AN APPLIED GENERAL EQUILIBRIUM ANALYSIS OF THE IMPACT OF A CANADA - MEXICO - U.S. FREE TRADE AGREEMENT ON CANADA: A PROGRESS REPORT

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1. Introduction

This paper is a progress report on the construction of an applied general equilibrium model to be used to evaluate the impact of a Canada-Mexico-U.S. Free Trade Agreement (F.T.A.) on the Canadian economy. The starting point for our study is earlier work we undertook to examine the impact of trade liberalization on the Canadian economy (Harris, 1984ab; Cox and Harris, 1985, 1986). The most recent version of the model (Harris, 1988) was designed to focus on the Canada-U.S. F.T.A. of 1988.

In many respects the model is similar with applied general equilibrium models in the Walrasian tradition, surveyed for example by Shoven and Whalley (1984). The model departs from the Walrasian tradition by incorporating economy of scale and imperfect competition into the model structure. Both of these features are thought by industrial organization economists to be important in accessing the costs of protection in small open economies such as Canada. There is a long tradition of Canadian economists beginning with Eastman and Stykolt (1966) who have argued that the effect of trade protection, by restricting market size and limiting foreign competition, is to create an inefficient manufacturing sector with too many firms operating at too small a scale. Earlier results from our model suggest the costs of protection are substantially greater than those found in competitive, constant returns to scale models.

As in our earlier work the question to be examined by this research is: what impact will further North American trade liberalization have on the allocation of resources within Canada and how will real incomes be affected? Unfortunately, at the present time the model, although operational, has not been fully calibrated and as a consequence we do not report, in this paper, the results of any Canada-Mexico-U.S. trade liberalization experiments.

The paper is organized as follows. In section 2, we specify the model economy. In section 3 the calibration process is outlined. In lieu of results on Canada-Mexico-U.S. trade liberalization we report some of our results from an earlier study of the Canada-U.S. F.T.A. in Section 4. A concluding comment is contained in Section 5.

2. Model Structure

In this section a brief overview of the model will be undertaken. The mathematical structure of the model is outlined in the appendix and a fuller account of the model can be found in Harris (1988).

Within the model there are four economic regions: Canada, the United States, Mexico and all other countries aggregated into the Rest-of-World (R.O.W.). The Canadian economy is modelled in detail but the model is less than a "full" general equilibrium model as the behavior of the U.S., Mexico and R.O.W. is summarized by exogenous import prices and a set of export demand functions. A principal distinguishing feature of the model is the assumption that each type of product, defined by its physical characteristics, is distinguished by the region in which it is produced. This is often referred to as the Armington assumption (following Armington (1969)). Canadian manufacturing goods are thus treated as qualitatively different products from U.S. and Mexican manufacturing goods. This assumption of product heterogeneity by region is used both to account for cross-hauling or two-way trade between regions within the same commodity category and to exclude complete specialization as a behavioral response of the model.

In terms of the regional structure, Canada is thought of as small relative to the other regions. Thus import supply prices in Canada, from all foreign regions, are treated as exogenous. Nevertheless, because Canadian goods are distinct from U.S., Mexican, and R.O.W. goods the prices of Canadian supplied goods are influenced by supply and demand conditions within Canada. Thus because export prices are endogenously determined, but import prices are exogenous, the terms of trade within Canada are endogenously determined within the model. Following Harris (1984) we have referred to this as the "almost small open economy" assumption.

The model consists of eighty-eight products produced in each region by separate industries. Sixty-three of these industries are in the manufacturing sector and correspond to Canadian manufacturing industries at the three and four digit level of the Standard Industrial Classification code. The remaining twenty-five industries consist of natural resource and service industries. Within the model, the manufacturing industries are treated as noncompetitive, increasing return to scale industries and the remaining industries are treated as competitive, constant returns to scale industries.

There are two primary factors of production in the model: capital and labour. Each factor is assumed to be homogeneous and mobile across industries and firms. Capital is internationally mobile and in perfectly elastic supply at the world central rate. Labour is internationally immobile. The domestic wage is determined in a perfectly competitive labour market. The resource endowment of the economy consists of a fixed supply of labour and capital.

