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Market Structure, the Exchange Rate, and Pricing Behavior by Firms: Some Evidence from Computable General Equilibrium Trade Models*

by

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I. Introduction

Recent experience with exchange rate movements, particularly of the U.S. dollar, suggests that purchasing power parity is not restored following an exchange rate change in some markets even at the firm level. During the period of the strong dollar in the early 1980s, it was observed that the foreign currency price on sales to the U.S. market tended to be higher than the foreign currency price on goods in foreign markets both for broad trade categories and for individual manufacturers. Prices on the U.S. market did not fall as much as the law of one price would predict in response to the dollar appreciation. Rather, the profit margin on sales to the U.S. market were permitted to increase. This phenomenon, known as *pricing to market*, has been used subsequently to explain the slow response of the U.S. current account deficit to the decline of the dollar.

Empirical evidence to support this view is fairly convincing and has been carefully documented by Mann (1986), Hooper and Mann (1987), Krugman (1987), and others. For example, Krugman compares the average price of German exports[1] to the United States and to the rest of the world between 1980 and 1983, a time period in which the Deutsche mark declined against the U.S. dollar by 29 percent. The Deutsche mark price index for German manufactured exports to the United States fell by one percent, while the price of this same bundle of exports to the rest of the world declined by 14 percent. Consequently, the profitability of German exports to the U.S. market relative

[1]The price indexes were constructed by first calculating unit values for German exports to the United States and for exports to the rest of the world. Unit values were then aggregated weighting by German exports to the United States in 1980.

to sales to other markets improved considerably. Data from individual SITC categories indicate, however, that evidence of pricing to market by German exporters is confined primarily to the machinery and transport equipment sectors. There is little or no divergence between export prices to the United States and the rest of the world in such categories as chemicals and basic manufactures.

Similarly, Hooper and Mann found that between 1985:1 and 1987:1, Japan's yen export prices to all countries increased nearly twice as fast as its export prices to the United States. Profit margins on Japanese exports to the United States correspondingly declined.

Dornbusch (1987) employed a static Cournot model, in which national markets are segmented, to demonstrate that a dollar appreciation will reduce the equilibrium dollar price of traded goods in the United States but by proportionately less than the appreciation of the currency. Segmented markets are those in which a firm can effectively prevent arbitrage in its product across national boundaries. Under these circumstances, a U.S. dollar appreciation will result in foreign suppliers receiving more for sales to the U.S. market than for sales in other markets.

Krugman (1987), however, points out that the dollar appreciation will also raise the equilibrium foreign currency price in the foreign market in the Cournot model. If the elasticity of demand in each market is constant, then the exchange rate change will be exactly reflected in the relative local currency price between the two markets, even in the absence of arbitrage. Therefore, whatever difference which initially exists between the prices charged in the two markets will be unaffected by the dollar appreciation.

In response to Krugman's criticism of the static model, a number of dynamic models have been developed which yield pricing to market in the face of an exchange rate change. (See in particular, Dohner (1984), Krugman (1987), and Giovannini (1988).) These models generally depend on dynamic cost of adjustment on the supply side, lags in the adjustment of prices, or lags in the effect of price changes on demand. In almost all cases the analysis is partial equilibrium and, therefore, ignores general equilibrium effects that may give rise to pricing to market.

This paper returns to the static Cournot model, criticized by Krugman, and demonstrates that an exchange rate change will have general equilibrium effects that, in the presence of tariffs or transportation costs, are likely to give rise to pricing to market. In particular, a dollar appreciation will cause changes in the prices of primary factors and intermediate inputs which lower marginal cost for U.S. producers relative to foreign producers. Remarkably, the fall in U.S. production costs, in turn, lowers the *foreign* market price relative to the U.S. market price when tariffs or transportation costs are present. Thus, exchange rate pass-through appears to be incomplete because the change in relative production costs has also altered the real equilibrium price structure for the two markets. This outcome is entirely consistent with profit-maximization in a one-period model.

Section II below discusses in theoretical terms the determinants of the relative price of goods sold in the domestic market and those exported using a two-country Cournot model. A general equilibrium computational trade model is then used to illustrate the likely implications of a U.S. dollar appreciation for the pricing to market hypothesis. The model is described in section III and results are presented in section IV. Conclusions follow.

II. A Theoretical Model

In this section, a two-good two-country model is used to illustrate the effect of a U.S. dollar appreciation on relative prices between the United States and foreign markets. Good 1 is produced with capital and labor using constant returns to scale technology, sold on perfectly competitive domestic markets, but not traded internationally. Production of good 2 requires a fixed input of capital plus variable inputs of capital and labor. Variable input requirements are characterized by constant returns to scale, but the fixed capital requirement gives rise to a downward sloping average total cost curve.

One firm in each country supplies good 2 to the domestic and foreign markets. Each firm plays a Cournot game, taking sales in each market by the other firm as fixed. National markets for good 2 are assumed to be segmented so that the price in each market can be set independently to maximize firm profits. Without this assumption, arbitrage would automatically eliminate any pricing to market which might otherwise emerge.

In contrast, all firms in both industries behave as price takers in the input markets, paying each factor its marginal value product. Capital is assumed to be mobile between sectors, but not between countries, and the return to capital is determined to equate supply and demand.

The nominal wage paid to labor is set exogenously. This assumption is necessary because the price system would be characterized by zero-degree homogeneity in the absence of some rigidity. The exchange rate, as a nominal variable, would not be able to affect the real equilibrium and would, therefore, have no role. By fixing the wage, a change in the exchange rate can affect the real equilibrium by altering the relative wage between the two countries in the model.

The utility function underlying demand in each market is assumed to be Cobb-Douglas. Krugman (1987), drawing on Brander and Spencer (1984), has demonstrated that an exchange rate change will lead to pricing to market if the elasticity of demand is increasing in price, but not if the elasticity of demand is constant. Here, our intention is to abstract from the ambiguity associated with various curve shapes and, therefore, choose a demand function with constant elasticity. The Cobb-Douglas utility function is chosen for simplicity, but the results generalize to any demand function with this property.

The profit maximization problem faced by the producer of good 2 in the home country (the United States) is

$$\max_{\{P_2,P_2^*\}} \left[\frac{\alpha E}{P_2} - s_H^*\right] (P_2 - MC_2) + \left[\frac{\alpha^* E^*}{P_2^*} - s_F^*\right] \left[\frac{P_2^*}{R(1+t^*)} - MC_2\right] - FC_2 \tag{1a}$$

where P_2 is the price of good 2 prevailing on the market in the home country valued in the local currency, αE is expenditure on good 2, s_H (s_F) is firm supply to the home (foreign) market, MC_2 is marginal cost in industry 2, t is the ad valorem import tariff, FC_2 is the fixed cost, and R is the foreign currency price of the U.S. dollar. (An increase in R is an appreciation of the U.S. dollar.) An asterisk indicates a foreign variable. Similarly, the profit maximization problem faced by the foreign firm in industry 2 is

$$\max_{\{P_2,P_2^*\}} \left[\frac{\alpha E}{P_2} - s_H\right] \left[\frac{R\ P_2}{1+t} - MC_2^*\right] + \left[\frac{\alpha^* E^*}{P_2^*} - s_F\right] (P_2^* - MC_2^*) - FC_2^*. \tag{1b}$$

