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INDUSTRIAL ORGANIZATION AND THE GENERAL EQUILIBRIUM COSTS OF PROTECTION IN SMALL OPEN ECONOMIES

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This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the author.

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INDUSTRIAL ORGANIZATION AND THE GENERAL EQUILIBRIUM COSTS OF PROTECTION IN SMALL OPEN ECONOMIES*

by

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1. Introduction

This paper outlines the theoretical structure and empirical implementation of a real trade general equilibrium model of a small open economy incorporating some features associated with the "industrial organization"(henceforth I.O.) approach to trade. While the theoretical literature in this area is quite recent, and growing rapidly, the general concern with imperfect competition, economies of scale, entry barriers, product differentiation and other aspects of industry structure is certainly not new to the discussion of trade economists on the costs and benefits of trade liberalization. Balassa (1967) and others for example have emphasized the benefits of "industrial rationalization" in the case of the formation of the E.E.C. For small open economies such as Australia, Canada and Sweden there is a long history in the policy debate over free trade as to the adverse consequences of protection on the efficiency of manufacturing industries.

The common argument put forth in the I. O. view is that protection, by restricting market size and limiting foreign competition, promotes too many firms within an industry, operating at too small a scale, and with too many product lines being produced within the plant. It is well known that conventional calculations of the costs of protection give numbers which are quite small; often in the order of 0.5% to 2% of G.N.P. This result holds for almost all known studies based

on the competitive neoclassical model, either partial or general equilibrium. Recent examples include Boadway and Treddenick (1979), Cline (1978), Deardorff and Stern (1981), Magee (1971) and Whalley (1980). The remarkable robustness of these small welfare gain estimates has been of little comfort to economists promoting free trade. On the other hand, those of the I.O. persuasion have suggested these estimates are too small, particularly for small open economies, because of the competitive assumptions underlying the analysis. In Canada, one of the most notable estimates of the gains to multilateral tariff reduction was that of the Wonnacotts (1967) who estimated the mid 1960's gain to be in the order of 10.5% This is a very large number in comparison to the conventional calculation. One question this paper addresses is whether or not a cost of protection estimate of this order is reasonable within a non-competitive empirical general equilibrium model. In anticipation of later results, let me report that my findings are in remarkable conformity with the I.O. view of trade liberalization. For a wide variety of parameter values the gains from trade liberalization to Canada are substantial - in the range of 8-12%.

The message then is that industrial organization matters in the discussion of trade liberalization. Further it matters even more when embedded within a general equilibrium framework, in which intersectoral resource shifts and factor price changes are accounted for.

The empirical general equilibrium methodology used here is in the spirit of that used by Shoven and Whalley and their co-authors. Using a variety of data sources and econometric estimates, the model is required to produce an observed historical data set as an equilibrium. In this paper I will not detail this procedure or document the data sources. For the interested reader this is contained in Harris (1982). There are some quite interesting differences in parameterizing this type of model and the conventional neoclassical general equilibrium models. The paper focuses on the theoretical model and the results of trade liberaliztion experiments. In attempting such an exercise there is the inevitable compromise between the perceptions of the real world, data limitations and model tractability. These compromises, while always present, seem to be more acute, as soon as one attempts to deal with the firm as a model decision unit, and the interaction between firms. The theoretical model developed is what might be referred to as a "bare bones" industrial organization model; the level of detail as to industry structure and conduct is minimal. This is, for the most part, due to the objective of integrating each industry model within a general equilbrium model. Partial equilibrium empirical analysis, such as that of Caves, Porter and Spence (1981), can accomodate a much richer level of detail at the industry level. Nevertheless, I think the model is quite useful and incorporates a number of important structural and behavioural effects that the competitive constant returns neoclassical model misses.

The paper proceeds as follows. In the next section an overview of the model is given. In sections 3 through 8 particular components of the model and equilibrium concepts used are described. Sections 9 and 10 report the results for simulations on multilateral and unilateral tariff cuts. Additional empirical results are contained in Harris (1982) .

2. An Overview of the Model

The model is a real trade model of a small open economy with one fixed factor, labour, and one internationally mobile factor, capital services; both are mobile between industries and firms. Industries divide a priori into those which are competitive and constant cost, and those which are non-competitive increasing returns industries. There are decreasing costs at the level of the plant for a given set of product lines, and there are economies of scale to longer production runs, or equivalently diseconomies to having a larger number of product lines within a given plant. In each non-competitive industry, with product differentiation, products produced by different firms are imperfect but close substitutes. Product differentiation is the basis for the recent theoretical models of Helpman (1980), Krugman (1979), and Lancaster (1979). Likewise, foreign and domestic goods in any industry are imperfect substitutes. For this and other reasons (see Brander(1981)) intra-industry trade is a characteristic of the model.

The economy is presumed to be a price taker in its import markets and a price maker in export markets; an "almost" S. O. E. Domestically produced goods are used in both final demand (domestic and foreign) and as intermediate inputs. All factor markets are competitive with rental capital in infinitely elastic supply at the world rental rate. In competitive industries constant returns is assumed so price must equal unit cost.

Much of the novelty of the model is with respect to the treatment of the firm in non-competitive industries. As all products within an industry are viewed as symmetric imperfect substitutes, and all firms have access to the same technology, each industry consists of some number of representative firms. Each firm produces a set of representative industry products, and chooses a representative price for each product. Quantity is demand determined. The firm sets its price by marking up on unit variable cost. Two alternative pricing hypotheses are used. One uses a Negishi (1961) perceived demand curve approach. The firm uses a perceived constant elasticity demand curve to determine the optimal mark-up (monopolistic pricing hypothesis-MPH). An alternative is a normal cost pricing hypothesis-(NCPH) in which the firm uses information on current demand, fixed and variable costs to set a price consistent with a "normal" rate of return on its fixed capital. In both MPH and NCPH a Nash assumption is used on competitors' prices. In the absence of product differentiation the Cournot assumption of Nash on quantity is used.