The model takes account of a number of tax and tariff in the Canadian economy. All tax, tariff and subsidy rates are expressed in ad valorem form. Among the domestic taxes incorporated in the model are sales taxes on final domestic consumption, taxation of intermediate

goods, and export taxes. Tariff rates include ad valorem equivalents of non-tariff barriers when available.

The income of the domestic consumer derives from ownership of the economy's endowment of capital and labour, from possible economic profits accruing to domestically owned firms in noncompetitive industries, and from net government transfers. Government revenue is raised through the system of taxes, tariffs, and subsidies in place. All government revenue raised in this manner is returned to the consumer in the form of a lump-sum transfer.

Domestic final demand for each commodity, from all regions, is assumed to be generated by a single aggregate consumer maximizing a utility function subject to a budget constraint. The utility function across commodity classes is Cobb-Douglas. Within each commodity class the Armington assumption is maintained; foreign and domestic goods are imperfect substitutes as given by a CES aggregator over these four commodity groups.

Export demand for Canadian goods is generated by U.S., Mexican, and R.O.W. aggregate consumers, with exogenous incomes, who maximize utility functions defined over commodities from all four regions. Like the Canadian consumer the utility functions of the foreign consumers have a nested form in which the top level is Cobb-Douglas defined over commodity aggregates. The second level is a CES function in which goods from all regions are viewed as imperfect substitutes. As a result, the demand for Canadian goods will depend on the prices of goods from all regions.

The technology of each competitive industry is represented by a unit cost function. The costs of each industry include not only labour and capital costs but also expenditures on the output of other industries, both domestically produced and imported. The unit cost function, assumed independent of industry output, is specified as a Cobb-Douglas functional form, defined over the input prices of the primary factors and price indices for each of the 88 commodity categories. The price index of each commodity aggregate is assumed to be a Cobb-Douglas subaggregator defined over the price of the corresponding domestically produced and imported commodities. With this specification of technology, substitution in production is not only possible between primary factors and intermediate commodity aggregates but, within each commodity aggregate, is also feasible between domestic and imported goods.

The assumption of constant per unit costs, together with a zero profit condition, requires, in equilibrium, that price in each competitive industry be equal to unit cost.

Each of the 63 noncompetitive industries consists of an endogenously determined number of firms. Within an industry all firms are assumed identical with respect to their technology and economic behavior. Freedom of entry and exit exists in all industries, so that firms will enter and exit industries in response to the presence of economic profits or losses. In this manner, in the long run, the number of firms is determined endogenously.

The cost function of each representative firm consists of both variable and fixed costs. The use of primary factors, capital and labour, enters into both the variable and fixed costs of the firm. Variable per unit costs are assumed to be independent of the level of output produced by the firm. The functional form of the firm's unit variable cost function is identical to that of the industry unit cost function in the competitive industries. This is a Cobb-Douglas function specified over the input prices of primary factors and price indices of all commodity aggregates, where each index is a Cobb-Douglas subaggregator. The fixed costs of the firm consist only of capital and labour costs. The presence of fixed costs in the firm's cost structure is explained by

an indivisibility; a fixed amount of capital and labour is required to set up a plant. The specification of constant per unit variable cost plus a fixed cost component leads, at given input prices, to declining average costs that asymptotically approach unit variable cost.

In each noncompetitive industry, firms are viewed as price makers. Two hypotheses regarding how prices are chosen by firms are considered. The first hypothesis is based on the Negishi (1961) perceived-demand-curve approach. Each representative firm is assumed to perceive a constant-elasticity demand curve for its product. On the basis of this perceived demand curve, the firm chooses a markup of price over unit cost that maximizes profits. The optimal markup chosen in this manner satisfies the familiar Lerner Rule. The elasticity the firm uses in its perceived demand curve corresponds to a "true" elasticity from the underlying general equilibrium model. Price setting in this manner will be referred to as the monopolistic competitive pricing hypothesis (MCPH). The other pricing hypothesis considered will be referred to as the Eastman-Stykolt (1976) hypothesis (ESH). Under the ESH the firm sets its price equal to the price of the import-competing good, inclusive of the domestic tariff. The ESH represents a collusive form of price setting in which the price of the import-competing good acts as a "focal point" for domestic producers. In the policy simulations of the model, the actual price selected by the firm is taken to be a weighted average of the prices set according to the MCPH and ESH.