Profit maximization yields the usual first order conditions which imply that supply by the home and foreign firms to the home country market are, respectively,

$$s_H = \frac{\alpha E}{P_2} \frac{(P_2 - MC_2)}{P_2} \tag{2a}$$

and

$$s_H^* = \frac{\alpha E}{P_2} \frac{\left[\frac{R\ P_2}{1+t} - MC_2^*\right]}{\frac{R\ P_2}{1+t}} \tag{2b}$$

and to the market in the foreign country are

$$s_F = \frac{\alpha^* E^*}{P_2^*} \frac{\left[\frac{P_2^*}{R(1+t^*)} - MC_2\right]}{\frac{P_2^*}{R(1+t^*)}} \tag{2c}$$

and

$$s_F^* = \frac{\alpha^* E^*}{P_2^*} \frac{(P_2^* - MC_2^*)}{P_2^*}. \tag{2d}$$

Using the market clearing condition that demand in each market must be equal to supply, we can find the equilibrium price in each market to be

$$P_2 = MC_2 + \frac{(1+t)}{R} MC_2^* \tag{3a}$$

and

$$P_2^* = MC_2\ R\ (1+t^*) + MC_2^*. \tag{3b}$$

It is obvious from equations (3a) and (3b) that a U.S. dollar appreciation will reduce P_2 and increase P_2^* but in both cases by proportionately less than the change in R.

If pricing to market occurs as the result of an appreciation of the U.S. dollar, then an increase in R must increase P_2^*/P_2 but by proportionately less than the change in the exchange rate. As a result, the foreign firm will find sales to the home country market more profitable than sales to the foreign country market. Proportionately differentiating the equilibrium price equations, equations (3a) and (3b), we find that

$$\hat{P}_2^* - \hat{P}_2 = \left[\frac{K_2}{K_2 + 1} - \frac{K_1}{K_1 + 1}\right] \hat{MC}_2 + \left[\frac{1}{K_2 + 1} - \frac{1}{K_1 + 1}\right] \hat{MC}_2^* + \left[\frac{K_2}{K_2 + 1} + \frac{1}{K_1 + 1}\right] \hat{R}, \quad (4)$$

where $K_1 = R\ MC_2/MC_2^*(1+t)$, $K_2 = R(1+t^*)MC_2/MC_2^*$, and the circumflex indicates proportionate change. K_1 and K_2 can be interpreted as a measure of the tariff adjusted relative competitiveness of the home country firm in the home and foreign markets, respectively. K_1 will differ from K_2 if tariff protection by either or both countries is significant.

There are a couple of points worth noting about equation (4). First, if tariffs and transportation costs are zero then $K_1 = K_2$ so that the coefficients on the two marginal cost terms are zero and the coefficient on the exchange rate term is unity. Under such circumstances a change in the underlying cost structure would not affect relative prices in the two markets, and a change in the exchange rate will be proportionately reflected in the relative domestic currency prices of domestic sales and exports. Thus, we would not expect a change in the exchange rate to give rise to pricing to market behavior by firms. This is the point made by Krugman (1987, p. 62).

The presence of positive tariffs and transportation costs makes the case against pricing to market and the exchange rate is even stronger. The coefficient on the exchange rate term is increasing in both tariff rates. Therefore, a change in the exchange rate will imply a *greater* than proportionate increase in the foreign market price relative to the U.S. market price. This is exactly the opposite of the relative price movement predicted by the pricing to market hypothesis.

However, an appreciation of the U.S. dollar ($\hat{R} > 0$) might also be expected to increase marginal cost in the foreign country, while lowering marginal cost in the home country valued in the local currency. The coefficient on the MC_2 term in equation (4) is positive and the coefficient on the MC_2^* term is negative. Therefore, if changes in the cost structure are significant, then the change in relative prices between the two markets may be smaller than the change in the exchange rate, giving an explanation of pricing to market that we are seeking.

The outcome that a reduction in U.S. production cost lowers the price on the foreign market relative to the domestic market may seem paradoxical at first, but can be understood by considering equations (3a) and (3b). These two equations give equilibrium prices for the two markets which are the outcome of a Cournot game. Note that the prices in the two markets differ only if import tariffs are present. It is clear that a change in foreign production cost is magnified by the ad valorem tariff before it is transmitted to the domestic price level. A change in domestic production cost, on the other hand, is not subject to a tariff so there is no magnification effect on the domestic price level. Consequently, a change in the production cost of the foreign producer has a bigger effect on the domestic market price than on the foreign market price.

There are two channels through which the exchange rate could alter marginal cost. First, the U.S. dollar appreciation is expected to lower the return to capital in the United States, while raising the return to capital in the foreign country. To see this point the model must be completed by adding the factor markets and the market for good 1.

Turning first to the market for good 1, it has been assumed that this market is perfectly competitive, implying that price equals marginal cost. That is

$$\hat{P}_1 = \theta_{K1}\,\hat{r} \tag{5}$$

where P_1 is the price of good 1 in the home country, r is the return to capital, and θ_{ij} is factor i's share of total cost in industry j. Here the effect of changes in the wage on marginal cost have been suppressed since the wage is set exogenously. The demand for good 1 is derived from a Cobb-Douglas utility function, implying that

$$\hat{Q}_1 = -\,\hat{P}_1 \tag{6}$$

where Q_1 is quantity of good 1.

Capital market equilibrium requires that the demand for capital equal a fixed supply, so that

$$K = a_{K1}(r)\;Q_1 + a_{K2}(r)\;q_2 + K_F \tag{7}$$

where a_{ij} is the unit input requirement of factor i in industry j, K_F is the fixed capital requirement in industry 2, and $q_2 = s_H + s_F$ is total output by industry 2. Proportionately differentiating equation (7) yields

$$\delta_K\,\hat{r} = \lambda_{K1}\,\hat{Q}_1 + \lambda_{K2}^{V}\,\hat{q}_2 \tag{7'}$$

where $\delta_K = \lambda_{K1}\,\theta_{L1}\,\bar{\sigma}_1 + \lambda_{K2}^{V}\,\theta_{L2}\,\bar{\sigma}_2$,

λ_{K2}^{V} is variable capital in industry 2's share of total capital employment, λ_{ij} is industry j's share of total employment of factor i, and $\bar{\sigma}_i$ is the elasticity of substitution between capital and labor in industry i.

Combining (5), (6), and (7') we find that

$$\hat{r} = \frac{\lambda_{K2}^{V}}{\delta_K + \lambda_{K1}\,\theta_{K1}}\,\hat{q}_2. \tag{8}$$

Equation (8) implies that if the U.S. dollar appreciation reduces output by industry 2 then the return to capital must also fall. This in turn implies that marginal cost in industry 2,

$$\hat{MC}_2 = \theta^V_{K2}\, M\, \hat{r}, \tag{9}$$

(where $M = ATC_2/MC_2$), will decline. Industry 2 output then plays an important role in determining whether pricing to market emerges in this model.

