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INSTITUTE FOR ECONOMIC RESEARCH

QUEEN'S UNIVERSITY

Kingston, Ontario, Canada K7L 3N6

A NON-NEOCLASSICAL GENERAL EQUILIBRIUM TRADE MODEL IMPLEMENTED FOR QUEBEC

Tim Hazledine *

Queen's University
Department of Economics
Kingston, Ontario

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ABSTRACT

A general equilibrium model is developed of the consequences for a trading economy of changes in the tariffs imposed on flows of goods between it and its trading partners. Expressions are given for the adjustments in exchange rates and wage rates needed to restore internal and external balance following changes in the tariff structure.

It is suggested that the neoclassical 'law-of-one-price' does not hold in the international markets for manufactured goods. In its place is put a model of market behaviour when goods are generally heterogeneous. This model is consistent with the phenomenon of 'intra-industry trade', as well as with other empirical findings about the pricing and output behaviour of firms.

The model is implemented with data on the Quebec economy in 1974. Various changes in Quebec's trading relations with the rest of Canada and with other countries, such as those which might follow should Quebec become an independent country, are examined.

I. INTRODUCTION

Empirical general equilibrium analyses of the effects of tariff changes have been developed in the recognition that partial equilibrium calculations of 'effective rates of protection' are not valid predictors of the magnitude or even the direction of resource reallocations in a world of inter-industry linkages and exchange rate adjustments to preserve the balance of trade.[1]

Previous work (Taylor and Black (1974), Boadway and Treddenick (1978)) on Chile and Canada has followed the neoclassical approach introduced by Johansen in his multi-sectoral growth models (1964, 1968). In the present paper, it is suggested that the neoclassical assumptions are not generally valid, and an alternative model is offered. The two important distinguishing features of this are (a) the rejection, for most sectors, of the 'law-of-one-price', which predicts that the prices of imports and competing domestic commodities are the same and reflect in full any change in exchange rate or tariff, and, (b) the separation, in most instances, of pricing and output decisions.

The model may appeal to those who, coming, as I did, from the low-caste activities of applied pricing and factor demand analyses, find the fine sweeping assumptions of international trade theory offensive to their sense of reality. It may also be of interest to economists who, without necessarily conceding the validity of non-neoclassical propositions about market behaviour, would nevertheless be interested to compare their general equilibrium implications with those of the orthodox approach.

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[1] *Cf*. Bhagwati and Srinivasan (1973), Bruno (1973).

The work reported in this paper was part of a study sponsored by the Economic Council of Canada, on the 'political economy' of the Canadian Confederation.[2] My brief was to examine the allocative and distributive consequences for each of the 'regions' of Canada[3], (a) of their membership in the present Canadian customs union, and (b) of conceivable changes in the terms of the customs union, such as a declaration by the federal government of unilateral free trade.

In section II, I attempt to precis the important features of the orthodox, neoclassical model, note the modifications that have to be grafted on to this model when it is confronted with actual data, and suggest that this dissonance between theory and reality might better be resolved by working with a different paradigm, in which the apparently persistent 'non-neoclassical' (no more positive term is available) elements in observed market behaviour are built right in from the beginning of the model-building exercise. This leads to the proposed model, which is discussed in detail and illustrated graphically in section III. Three sectors of the economy are identified. In *primary* industries, the neoclassical rules are assumed to hold. In *manufacturing* they do not, due to general conditions of oligopoly and differentiated products. *construction and services* are different again -- small scale production is possible, and output is not traded.

The model is formulated algebraically, in section IV. Equations are developed giving changes in prices, shipment flows, and employment, as a function of changes in exchange rates, tariffs and input prices. Then, in section

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[2]Summaries of all the contributions to the study are available in Swan (1979).

[3]The regions were: 'Atlantic' (Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick), Quebec, Ontario, 'Prairies' (Manitoba, Saskatchewan, Alberta), British Columbia.

V, these equations are applied to the actual 'base-period' (1974) values of variables and combined into expressions giving, for each region, the levels of total employment, real domestic product and the balance of trade that would result from a given adjustment to the terms of the Customs Union.

Three useful features of the procedure are:

1) since it is set up in terms of rates-of-change, the model does not have to be 'calibrated' to replicate the actual base-period values of variables;
2) the model is closely approximatable as a linear system which can be solved with just the four arithmetic operations. There is no need for expensive and mysterious nonlinear solution algorithms;
3) linearity also means that the model can be rearranged to give the 'instrument' variables (exchange rate, tariffs, input prices) as functions of the 'targets' (employment, RDP, balance of trade) in order to calculate the changes in instruments that would be needed to achieve given targets.

Section VI describes the data used in the implementation of the model. The base-period year chosen was 1974, for which reasonably comprehensive data are available on inter-regional shipments of manufactured products. In section VII some results are shown, for just one region -- Quebec. There is no space to show and discuss results for more than one region.[4] With its separation movement, Quebec is obviously a particularly interesting subject for this sort of exercise.

Finally, in section VIII, the paper is summarized, and a number of suggestions made for improvements to the model.

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[4]Results for all regions are given in Hazledine (1979a), which also includes a non-technical description of the model.

II. PROBLEMS OF THE NEOCLASSICAL APPROACH

The defining feature (it seems to me) of what is called a 'neoclassical' general equilibrium model is that it assumes an economy of perfectly competitive markets. That is (a) in each market all producers are too small to believe that any one of them could affect the market price by altering its output, and (b) inputs are mobile between firms and markets so that rates of return and wage rates are everywhere equal.

In a model with international trade, the 'small country' assumption usually is added -- not only are the individual agents small, but the whole economy is small relative to the world market, so that it cannot affect the world price by the quantities it imports or exports.

As well, in the empirical neoclassical models discussed below, constant returns to scale are assumed to hold in each industry, though a sufficient assumption would be just that returns are non-increasing.

The theoretical properties of this neoclassical system have been exhaustively examined theoretically within the analytically manageable context of two-sector, two-factor models.[5] To be of any use empirically, however, the scope of the model must be extended to more than two industries, if not more than two primary factor inputs (labour and capital). However, when this is done something rather bothersome happens. The key implication of the small-country assumption is the 'law-of-one-price' -- the proposition that the domestic price of any traded commodity is its world-market price, converted into the domestic currency, and with any domestic tariff added on. But, with constant returns to scale (and profit-maximization), the domestic price is *also*

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[5]For references, *cf*. Boadway and Treddenick (1978), footnote 1, p. 424.

given as a function of the prices of inputs. Thus, so long as there are more commodities than primary factor inputs, prices are over-determined. What would, in fact, be predicted by a two-factor model with fixed exchange rates is that only two commodities would be produced.

Since more than two commodities *are* produced, something must be done to bring into balance the number of equations and unknowns in the system. Four ways of doing this are considered in the papers of Taylor and Black, and Boadway and Treddenick:

(i) it could be assumed that there are other factors which are fixed in supply -- for example, land or entrepreneurial ability -- so that returns to labour and capital together are decreasing, and the price of each domestically produced commodity would not be uniquely related to the relative price of labour and capital -- the scale of output in each industry would matter as well. The problem with this, noted by Taylor and Black (1974, p. 44, fn. 4), is that we do not usually have data on the contribution of these other factors to production;

(ii) the perspective of the model could be restricted to a 'short-run' in which capital stocks are assumed fixed, so that profit rates become rents, determined residually, and able to differ in each industry. This is what Taylor and Black do. An objection that can be raised against this procedure is that, although it suppresses the over-determinary problems, it doesn't *solve* it -- Taylor and Black are still working with a model whose long-run properties they find unacceptable.