In models with product differentiation it is assumed foreign importers match in percentage terms any changes in domestic product differentiation. This assumption of competitive foreign product differentiation (CFPD), or something analogous to it, is required in a S. O. E. model with an otherwise exogenous foreign sector. The reason is that increasing domestic product differentiation squeezes out foreign imports at constant industry terms of trade.

Firms enter and exit in response to pure profits and losses (free entry/exit assumption). The only entry barriers are fixed costs. Equilibrium at the industry level requires that all firms make (approximately) zero profits. Under MPH a "true elasticity" and perceived elasticity are required to be equal. Firms also choose the profit maximizing number of product lines. This type of equilibrium at the partial equilibrium level is analogous to the Cournot-Chamberlain equilibrium.

A general equilibrium results when all industries are in equilibrium, all product and factor markets clear, and the balance of payments is in equilibrium. Balance of payments equilibrium is current account balance, or trade surplus equal rental payments on foreign owned capital. All tax and tariff revenue is returned to consumers in a non-distorting manner.

3. The Model: Technology

This is the first of four sections detailing the model. It is important to emphasize the aggregation basis for

the model, particularly under product differentiation. Industry "output" is a composite commodity aggregate of the output of a number of symmetric but imperfect substitutes. For example, if the shoe industry produces 2 pairs of sneakers and 2 pairs of slippers, total output is referred to a 4 pairs of "shoes". This aggregation procedure is the basis for empirical implementation.

Table 1 lists some of the relevant notation. The model will be detailed without taxes, tariffs, or subsidies. In the empirical implementation of the model most of the relevant tax and tariff distortions are present.

Costs are divided into fixed and variable costs. Variable unit costs are independent of the level of output. Define the unit variable cost function as $v^i(P)$. One particular form used for v^i is the Cobb-Douglas.

TABLE 1

Notation

N: index set for non-competitive industries

C: index set for competitive industries

B: index set for non-competing imports

$$M = N \cup C \qquad G = M \cup B$$

$(p_i)_{i\varepsilon M}$ domestic commodity prices

$(p_i^*)_{i\varepsilon M}$ foreign commodity prices

$(q_i)_{i\varepsilon B}$ foreign prices on non-competing imports.

w: domestic wage

r: world rental rate on capital

p $= (p, p^*, q, r, w)$: price system

D_i: domestic product set for $i\varepsilon N$; $n_i = \#(D_i)$

D_i^*: foreign competing product set, $i\varepsilon N$; $n_i^* = \#(D_i^*)$

$$\log v^i(P) = \alpha_{oi} + \Sigma_{j\varepsilon M}\alpha_{ij} \log w_j^i + \Sigma_{k\varepsilon B}\alpha_{ik} \log q_k + \alpha_{iw} \log w + \alpha_{ir} \log r .$$

w_j^i is a price index of a composite input used by industry i; a composite of both foreign and domestic inputs from commodity j. w_j^i is assumed to have the form

$$\log w_j^i = \beta_{ij} \log p_j + (1 - \beta_{ij}) \log p_j^* . \qquad (2)$$

(2) is unsatisfactory in that foreign and domestic intermediate inputs have a unitary elasticity of substitution. (2) also implies that the degree of product differentiation in each industry has no effect on intermediate demand for the composite input. The input/output matrices are derived from the unit cost functions assuming price taking behaviour in input markets. The domestic Leontief matrix $[a_{ij}(P)] = A(P)$ is defined by

$$a_{ij}(P) = \frac{\alpha_{ij}\ \beta_{ij}\ v^i(P).}{p_j} \qquad (3)$$

a_{ij} is the demand for domestic composite good j, per unit output of composite domestic good i.

Each representative firm in non-competitive industries N_2 has non-zero fixed costs. These are

$$F_i(r,k_i) = rf_k^i + rc^i\,(k_i-1)^{\gamma_i},\ k_i \geq 1. \tag{4}$$

Fixed costs consist only of capital costs. Plant fixed costs are f^i_k in capital units; this is the amount of capital required to produce the minimum number of product lines, k_i, defined as $k_i = 1$. As the number of product lines in the plant increases total fixed costs, F_i, increases at a greater than unit elastic rate; i.e. γ_i greater than 1.0. The assumption that all fixed costs are capital costs is unfortunately restrictive but made for reasons of data availability. For example labour costs associated with changeover from one product line to another are excluded by assumption.

Define z_i as the length of the representative production run in the representative firm in industry i. Total output in the firm is defined as $y_i = k_i z_i$. Total costs in the firm are

$$TC_i = v^i(P)y_i + F_i(k_i,r). \tag{5}$$

Let $AC^i(y_i \mid \bar{k}_i)$ be average cost per unit output <u>given</u> a fixed number of product lines. Let $DC^i(k_i \mid \bar{y}_i) = v^i + F_i(k_i)/\bar{y}_i$ be average cost per unit of output as the number of product lines vary, holding total output constant. Figure 1 illustrates the relevant assumptions regarding these costs.

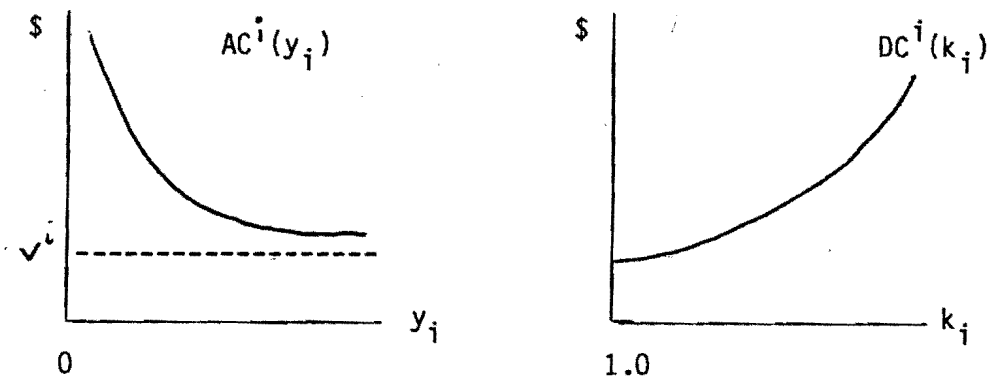

Figure 1

While k_i should be treated as an integer variable it does little harm to treat it as continuous. MES output is defined as that y_i where average cost is within 1% of average variable cost. In the model most firms will operate at MES or below. Low fixed cost industries will be relatively competitive with small MES and large numbers of firms.