Industry 2 output can be determined by evaluating the supply functions at the equilibrium price. Proportionately differentiating equations (2a) and (2c), we obtain home country supply to each market to be

$$\hat{s}_H = (K_1 - 1)\,\hat{P}_2 - K_1\,\hat{MC}_2 \tag{2a'}$$

and

$$\hat{s}_F = (K_2 - 1)\hat{P}^*_2 - K_2(\hat{R} + \hat{MC}_2). \tag{2c'}$$

The proportionate change in industry output is a sales share weighted average of the proportionate change in supply to each of the two markets. That is

$$\hat{q}_2 = \epsilon_H\,\hat{s}_H + \epsilon_F\,\hat{s}_F, \tag{10}$$

where ϵ_i is the share of home country production sold to market i. Combining the proportionately differentiated version of equations (3a) and (3b) with equations (2a'), (2b'), (9), and (10), we obtain

$$\hat{q}_2 = - \frac{\left[\dfrac{\epsilon_H(K_1 - 1)}{K_1 + 1} + \dfrac{2\,\epsilon_F\,K_2}{K_2 + 1}\right]}{1 + \dfrac{2\,M\,\theta^V_{K2}\,\lambda^V_{K2}}{\delta_K + \lambda_{K1}\,\theta_{K1}}\left[\dfrac{\epsilon_H\,K_1}{K_1 + 1} + \dfrac{\epsilon_F\,K_2}{K_2 + 1}\right]}\,\hat{R}. \tag{10'}$$

It can be seen from equation (10') that an appreciation will unambiguously reduce industry 2 output, and therefore, reduce marginal cost, if the U.S. firm is the high cost supplier in the U.S. market, i.e., $K_1 > 1$. In this case, the fall in marginal cost in the United States could be large enough to give rise to pricing to market. However, if the United States is the low cost supplier and exports account for a sufficiently small fraction of total production (ϵ_F is small), then industry 2 output could increase, with the implication that pricing to market will definitely not occur in response to an appreciation.

The ambiguity stems from the fact that in the home country market, the reaction function for the home country firm is not monotonic. It is straightforward to show, from the maximization problem of equations (1a) and (1b), that the reaction functions for the home and foreign firms in the home market are

$$s_H = \left[\frac{\alpha E\ s_H^*}{MC_2}\right]^{1/2} - s_H^* \tag{11a}$$

and

$$s_H^* = \left[\frac{\alpha E\ s_H\ K_1}{MC_2}\right]^{1/2} - s_H, \tag{11b}$$

respectively. The home firm reaction function reaches a maximum at

$$s_H = s_H^* = \frac{\alpha E}{4\ MC_2} \tag{12a}$$

and the foreign firm reaction function reaches a maximum at

$$s_H = s_H^* = \frac{\alpha E\ K_1}{4\ MC_2}, \tag{12b}$$

as depicted in Figure 1.

A U.S. dollar appreciation will shift the foreign reaction function, s_H^*, to the right (by increasing K_1), increasing foreign supply to the home market.

There are two possible implications of an appreciation for domestic supply to the domestic market. If the foreign supplier is more cost competitive in the home country market than the domestic firm, so that $K_1 > 1$, then its market share would be greater than one-half. This would imply that the initial equilibrium would occur on the downward sloping portion of the home country reaction function, such as point A. A currency appreciation would shift the new equilibrium to A′, reducing s_H and increasing s_H^*.

In this case, the currency appreciation will reduce home country supply to both the domestic and foreign markets. Industry output will therefore decline, lowering the return to capital, which in turn lowers marginal cost. As discussed above, this decline in marginal cost may give rise to pricing to market in the presence of tariffs.

In contrast, if the foreign supplier is less cost competitive in the home country market, so that $K_1 < 1$, then its market share will be less than one-half. The initial equilibrium in this case will occur on the upward sloping portion of the home country reaction function, such as point B. A currency appreciation will shift the new equilibrium to a point such as B′, increasing both s_H and s_H^*. As a result, industry output in the home country may rise or fall, having an ambiguous effect on the return to capital and marginal cost.

A dollar appreciation will also lower the price of traded intermediate inputs in the United States, while having the opposite impact on the foreign firm. In this case, a dollar appreciation will further reduce MC_2 and increase MC_2^*, increasing the likelihood that pricing to market occurs. In fact, the change in traded intermediate input prices is perhaps of greater importance in determining marginal cost than changes in the return to capital.

In order to shed further light on the possibility that a Cournot market structure might explain the pricing to market phenomenon during the most recent dollar cycle, we have constructed a large scale general equilibrium computational model that can be used to calculate the trade and price effects of a U.S. dollar appreciation. The model and computational results are presented in the following sections.

III. The Computational Model

We have constructed a four-region computational model for the purpose of illustrating the theoretical issues discussed in section II, above. 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.[2] Sectoral coverage includes twenty-two tradable product categories based on three-digit ISIC industries and seven nontradable categories based on one-digit ISIC industries.

Each sector in the model is assigned one of five different market structures. Six of the tradable sectors are assumed to have nationally segmented markets and are organized along the lines outlined in the previous section, though typically with more than one firm in each country. Each product is homogeneous across firms and countries, but arbitrage between national markets is assumed not to occur. Firms play a Cournot game, setting price in each market to maximize total profits, taking output by other firms as fixed. In the base run of the model, entry by new firms is not possible.

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[2]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.

However, we subsequently consider the possibility that non-zero profits will change the number of firms.

The other sectors of the model are characterized by varying types of product differentiation. Products in the perfectly competitive sector are differentiated by national origin. These goods are produced with constant returns to scale technology and free entry guarantees zero economic profits. Monopolistically competitive sectors differ in that product differentiation exists at the firm level, there are increasing returns to scale, firms set price as a profit-maximizing mark-up over marginal cost assuming that prices of other goods are fixed, and free entry guarantees that profits are zero. In highly concentrated industries entry is unlikely, so an oligopolistic structure is adopted. Each firms sells a differentiated product, sets a profit-maximizing mark-up of price over marginal cost, but may earn positive profits.

Inevitably, the theoretical market structures outlined here can only approximate firm behavior so that, in practice, most industries are not easily assigned a single market type. Our purpose, however, is to explore the ability of the Cournot market segmentation model to explain pricing to market behavior for those industries in which incomplete exchange rate passthrough for the U.S. dollar occurred during the early 1980s. Empirical analysis shows that in most sectors arbitrage across national boundaries is feasible and likely. Therefore, we have chosen to impose the law of one price on the three market types in which products are differentiated, ruling out the possibility that pricing to market could occur in these sectors. The market structure assignments by industry are detailed in Table 1.

Turning now to the determination of demand, consumers in all sectors initially allocate final demand and producers allocate intermediate demand across sectors without regard to the production source. Bilateral trade flows are identified in the perfectly competitive sectors by assuming that consumers and producers aggregate the variety produced by each country using a CES aggregator 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, $P_{ij}D_{ij}$, is

$$D^r_{ij} = \frac{P_{ij}D_{ij}(P^r_{ij})^{-\sigma}}{\sum_{s=1}^{m}(P^s_{ij})^{1-\sigma}} \tag{13a}$$

where P^r_{ij} is the price consumers in country i pay for good j produced in country r and σ is the elasticity of substitution among the varieties of good j. The consumer price differs between countries only by the exchange rate and tariffs, that is

$$P^i_{sj} = P^i_{rj}\,\frac{R_s}{R_r}\,\frac{(1+t_s)}{(1+t_r)},$$

where t_i is country i's import tariff.