(iii) Boadway and Treddenick make their modifications to the pure neoclassical model in its product market. First (1974, p. 428) they drop the assumption of exogenous world prices and make imports an increasing function of the domestic price. Later, though (p. 434), they reject this on the grounds that it implies different prices paid on the world market for exports and imports. They might also have noted that it is probably unwise empirically to rely on upward-sloping import supply curves in a model of a relatively 'small' economy such as Canada.

(iv) Boadway and Treddenicks' preferred solution is to drop the assumption of perfect substitutability and allow imported and domestically produced versions of a commodity to sell at different prices -- the import price being determined by the world price (and the tariff and exchange rate), and the domestic output price by factor prices set to be consistent with a general equilibrium under perfectly competitive domestic market conditions. Domestic market shares of two sources of supply are determined by their relative price.

This procedure represents a sharp break with orthodox neoclassical practice, since it implies that tariffs on imports have no *direct* effect on prices of domestically produced competitive goods; only an indirect effect through the changes in factor prices needed to restore general equilibrium. Thus, a change in the tariff levied on just one imported commodity would have virtually no effect on the price of the domestic output of that commodity, in defiance of the law-of-one-price and the partial equilibrium theory of effective protection.

Exogenous world prices for exports would also lead to over-determinancies, and both Taylor and Black and Boadway and Treddenick assume less-than-infinite elasticities of demand for exports. Given that economies tend to be more specialized in their export activities than in their imports, this may be a reasonable-enough qualification of the 'small open economy' model,[6] although in section III, I will suggest that fixed world prices are plausible for primary-sector industries.

III. THE MODEL: THE THREE CATEGORIES OF MARKET BEHAVIOUR

The general equilibrium trade model developed in the remainder of this paper distinguishes three market types, corresponding, it is suggested, to three observed industrial categories:

(i) *primary* industries produce, under conditions of diminishing returns to scale, homogeneous commodities which are bought and sold at given prices on world markets;

(ii) *manufacturing* industries produce, at constant unit costs, heterogeneous (differentiated) products of which the prices reflect both costs and the prices of competing products, with the relative weights given these two factors dependent on the extent to which oligopolistic co-ordination and barriers to entry allow sellers to earn rates of return above those obtained in perfectly competitive markets;

(iii) *construction and services* industries also produce heterogeneous products under constant returns but at scales of efficient production sufficiently small for competition in the capital market to work to keep returns to inputs equal across firms and industries.

This taxonomy of market types allows us to include both variants of the neoclassical model as special cases, each appropriate in a particular sector

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[6]Appelbaum and Kohli (1979) could not reject empirically the propositions that Canada is a price-taker for its imports but not for exports.

of the economy, while adding a new pricing model to deal with that significant portion of economic activity which apparently fails to conform to the neoclassical postulates. Thus, the law-of-one-price holds in the primary sector with over-determinancy dealt with by assuming diminishing returns to variable inputs; this being a reasonable, even essential, property of a model of these land-based industries. Industries in which entry is easy and products differentiated have price set to keep returns to factors at perfectly competitive levels, so that 'world' prices are not directly relevant even if products are traded (in many cases they are not).

Industries with some market power require a different approach, since they are influenced but not dominated by world prices, and are not, in general, subject to the discripline at a perfectly competitive capital market.

The development of a model of pricing and output behaviour for these three market types is carried out in the remainder of this section. The perspective of the model will be 'medium term', by which is meant a time period long enough for firms not making profits to be forced to exit from an industry, but not long enough for gross investment, either by new or existing firms, to occur. Thus, the model will be slightly broader in scope than that of Taylor and Black, who had industry capital stocks fixed, and possibly more realistic than that of Boadway and Treddenick who have a constant total capital stock, but assume that it can be redistributed amongst industries.[7]

1. Primary Industries

Primary industries apply labour and capital to 'land' to produce standardized commodities which are extensively traded in world markets. In this

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[7]It seems that capital is rather fixed in use once installed -- exceptions being vehicles and, possibly, buildings.

sector of the economy it is reasonable to assume that both assumptions of the standard neoclassical partial equilibrium model hold -- that is, diminishing returns to variable inputs and the 'law-of-one-price'. The situation is depicted on Figure 1. Domestic demand for the primary commodity is a downward sloping function D. Any quantity can be bought or sold in the world market at

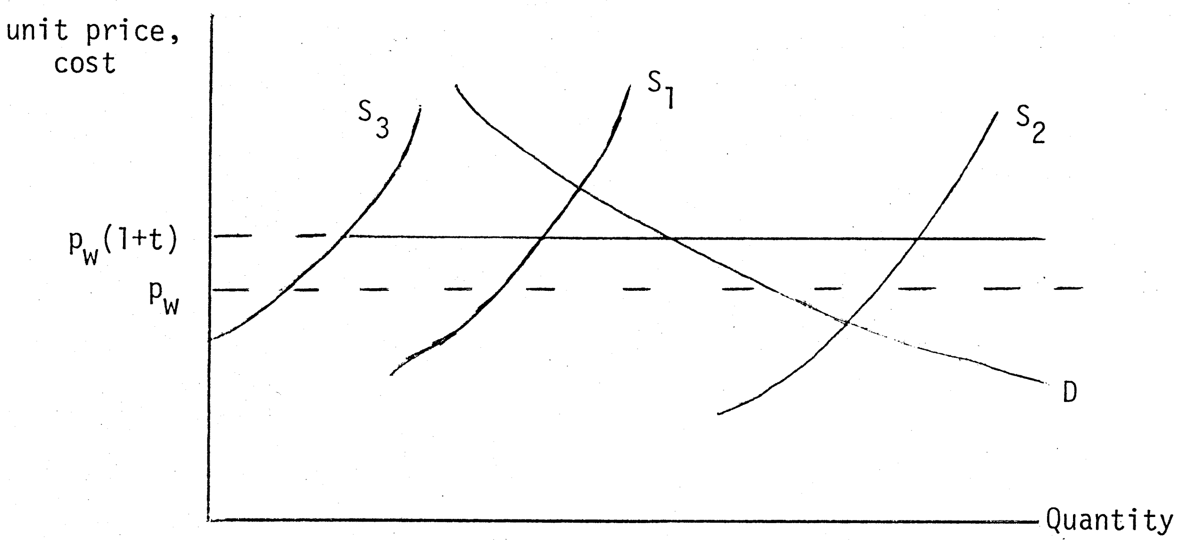

Figure 1: Price and Output in a Primary Commodity Market

the price p_w, so that with a tariff rate t, the domestic market price can only be p_w (1 + t). If the supply (marginal cost) curve of the domestic industry were S_1, OM of total domestic demand ON would be produced domestically, and the rest, MN, imported. If the tariff were removed, demand would increase to OR, and domestic production fall to OL, leaving LR to be supplied from abroad. If the domestic supply curve were to the right of the demand curve at p_w (S_2), the industry would export quantity RS.[8]

[8] Presumably there would be no tariff in an exporting industry. If there were, it would pay the domestic producers to price discriminately, selling locally at p_w (1 + t) and internationally at p_w.