4. The Model: Final Demand

Final demand in each commodity category consists of export and final domestic demand. Export demand (R.O.W.) for representative product u in industry i is

$$e_{iu} = \Gamma_i \, (p_{iu}/p_i^*)^{\lambda_i} \, (\hat{n}_i/n_i). \tag{6}$$

The functional form in (6) incorporates a unit elastic "crowding out" effect of domestic product differentiation, n_i, relative to R.O.W. competing product differentiation, $\hat{n}_i$. In equilibrium all $e_{iu} = e_i$ and $p_{iu} = p_i$, so total export demand for industry i is

$$E_i = n_i e_i = \Gamma_i \, (p_i/p_i^*)^{\lambda_i}. \tag{7}$$

(7) is also the form for non-PD cases. The S.O.E. hypothesis implies Γ_i and $\hat{n}_i$ are constant. It would be very difficult to empirically implement a non-unit elastic P.D. crowding out effect.

Domestic final demand is generated by treating the economy as a single consumer. Adding multiple consumers would add little to the I.O. aspects of the model. The consumer maximizes a utility function over all commodity categories of the log-linear form

$$\log U = a_0 + \sum_{i \varepsilon G} a_i \log C_i. \tag{8}$$

For non competing imports, $i \varepsilon B$, C_i represents the amount of the import. For $i \varepsilon C$, competitive industries, the 'Armington' assumption is used; foreign and domestic goods are imperfect substitutes as reflected in the C.E.S. aggregator

$$C_i = [\delta_i x_i^{\rho_i} + (1 - \delta_i) x_i^{*\rho_i}]^{1/\rho_i}. \qquad (9)$$

x_i and x_i^* are domestic and foreign components respectively of final demand.

In P.D. industries a Spence (1975) type generalization of (9) is used which allows the product set to vary.

$$C_i = [\sum_{k \varepsilon D_i} x_{ik}^{\rho_i} + \sum_{k \varepsilon D_i^*} x_{ik}^{*\rho_i}]^{1/\rho_i}. \qquad (10)$$

The common elasticity of substitution between all goods in category i is $\sigma_i = 1 - 1/\rho_i$; for $i \varepsilon N$ $\sigma_i > 1$ for well known reasons. In equilibrium all $x_{ik} = x_i$ and all $x_{ik}^* = x_i^*$.

Given disposable income Y, and prices P, the demand for a representative product in industry i by consumers is

$$x_i = a_i Y \frac{p_i^{-\sigma_i}}{n_i p_i^{-\sigma_i+1} + n_i^* p_i^{*\,-\sigma_i+1}}. \qquad (11)$$

Multiplying by the number of domestically produced goods, n_i, gives total consumer demand for the domestic composite i, X_i,

$$X_i = n_i x_i = a_i Y \frac{n_i p_i^{-\sigma_i}}{n_i p_i^{-\sigma_i+1} + n_i^* p_i^{*-\sigma_i+1}} \qquad (12)$$

In (12), the relative number of domestic to foreign imported goods, (n_i/n^*_i) acts like a share parameter in the conventional C.E.S. function. Consequently, there are competitive benefits to increasing the number of domestic products. (10) also incorporates the usual Chamberlain taste for diversity on the part of consumers.

5. Short-Run Equilibrium

The "short-run" is a period in which industry structure is fixed. The following variables are held constant:

(1) markups on unit cost by firms, $i \varepsilon N$. $(m_i) = m$

(2) number of firms in each industry, $i \varepsilon N$. $(Fm_i) = Fm$.

(3) number of product lines of each firm. $(k_i) = k$.

(4) domestic and foreign P.D. each $i \varepsilon N$. n and n^*.

Let $S = (m, Fm, k, n, n^*)$ be the vector of structural variables.

In the short-run pure profits and losses will occur in each of the industries, $i \varepsilon N$. Let π_i denote industry i's pure profit or loss after paying all factors opportunity cost. Aggregate consumer income is given by

$$Y = w\bar{L} + rK_D + \psi \sum_{i \varepsilon N} \pi_i$$

$\bar{L}$ is aggregate labour endowment, K_D domestic capital endowment, and ψ the share of domestic ownership in industry, all exogenous (even in the long run) variables.

Equilibrium commodity prices are determined by the equations

$$\begin{aligned} p_i &= m_i v^i(P) \qquad i \varepsilon N \\ p_i &= v^i(P) \qquad i \varepsilon C \end{aligned} \tag{14}$$

Solving equation (14) will determine domestic commodity prices as a function of factor prices, (w,r), and world prices, (p_i^*) (q_i).

With the exception of w all other prices in P are exogenous, given S. Let X(P,Y,S) and E(P) denote final demand vectors. Commodity market clearing implies the vector of total outputs

$Z = (Z_i)_{i \varepsilon M}$ must satisfy

$$Z = [I - A(P)^T]^{-1} \quad [X(P,Y,S) + E(P)]. \tag{15}$$

Labour market clearing given the vector of domestic outputs is

$$\bar{L} = \sum_{i \varepsilon M} a_{iw}(P) \, Z_i \tag{16}$$

Industry profits, π_i, are

$$\pi_i = Fm_i \quad (p_i - v^i) \, (Z_i/Fm_i) - F_i(k_i, r) \; . \tag{17}$$

A short-run equilibrium for a given S, is a wage w(S), income Y(S), and vector of outputs Z(S) satisfying (13)-(17). This definition has to be modified with the addition of taxes and tariffs in the usual way. Walras' law implies a balance of payments equilibrium of the form

$$\sum_{i \varepsilon M} P_i E_i - \sum_{i \varepsilon G} P^*_i M_i = r(K - K_D) \tag{18}$$

$$+ (1 - \psi) \Sigma \cdot \pi_i$$

Surplus on trade account equals rental payments on net capital service imports $(K-K_D)$ plus quasi-rents to foreign ownership, $(1 - \psi)\pi$. K is total domestic demand for capital services.

