-0.0
Financial Services				-0.1	-0.0	0.1	0.1	-0.1	0.1	0.0
Personal Services				-0.2	-0.0	0.0	0.0	-0.3	0.1	-0.2

TABLE 7
SECTORAL EFFECTS ON CANADA OF U.S.-CANADA FREE TRADE, TARIFFS ONLY, POST-TOKYO ROUND
MARKET SEGMENTATION MODEL
PERCENT CHANGE

SECTOR	EXPORTS	IMPORTS FROM		OUTPUT	FIRMS CANADA	PRICE	MARGINAL COST	CAPITAL	RENTAL RATE	EMPLOYMENT
		WORLD	U.S.							
Agriculture	-11.5	38.7	55.3	-11.2	-7.8	0.9	0.5	-11.0	1.3	-10.5
Food	20.7	49.9	110.5	-4.2	-4.0	0.5	0.5	-5.2	1.3	-4.1
Textiles	-16.3	160.1	297.6	-39.8	-46.8	-0.6	-0.1	-46.1	1.3	-39.7
Clothing	111.0	42.1	378.1	-10.9	-11.3	-0.4	-0.4	-13.0	1.3	-10.9
Leather Prod.	1116.8	-93.6	-73.2	1098.2	1094.5	-7.6	-0.3	1095.4	1.3	1098.3
Footwear	170.0	-21.6	304.8	20.6	15.6	-2.6	-2.0	15.3	1.3	20.7
Wood Prod.	-18.0	48.8	58.7	-15.4	-13.9	0.7	0.4	-15.8	1.3	-15.3
Furniture, Fixtures	75.4	151.1	233.7	-5.4	-9.2	-0.9	-0.0	-9.3	1.3	-5.4
Paper Prod.	-42.3	134.6	143.5	-34.9	-31.8	1.4	0.5	-34.7	1.3	-34.7
Printing, Publishing	-6.6	26.4	30.5	-4.1	-4.5	0.5	0.4	-5.6	1.3	-4.1
Chemicals	-64.9	127.1	161.6	-72.5	-64.2	1.4	0.4	-69.4	1.3	-72.1
Petrol. Prod.	72.2	-5.4	17.2	75.3	72.0	-0.2	0.1	72.4	1.3	77.0
Rubber Prod.	64.8	84.8	140.7	35.3	14.0	-1.9	0.2	16.3	1.3	35.8
Nonmetal Mineral Prod.	-8.1	52.0	83.2	-7.9	-10.5	-0.3	0.0	-10.5	1.3	-7.6
Glass Prod.	57.4	72.1	99.4	-14.1	-23.4	-1.9	0.0	-20.8	1.3	-13.9
Iron & Steel	23.9	34.5	82.8	-19.3	-11.7	0.3	-0.0	-12.5	1.3	-19.3
Nonferr. Metals	-191.6	21.4	50.1	-191.9	-195.0	0.5	0.2	-192.6	1.3	-191.8
Metal Prod.	37.9	113.9	156.2	-4.0	-8.9	-0.4	0.1	-7.5	1.3	-3.9
Nonelectrical Machinery	37.6	22.6	37.6	5.3	2.5	-2.8	-0.2	1.2	1.3	5.5
Electrical Mach.	35.0	80.0	127.7	-14.7	-19.0	-0.9	-0.4	-18.1	1.3	-14.6
Transport Equip.	185.3	-40.3	-42.2	170.6	153.3	-4.3	-1.4	156.8	1.3	170.7
Misc. Mfrs.	-70.0	60.5	100.2	-76.7	-78.7	-0.2	0.2	-78.7	1.3	-76.3
Mining & Quarrying				33.1	14.1	-0.0	0.7	31.3	1.3	34.6
Utilities				-3.3	-1.9	0.8	0.6	-4.3	1.3	-1.6
Construction				-0.9	-1.0	0.2	0.1	-2.0	1.3	-0.5
Wholesale Trade				-0.4	-0.7	0.3	0.3	-3.0	1.3	0.1
Transportation				0.1	-0.5	0.1	0.1	-1.7	1.3	0.5
Financial Services				1.2	0.2	0.5	0.6	0.1	1.3	2.4
Personal Services				-1.8	-1.3	0.5	0.4	-2.6	1.3	-1.3