Note that this model implies (a) that the commodity is either exported or imported but not both;[9] and (b) that changes in domestic costs affect only quantity, not price. An increase, say, in unit costs that shifted the supply curve to S_3 would reduce domestic output to OK but cannot change the market price.

2. Manufacturing Industries

The law-of-one-price model does not appear to be tenable for manufacturing, in which neither its assumptions nor its implications are empirically valid:

(a) Even in the 'medium term' in which labour is the only fully variable factor, returns to scale in manufacturing industries are typically non-decreasing.[10]

(b) Direct tests of the law-of-one-price have not supported it. Isard (1977) found significant exchange rate-related fluctuations in the ratio of U.S. import-to-export unit values at the 7-digit commodity level. Kravis and Lipsey, and Richardson (both 1978) show further evidence which leads Dornbusch and Jaffee to conclude that the law-of-one-price hypothesis is left 'rather in shambles' (1978, p. 159).

(c) There is quite pervasive evidence (Grubel and Lloyd (1975), Caves (1979)), of 'intra-industry' trade in manufactured commodities -- that is, of countries persistently both exporting and importing goods within the same commodity classification

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[9] With transport costs, there is a zone of possible intersection points of domestic supply and demand curves in which no trade takes place.

[10] For a survey of empirical results, *cf.* Hazledine (1980a). For results on productivity behaviour in the Canadian provinces, *cf.* Hazledine, *et. al.* (1980).

(d) Most econometric models of manufacturing industries find that changes in domestic costs are closely associated with changes in prices (for Canada, *cf.* Bodkin and Tanny, 1975).

The key to building a pricing model consistent with this evidence lies, I suggest, in dropping the assumption of a homogeneous good in each market. Instead, suppose that products are, in general, differentiated (heterogeneous) by reputation, availability, special attributes, and so on, so that each firm has some *market power* -- it can change the price of its product without experiencing a very large change in the quantity demanded, unlike the seller of a primary product.

Then, price becomes a decision variable for the firm, to be set to meet its goals subject to costs and to the rules of both domestic and foreign sellers of substitute goods. The situation is illustrated by Figure 2, in which it is assumed that unit, and thus marginal, costs are constant. Consider a firm

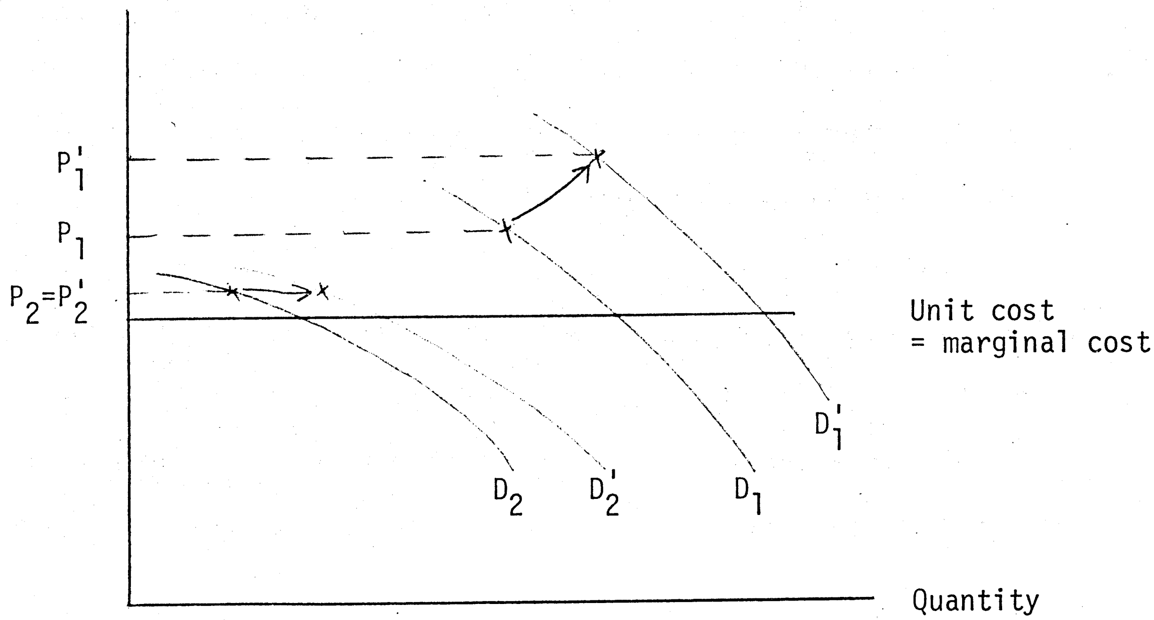

Figure 2: Price and Output of Manufactured Commodities

initially facing the demand curve D_1 for its product, and selling at price P_1. This point may lie above the intersection of the cost curve and the marginal revenue curve implied by D_1, but we will not restrict it to do so, in order not to rule out, *a priori*, more complicated motives than simple profit-maximization. Suppose a tariff is imposed on imports of products which compete with the domestic firm's output. This shifts out the domestic demand curve, to D_1'. The extent of the shift and of the price increase that will follow it depend on such factors as the degree of substitutability of imports and domestic output, the extent to which domestic firms co-ordinate to follow each other's price increase, and the extent to which they are vulnerable to entry from new competitors attracted by the higher profit rates generated by higher prices.

We should expect that this ability to take advantage of tariff protection is not equal across industries. In particular, industries of which the technology permits relatively large numbers of small firms to survive are likely to be less able either to co-ordinate prices or to resist entry, and so may be unable to change much of their prices when import prices alter. The extreme case is illustrated with the curves D_2 and D_2' -- competition between existing firms or between them and potential new firms is vigorous enough to prevent any change in profit margins so that the full effect of, say, a tariff increase falls on quantity; price stays at level P_2.

Even this extreme case, however, does not correspond to the orthodox model of perfect competition. Products are still heterogeneous, so that firms are demand-constrained and the prices of each of them, in general, differ.[11] As well, a change in costs will change price, because it will *shift the demand*

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[11] In particular, in all the situations shown on Figure 2, the domestic price could be less or greater than the price(s) of competing imports, depending on the particular characteristics of the various products.

curve, to maintain the relationship between price and the sustainable rate of profit.

This view of the pricing of differentiated products is developed more fully in Hazledine (1980b), and tested there with data on relative Canadian/U.S. prices in 33 manufacturing industries. The model seems to be quite successful empirically; certainly, it does better than the law-of-one-price. The results of that paper are used below in section IV to provide a mathematical formula for price setting behaviour in manufacturing industries when costs, tariffs, and exchange rates change.

The model outlined here differs from the usual marginalist model of the firm with some monopoly power (*i.e.* facing a downward sloping demand curve) in that it does not make price- and quantity- setting a *joint* decision of the firm. Instead, price is set as a margin over costs taking into account the prices of imported substitutes and the likely reactions of present and potential competitors; then the firm supplies whatever demand is forthcoming at that price. The price structure performs a largely *income-distributive* role and quantity-adjustment is what *reallocates* resources.