Bilateral trade flows in the monopolistically competitive and oligopolistic sectors are similarly identified. However, product differentiation is firm specific. Therefore, demand in country i for the output of a representative firm in country r is

$$D^r_{ij} = \frac{P_{ij}D_{ij}(P^r_{ij})^{-\sigma}}{\sum_{s=1}^{m}n_{sj}(P^s_{ij})^{1-\sigma}}, \tag{13b}$$

where n_{sj} is the number of firms in industry j in country s.

Monopolistically competitive and oligopolistic firms set price as a profit-maximizing mark-up over marginal cost according to

$$MC = P\ (1 + \frac{1}{\eta}) \tag{14}$$

where $\eta < -1$ is the firms perceived elasticity of demand. The elasticity of demand for a firm's sales to country i can be calculated from equation (13b) to be

$$\eta^i = -\sigma + (\sigma-1)\ \theta^i, \tag{15}$$

where θ^i is the firm's share of the market in country i. The elasticity of demand in equation (14) is a sales weighted average over all national markets of equation (15). In the imperfectly competitive sectors in which freedom of entry is permitted, profits must be zero. Therefore, price must also equal average total cost.

The production function in all market types 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 monopolistically competitive, oligopolistic, and Cournot sectors.

Capital and labor are mobile between sectors but not countries. The return to capital is determined by equating demand to a fixed supply of capital. The nominal return to labor is held constant. As discussed above, this assumption is necessary to give the exchange rate a role in determining real variables in the model.

A difficulty with fixing the nominal wage is that a currency appreciation is likely to lower employment in the United States. However, the dollar appreciation in the early 1980s was largely due to a fiscal expansion so that employment generally rose during this period. Accordingly, we make the neutral assumption that fiscal policy is assumed to adjust aggregate demand to hold total employment constant at the base level.

There are two main implications of this choice for fiscal policy. First, the fiscal stimulus, by maintaining the employment level, will put upward pressure on the return to capital. The increase in the return to capital will, in turn, raise marginal cost for U.S. firms, thereby weakening the possibility that pricing to market will emerge when the dollar appreciates. Second, the fiscal expansion will fall partly on imports, reinforcing the effect that the currency appreciation is expected to have on the current account. These points will become apparent from the computational results.

Equilibrium prices are determined in global markets to equate supply and demand. In the perfectly competitive sectors one price is determined for each national variety of each good, whereas in the monopolistically competitive sectors one price is determined for each firm. However, firms within each country face identical production costs and demand is symmetric with regard to product variety. Therefore, all firms within an industry and country charge the same price. In the Cournot sectors, one price is determined for each national market. Thus, all firms selling in a single national market must charge the same price.

The equations of the model are log differentiated so that the model can be solved using straightforward matrix inversion. 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 elasticity of substitution between capital and labor in the production function was adapted from estimates reported by Zarembka and Chernicoff (1971). The factor cost shares and the firm's perceived elasticity of demand can be calculated from the base year data once the elasticity of substitution among different varieties of each good in equation (12) has been chosen.[3] Reliable estimates of the elasticity of substitution in the utility function are not available, so results are reported for a range of choices for this parameter.

IV. Results

The model described in section III has been used to evaluate the effect of a ten percent appreciation of the U.S. dollar relative to all other currencies of the world. There are two parameters of the model which are central to the computations for which there are no very reliable empirical estimates. These are the elasticity of substitution among different varieties in the monopolistically and perfectly competitive industries and the mark-up over marginal cost in the Cournot industries. Therefore, rather than choose single values for each parameter, the model was rerun several times varying the values over a wide range.

A summary of the trade effects of a U.S. dollar appreciation for exports, imports, the current account, and the return to capital is presented in Table 2. For sections A, B, and C, it is assumed that the value of the mark-up over marginal cost in the Cournot industries is five percent while the

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[3]For a complete description of the derivation of the parameters of the model from the base period data, see Brown and Stern (1988).

elasticity of substitution is varied between three and fifteen. Sections D, E, and F hold the value of the mark-up at twenty percent, while varying the elasticity of substitution between three and fifteen. No entry is permitted in the Cournot sectors in any of these cases.

The value for the mark-up apparently has little impact on the aggregate trade effects of the U.S. dollar appreciation. However, the elasticity of substitution plays a key role. The higher the elasticity of substitution the more sensitive consumers are to changes in relative prices and therefore the greater the substitution between imports and the domestic good as the exchange rate changes. For example, U.S. imports may increase by as little as 16 percent, valued in base period prices, or by as much as 86 percent depending on the degree of substitutability among different varieties of a good. Similarly, the decline in U.S. exports ranges from a low of 10 percent to a high of 58 percent.

The value of the mark-up over marginal cost in the Cournot sectors plays a more important role in determining the return to capital, as can be seen from the last column of Table 2. Based on the theoretical discussion in Section II, we had expected that the return to capital in the United States would decline, while rising in the other countries of the world. The return to capital in Canada does indeed rise between 1.6% and 5.2% depending on the value of the elasticity of substitution. The return to capital in the United States generally falls, though the smaller the mark-up over marginal cost and the smaller the elasticity of substitution the more likely it is that the return to capital in the United States increases.

The surprise here is that the return to capital in the rest of world declines more or rises less than the return to capital in the United States for all values of both parameters. It is likely that this result follows from the assumption that fiscal policy is used to maintain base-period employment. During the dollar appreciation a fiscal expansion was required in the United States, putting upward pressure on the return to capital. However, a fiscal contraction was required in Canada and the rest of the world. The fiscal contraction in the rest of the world appears to have been sufficient to lower the return to capital.

Sectoral results for the Cournot industries are presented in Table 3. In the first three columns, the percent change in the domestic currency price in each of the three countries is reported. Without pricing to market, a ten percent appreciation of the U.S. dollar should cause the price on the U.S. market to fall by ten percentage points relative to the prices prevailing on the markets in the rest of the world and Canada. Indeed, prices on the U.S. market fall and prices on other markets rise, but pricing to market is clearly evident for all parameter values. U.S. prices fall by less than three percentage points relative to rest of world prices, and by three to eight percentage points relative to prices in Canada.

It is interesting to note that despite the obvious presence of incomplete passthrough of the exchange rate to the domestic price level, the U.S. current account nevertheless deteriorated significantly. This outcome is partly the result of the fact that pricing to market is possible only in a limited number of product categories. The change in fiscal policy, however, is undoubtedly playing an important role. In comparison, the dollar depreciation of the mid-1980s was not accompanied by a change in fiscal policy in the United States. As a result, it is not surprising that pricing to market has been more prominent during the dollar decline and the improvement in the current account has been very small.

As discussed in Section II, we expect pricing to market to occur if marginal cost for U.S. firms falls relative to firms in the rest of the world. The percent change in marginal cost is reported for the United States, the rest of the world, and Canada in columns 4, 6, and 9, respectively. Marginal cost falls in the United States by about one percent, rises slightly in the rest of the world, and rises by about two percent in Canada. The fall in the return to capital and in the price of imported intermediate inputs put downward pressure on marginal cost in the United States. The opposite is occurring in Canada, in which both the return to capital and the price of traded intermediate inputs are rising.