With PD we have the identities

$$n_i = Fm_i k_i \qquad\qquad y_i = Z_i/Fm_i$$

In non-PD equilibrium n_i, n_i^* and k_i are treated as constants in both short and long run.

6. Firm Behaviour

I now turn to how the firm behaves with respect to its pricing and product decisions. Under MCPH each firm in each industry has a perceived demand curve for its representative product, holding the number of products fixed. Let Z_{iv} be the perceived demand in industry i, by firm v for its representative product. The perceived demand curve for this product is assumed to have the constant elasticity form,

$$Z_{iv} = \psi_{iv} p_{iv}^{-\varepsilon_{iv}} \tag{19}$$

The optimal pricing rule,given (19) is the Lerner formulae

$$\frac{p_i - v^i}{p_i} = \frac{1}{\varepsilon_i} \tag{20}$$

where the k has been dropped for convenience. Later I shall return to the problem of where (19) comes from. Under normal cost pricing (NCPH), the firm uses its current output, $\hat{z}_i$, to calculate a price which yields a normal return on fixed capital. That is, p_i, must satisfy

$$(p_i - v^i)\,\hat{z}_i = F_i \tag{21}$$

Under NCPH, the key piece of information is the observed short-run market clearing output level for the firm.

In the case of product differentiation it remains to determine the optimal k_i^*. Let z(p,k) denote the <u>perceived demand curve</u> facing a firm for a representative product given its price, p, and number of product lines k. The firm solves the problem

$$\max_{p,k} \; (p-v)z(p,k)k - F(k) \tag{22}$$

where F(k) is total fixed costs as a function of k. At the optimum, the first-order condition for k is given by

$$(p-v)z(p,k) + (p-v)z_k(p,k) - F'(k) = 0. \qquad (23)$$

To get a manageable problem the individual firm in each industry is assumed to take total industry demand, Z, as given and unchanged by changing its number of products. The firm observes its current demand per product

$\hat{z} = \hat{Z}/\hat{n}$, where $\hat{n} = \hat{k}\ \hat{F}m$, its current number of product lines, $\hat{k}$, and contemplates adding Δ product lines. Its approximate problem is to choose Δ to maximize

$$(p-v)\left\{ \hat{k}\left(\frac{\hat{Z}}{\hat{n} + \Delta}\right) + \Delta\hat{z} \right\} - F(\hat{k} + \Delta) \qquad (24)$$

Solving this problem and noting that in equilibrium, $k = \hat{k}$, or $\Delta = 0$, gives the first-order condition

$$(p-v)\ y\left(1 - \frac{1}{F_m}\right) = F'(k)k \qquad (25)$$

treating k as a continuous variable. Clearly more sophisticated hypotheses are possible but this one seems informationally realistic.

An implication of (25) is that for industries with a very large number of firms, (25) becomes approximately

$$(p-v)\ z = F'(k).$$

The zero profit condition is

$$(p-v)\ z = F(k)/k.$$

Treating $(p-v)\ z = \alpha$ as variable, these jointly determine (α,k) as in figure 2.

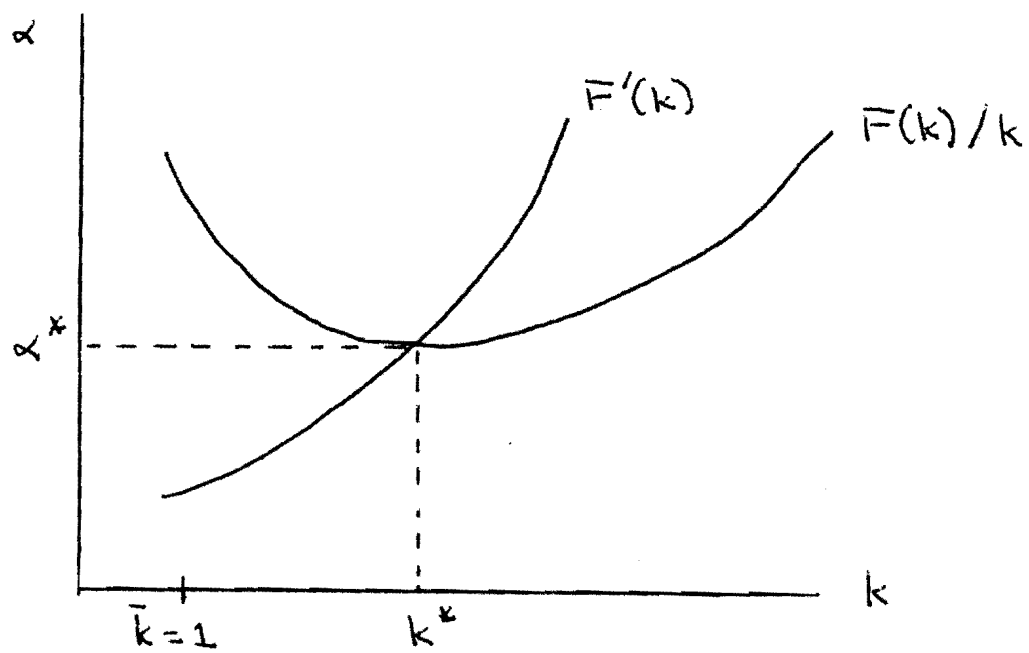

Figure 2.

Analogous to the Marshallian analysis of firm output, k* is determined independently of α, and given by the intersection of average and marginal fixed cost curves. Thus the only thing which shifts k* will be changes in the fixed cost technology or the rental rate on capital. Corner equilibrium are the other possibility as in figure 3.