Support for these propositions is to be found in two separate bodies of empirical research; each quite substantial in itself, but neither much examined hitherto for its implications for economic theory and model-building. In the *industrial organization* literature, a good deal of the variability across time and industries in profit margins is by now able to be explained by various 'market structure' variables, such as seller concentration, type of customer, and scale economies and other 'barriers to entry' (*cf.* Weiss, 1974, and Hazledine, 1980c, for surveys of results). When 'demand' is a factor, it seems to affect the outcome of the explicit or implicit bargaining that goes on between buyer and seller, rather than have much to do with a price-quantity trade-off made by a seller unilaterally choosing the profit-maximizing point on a demand curve. Indeed, demand appears almost always to be price-inelastic, inconsistent with the simple profit-maximizing model (Hazledine, 1979b).

Then, the studies of *employment functions* find that quantity demand constraints such as sales or orders are the primary determinants of levels of output and employment, and have, in particular, had no success in finding a link between employment and product prices that would be consistent with either price-taking behaviour or the joint price-output decisions making postulated in standard models of imperfectly competitive markets (Hazledine, 1980a, section 3).

Of course it is most unlikely that firms *never* take account of possible demand responses to their price changes, but the evidence noted above seems to me to be strong enough to support as an acceptable approximation a model which has the pricing decision independent of the output changes that succeed it. A valuable by-product of this assumption in the present context is that it leads to a general equilibrium model that can be solved recursively, with no need for complicated simultaneous-equation algorithms.

Finally, we may note that the market model proposed here is obviously consistent, unlike the law-of-one-price, with all the phenomena noted at the beginning of the sub-section -- nondecreasing returns to scale, failure of the law-of-one-price, intra-industry trade, and cost-related prices. A model which can deal with intra-industry trade can also handle changes in the shares of exports and imports between several regions or countries in each industry. The neoclassical model of Figure 1 is at a loss when more than two regions are considered.[12]

3. Services and Construction Industries

Firms in these industries are assumed to, in general, produce heterogeneous products, but under conditions of such easy entry and exit of competitors (due mostly to the small scale required for efficient operation) that no firm has any market power -- prices are set in equilibrium, at that 'normal' margin over costs such that the number of firms in each industry is stable. Assuming this margin to be constant, price is then simply a function of costs. The situation is illustrated by Figure 3. Initially, with demand curve D_1 and unit costs C_1, price P_1, is such that the profit margin (P_1 - C_1) neither attracts nor repells firms. With an increase in

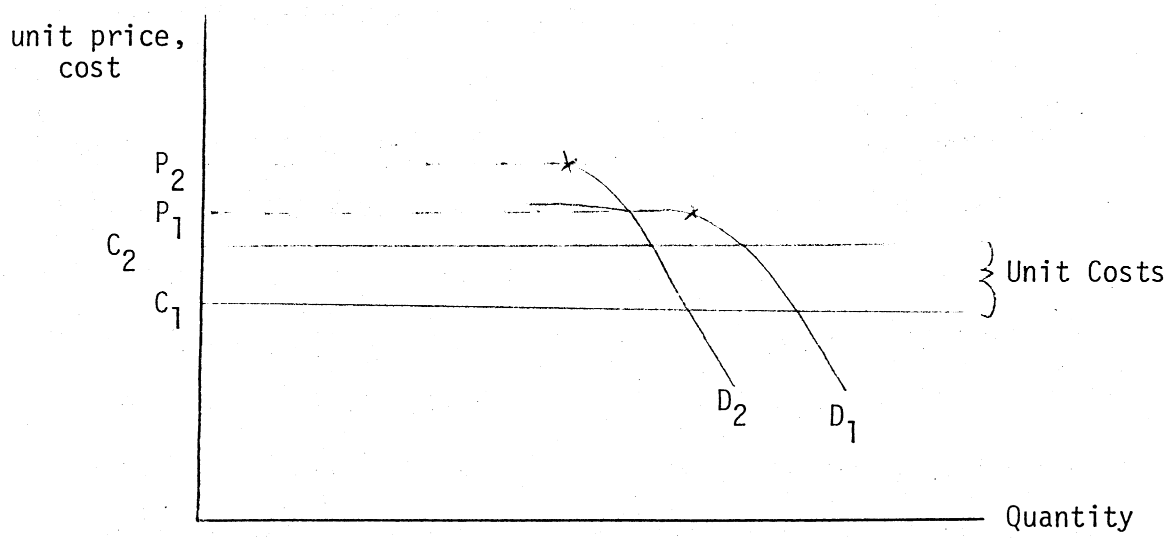

Figure 3: Price and Output of Services and Construction Industries

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[12] Unless a full general equilibrium model of the entire world economy is developed, as suggested by Shoven and Whalley (1974).

costs to C_2, price adjusts to P_2 such that $(P_2 - C_2)$ gives the same margin as before. The demand curve, and thus quantity sold, shift to the left as the higher price discourages some customers.

The output of these industries is not usually traded across borders. If it were, we would have the same situation as that depicted by curves D_2 and D_2' in Figure 2 -- a change in, say, tariffs, will affect the position of the demand curve, but not price.

In this study, it is assumed that no trade takes place, so that only cost changes matter.

IV. THE MODEL: BEHAVIOURAL EQUATIONS

In this section, the categories of market behaviour described in section III are formalized. First, all variables to be used are introduced and defined. Then the behavioural equations for changes in prices, shipments, and employment are developed for each of the three sectors identified in section III. Finally, an equation is given for changes in costs which are common to all sectors.

1. Variable Definitions

Variables are listed and defined approximately in the order in which they will appear in the rest of section IV. The model distinguishes three geographical entities, which, in the implementation, are Quebec (the 'domestic' economy, D), the rest of Canada (the 'regions', R), and the non-Canadian 'World' (W). We distinguish, when necessary, between the price paid (the 'demand price') and the price received (the 'supply price') for a commodity when it crosses a border and so is potentially subject to tariffs. No other form of taxation is considered in the model at present. The subscript i is used interchangeably for industry i and for the commodity or commodities that it produces. The variables are:

p_{Di} - the price at which Quebec industry i sells at domestically (within Quebec), in Quebec's currency.

p^S_{RXi} - the supply price of Quebec industry i's exports to the rest of Canada, in Quebec's currency.

p^d_{RXi} - the demand price of Quebec industry i's exports to the rest of Canada, in the rest of Canada's currency.

p^S_{WXi} - the supply price of Quebec industry i's exports to the World, in Quebec's currency.

p^d_{WXi} - the demand price of Quebec industry i's exports to the World, in the World currency.

p_{RMi} - the price in Quebec of imports of commodity i from the rest of Canada.

p_{WMi} - the price in Quebec of imports of commodity i from the World.

P_{Wi} - the World market price of industry i, in the World currency.

r_Q - the price of Quebec currency in foreign (World) exchange.

r_R - the price of rest of Canada currency in foreign exchange.

t_{QRi} - the tariff rate imposed by Quebec on imports of commodity i from the rest of Canada.

t_{QWi} - the tariff rate imposed by Quebec on imports of commodity i from the World.

t_{RQi} - the tariff rate imposed by the rest of Canada on exports by industry i from Quebec.

t_{WQi} - the tariff rate imposed by the World on exports by industry i from Quebec.

c_i - index of input prices of industry i in Quebec with the shares of each input in total costs as weights.

ε_{Xi}^{MC} - the percentage change in output associated with a one percent change in marginal costs in industry i.

S_{Di} - shipments of Quebec industry i within Quebec.

S_{RMi} - shipments of commodity i into Quebec from the rest of Canada (regional imports).

S_{WMi} - shipments of commodity i into Quebec from the World (World imports).

S_{Mi} - total shipments of commodity i into Quebec from the rest of Canada and the World (total imports).