The perturbing aspect of Table 3 is that relatively small changes in marginal cost give rise to very pronounced pricing to market. This result follows from the relatively small market share of imports in each country. From equation (2) we can find that the proportionate change in supply of country i to country r is

$$\hat{s}_r^i = \hat{D}_r + \frac{\hat{P}_r^i - \hat{MC}_i}{M}, \tag{16}$$

where D_r is total demand in country r, P_r^i is the price that a firm in country i receives for its sales to country r, and M is the mark-up of price over marginal cost in the base period. The market clearing condition is

$$\hat{D}_r = \sum_i \theta_r^i \hat{s}_r^i, \tag{17}$$

where θ_r^i is country i's market share in country r. Substituting equation (17) into equation (16) yields

$$\sum_i \theta_r^i \frac{(\hat{P}_r^i - \hat{MC}_i)}{M} = 0. \tag{18}$$

In words, the market share weighted average change in the price-cost margin for all suppliers to the market in country r must be zero. The U.S. dollar appreciation increases the price that foreign producers are receiving for sales to the U.S. market relative to marginal cost. In order to maintain equilibrium in the U.S. market, the price U.S. producers receive locally must fall. However, due to the dominant position of U.S. firms in the U.S. market, a relatively small decline in the price U.S. firms receive locally is sufficient to satisfy the equilibrium condition in equation (18). Therefore, the change in price on the U.S. market is fairly small.

A similar situation exists in the foreign market. The U.S. dollar appreciation reduces the return that U.S. firms are receiving for their sales abroad. According to equation (18), this must be balanced by an increase in the price received by foreign producers in their own market. However, as before, the local price increase will be small since foreign firms have a very large market share in the foreign market.

The implication is that the disequilibrium generated by a U.S. dollar appreciation can easily be removed by relatively small changes in the local currency price in the U.S. and foreign markets. Significant pricing to market is the result. Pricing to market is less noticeable between the Canadian and U.S. markets because U.S. firms have a much larger market share in Canada than in the rest of the world.

Evidence concerning changing profit margins when entry is ruled out can also be obtained from the first part of Table 3. The percent change in the average sale price valued in the domestic currency for representative firms in each country are reported in columns 5, 7, and 10. In the case of the United States, for example, sale prices fall by two to three percent, while marginal cost only falls by about one percent, implying a slightly smaller profit margin for U.S. firms. In contrast, profit margins rise slightly for firms in the rest of the world and rise appreciably for Canadian firms.

It is interesting to note that the profit margin on rest-of-world and Canadian exports to the United States rise significantly. The prices that firms receive on their sales to the United States, valued in the domestic currency, are reported in columns 8 and 11. After adjusting for the appreciation of the U.S. dollar, the prices that foreign firms receive for their sales to the U.S. market increase by seven to nine percent. This compares with a one to three percent increase in marginal cost. The practice of increasing the profit margin when the dollar rises and squeezing the profit margin when the dollar falls, observed in the last dollar cycle, appears to be entirely consistent with profit maximizing behavior even for firms with a one period planning horizon.

The existence of positive profits on exports to the United States will ultimately lead to entry by competing firms. In order to determine the long run effect of the dollar appreciation, the model was rerun assuming that entry would ultimately lead to zero-profits in the Cournot sectors. The trade effects are summarized in sections G, H, and I of Table 2 and results for individual sectors are reported in the last three sections of Table 3.

The Cournot model with entry has been carefully explored by Venables (1985). Therefore, the results are not unexpected. As seen above, the dollar appreciation reduced the profitability of U.S. firms while improving the profitability of foreign firms. In order to restore the zero profits condition, the average price received by U.S. firms must rise and the average price received by foreign firms must fall. This is accomplished by raising the price in the market in which U.S. firms have a comparatively large market share, while lowering the price in others. The price on the U.S. market therefore rises and prices in the rest of the world fall. As can be seen from the first three columns of Table 3, U.S. prices rise between zero and seven percent and rest of world prices fall between zero and two percent. Therefore, pricing to market in response to the U.S. dollar appreciation will ultimately reverse itself once entry occurs.

These results suggest theoretical reasons as to why lags in the adjustment of domestic prices to changes in the exchange rate may be considerably longer than previously thought. In the perfectly competitive model, the response of the trade account only depends on the length of time required to build greater foreign production capacity. However, in the imperfectly competitive models presented here, foreign firms will not willingly pass the exchange rate change through to the U.S. market until new entrants gain a significant market position. Such a process may not be complete until several years after the original change in the exchange rate if barriers to entry are important.

Finally, sectoral results for trade and production are reported for all industries of the model in Table 4 for the case in which the elasticity of substitution in the monopolistically and perfectly competitive sectors is 3 and the mark-up over marginal cost in the Cournot sectors is 20 percent. The U.S. dollar appreciation has the expected effect of reducing exports, stimulating imports, and shifting resources from the production of tradable goods to the production of nontradables.

V. Conclusions

The purpose of this paper is to investigate the effects of a U.S. dollar appreciation on profit margins and relative prices between markets for exporting firms using a computable general equilibrium trade model. We are particularly concerned with the observed deviations from the law of one price at the firm level during the last dollar cycle and the practice of increasing profit margins on exports to the United States during the period of the strong dollar and squeezing profit margins as the dollar declined.

A model in which firms play a Cournot game and national markets are segmented for some sectors is used to evaluate the effect of a ten percent appreciation of the U.S. dollar, theoretically and empirically. We find that, theoretically, an appreciation could cause a less than proportionate change between nominal prices in the U.S. and other markets if the appreciation also lowers marginal cost in the United States and tariffs or transportation costs are present. The theoretical results are confirmed using a multi-sector, multi-country general equilibrium computational trade model, in which both a fall in the cost of capital and in the price of intermediate traded inputs contribute to improved competitiveness of U.S. firms. Nominal prices on the U.S. market fall relative to prices on other markets by two to seven percentage points, which is considerably smaller than the ten percentage points expected based on the law of one price.

The relatively small fall in the price on the U.S. market also implies that the profit margin on exports to the United States rises relative to sales in other markets for foreign firms. This result provides a possible explanation of the fact that foreign firms squeezed profit margins on sales to the United States as the dollar declined between 1985 and 1988. It has frequently been suggested (Krugman (1987) and Giovannini (1987)) that this phenomenon is the outcome of a multi-period profit maximization problem in which firms are attempting to avoid short term fluctuations in market share. However, the results presented here suggest that this outcome is entirely consistent with profit-maximization in a one-period model. The dollar depreciation reduces the profit opportunities available to firms exporting to the United States. To the extent that profits become negative, foreign firms will exit until a condition of zero-profits is restored.

Finally, it is shown that failure to pass exchange rate changes through to the domestic market is unlikely in this framework if relatively free entry and exit are possible. This suggests that barriers to entry may play a key role in the slow adjustment of domestic prices to exchange rate movements and adjustment lags may be considerably longer than previously seemed reasonable.