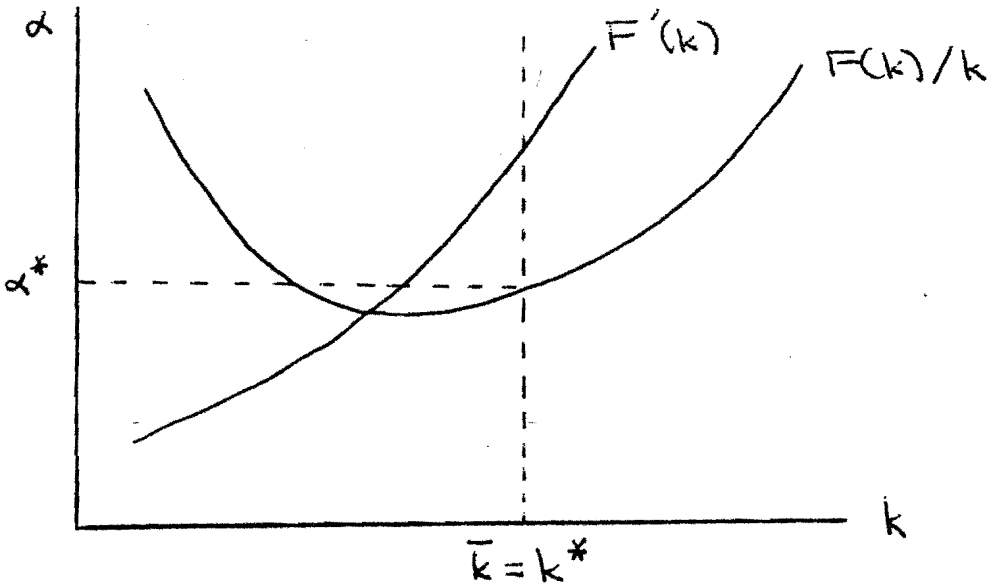

Figure 3.

In figure 3, the firm has the minimum number of product lines. Note that in both cases α must adjust in long-run equilibrium to α^*. The composition of α between output and mark-up is determined essentially as in the Chamberlain model. For industries with "small" numbers of firms, neither of these comments is true. It is also worth noting that if the marginal cost of adding product lines were <u>falling</u> (possible economies to shorter production runs), then the number of firms in equilibrium must be small.

7. Entry, Perceived Demand and Long-Run Equilibrium

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

(1) all industries are in (approximately) a zero pure profit condition.

(2) under MCPH the perceived elasticity is the "true" elasticity.

What is the true demand curve of the firm? (2) requires that the firm be locally correct in its perceptions as to its true demand curve. There are clearly different routes one can go as to the true demand curve.

Begin with the identity for total industry output

$$Z_i = X_i + E_i + \sum_{j \varepsilon M} I_{ji}$$

where $I_{ji} = a_{ji} Z_j$, intermediate use of i by j. The elasticity of Z_i with respect to a variable x is

$$\eta^i_Z = \left(\frac{x_i}{Z_i}\right)\eta^i_x + \left(\frac{E_i}{Z_i}\right)\eta^i_E + \sum_{j \varepsilon M}\left(\frac{I_{ji}}{Z_i}\right)\eta^i_{Ij}. \qquad (26)$$

The firm in calculating its elasticity does a general equilibrium comparative statics exercise, changing its own price and taking as constant (i) all other prices, (ii) product differentiation (iii) aggregate income, and (iv) the output of other industries. The last one is the most crucial. It

ies the firm does not account for induced changes in intermediate demand as a result of changes in the marginal cost of production to other industries. Consequently the elasticity of intermediate demand arises solely from the factor substitution effect.

An alternative to this would be to differentiate (15) totally, but this is an extremely complex calculation. An implication of (26) is that shifts in the compositon of total demand will change the elasticity and hence mark-up.

In going from (26) to the firm's elasticity the formulae is essentially the same given the assumption of symmetric substitutes, and assuming all firms share the same proportions of each demand category.

The component elasticities under P.D. are as follows.

$$\eta^{i}_{X} = -\sigma_i + s_i(\sigma_i - 1) / Fm_i$$

$$s_i = p_i X_i / a_i Y \tag{27}$$

$$\eta^{i}_{E} = \lambda_i \tag{28}$$

$$\eta^{i}_{I_j} = \tau_{ij} + \tau_{ij}\left(\frac{\alpha_{ij}\beta_{ij}}{Fm_i} - 1\right) \tag{29}$$

(27) and (28) are self-explanatory. (29) giving the elasticity of intermediate demand introduces the parameters τ_{ij}. In each industry j the <u>perceived</u> input from domestic i is taken as a C.E.S. aggregate with elasticity of substitution τ_{ij}. This yields the output constant factor demand elasticity (29). In the true model, however, the aggregator is Cobb-Douglas with share parameters $\beta_{ij}\ \alpha_{ij}/n_j$ on each domestic product in category j.

The difficulty with maintaining the Cobb-Douglas assumption is that intermediate demand elasticities are very close to -1; this yields unreasonably high mark-ups. The τ_{ij} are chosen in the range 3.0 to 5.0.

Under P.D. (n_i/n_i^*) is held constant - competitive foreign product differentiation. This hypothesis on the behaviour of importers seems reasonable as it keeps their market share constant, given constant industry terms of trade.

With normal cost pricing a multiple equilibrium problem comes up. Given myopic behaviour by firms they can end up with low output, high price, or high output low price. It turns out, however, that for a wide range firm entry rates in the algorithm the model converges to the same equilibrium. If the algorithm uses a very high firm entry rate parameter, the model will converge to high price-low output equilibrium.

8. Cost and Benefits of Trade Liberalization

The potential benefits from trade liberalization in an economy such as the one outlined here has been discussed by numerous economists. In addition to the conventional source of gains, the following can be included.

(1) increases in real utility due to increased domestic and foreign product differentiation.

(2) realization of economies of scale at the plant level

(3) longer production runs within the plant

(4) aggregate efficiency gains due to intersectoral resource shifts as a consequence of (2) and (3).