C_{Di} - total value of sales from all sources in Quebec of commodity i (consumption).

ε_{Ci}^{p} - the percentage change in Quebec consumption of commodity i associated with a one percent change in its price.

S_{RXi} - shipments of commodity i to the rest of Canada from Quebec (regional exports).

S_{WXi} - shipments of commodity i to the World from Quebec (World exports).

S_{Xi} - total shipments of commodity i from Quebec (total exports).

H_i - the Herfindahl index of seller concentration in the Canadian industry producing commodity i (the sum of squared market shares of the sellers in industry i).

c_i' - ratio of Quebec to World unit costs in industry i.

α_{Wi} - share of wages in total variable costs in industry i.

W_i - wage per employee in industry i.

$\varepsilon_{X_i}^{AC_i}$ - the percentage change in industry i's capacity associated with a one percent fall in its price-cost margin.

$\varepsilon^{p}_{S_i}$ - the percentage change in demand for shipment category 'S_i' associated with a one percent change in price 'p'.

$\eta_{Di}, \eta_{RXi}, \eta_{WXi}$ - the proportion of a particular market not supplied by domestic industry i.

E_i - number of employees in Quebec industry i.

$\varepsilon^{X_i}_{E'_{oi}}$ - percentage fall in employment following closing down of the highest-cost one percent of capacity in industry i, holding outputs of remaining plants constant.

X_i - the 'capacity' of industry i, defined as the sum of the base period gross outputs of all the establishments in i which survive a cut in profit margins.

Y_i - net output (gross domestic product) of Quebec industry i.

S_i - total shipments (gross output) of Quebec industry i.

B_i - the difference between the supply price value of exports and the domestic price value of imports, net of duty, in industry i.

2. Primary Sector Industries

(a) Prices

In section III, it was proposed that the output of each primary industry is tradable and homogeneous so that the law-of-one-price holds. Then,

$$p_{Di} = p_{RMi} = p_{WMi} = \frac{p_{Wi}}{r_Q} (1 + t_{QWi}) \tag{1}$$

$$p^{S}_{RXi} = p^{S}_{WXi} = \frac{p_{Wi}}{r_Q} \tag{2}$$

$$p^{d}_{RX_i} = \frac{p_{Wi}}{r_R} (1 + t_{RQi}) \tag{3}$$

$$p^{d}_{WXi} = p_{Wi} (1 + t_{WQi}) \tag{4}$$

We need expressions for the changes in prices that would follow changes in tariffs and exchange rates. Defining the proportional rate of change of a variable y over a period θ as

$$\dot{y} \equiv (dy/d\theta)/y_o \qquad (5),$$

where y_o is the value of y at the beginning of the period, we obtain (assuming no change in the World price):

$$\dot{p}_{Di} = \dot{p}_{RMi} = \dot{p}_{WMi} = -\dot{r}_Q + \left(\frac{t_{QWi}}{1+t_{QWi}}\right) \dot{t}_{QWi} \qquad (6)$$

$$\dot{p}^S_{RXi} = \dot{p}^S_{WXi} = -\dot{r}_Q \qquad (7)$$

$$\dot{p}^d_{RXi} = -\dot{r}_R + \left(\frac{t_{RQi}}{1+t_{RQi}}\right) \dot{t}_{RQi} \qquad (8)$$

$$\dot{p}^d_{WXi} = \frac{t_{WQi}}{1+t_{WQi}} \dot{t}_{WQi} \qquad (9)$$

(b) Shipments

According to the law-of-one-price model output is supply-determined by the price received, such that domestic industries supply first to their protected domestic market and then export any remaining output that is profitable, at the World price. If the marginal cost curve of the domestic industry is such that it is not profitable to meet all the domestic market demand, imports are elastically available to make up the difference.

For an imported primary commodity, shipments of the domestic industry (S_i) change with changes in price and input prices according to the elasticity of the marginal cost curve. Assuming (i) constant elasticity, (ii) constant input proportions, the proportional change in shipments is approximately[12]

$$\dot{S}_i = \varepsilon^{MC}_{Xi} (\dot{p}_{Di} - \dot{c}_i) \tag{10}$$

With a homogeneous commodity, we do not distinguish between sources of imports, so have total demand or consumption

$$C_{Di} = S_{Mi} + S_i \tag{11}$$

We can write

$$\dot{S}_{Mi} = \frac{C_{Di}}{S_{Mi}} \dot{C}_{Di} - \frac{S_i}{S_{Mi}} \dot{S}_i \tag{12}$$

$$= \frac{C_{Di}}{S_{Mi}} \varepsilon^{p}_{Ci} \dot{p}_{Di} - \frac{S_i}{S_{Mi}} \varepsilon^{MC}_{X_i} (\dot{p}_{Di} - \dot{c}_i) \tag{13}$$

with $\dot{p}_D$ given by equation (6).

For an exported primary commodity, total output is determined by the World price in domestic currency, and the elasticity of marginal costs. In this case, analogous to equation (10), we have

$$\dot{Y}_{Di} = \varepsilon^{MC}_{X_i} (\dot{p}^{S}_{WX_i} - \dot{c}_i) \tag{14}$$

For a homogeneous commodity we have

$$S_{Xi} = S_i - C_{Di} \qquad (15);$$

from the total output, domestic customers consume their requirements, and the rest is exported. Thus

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[12]The formula ignores a second-order interaction effect when both p and c change. Assumption (i) implies that input proportions at the margin are the same as those observed overall. It would have been more realistic to assume constant material and variable labour input proportions.

$$\dot{S}_{Xi} = \frac{S_i}{S_{Xi}} \dot{S}_i - \frac{C_{Di}}{S_{Xi}} \dot{C}_{Di} \tag{16}$$

$$= \frac{S_i}{S_{Xi}} \varepsilon^{MC}_{X_i} (\dot{p}^S_{WX_i} - \dot{c}_i) - \frac{C_{Di}}{S_{Xi}} \varepsilon^{p}_{c_i} \dot{p}_{Di} \tag{17}$$

with $\dot{p}_{Di}$ given by (6) and $\dot{p}^S_{WX_i}$ by (7).

(c) Employment

For primary sector industries, employment is assumed to be proportional to gross output, so that

$$\dot{E}_i = \dot{S}_i \tag{18}$$

where

$$S_i = S_{Di} + S_{RXi} + S_{WXi} \tag{19}$$

The exception to (18) in the model is Agriculture, with its small proportion of hired labour to total workforce, in which employment is assumed to be constant.

The proportionality assumption is likely to be valid only if the reason for increasing marginal costs in primary industries is decreasing returns to factors other than labour (due, say, to accessibility of raw materials). This may not be generally so.

3. Manufacturing Sector Industries

(a) Prices

Manufactured commodities are assumed to be marketed under conditions of imperfect competition such that domestic prices are given by

$$p_{Di} = \frac{p_{Wi}}{r_Q} (0.436 + 3.94\ H_i t_{QWi} + 0.547\ c_i') \tag{20}$$

Equation (20) is derived from the estimated version in Hazledine (1978) of the pricing model discussed in the previous section, differing in the substitution of 'World' for 'U.S.' variables, and the incorporation of the effects of variations in export intensity into the constant term, by holding it constant at its mean value (=0.135) and multiplying by its estimated coefficient. This simplification was justified by the small size of the estimated coefficient on export intensity.