A distinction is made in the model between the short run and the long run. The short run corresponds to a period of time during which the industrial structure in each of the noncompetitive industries is assumed fixed. By industry structure is meant the markup on unit variable cost set by each firm and the number of firms existing in each industry. A short-run equilibrium of the model is defined as a set of product prices, one for each domestically produced good, and a wage rate such that all product markets and the factor market clear. Walras's Law implies that the balance of payments is in equilibrium. Balance of payments equilibrium refers to current account balance, or requires that the trade surplus be equal to the sum of rental payments on foreign-owned capital and economic profits accruing to foreign ownership of domestic industry. Consistent with a short-run equilibrium is the possibility that, in some industries, firms will be earning pure profits or losses.

The long run of the model corresponds to a time horizon long enough to allow firms to enter or exit all industries in response to the presence of pure profits or losses. A long-run equilibrium is defined as a short-run equilibrium with the additional requirements that in each industry (approximately) zero profits be earned and that the elasticity of the perceived demand curve under MCPH be equal to the elasticity of the firm's true demand curve.

3. Calibrating the model and computing equilibrium

The model is calibrated to a 1981 data set for Canada (see Harris (1988) for more detail). There are eighty-eight industries. These industries correspond to S.I.C. industries at the three and four digit level. Sixty-three of these industries are manufacturing sectors modelled as noncompetitive industries. The remaining twenty-five industries include the natural resource and service sectors of the economy. These are treated as competitive constant cost industries.

The parameters of the model are selected by reference to existing econometric studies and so as to be consistent with a benchmark data set. The benchmark data is constructed from the Canadian input-output tables for 1981. This data set is assumed to represent a short-run equilibrium of the model in which the industrial structure of the noncompetitive industries is held fixed. In the benchmark data set firms in the noncompetitive industries maybe making profits

or losses. The calibration procedure is to select values for all of the parameters of the model, taking as given the observed benchmark number of firms and markups in non-competitive industries, to be consistent with the benchmark data. The industrial structure variables are then determined endogenously by computing the long-run equilibrium of the model. It is from this initial long-run equilibrium, referred to as the reference equilibrium, that the counterfactual policy experiments are undertaken.

In the model there are two sets of important parameters. On the demand side there are the elasticities of substitution between the goods of the four regions. These elasticities representing the willingness of consumers to substitute between domestic and foreign goods and must be selected for the aggregate consumer in each of the four regions. In the noncompetitive industries the level of fixed costs in the total cost function must be determined. Values for both sets of parameters were selected on the basis of reported econometric values in the literature.

A key input to the model is estimates of scale elasticities at the level of the plant. The fixed costs in the noncompetitive firms' total cost functions were selected so as to be consistent with estimated scale economies, and the related concepts of minimum efficient scale and cost disadvantage ratio. The economies of scale estimates used in the model are drawn from a study by Robidoux (1986).

A final parameter of importance in the model is the relative weighting of the ESH and MCPH pricing hypotheses. Although admittedly "ad hoc" the use of this weighted pricing hypothesis does have some empirical support in the Canadian case. In an empirical study of the Canadian manufacturing industries Hazledine (1985) successfully estimates a pricing model in which the observed industry price is explained as a weighted average of the prices predicted by the ESH and MCPH hypotheses. In a sample of thirty-three industries at the three and four digit SIC level Hazledine finds that, on average, a weight of approximately one-half characterizes the estimated pricing sale. In the simulations of the model this value of one-half is taken as the "best guess" value of the weighting parameter. Further discussion of pricing conduct in the Canadian manufacturing sector is provided in Caves, Porter, and Spence (1980).