Theoretically, it is very difficult in a general equilibrium framework to make any qualitative predictions as to these effects. In fact because of the maintained presence of imperfect competition one is inevitably faced with the second best problem; removal of one set of distortions such as domestic tariffs may well reduce welfare. In addition because even a small open economy faces less than perfectly elastic demand curves for its products, there is the optimal tariff problem. It is, of course, possible in a partial equilibrium framework with strong assumptions on tastes and technology to get definite predictions as to some of these effects. Yet the lack of generality of these theoretical results is yet another reason to resort to empirical analysis.

In the model the welfare measure used is the Hicks equivalent variation (E.V.), signed so welfare improvements are positive. The welfare gain in % terms is expressed as $E.V./Y_0$, where Y_0 is base income. In the case of a changing product set under P.D. the E.V. is evaluated at the <u>base</u> product set.

9. Some Results

The model outlined in the previous sections was scaled to a 1976 Canadian data set, together with extraneous econometric estimates on various elasticities. The model has 29 industries, 20 manufacturing industries treated as potentially non-competitive and the other 9 as competitive. Capital services is a mobile factor in perfectly elastic supply at the world rental rate. Labour is in inelastic supply but mobile between industries. The model was scaled relative to a short-run equilibrium with the number of firms held constant in each non-competitive industry. Alternative long-run equilibrium are simulated under various assumptions as to firm behaviour and policy parameters. The algorithm used solves the short-run equilibrium using a conventional numerical interpolation procedure. The long-run equilibrium is solved by an iterative procedure which essentially mimics the Marshallian textbook procedure of exit and entry in response to profits and losses, together with an up-dating of elasticities. In this paper I report briefly on some of the results. These are reported in Tables 2-10. The policy simulations reported involve a unilateral cut of all domestic tariffs (including N.T.B. ad valorem equivalents) and a multilateral cut of all tariffs (and N.T.B. ad valorem equivalents), foreign and domestic. These tariffs were those in place in 1976. Table 2 explains the definitions of the variables reported. The discussion is restricted to the general results.

Tables 3-10 report summary results on trade liberalization experiments under four alternative behavioural hypotheses, for the same parameter values. The parameter values used are "best guess" parameter values. The four behavioural hypotheses are

(A) Monopolistic Pricing with Product Differentiation

(B) Normal Cost Pricing with Product Differentiation

(C) Monopolistic Pricing with no Product Differentiation

(D) Normal Cost Pricing with no Product Differentiation

A matrix of welfare gains to multi-lateral cuts (in percentage terms) in the alternative situations is given below.

	P.D.	No P.D.
MCPH	14.0% (25.9%) -2.1%*	6.8% (-1.8%) -0.3%*
NCPH	16.3% (22.2%) -0.6%*	8.6% (17.1%) -0.2%*

The welfare gain to multilateral cuts or "Free trade" in all cases is quite large.

This matrix indicates both product differentiation and normal cost pricing tend to yield larger welfare gains from trade liberalization. Explaining the product differentiation effect seems straightforward enough; larger world markets allow increased domestic product differentiation and hence foreign product differentiation. Consumers taste for diversity translate this into a welfare gain. Under normal cost pricing mark-ups tend to be lower with a fewer number of firms, than with MCPH. When the market demand curve shifts to the right under a multilateral tariff cut, this translates into more output and more firms at relatively lower margins on cost. Under MCPH a shift in the demand curve can also lead to an increase in the mark-up on cost, particularly if export demand is relatively less elastic than domestic demand.
The figure in brackets is one indicator of the rationalization effects; it is an index of the change in the length of production runs in the economy. The rationalization effects are quite strong. At the level of the industry these effects are even stronger. Industries which rationalize a lot tend to expand; those which do not tend to contract. The welfare gains are substantially larger than traditional estimates. Yet they are also sensitive to behavioural hypotheses. This highlights the difficulty of incorporating Industrial Organization into

general equilibrium because of the variety of behavioural assumptions one might use. The figures in the matrix marked with * are the welfare gains due to unilateral cuts. These are in all cases small and negative. Some rationalization occurs as a result of unilateral cuts, but not a great deal. The welfare loss is attributable to an optimal tariff effect (inelastic world demand curves for some products). Thus for a small open economy it would seem the cost of its own tariff, is the tariff of foreigners. Larger world markets are a major source of efficiency gains in manufacturing industries. These efficiency gains are not only those within an industry, but also those resulting from intersectoral resource shifts within manufacturing which occur.

In all the simulations, two fundamental features emerge in addition to the large gains due to trade liberalization.

(1) A dramatic fall in intra-industry trade with multi-lateral tariff cuts and large inter-industry shifts of labour within manufacturing.

(2) A negligible shift in the total labour force between manufacturing and other sectors in the economy.

The picture one gets then, is that the adjustment costs are likely to be large in the Canadian case. Thus while rationalization effects are significant in the movement to free trade, rather than mitigating intersectoral resource shifts, they seem to exaggerate them. However, the total effect on manufacturing versus other sectors is relatively neutral.

One feature which is not reported in the tables is the stability of firms product line decisions under trade liberalization experiments. Rationalization of product lines for example does not seem to occur in the move to a free trade equilibrium. This seems to be a consequence of (a) the imperfect foreign-domestic substitutes assumptions and (b) the "capital only" nature of product diversity costs. For example if perfect world substitutes existed for each domestic good at some price, this would undoubtedly yield greater product rationalization effects. Modelling this in a consistent way, however,is extremely difficult in a general equilibrium framework.

10. Conclusion

A general equilibrium model of a small open economy with an imperfectly competitive sector is constructed and implemented on a Canadian 1976 data set. The details of industrial organization in the non-competitive sectors include economies of scale, economies of long production runs, and product differentiation. A number of general equilibrium

simulations on trade liberalization were carried out. The major conclusion is that the welfare gains from trade liberalization are substantial in the Canadian case; somewhere in the neighbourhood of 7-15% of GNE. The "rationalization" of industry is an important source of these welfare gains. However the adjustment costs in a movement to free trade are likely to be substantial. There is a large decrease in intra-industry trade, and significant intersectoral shifts in labour.