Equation (20) makes the effect of tariff protection on domestic prices dependent on the level of seller concentration (measured by the 'Herfindahl' index, H) in the industry. Seller concentration measures are expected to reflect both the ability of existing sellers to co-ordinate their actions, and the strength of the threat posed by potential sellers to existing firms; both of which, it was argued in section III, help determine the extent to which the domestic industry can take advantage of tariff protection to earn greater than 'normal' profits.

In subsequent work (1980b) I have developed further the pricing model to allow the effect of costs on price to be stronger, the weaker is that of tariffs (in line with the arguments given in section III). In light of the newer results, I would now recommend that the pricing equation be written

$$P_{Di} = \frac{P_{wi}}{r_Q} [0.125 + 0.849\, c_i' + 3.265\, H_i\, (1 + t_{Qwi} + c_i')] \qquad (20)$$

where t_{Qwi} is now gross rather than net tariff protection.

The proportional change in p_{Di} is calculated as follows (with given World prices):

$$dp_{Di}/d\theta = -0.436\, p_{Wi} \frac{dr_Q}{d\theta} - 0.394\, H_i t_{QWi}\, p_{Wi} \frac{dr_Q}{d\theta}$$

$$+ 3.94\, H_i \frac{p_{Wi}}{r_Q} \frac{dt_{QWi}}{d\theta} - 0.547\, c_i'\, p_{Wi} \frac{dr_Q}{d\theta} + 0.547\, \frac{p_{Wi}}{r_Q} \frac{dc_i'}{d\theta} \quad (21)$$

write $\quad \alpha \equiv 0.436 + 3.94\, H_i t_{QWi} + 0.547\, c_i' \quad$ (22)

then,

$$\dot{p}_{Di} = \frac{dp_{Di}}{d\theta} / p_{Di} = \frac{-0.436}{\alpha} \dot{r}_Q - \frac{0.394}{\alpha} H_i t_{QWi}\, \dot{r}_Q$$

$$+ \frac{3.94}{\alpha} H_i t_{QWi}\, \dot{t}_{QWi} - \frac{0.547}{\alpha} c_i'\, \dot{r}_Q + \frac{0.547}{\alpha} c_i'\, \dot{c}_i'$$

$$= -\dot{r}_Q + \frac{3.94}{\alpha} H_i t_{QWi} \dot{t}_{QWi} + \frac{0.547}{\alpha} c_i'\, \dot{c}_i' \quad (23)$$

Equation (23) is not quite usable as it stands. Since the data from which it was estimated are cross-sectional, they contain no information on the effects of *changes* in the exchange rate on domestic prices. However (20), as specified in terms of the domestic currency value of World prices, implies a *unit* coefficient on exchange rate changes in the price change equation (23).

This is probably unrealistic, given the implication of (20) that a change in the price of imports due to a tariff change is not, in this imperfectly competitive world, reflected in a one-for-one change in the price of the domestic substitute. More consistent with the coefficient of $H_i t_{QWi}$ in (20), which, at the mean value of H_i, implies that between 40 and 50 percent of a tariff is matched by domestic prices, would be a coefficient on $-\dot{r}_Q$ in (23) less than one. A value of 0.5 was assumed to be reasonable, so that (23) becomes

$$\dot{p}_{Di} = -0.5\dot{r}_Q + \frac{3.94}{\alpha} H_i t_{QWi} \dot{t}_{QWi} + \frac{0.547}{\alpha} c_i' \dot{c}_i' \qquad (24)$$

In the present Canadian customs union, we have

$$p^S_{RXi} = p^d_{RXi} = p_{Di} \qquad (25);$$

assuming, for want of information to the contrary, equality of Canadian prices across regions.[13] After separation, shipments between Quebec and the rest of Canada might be subject to tariffs, and be affected by changes in either regions exchange rate and costs. We have, of course, no empirical evidence from which to derive formulae for the effects of these changes on inter-regional shipments prices. Specifications and parameters must be imposed *a priori*. In doing this, however, it was possible to maintain the spirit of the imperfectly competitive market behaviour described in section III. In general, we postulate that the post-separation supply price of regional exports differs from the original domestic price, p^o_{Di}, according to a modifier f:

$$p^S_{RXi} = p^o_{Di}\ f(t_{RQi}, c_i, r_R/r_Q) \qquad (26),$$

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[13] This assumption is also implicit in the derivation of the Quebec pricing equation (24) from a relationship estimated with Canadian data.

with f(...) taking the value 1 when its arguments are set at their pre-separation values.

In keeping with the implication of equation (24) that changes in exogenous cost and price factors are about equally shared between buyers and sellers, (26) is restricted to

$$p^S_{RXi} = p^o_{Di} \; (-0.5 \; t_{RQi} + 0.5 \; c_i/c^o_i + 0.5 \; r_R/r_Q) \qquad (27)$$

where c^o_i is the pre-separation level of costs. Then

$$\dot{p}^S_{RXi} = -0.5 \; t_{RQi} + 0.5 \; c_i/c^o_i + 0.5 \; r_R/r_Q - 1 \qquad (28),$$

using the pre-separation value of p^S_{RXi} $(=p^o_{Di})$ as the denominator in computing the proportional rate of change.

The demand price (price paid) of Quebec's regional exports differs, post-separation, from the supply price, by being in the other region's currency and including its tariff:

$$p^d_{RXi} = p^S_{RXi} \; (1+t_{RQi}) \; r_Q/r_R \qquad (29).$$

It can then be calculated that

$$\dot{p}^d_{RXi} = -0.5 \; \frac{r_Q}{r_R} \; (1+t_{RQi})t_{RQi} + 0.5 \; \frac{c_i}{c^o_i} \; \frac{r_Q}{r_R} \; (1+t_{RQi}) + 0.5 \; (1+t_{RQi})-1 \qquad (30)$$

The terms in relative costs and exchange rates in (28) and (30) can be manipulated into proportional-rate-of-change form, so that

$$\dot{p}^S_{RXi} = -0.5 \; t_{RQi} + 0.5 \; (1+\dot{c}_i) + 0.5 \; \frac{(1+\dot{r}_R)}{(1+\dot{r}_Q)} - 1 \qquad (31)$$

and

$$\dot{p}^d_{RXi} = -0.5 \frac{(1+\dot{r}_Q)}{(1+\dot{r}_R)} (1+t_{RQi})t_{RQi} + 0.5(1+\dot{c}_i) \frac{(1+\dot{r}_Q)}{(1+\dot{r}_R)} (1+t_{RQi})$$

$$+ 0.5\ (1+t_{RQi}) - 1 \qquad (32)$$

Analogously with p^d_{RXi}, we get

$$\dot{p}^d_{RMi} = -0.5 \frac{(1+\dot{r}_R)}{(1+\dot{r}_Q)} (1+t_{QRi})t_{QRi} + 0.5(1+\dot{c}_{Ri}) \frac{(1+\dot{r}_R)}{(1+\dot{r}_Q)} (1+t_{QRi})$$

$$+ 0.5\ (1+t_{QRi}) - 1 \qquad (33)$$

where c_{Ri} is Rest of Canada costs. These are assumed not to change in the implementation of the model, so that (33) simplifies to

$$\dot{p}^d_{RMi} = 0.5 \frac{(1+\dot{r}_R)}{(1+\dot{r}_Q)} (1-t^2_{QRi}) + 0.5\ (1+t_{QRi}) - 1 \qquad (34)$$

To model changes in prices of internationally traded goods, we assume that Canada is a relatively unspecialized and 'small' buyer of the goods that it imports, so that it is reasonable to suppose that changes in imports from the World do not affect the price paid in foreign currency.[14] If so, the domestic price of World imports of manufactured goods is given by same formula -- equation (1) -- that applies to primary sector imports, and their proportional change by equation (6), which we write again:

$$\dot{p}_{WMi} = -\dot{r}_Q + (\frac{t_{QWi}}{1+t_{QWi}})\ \dot{t}_{QWi} \qquad (35)$$

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[14] For recent evidence in support of the assumption that Canada is a price-taker in its importing but not its exporting, *cf.* Appelbaum and Kohli (1979).