Once all of the parameters of the model, excluding the industrial structure variables, have been calibrated the long-run equilibrium of the model is computed. The algorithm used to compute the equilibrium mimics the Marshallian process of adding firms to industries earning profits and withdrawing firms from industries earning losses. In qualitative terms the values of the economy-wide aggregates such as national income, the wage rate and government revenue are, in the long-run equilibrium, close to their benchmark values. Finally, a comment about uniqueness of equilibrium. There is no assurance that the equilibrium of the model is unique. In practice we have attempted a number of ad hoc tests such as beginning the algorithm at different starting values and in no cases have multiple equilibria been found. However, we must regard the question of uniqueness of equilibrium for our model as open.

4. Trade Liberalization Experiments - Canada - US Free Trade

Once the model has been calibrated it can be used to conduct experiments in trade liberalization and examine their impact on the Canadian economy. At the present, work is continuing on making the model operational. Unfortunately, at the present time, the Mexican trade sector has not been fully integrated into the model. As a result we do not have any results yet on full North American trade liberalization. As a substitute for this we will present some of our findings for the formation of the Canada - US FTA. Hopefully this will provide some insight

into the operation of the model and help in forming conjectures as to impact of including Mexico in a North American FTA.

Canada and the United States signed a free trade agreement in 1988 which went into effect in January of 1989. The effect of the free trade agreement is, among other things, to remove tariffs in many industries over a 10 year period. Our model was initially developed and refined to examine this issue. In the simulations reported here two trade liberalization experiments are considered: a unilateral cut in Canadian tariffs and a bilateral cut in Canadian and U.S. tariffs. In each case the new long-run equilibrium of the model is computed and compared with the initial reference equilibrium.

The aggregate impact of a unilateral elimination of Canadian tariffs is reported in the first column of Table 1. With the removal of domestic tariffs the economy experiences a real income gain, as measured by the Hicks equivalent variation, of 1.6% of the base GNE. Accompanying this gain in real income is an increase in the domestic wage of 1.86%. A large proportion of the gain in welfare can be attributed to rationalization effect within the manufacturing sector. The length of production runs in the manufacturing sectors increase by 14%. The mechanism by which this is accomplished is through a reduction in the markup firms charge over marginal cost. Recall under the ESH pricing hypothesis that a domestic tariff cut will lead to a one for one fall in the domestic price. Indeed in the manufacturing sector 61 of 63 industries experience a fall in their price-cost markup. In order to restore profitability this is accompanied by an exit of firms and an increase in output per firm in almost all of the manufacturing industries.

The increase in output per firm has a favourable effect on total factor productivity which increases by 3.78%. Another interesting aspect of the domestic tariff cut is the impact on the intersectoral allocation of resources. Although not reported in table 1 employment in the manufacturing sector increases by about one percent at the expense of the natural resource and service sectors. This result is quite interesting in that it is commonly thought (see for example Harkness (1983)) that Canada has a factor abundance in natural resources, and its comparative advantage does not lie in the manufacturing sector.

Overall then the picture which emerges from the unilateral removal of domestic tariffs is an increase in real income accompanied by a rationalization and slight expansion of the manufacturing sector.

Table 1

Aggregate effects of Canada - U.S. trade liberalization

(percentage changes relative to reference equilibrium)

	Unilateral Canadian tariff cut	Bilateral tariff cut
Wage	1.86	3.86
Welfare Gain	1.63	2.40
GNE	0.43	1.88
Length of Production Runs	14.06	20.56
Total Factor Productivity	3.78	4.49
Trade Volume	7.56	10.50
Labour Reallocation Index	0.73	1.14
Intra industry Trade Index	2.05	3.89

Note: (1) The welfare gain is measured as the Hicks Equivalent Variation as percentage of initial GNE. (2) GNE is gross national expenditure. (3) The lengh of production run index is the weighted average of output per firm in each manufacturing industry, where the weights are the industries' shares of total manufacturing output. (4) The labour productivity index is defined as the weighted average of labour productivity in each industry. (5) Total factor productivity is measured by a geometric quantity index of all inputs. (6) The labour reallocation index measures the proportion of the labour force which must reallocate between industries. (7) The intraindustry trade index is the weighted average of the Grubel-Lloyd intraindustry trade index in each industry.