These results indicate that incorporating scale economies, and other features of industrial organization, into general equilibrium models can have important consequences which are different than the traditional model, at least in the case of small open economics. Whether this will turn out to be the case for large, and closed economies remains to be seen. Clearly, howver I.O. matters in general equilibrium models of small open economies. Additional work in this area is unlimited. The major barriers are data limitations and the inevitable necessity of aggregation.

Table 2: Notes to Tables[1]

Wage: base 1976 wage = 1.0

GNE: millions of '76 Canadian $

Trade Volume: the absolute value of exports plus absolute value of imports

Value Added: millions of '76 Can. $.

Capital Imports: denote the rental payments on foreign owned capital, or - trade surplus

Employment: 1 unit labour = 1 $M of labour in base equilib.

EQUIV VAR: millions of '76 Can. $, Hicks Equivalent Variation

D-EQUIV VAR: deadweight loss as proportion of base G.N.E. = E.V./G.N.E.^{0}

PRL: change in index of length of production runs in plant

AFC: index of average plant fixed costs

ADC: index of average product fixed costs

LPRCT: index of labour productivity

TVOL: trade volume (value terms)

AGTRA: weighted average of Balassa-Grubel index of intra-industry trade. (If AGTRA = 1.0 all trade is intra-industry)

D-X: denotes relative change in x; (x' - x)/x

LABREALLOCATION INDEX: % of employment which is shifted inter-sectorally

1/0: denotes a unilateral tariff cut

2/0: denotes a multilateral tariff cut

1. All figures exclude government demand for and ownership of factors of production, the former always assumed equal to the latter

Table 3

MCPH - Product Diff.

SUMMARY AGGREGATE STATISTICS

	VARIABLE	(1/0)	(2/0)
1.	D - WAGE	-0.0186257	0.2316467
2.	D - GNE	-0.0348988	0.1083607
3.	D - EQUIV. VAR.	-0.0211357	0.1399642
4.	EQUIV. VAR.	-3163.2680664	20947.7343750
5.	D - AGPRL	0.1525790	0.2589441
6.	D - AGAFC	0.0346700	-0.0639662
7.	D - AGADC	-0.0454660	-0.2115036
8.	D - LPRCT	0.0128323	0.2010744
9.	D - TFACT	-0.0165032	-0.1663630
10.	D - TVOL	0.0897905	0.6223682
11.	D - GNP	-0.0002903	-0.0166993
12.	LAB.REALLOC.INDX.	0.0103792	0.0794402
13.	D - AGTRA	-0.0114475	-0.2704747

Table 4

MCPH - Prod. Diff.

SOME SUMMARY STATISTICS

TARIFF CUT EXPERIMENT

VARIABLE	ALL TARIFFS IN PLACE	CANADIAN TARIFFS REMOVED	FOREIGN TARIFFS REMOVED
WAGE	0.88683	0.87032	1.09227
G.N.E.	149665.00000	144441.87500	165882.81250
G.N.P. (REAL)	145967.81250	145925.43750	143530.25000
CAPITAL IMPORTS	-4412.71094	-5242.87500	16085.91406
TRADE VOLUME	77948.12500	84947.12500	126460.56250
INTRA-INDUSTRY TRADE INDEX	0.61599	0.60894	0.44938
TOTAL VALUE ADDED	130550.12500	128217.06250	167602.25000
VALUE ADDED (MFG.)	28933.45313	28709.30469	38026.14453
TOTAL EMPLOYMENT	85336.81250	85336.81250	85336.81250
EMPLOYMENT IN MFG	22325.66797	22529.87891	22766.98438
FIXED / TOTAL CAPITAL RATIO	0.12340	0.12435	0.10084

Table 5

NCPH - Prod. Diff.

SUMMARY AGGREGATE STATISTICS

	VARIABLE	(1/0)	(2/0)
1.	D - WAGE	-0.0133103	0.3052883
2.	D - GNE	-0.0311224	0.1500635
3.	D - EQUIV. VAR.	-0.0061456	0.1627136
4.	EQUIV. VAR.	-914.8811035	24222.8125000
5.	D - AGPRL	0.0580482	0.2225341
6.	D - AGAFC	-0.0244219	-0.1849537
7.	D - AGADC	-0.0246940	-0.1958000
8.	D - LPRCT	0.0170422	0.2349913
9.	D - TFACT	-0.0210959	-0.1903704
10.	D - TVOL	0.1022135	0.7357734
11.	D - GNP	-0.0005077	-0.0196667
12.	LAB.REALLOC.INDX.	0.0137804	0.1017901
13.	D - AGTRA	-0.0015716	-0.3341907

Table 6

NCPH - Prod. Diff.

SOME SUMMARY STATISTICS

TARIFF CUT EXPERIMENT

VARIABLE	ALL TARIFFS IN PLACE	CANADIAN TARIFFS REMOVED	FOREIGN TARIFFS REMOVED
WAGE	0.87988	0.86817	1.14850
G.N.E.	148867.75000	144234.62500	171207.37500
G.N.E. (REAL)	145887.12500	145813.06250	143018.00000
CAPITAL IMPORTS	-4625.10938	-5100.64063	18885.41406
TRADE VOLUME	76540.12500	84363.56250	132856.31250
INTRA-INDUSTRY TRADE INDEX	0.59201	0.59108	0.39416
TOTAL VALUE ADDED	129662.37500	128157.18750	175056.181750
VALUE ADDED (MFG.)	28463.96484	28625.45703	41519.33203
TOTAL EMPLOYMENT	85336.81250	85336.81250	85336.81250
EMPLOYMENT IN MFG	22169.69922	22481.95313	23633.24609
FIXED / TOTAL CAPITAL RATIO	0.11445	0.11683	0.08070

Table 7

MCPH - No. Prod. Diff.