For exports of manufactured goods, it was assumed that, as in the case of locally sold output, the supply price is a function of both domestic factors and the price of competing goods. Domestic market concentration probably does not cut much ice abroad, so change in the supply price of exports is assumed to be a weighted average of changes in costs and in the price of competing goods in the world market, converted to domestic currency:

$$\dot{p}^S_{WXi} = 0.5\ \dot{c}_i + 0.5\ (\dot{p_{Wi}/r_Q}) \qquad (36)$$

$$= 0.5\ \dot{c}_i - 0.5\ \dot{r}_Q \qquad (37)$$

weighting equally the two factors and assuming no change in world market prices.

The demand price (price paid in world markets) for these exports satisfies

$$p^d_{WXi} = p^S_{WXi} r_Q\ (1+t_{WQi}) \qquad (38),$$

so that

$$\dot{p}^d_{WXi} = \dot{p}^S_{WXi} + \dot{r}_Q$$

$$= 0.5\ \dot{c}_i + 0.5\ \dot{r}_Q \qquad (39)$$

assuming no change in world tariffs.

(b) Shipments

Changes in prices and costs affect shipments of manufactured products in two ways: (i) through own-and-cross-price elasticities of demand, and (ii) through the effect on high-cost 'fringe' capacity, of a fall in the industry price-cost margin. Assuming, as explained in (c) below, that the highest-cost establishments in each industry just break even, and that all capacity can expand or contract its output at constant average cost, and will do so in response to any change in demand for its output, the change in domestic shipments is given by

$$\dot{S}_{Di}\begin{cases} = \varepsilon_{S_{Di}}^{p_{Di}}\dot{p}_{Di} + \varepsilon_{S_{Di}}^{p_{RMi}}\dot{p}_{RMi} + \varepsilon_{S_{Di}}^{p_{WMi}}\dot{p}_{WMi} + \eta_{Di}\varepsilon_{Xi}^{AC}(\dot{p}_{Di}-\dot{c}_i) & , \dot{p}_{Di}-\dot{c}_i < 0 \\ = \varepsilon_{S_{Di}}^{p_{Di}}\dot{p}_{Di} + \varepsilon_{S_{Di}}^{p_{RMi}}\dot{p}_{RMi} + \varepsilon_{S_{Di}}^{p_{WMi}}\dot{p}_{WMi} & , \dot{p}_{Di}-\dot{c}_i \geq 0 \end{cases} \quad (40)$$

In (40), the ε_S^p's are own- and cross-price demand elasticities, ε_{Xi}^{AC} -- the 'average cost elasticity' -- gives the percentage of domestic capacity which will become unprofitable following a one percent fall in profit margins, given the assumption that the least profitable establishment just breaks even. The proportion of the domestic market which is not supplied by the domestic industry, η_{Di}, is given by

$$\eta_{Di} = \frac{C_{Di}-S_{Di}}{C_{Di}} \quad (41),$$

and appears in (40) on the assumption that the sales of the exiting domestic capacity are spread evenly amongst the three sources of supply. The direct price effects on demand are assumed to be shared equally amongst surviving firms. The model does not include any demand effects of price changes outside each industry. Nor, since it does not model any prices other than those paid in Quebec or for Quebec output, does it attempt to allow for cross-price effects in regional or World export markets. Thus

$$\dot{S}_{RXi} \begin{cases} = \varepsilon^{p_{RXi}}_{S_{RXi}} \dot{p}^{d}_{RXi} + \eta_{RXi}\varepsilon^{AC}_{Xi}(\dot{p}^{S}_{RXi} - \dot{c}_i), & \dot{p}_{RXi} - \dot{c}_i < 0 \\ = \varepsilon^{p_{RXi}}_{S_{RXi}} \dot{p}^{d}_{RXi}, & \dot{p}_{RXi} - \dot{c}_i \geq 0 \end{cases} \qquad (42),$$

and

$$\dot{S}_{WXi} = \varepsilon^{p_{WXi}}_{S_{WXi}} \dot{p}^{d}_{WXi} \qquad (43)$$

where

$$\eta_{RXi} = \frac{\text{Rest of Canada Consumption} - S_{RXi}}{\text{Rest of Canada Consumption}} \qquad (44)$$

The specification of (43) reflects the assumption that Quebec firms which are able to export to World markets are not likely to be among those marginal operators who would be driven out of business by a squeeze in margins. The use of the capacity elasticity ε^{AC}_{Xi} in both (40) and (41) implies that the cost distribution of capacity is the same for both categories of shipments -- an assumption which may be wrong, but it is forced on us by the data on costs, which are for the domestic industry as a whole.

In the case of Regional and World imports, it is assumed that Quebec is small enough for supply to be perfectly elastic. Then we have

$$\dot{S}_{RMi} = \varepsilon^{p_{RMi}}_{S_{RMi}} \dot{p}_{RMi} + {}^{p_{Di}}_{S_{RMi}} \dot{p}_{Di} + {}^{p_{WMi}}_{S_{RMi}} \dot{p}_{WMi} \qquad (45)$$

$$\dot{S}_{WMi} = \varepsilon^{p_{WMi}}_{S_{WMi}} \dot{p}_{WMi} + {}^{p_{Di}}_{S_{WMi}} \dot{p}_{Di} + {}^{p_{RMi}}_{S_{WMi}} \dot{p}_{RMi} \qquad (46)$$

(c) Employment

For manufacturing employment, the proportionality assumption of equation (18) is probably reasonable for situations in which the price-cost margin does not fall, so that no capacity is forced out of the industry, given the assumptions made above that changes in demand are distributed evenly across firms, and that average costs are constant.

This is not so when exit does occur, though, since in manufacturing we may expect relatively high unit costs to be at least in part due to relatively low output per worker (because of relatively low levels of capital and/or management per worker). In fact, the database included estimates, derived from data on the individual establishments in each industry, of an 'employment elasticity', defined as

$\varepsilon^{Xi}_{E'_{oi}}$ = the percentage fall in employment in industry i following closing down of the highest-cost one percent of industry i's capacity (holding output constant in the rest of the industry).

Table 2 shows values of this elasticity for the manufacturing industries of Quebec. Most (though not all) of the values are greater than one, as would be expected.