In column two of table 1 the aggregate results of a removal of both Canadian and American tariffs are reported. In qualitative terms the results are very similar to those experienced under the unilateral tariff cut. The major difference is the larger relative changes the aggregate variables undergo. The real income gain is 2.4% of base GNE which is about 50% larger than that experienced with the unilateral tariff cut. The mechanism by which this real income gain is realized is again through a rationalization of the manufacturing sector. There is an increase in length of production runs of 20% and this is accompanied by a 4.5% increase in total factor productivity. Clearly the manufacturing sector benefits from its improved access to the U.S. market. Again employment in the manufacturing sector increases at the expense of the rest of the economy, this time by about 2%. Note however that the proportion of the labour force which has to switch sectors is only slightly over one percent. This suggests that the aggregate adjustment costs to the economy of this policy may be quite small. However, it is important to keep in mind that substantial adjustment is taking place at the intra-industry level.

Finally, a word about the sensitivity of the results to the underlying parameters. In our experience with the model we have found that the results are sensitive to two parameters in particular. The first is the degree of scale economies available in the manufacturing industries. Perhaps not surprisingly, the larger are the imputed scale economies the larger is the impact of trade liberalization on real income. The other important parameter is the weight that put on each of the pricing hypotheses. Putting more weight on the ESH hypothesis leads to increased gains in real income. Recall that under the ESH hypothesis there is a strong procompetitive pricing effect on domestic industry. The reduction in prices implies that rationalization in industry must take place. Under the MCPH hypothesis, domestic prices fall only to the extent that industry

shifts its demand toward more elastic demand. This will happen if, for example, industry shifts from supplying inelastic domestic demand to supplying more elastic foreign demand.

5. A Concluding Comment

Our model suggests that the Canada-U.S. F.T.A. will generate a gain in real income to the Canadian economy. A principal means by which this is achieved is through the improved access Canadian industry gets to the large U.S. market vis-a-vis rest of world competitors. Clearly one aspect of a Canada-Mexico-U.S. F.T.A. will involve Canada losing some of its preferential access to the U.S. market. How significant this might be to the Canadian economy is something we hope our model will be able to address.

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Appendix

This appendix outlines the equations of the model. For the sale of brevity the model will be presented without taxes, tariffs, or subsidies. In the empirical implementation of the model most of the relevant tax and tariff distortions are present.

1. Notation

Regional Superscripts: c Canada
u United States
m Mexico
r R.O.W.

Commodity Classes: N: index set for noncompetitive industries
C: index set for competitive industries
L: N U C

$p^c = (p^c_i)_{i \in L}$	Canadian commodity prices
$p^u = (p^u_i)_{i \in L}$	U.A. commodity prices
$p^m = (p^m_i)_{i \in L}$	Mexican commodity prices
$P^r = (p^r_i)_{i \in L}$	R.O.W. commodity prices
w	domestic wage
r	world rental on capital
P =	$(p^c, p^u, p^m, p^r, w, r)$ price system

2. Domestic Final Demand

The consumer's utility function over commodity aggregates is given by the log-linear (Cobb-Douglas) form

$$\log U = \log \mu_0 + \sum_{i \in L} \mu_i \log C_i \tag{A1}$$

C_i is the CES aggregator over domestic, U.S., Mexican and R.O.W. goods

$$C_i = \left[\gamma_i^c D_i^{c\,\rho_i} + \gamma_i^u D_i^{u\,\rho_i} + \gamma_i^m D_i^{m\,\rho_i} + \gamma_i^r D_i^{r\,\rho_i}\right]^{\frac{1}{\rho_i}} \tag{A2}$$

with the elasticity of substitution between goods in category i given $\sigma_i = 1/1\text{-}\rho i$.
Given income I and the price vector P, the demand for domestic good D^C_i is given by

$$D_i^C = \frac{\mu_i\, I\, \gamma_i^{c\,\sigma_i}\, p_i^{c\,-\sigma_i}}{\gamma_i^{c\sigma_i} p_i^{c(1-\sigma_i)} + \gamma_i^{u\sigma_i} p_i^{u(1-\sigma_i)} + \gamma_i^{m\sigma_i} p_i^{m(1-\sigma_i)} + \gamma_i^{r\sigma_i} p_i^{r(1-\sigma_i)}} \tag{A3}$$

Final import demands D^u_i, D^m_i and D^r_i have similar functional forms.