SUMMARY AGGREGATE STATISTICS

VARIABLE	(1/0)	(2/0)
1. D - WAGE	-0.0186173	0.2321119
2. D - GNE	-0.0348372	0.1084277
3. D - EQUIV. VAR.	-0.0034428	0.0684816
4. EQUIV. VAR.	-515.2626953	10249.2343750
5. D - AGPRL	0.0134675	-0.0184008
6. D - AGAFC	-0.0338532	-0.0288982
7. D - AGADC	-0.0338534	-0.0288978
8. D - LPRCT	0.0128348	0.2013280
9. D - TFACT	-0.0165395	-0.1659465
10. D - TVOL	0.0898114	0.6214125
11. D - GNP	-0.0002471	-0.0170514
12. LAB.REALLOC.INDX.	0.0103762	0.0791438
13. D - AGTRA	-0.0114511	-0.2702805

Table 8

MCPH - No Prod. Diff.

SOME SUMMARY STATISTICS

TARIFF CUT EXPERIMENT

VARIABLE	ALL TARIFFS IN PLACE	CANADIAN TARIFFS REMOVED	FOREIGN TARIFFS REMOVED
WAGE	0.88690	0.87039	1.09277
G.N.E.	149664.18750	144450.31250	165891.93750
G.N.P. (REAL)	145955.56250	145919.50000	143466.81250
CAPITAL IMPORTS	-4412.55469	-5243.81250	16050.97656
TRADE VOLUME	77943.18750	84943.37500	126378.06250
INTRA-INDUSTRY TRADE INDEX	0.61599	0.60894	0.44950
TOTAL VALUE ADDED	130545.12500	128217.43750	167538.81250
VALUED ADDED (MFG.)	28931.03516	28707.50781	37989.00000
TOTAL EMPLOYMENT	85336.81250	85336.81250	85336.81250
EMPLOYMENT IN MFG	22322.06250	22526.60547	22737.43750
FIXED / TOTAL CAPITAL RATIO	0.12343	0.12433	0.10076

Table 9

NCPH - No Prod. Diff.

SUMMARY AGGREGATE STATISTICS

	VARIABLE	(1/0)	(2/0)
1.	D - WAGE	-0.0139804	0.3021098
2.	D - GNE	-0.0313960	0.1487839
3.	D - EQUIV. VAR.	-0.0023775	0.0860861
4.	EQUIV. VAR.	-355.0751953	12856.8046875
5.	D - AGPRL	0.0479521	0.1712738
6.	D - AGAFC	-0.0217721	-0.1828780
7.	D - AGADC	-0.0217722	-0.1828777
8.	D - LPRCT	0.0167146	0.2335721
9.	D - TFACT	-0.0211968	-0.1891243
10.	D - TVOL	0.1024529	0.7379100
11.	D - GNP	-0.0003464	-0.0195314
12.	LAB.REALLOC.INDX.	0.0136922	0.1006302
13.	D - AGTRA	-0.0016066	-0.3342713

Table 10

NCPH - No Prod. Diff.

SOME SUMMARY STATISTICS

TARIFF CUT EXPERIMENT

VARIABLE	ALL TARIFFS IN PLACE	CANADIAN TARIFFS REMOVED	FOREIGN TARIFFS REMOVED
WAGE	0.88513	0.87276	1.15254
G.N.E.	149348.25000	144659.31250	171568.87500
G.N.P. (REAL)	146491.68750	146440.93750	143630.50000
CAPITAL IMPORTS	-44971.83203	-5457.81641	18375.03906
TRADE VOLUME	75990.37500	83775.81250	132064.43750
INTRA-INDUSTRY TRADE INDEX	0.59477	0.59381	0.39595
TOTAL VALUE ADDED	129737.50000	128194.37500	174859.37500
VALUE ADDED (MFG.)	28277.06250	28432.82031	41156.24219
TOTAL EMPLOYMENT	85336.81250	85336.81250	85336.81250
EMPLOYMENT IN MFG	22366.01172	22683.46875	23743.25781
FIXED / TOTAL CAPITAL RATIO	0.10593	0.10840	0.07425

References

Balassa, B. (1967) Trade liberalization among industrial countries (McGraw Hill, New York)

Boadway, R. and J. M. Treddenick (1979) A general equilibrium computation of the effects of the Canadian tariff structure, Canadian Journal of Economics.

Brander, J. (1981) Intra-industry grade in identical commodities, Journal of International Economics.

Caves, R., Porter, M. and Spence, M. (1981) Competition in the International Economy, (Harvard U. Press, Cambridge).

Cline, W. R., Kawanabe, N., Krunsjo, T. O. M. and Williams, T. (1978) Trade Negotiations in the Toyoko Round: A Quantitative Assessment, Brookings Institution.

Deardorff, A. V. and Stern, R. M. (1981) A Disaggreagated Model of World Production and Trade: An Estimate of the Impact of the Tokyo Round, Journal of Policy Modeling.

Grubel, H. and Peter Lloyd (1975) Intra-industry trade (MacMillan, London).

Harris, R. (1982) Tariffs, industrial subsidies and the manufacturing industries in Canada, mimeo, U. of British Columbia.

Helpman, E. (1980) International trade in the presence of product differentiation, economies of scale and monopolistic competition, working paper 24-80, Tel-Aviv University.

Johnson, H. (1960) The cost of protection and the scientific tariff, Journal of Political Economy.

Krugman, P. (1979) Increasing returns, monopolistic competition and international trade, Journal of International Economics.

Lancaster, K. (1979) Variety, Equity and Efficiency (Columbia University Press, New York).

Magee, S. P. (1972) The Welfare Effects of Restrictions on U. S. Trade, Brookings Economic Papers.

Spence, M. (1975) Monopolistic Competition & Product Variety, Review of Economic Studies.

Whalley, J. and Brown, F. (1980) General equilibrium evaluations of tariff-cutting proposals in the Tokoyo Roun d and more extensive liberalisation of world trade, Economic Journal.

Wonnacott, P. and Wonnacott, R. (1967) Free trade between Canada and the United States (Harvard U. Press).