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TABLE 1

INDUSTRY STRUCTURE OF THE MODEL

Sector	Market Structure
Tradable Industries:	
Agriculture	Perfect Competition
Food	Monopolistic Competition
Textiles	Oligopoly
Clothing	Monopolistic Competition
Leather Products	Perfect Competition
Footwear	Monopolistic Competition
Wood Products	Perfect Competition
Furniture, Fixtures	Monopolistic Competition
Paper Products	Monopolistic Competition
Printing, Publishing	Monopolistic Competition
Chemicals	Oligopoly
Petroleum Products	Oligopoly
Rubber Products	Market Segmentation
Nonmetal Mineral Products	Monopolistic Competition
Glass Products	Market Segmentation
Iron, Steel	Market Segmentation
Nonferrous Metals	Monopolistic Competition
Metal Products	Monopolistic Competition
Nonelectrical Machinery	Market Segmentation
Electrical Machinery	Market Segmentation
Transport Equipment	Market Segmentation
Miscellaneous Manufactures	Monopolistic Competition
Nontradable Industries:	
Mining, Quarrying	Market Segmentation
Utilities	Market Segmentation
Construction	Perfect Competition
Wholesale Trade	Monopolistic Competition
Transportation	Monopolistic Competition
Financial Services	Oligopoly
Personal Services	Perfect Competition

TABLE 2

SUMMARY RESULTS OF A TEN PERCENT APPRECIATION OF THE U.S. DOLLAR: PERCENT CHANGE IN IMPORTS, EXPORTS, EXCHANGE RATES, CURRENT ACCOUNT, AND RETURN TO CAPITAL

COUNTRY	IMPORTS	EXPORTS	EXCHANGE RATE*	CURRENT ACCOUNT	RETURN TO CAPITAL
A. Elasticity of Substitution = 3, Mark-up = 5%, No Entry					
United States	17.1	-10.6	0.0	-123.1	0.5
Other	-4.1	4.6	10.0	54.5	-0.1
Canada	-1.9	23.2	10.0	74.4	1.7
B. Elasticity of Substitution = 7, Mark-up = 5%, No Entry					
United States	41.0	-26.1	0.0	-162.6	0.4
Other	-11.5	13.1	10.0	72.3	-0.7
Canada	-7.6	40.0	10.0	96.6	2.6
C. Elasticity of Substitution = 15, Mark-up = 5%, No Entry					
United States	86.4	-60.6	0.0	-240.6	-0.7
Other	-32.4	25.7	10.0	107.4	-1.8
Canada	-20.2	72.6	10.0	140.5	5.2
D. Elasticity of Substitution = 3, Mark-up = 20%, No Entry					
United States	16.0	-10.1	0.0	-49.0	-0.1
Other	-3.6	4.3	10.0	19.6	-0.2
Canada	-3.1	23.1	10.0	42.3	1.6
E. Elasticity of Substitution = 7, Mark-up = 20%, No Entry					
United States	39.4	-25.2	0.0	-86.6	-0.6
Other	-10.3	12.3	10.0	35.4	-0.8
Canada	-7.8	45.6	10.0	70.6	2.9
F. Elasticity of Substitution = 15, Mark-up = 20%, No Entry					
United States	85.2	-58.4	0.0	-164.3	-1.8
Other	-31.2	25.9	10.0	70.8	-1.9
Canada	-19.2	72.6	10.0	111.2	5.2
G. Elasticity of Substitution = 3, Mark-up = 20%, Entry					
United States	19.8	-10.0	0.0	-138.0	0.3
Other	-3.1	5.3	10.0	28.3	0.0
Canada	6.0	38.4	10.0	283.3	8.9
H. Elasticity of Substitution = 7, Mark-up = 20%, Entry					
United States	45.4	-25.9	0.0	-172.6	0.1
Other	-9.5	13.3	10.0	43.9	-0.7
Canada	0.2	69.9	10.0	302.5	9.1
I. Elasticity of Substitution = 15, Mark-up = 20%, Entry					
United States	97.9	-61.5	0.0	-245.1	-1.4
Other	-28.6	27.2	10.0	77.0	-2.0
Canada	-8.7	138.4	10.0	340.6	12.0

*(+) indicates depreciation of currency.

TABLE 3

CHANGE IN DOMESTIC CURRENCY PRICE, MARGINAL COST, AND PROFIT MARGIN
DUE TO TEN PERCENT APPRECIATION OF THE U.S. DOLLAR

(Percent)

Sector	Local Price			United States		Rest of World			Canada		
	U.S.	R.O.W.	Canada	Marginal Cost	Average Price	Marginal Cost	Price: Average	Price: U.S. Sales	Marginal Cost	Price: Average	Price: U.S. Sales
A. Elasticity of Substitution = 3, Mark-up = 5%, No Entry											
Rubber Prod.	-2.0	0.5	2.4	-1.4	-2.4	0.4	0.7	8.0	1.1	3.3	8.0
Glass Prod.	-0.9	0.2	5.3	-0.5	-1.3	0.1	0.4	9.1	1.4	5.6	9.1
Iron & Steel	-1.1	0.2	2.9	-0.6	-1.3	0.1	0.5	8.9	1.4	3.4	8.9
Nonelectrical Machinery	-1.3	1.0	6.4	-0.6	-2.5	0.2	1.4	8.7	1.6	6.5	8.7
Electrical Mach.	-1.5	0.5	3.7	-0.7	-2.3	0.2	0.9	8.5	2.2	3.8	8.5
Transport Equip.	-1.8	0.5	5.3	-0.8	-2.5	0.3	1.1	8.2	2.5	6.3	8.2
B. Elasticity of Substitution = 7, Mark-up = 5%, No Entry											
Rubber Prod.	-1.8	0.5	2.8	-1.2	-2.2	0.3	0.7	8.2	1.6	3.7	8.2
Glass Prod.	-0.8	0.2	5.4	-0.4	-1.2	0.0	0.3	9.2	1.6	5.7	9.2
Iron & Steel	-1.0	0.1	3.1	-0.5	-1.3	0.0	0.4	9.0	1.8	3.6	9.0
Nonelectrical Machinery	-1.2	0.9	6.4	-0.5	-2.5	0.1	1.3	8.8	1.9	6.6	8.8
Electrical Mach.	-1.5	0.4	3.9	-0.6	-2.2	0.1	0.9	8.5	2.4	4.0	8.5
Transport Equip.	-1.7	0.4	5.5	-0.8	-2.4	0.2	1.0	8.3	2.8	6.5	8.3
C. Elasticity of Substitution = 15, Mark-up = 5%, No Entry											
Rubber Prod.	-1.7	0.2	3.2	-1.1	-2.1	0.0	0.4	8.3	2.1	4.0	8.3
Glass Prod.	-0.9	-0.1	5.5	-0.6	-1.4	-0.2	0.1	9.1	2.1	5.7	9.1
Iron & Steel	-1.2	-0.2	3.6	-0.7	-1.4	-0.2	0.1	8.8	2.7	3.9	8.8
Nonelectrical Machinery	-1.4	0.7	6.4	-0.7	-2.6	-0.1	1.1	8.6	2.3	6.5	8.6
Electrical Mach.	-1.6	0.2	4.0	-0.8	-2.4	-0.1	0.7	8.4	2.8	4.1	8.4
Transport Equip.	-1.8	0.2	5.5	-0.9	-2.6	-0.1	0.8	8.2	3.1	6.4	8.2