3. Export Demand

(i) U.S. demand for Canadian goods

The U.S. consumer has a utility function over the 88 commodity aggregates which is assumed to have the Cobb-Douglas form. Within each commodity class i the utility function has CES sub-aggregators of the Armington form, aggregating utility from Canadian, U.S., Mexican and R.O.W. goods. Given the assumption of exogenous income, I^u, utility maximization will yield a demand function for Canadian exports to the U.S. of the form

$$E_i^u = \frac{\mu_i^u\, I^u\, \gamma_i^{uc\,\sigma_i}\, p_i^{c\,-\sigma_i}}{\gamma_i^{uc\sigma_i} p_i^{c(1-\sigma_i)} + \gamma^{uu\sigma_i} p_i^{u(1-\sigma_i)} + \gamma_i^{um\sigma_i} p_i^{m(1-\sigma_i)} + \gamma_i^{ur\sigma_i} p_i^{r(1-\sigma_i)}} \tag{A4}$$

(ii) Mexican and R.O.W. demand for Canadian goods

Demand for Canadian goods by these two regions is assumed to arise in the exact same manner as in the U.S. This will lead to export demand functions E^m_i and E^r_i which will have the same form as given by (A4).

4. Technology

All firms have a variable unit cost function $V^i(P)$, assumed independent of the level of output, of the form

$$\log V^i(P) = \gamma_{oi} + \sum_{j \in L} \alpha_{ij} \log \Gamma_{ij} + \alpha_{iw} \log w + \alpha_{ir} \log r \tag{A5}$$

Γ_{ij} is the price index of a composite input used by industry i, a composite of both domestic and foreign varieties of commodity j.

Assuming price-taking behavior in input markets, the input-output matrices for the economy are derived from the unit cost functions by applying Shepard's lemma. The domestic Leontief matrix $A^c(P) = [a^c_{ij}(P)]$ is defined by

$$a_{ij}^c(P) = \frac{\alpha_{ij}\beta_{ij}V^i(P)}{p_j} \tag{A6}$$

where a^c_{ij} is the demand for domestic good j, per unit of output of good i. The Leontief matrices $A^u(P)$, $A^m(P)$ and $A^r(P)$ for the U.S., Mexico, and the R.O.W. are derived in a similar manner.

The fixed costs of each representative firm in each noncompetitive industry, i∈N, are given by the function

$$F_i(r,w) = r f_k^i + w f_L^i \tag{A7}$$

where f^i_k and f^i_L are the minimum amounts of capital and labour, respectively, needed to setput a plant. In the noncompetitive industries the total cost function of a representative firm is given by

$$TC_i\,(P,y_i) = F_i\,(r,w) + V^i\,(P)y_i \tag{A8}$$

5. Short-Run Equilibrium

The industrial structure variables held constant in the short-run are markups on unit variable costs by firms, i$\in$N, $(m^i) = m$; number of firms in each industry, i$\in$N, $(Fm_i) = Fm$. Let S = (m, Fm) be the vector of structural variables. Aggregate consumer income is given by

$$I = wL + rK_D + \psi \sum_{i\in N} \Pi_i \tag{A9}$$

where L is the aggregate labour endowment, K^D is the domestic capital endowment, Π_i the short-run profits or losses in industry i$\in$N, and ψ is the share of domestic ownership in industry ($0 < \psi < 1$).

Equilibrium commodity prices are determined by the equations

$$p_i = m_i\,V^i(P) \qquad i\in N$$

$$p_i = V^i(P) \qquad i\in C \tag{A10}$$

Letting X(P,I,S) represent domestic final demand and E(P) representing total export demand by all regions, commodity market clearing implies that the vector of gross outputs Z must satisfy

$$Z = (I - A(P)^T)^{-1}\,(X\,(P,\,I,\,S) + E(P)) \tag{A11}$$

Given the vector of domestic gross output, labour market equilibrium requires

$$L = \sum_{i\in L} a_{iw}(P)\,.\,Z_i + \sum_{i\in N} Fm_i\,.\,f_L^i \tag{A12}$$

where a_{iw} is the labour requirements co-effecient in industry i. Industry profits Π_i are

$$\pi_i = Fm_i\left[(p_i - V^i)\left(\frac{Z_i}{Fm_i}\right) - F_i(r,w)\right] \tag{A13}$$

A short-run equilibrium for a given S is a wage (S), domestic commodity price vector p (s), income I(S), and vector of gross outputs Z (S) satisfying (A10) - (A12).