TABLE 3
(Continued)

CHANGE IN DOMESTIC CURRENCY PRICE, MARGINAL COST, AND PROFIT MARGIN
DUE TO TEN PERCENT APPRECIATION OF THE U.S. DOLLAR

(Percent)

Sector	Local Price			United States		Rest of World			Canada		
							Price			Price	
	U.S.	R.O.W.	Canada	Marginal Cost	Average Price	Marginal Cost	Average	U.S. Sales	Marginal Cost	Average	U.S. Sales
D. Elasticity of Substitution = 3, Mark-up = 20%, No Entry											
Rubber Prod.	-2.3	0.5	1.5	-1.5	-2.6	0.4	0.7	7.7	1.1	2.5	7.7
Glass Prod.	-1.0	0.2	2.9	-0.6	-1.5	0.1	0.4	9.0	1.0	3.6	9.0
Iron & Steel	-1.3	0.2	1.7	-0.7	-1.5	0.1	0.4	8.7	1.1	2.4	8.7
Nonelectrical Machinery	-1.4	0.9	4.2	-0.7	-2.7	0.2	1.3	8.6	1.3	5.6	8.6
Electrical Mach.	-1.6	0.5	2.3	-0.7	-2.4	0.2	0.9	8.4	1.7	2.6	8.4
Transport Equip.	-1.9	0.5	5.2	-0.9	-2.6	0.2	1.0	8.1	2.3	6.2	8.1
E. Elasticity of Substitution = 7, Mark-up = 20%, No Entry											
Rubber Prod.	-2.1	0.4	1.9	-1.3	-2.5	0.3	0.6	7.9	1.5	2.9	7.9
Glass Prod.	-1.0	0.1	3.1	-0.6	-1.5	0.0	0.3	9.0	1.3	3.8	9.0
Iron & Steel	-1.3	0.1	2.2	-0.7	-1.5	-0.0	0.3	8.7	1.6	2.8	8.7
Nonelectrical Machinery	-1.4	0.8	4.3	-0.7	-2.7	0.1	1.2	8.6	1.6	5.6	8.6
Electrical Mach.	-1.6	0.4	2.5	-0.8	-2.4	0.1	0.8	8.4	2.0	2.8	8.4
Transport Equip.	-1.9	0.4	5.3	-0.9	-2.6	0.1	0.9	8.1	2.6	6.3	8.1
F. Elasticity of Substitution = 15, Mark-up = 20%, No Entry											
Rubber Prod.	-2.1	0.1	2.3	-1.3	-2.5	-0.0	0.3	7.9	2.0	3.2	7.9
Glass Prod.	-1.2	-0.1	3.4	-0.8	-1.6	-0.2	0.0	8.8	1.8	3.9	8.8
Iron & Steel	-1.5	-0.2	2.8	-1.0	-1.7	-0.3	0.0	8.5	2.4	3.3	8.5
Nonelectrical Machinery	-1.6	0.6	4.5	-0.9	-2.9	-0.1	1.1	8.4	2.0	5.6	8.4
Electrical Mach.	-1.8	0.2	2.8	-1.0	-2.6	-0.1	0.6	8.2	2.4	3.0	8.2
Transport Equip.	-2.0	0.1	5.3	-1.2	-2.8	-0.1	0.7	8.0	2.8	6.2	8.0

TABLE 3
(Continued)

CHANGE IN DOMESTIC CURRENCY PRICE, MARGINAL COST, AND PROFIT MARGIN
DUE TO TEN PERCENT APPRECIATION OF THE U.S. DOLLAR

(Percent)

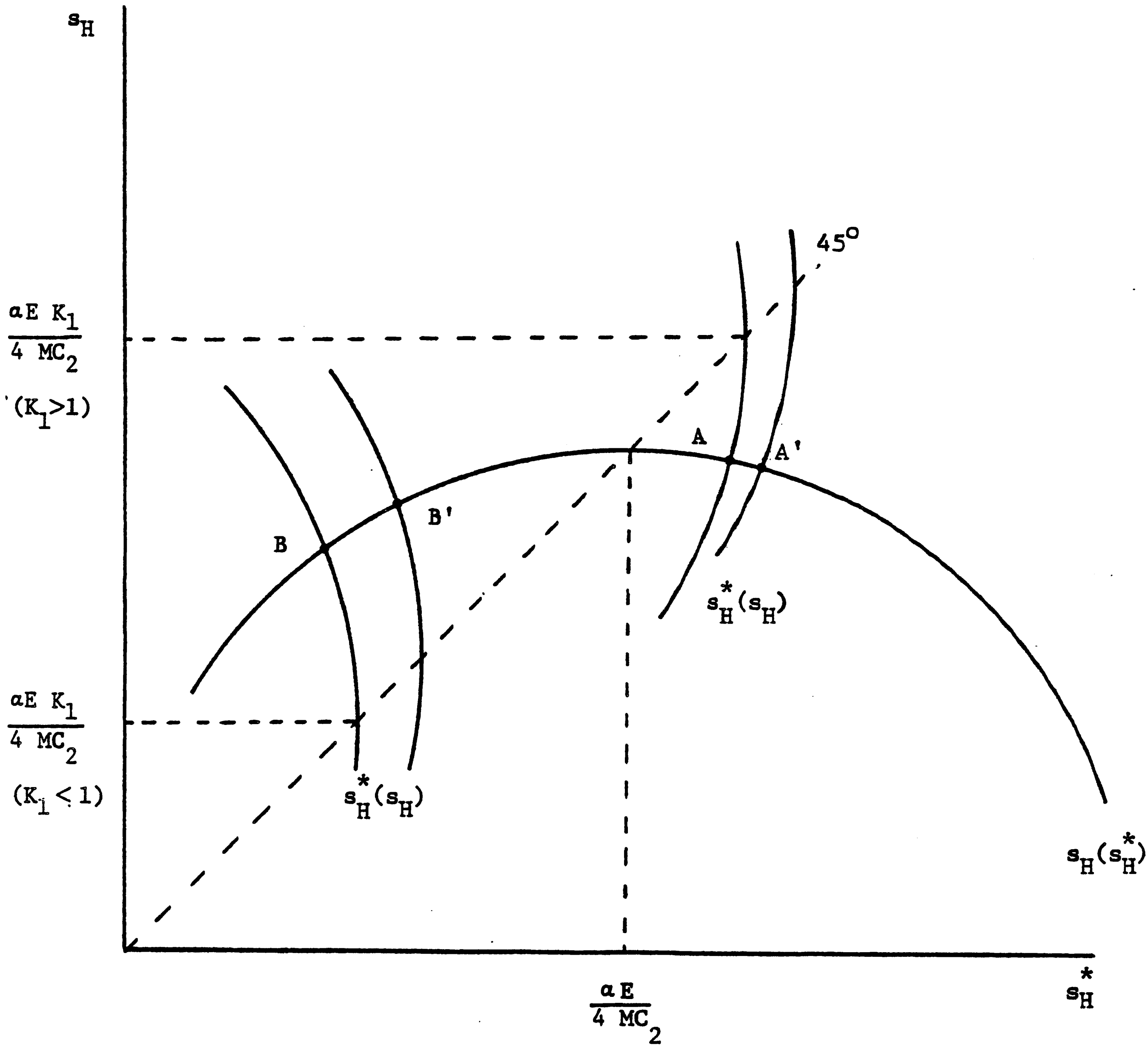
Sector	Local Price			United States		Rest of World			Canada		
							Price			Price	
	U.S.	R.O.W.	Canada	Marginal Cost	Average Price	Marginal Cost	Average	U.S. Sales	Marginal Cost	Average	U.S. Sales
G. Elasticity of Substitution = 3, Mark-up = 20%, Entry											
Rubber Prod.	0.0	-0.2	-6.8	-1.3	-0.6	0.4	0.1	10.0	-0.8	-4.0	10.0
Glass Prod.	1.0	-0.2	-2.1	-0.2	0.3	0.1	-0.0	11.0	0.8	-0.3	11.0
Iron & Steel	1.7	-0.6	-4.4	0.3	1.3	-0.1	-0.3	11.7	0.9	-2.4	11.7
Nonelectrical Machinery	4.5	-0.7	-13.3	0.7	1.0	-0.2	-0.2	14.5	-2.9	0.3	14.5
Electrical Mach.	1.8	-0.7	-3.7	0.2	0.4	-0.1	-0.1	11.8	-3.0	-2.7	11.8
Transport Equip.	6.3	-1.3	-44.0	1.4	1.2	-0.3	-0.3	16.3	-14.3	-18.1	16.3
H. Elasticity of Substitution = 7, Mark-up = 20%, Entry											
Rubber Prod.	0.1	-0.3	-4.4	-1.0	-0.5	0.3	-0.0	10.1	0.9	-1.9	10.1
Glass Prod.	1.1	-0.3	-1.4	-0.1	0.4	-0.0	-0.2	11.1	1.1	0.3	11.1
Iron & Steel	1.7	-0.7	-5.1	0.4	1.4	-0.3	-0.4	11.7	1.0	-3.0	11.7
Nonelectrical Machinery	4.4	-0.8	-12.3	0.7	0.9	-0.3	-0.3	14.4	-2.4	0.6	14.4
Electrical Mach.	1.7	-0.8	-2.8	0.2	0.4	-0.2	-0.2	11.7	-2.1	-1.9	11.7
Transport Equip.	5.7	-1.4	-38.5	1.3	1.0	-0.4	-0.5	15.7	-11.9	-15.2	15.7
I. Elasticity of Substitution = 15, Mark-up = 20%, Entry											
Rubber Prod.	-0.3	-0.6	-2.0	-1.1	-0.9	-0.1	-0.3	9.7	2.0	-0.1	9.7
Glass Prod.	0.6	-0.6	0.3	-0.4	-0.0	-0.3	-0.4	10.6	2.1	1.6	10.6
Iron & Steel	1.3	-1.0	-5.4	0.0	0.9	-0.6	-0.7	11.3	2.2	-3.3	11.3
Nonelectrical Machinery	3.5	-1.0	-8.3	0.4	0.4	-0.5	-0.5	13.5	-0.6	2.0	13.5
Electrical Mach.	1.2	-1.0	-0.9	-0.1	-0.1	-0.4	-0.4	11.2	-0.5	-0.2	11.2
Transport Equip.	4.2	-1.5	-30.0	0.8	0.3	-0.7	-0.7	14.2	-8.7	-11.1	14.2