6. Firm Behavior

(i) Under the monopolistically competitive pricing hypothesis (MCPH), each firm in industry i$\in$N perceives an industry demand curve of the constant elasticity form

$$z_i = k_i\,p_i^{-e_i} \tag{A14}$$

Under the assumption that individual firms view their own demand as proportional to market demand, the optimal pricing rule is given by

$$\frac{p_i - V^i}{p_i} = \frac{1}{e_i} \tag{A15}$$

In the long-run the perceived elasticity is equated to the elasticity of the "true" demand curve, which is given by

$$e_i = \epsilon_i^C\,.\,\frac{D_i^C}{Z_i} + \epsilon_i^U\,.\,\frac{E_i^U}{Z_i} + \epsilon_i^M\,.\,\frac{E_i^M}{Z_i} + \epsilon_i^R\,\frac{E_i^R}{Z_i} + \sum_{j\in L}\frac{a_{ij}Z_j}{Z_i}\,\epsilon_{ij}^I \tag{A16}$$

where ϵ^C_i is the elasticity of domestic final demand, ϵ^U_i is the elasticity of U.S. export demand, ϵ^M_i is the elasticity of Mexican export demand, ϵ^R_i is the elasticity of R.O.W. export and ϵ^I_{ij} is the elasticity of intermediate demand, and $a_{ij}\,Z_j$ is the intermediate use of commodity i by industry j.

(ii) Under the Eastman-Stykolt pricing hypothesis

$$p_i^C = p_i^U\,(1+t_i) \tag{A17}$$

where t_i is the domestic tariff.

7. Long Run Equilibrium

To close the model it is assumed that firms enter and exit in response to the presence of pure profits and losses as in the classic Marshallian adjustment process. A long-run equilibrium is a short-run equilibrium with two additional conditions.

(i) All industries are in (approximately) a zero profit condition.

(ii) Under the MCPH, the perceived elasticity is the "true" elasticity.

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Table A-1: Comparison of Estimated Elasticities of Substitution using the Cobb-Douglas and CES Price Aggregator Functions for 11 Selected Estimation Sectors

Sector	Description	Cobb-Douglas	CES
8	Chemical and fertilizer mineral mining	1.10 (13.22)	1.04 (12.43)
46	Sawmills	0.45 (2.23)	0.84 (4.86)
58	Paper bags, board, and stationery products	1.14 (6.11)	0.91 (4.73)
82	Shoes, except rubber	0.65 (2.33)	2.44 (2.94)
86	Cement, hydraulic	0.58 (2.72)	0.46 (3.03)
90	Ceramic plumbing and electrical supplies	1.00 (26.02)	0.97 (24.01)
91	China and earthenware products	1.14 (15.82)	1.01 (56.58)
98	Primary lead, zinc, and nonfer. metals, n.e.c.	0.95 (2.79)	1.00 (2.97)
129	Transformers, switchgear and switchboard app.	0.79 (14.62)	0.77 (15.07)
138	Radio, TV, phonograph records and tapes	1.08 (29.59)	1.00 (202.80)
144	Electrical equipment and supplies	1.05 (54.84)	1.02 (49.84)

Notes: [a]Estimates of the elasticity of substitution between U.S. imports from different sources are reported using two different methods. The t-statistic is reported underneath each estimate. [b]The first column of results is taken from Table 3. [c]The second column of results is obtained using the CES price aggregator function and nonlinear maximum likelihood estimation, correcting for first-order serial correlation. [d]Estimation sectors selected were those in which U.S. imports constituted a significant share of U.S. apparent consumption, U.S. imports from Mexico were a significant share of total U.S. imports, or U.S. imports from Canada were a significant share of total U.S. imports. Sectors with missing observations, denoted by *a* in Table 3, were eliminated from consideration.