TABLE 4

PERCENT CHANGE IN TRADE AND PRODUCTION
DUE TO TEN PERCENT APPRECIATION OF U.S. DOLLAR

SIGMA = 3, MARK-UP = 20 PERCENT, NO ENTRY

Sector	United States			Rest of World			Canada		
	Exports	Imports	Output	Exports	Imports	Output	Exports	Imports	Output
Tradable Industries									
Agriculture	-19.2	21.6	-4.1	9.0	-14.2	0.5	2.3	-14.7	0.3
Food	-16.4	26.8	1.2	7.7	-10.2	-0.7	7.4	-9.0	-4.6
Textiles	-17.1	20.8	-3.1	3.7	-5.9	0.5	4.4	-9.0	3.2
Clothing	-16.7	25.8	0.7	15.2	-5.9	0.6	3.1	-1.1	-8.0
Leather Prod.	-20.7	18.8	-10.7	8.2	-7.9	2.6	4.7	-7.1	4.8
Footwear	-27.4	27.2	-1.7	19.7	-8.8	2.0	6.4	2.2	-10.4
Wood Prod.	-25.3	21.5	-5.6	8.9	-6.4	0.5	13.3	-14.8	7.3
Furniture, Fixtures	-20.2	29.0	1.1	7.9	-4.7	-1.1	27.3	-21.4	-0.1
Paper Prod.	-24.9	39.6	-5.2	2.3	-7.6	0.3	31.3	-32.6	20.4
Printing, Publishing	-26.3	30.5	0.3	7.9	-24.4	-0.6	26.6	-18.5	6.5
Chemicals	-3.4	4.7	-0.0	1.6	-3.1	0.2	0.3	3.5	2.8
Petrol. Prod.	-8.2	9.8	0.4	2.6	-0.4	-0.7	5.4	1.8	3.7
Rubber Prod.	-35.7	3.9	-5.8	12.1	-0.5	2.4	30.2	-5.4	14.6
Nonmetal Mineral Prod.	-29.8	29.9	-1.8	7.8	-9.2	-0.6	12.1	-19.5	6.0
Glass Prod.	-39.3	2.1	-5.4	14.5	-0.5	1.4	28.7	-12.6	16.1
Iron & Steel	-36.8	2.8	-9.9	11.6	-0.4	3.3	20.3	-3.0	35.9
Nonferr. Metals	-39.9	80.2	-26.5	20.8	17.5	-0.4	135.6	41.9	136.5
Metal Prod.	-18.6	28.4	-2.9	5.7	-22.5	0.3	17.5	-17.9	4.9
Nonelectrical Machinery	-38.0	3.6	-10.5	14.2	-3.6	4.9	26.2	-50.8	36.3
Electrical Mach.	-41.1	4.4	-8.8	18.4	-1.5	3.2	16.2	-6.3	7.4
Transport Equip.	-29.4	4.6	-6.8	16.3	-1.2	3.5	27.6	-14.1	21.3
Misc. Mfrs.	-32.0	36.9	-13.2	17.1	-26.3	6.5	47.1	-20.2	34.3
Nontradable Industries									
Mining & Quarrying			-1.6			-0.3			8.2
Utilities			0.6			-0.5			-0.3
Construction			2.6			-1.4			-6.1
Wholesale Trade			1.5			-0.9			-3.2
Transportation			0.4			-0.7			-1.6
Financial Services			1.3			-0.9			-3.7
Personal Services			2.3			-1.1			-6.2



s_H
45°
$\frac{\alpha E K_1}{4 MC_2}$
$(K_1>1)$
A
A'
B'
B
$s^*_H(s_H)$
$\frac{\alpha E K_1}{4 MC_2}$
$(K_1<1)$
$s^*_H(s_H)$
$s_H(s^*_H)$
$\frac{\alpha E}{4 MC_2}$
s^*_H

Figure 1