With this parameter, the change in employment, when some plants are closed down, can be calculated as follows. Assume for the moment just one category of shipments, S_i. We have

$$E_i = S_i \; (E_i/S_i) \qquad (48)$$

so $$\dot{E}_i = \dot{S}_i + (E_i \dot{/} S_i) \qquad (49)$$

Given the assumptions of constant unit costs for each plant, and that changes in sales are spread around plants so as to keep per plant output shares constant, we can write

$$E_i/S_i = E'_{oi}/X_i \tag{50}$$

where E'_{oi} is the base period employment, and X_i the base period output of those plants which are not closed down. Thus,

$$(\dot{E_i/S_i}) = (\dot{E'_{oi}/X_i}) \tag{51}$$

Now

$$\frac{d}{d\theta}(E'_i/X_i) = \frac{dE'_{oi}}{d\theta}\cdot\frac{1}{X_i} - \frac{dX_i}{d\theta}\cdot\frac{E'_{oi}}{X_i^2}$$

$$= \frac{E'_{oi}}{X_i}\,\varepsilon^{X_i}_{E'_{oi}}\,\dot{X}_i - \frac{E'_{oi}}{X_i}\,\dot{X}_i$$

$$= \frac{E'_{oi}}{X_i}\,(\varepsilon^{X_i}_{E'_{oi}} - 1)\,\varepsilon^{AC_i}_{X_i}\,(\dot{p}_i - \dot{c}_i) \tag{52}$$

so that

$$\dot{E}_i = \dot{S}_i + (\varepsilon^{X_i}_{E'_{oi}} - 1)\,\varepsilon^{AC_i}_{X_i}\,(\dot{p} - \dot{c}_i) \tag{53}$$

For the particular cases of domestic shipments and regional exports, then, we have

$$\dot{E}_{Di}\begin{cases} = \dot{S}_{Di} + (\varepsilon^{X_i}_{E'_{oi}} - 1)\,\varepsilon^{AC_i}_{X_i}\,(\dot{p}_{Di} - \dot{c}_i), & \dot{p}_{Di} - \dot{c}_i < 0 \\ = \dot{S}_{Di}, & \dot{p}_{Di} - c_i \geq 0 \end{cases} \tag{54}$$

and

$$\dot{E}_{RXi} \begin{cases} = \dot{S}_{RXi} + (\varepsilon^{X_i}_{E'_{oi}} - 1)\, \varepsilon^{AC_i}_{X_i}\, (\dot{p}^S_{RXi} - \dot{c}_i), & \dot{p}^S_{RXi} - \dot{c}_i < 0 \\ = \dot{S}_{RXi}, & \dot{p}^S_{RXi} - \dot{c}_i \geq 0 \end{cases} \quad (55),$$

with $\dot{S}_{Di}$ and $\dot{S}_{RXi}$ given by equations (40) and (42). For World exports, we have simply

$$\dot{E}_{WXi} = \dot{S}_{WXi} \quad (56),$$

and $\dot{S}_{WXi}$ is set according to (43).

4. Construction and Services Industries

There were data on neither interregional nor international shipments of the output of Construction and Services industries, and so these were assumed to be zero. However, I do show below what interregional price and shipments equations would look like. Analogous expressions for international shipments could easily be built up.

(a) Prices

It was proposed in Section III that entry and exit to and from Construction and Services is easy, so that price is a simple mark-up function of costs:

$$p^S_{RXi} = p_{Di} = \mu_i c_i \;, \; \mu > 1 \quad (57),$$

where μ_i is the mark-up required to generate a 'normal' rate of return at which the number of firms in industry i is stable. This mark-up will differ according to different technologies (leading to different capital intensities), and different riskiness of industries. Then,

$$\dot{p}^{S}_{RXi} = \dot{p}_{Di} = \dot{c}_{i} \qquad (58)$$

We have

$$p^{d}_{RXi} = p^{S}_{RXi}\ (1 + t_{RQi})r_{Q}/r_{R} \qquad (59),$$

so that

$$\dot{p}^{d}_{RXi} = (1 + \dot{c}_{i})\ \frac{(1+\dot{r}_{Q})}{(1+\dot{r}_{R})}\ (1 + t_{RQi}) - 1 \qquad (60).$$

Analogously

$$\dot{p}_{RMi} = \frac{(1+\dot{r}_{R})}{(1+\dot{r}_{Q})}\ (1 + t_{QRi}) - 1 \qquad (61),$$

assuming no change (within the model) in costs in the rest of Canada. The "t" terms in these expressions most likely would correspond to licensing requirements or other non-tariff barriers to inter-regional trade, rather than tariffs as such.

(b) Shipments

In these industries price only changes *in response to* a change in costs so as always to maintain the mark-up μ, so there is no possibility of capacity between squeezed out - sales are determined solely by demand. The formulae are

$$\dot{S}_{Di} = \varepsilon^{p_{Di}}_{S_{Di}}\ \dot{p}_{Di} \qquad (62),$$

$$\dot{S}_{RXi} = \varepsilon^{p_{Di}}_{S_{Di}}\ \dot{p}^{d}_{WXi} \qquad (63)$$

$$\dot{S}_{RMi} = \varepsilon^{p_{Di}}_{S_{Di}}\ \dot{p}_{WMi} \qquad (64),$$

in which, for simplicity, (since they are not expected to be very important), cross-price effects are neglected, and the domestic price elasticity of demand is applied to all shipments.

(c) Employment

As with manufacturing, the assumption is made of unit costs that do not vary with output, so we can write

$$\dot{E}_i = \dot{S}_i \tag{65}$$

5. Changes in Costs

Within the 'medium-term' framework, the relevant inputs are labour and materials. It can be shown that the proportional change in unit costs due to a change in input prices, $\dot{c}_i$, can be expressed

$$\dot{c}_i = \alpha_{Wi}\dot{W}_i + (1 - \alpha_{Wi})\,\dot{M}_i \tag{66}$$

where α_W is the share of wages in total costs, and W and M are the price of a unit of labour and materials. In the model as implemented in this paper, only direct effects of wage changes were dealt with, so that $\dot{c}_i$ was calculated simply as

$$\dot{c}_i = \alpha_{Wi}\dot{W}_i \tag{67}$$

Obviously, the model would be improved by including the indirect effects of both wage and tariff changes through the changes in material input prices. This could fairly easily be done with available information on input-output coefficients and on the rate of tariff protection on inputs implied by differences between calculated nominal and 'effective' tariff protection rates.

V. SOLVING THE MODEL FOR POLICY TARGETS AND INSTRUMENTS

Section IV developed expressions for proportional changes in prices and quantities. We have 'base period' (actual 1974) data for the levels of employment and shipment flows in each industry, described below in Section VI. In Section IV formulae are developed for combining base period and proportional change information to give the levels of employment and shipment flows that would follow changes in tariffs, exchange rates, and wages (the 'instruments'). These variables, and their base period equivalents, will then be aggregated to give expressions for Quebec employment, balance of trade and real domestic absorption -- the 'targets' of economic performance -- which are linear functions of the instruments.

Denote the base period as "0" and the period after the economy has adjusted to a set of changes in instrument values as "1". The expression for total employment in Quebec industry i is

$$E_i(1) = E_{Di}(1) + E_{RXi}(1) + E_{WXi}(1)$$
$$= (1 + \dot{E}_{Di})E_{Di}(0) + (1 + \dot{E}_{RXi})E_{RXi}(0)$$
$$= (1 + \dot{E}_{WXi})E_{WXi}(0) \qquad (67)$$

for the Quebec economy in aggregate, we have

$$E(1) = \sum_i E_i(1) \qquad (68)$$

Denote by "1K" a period 1 quantity valued in period 0 prices. We will only need real values of shipments from Quebec industries (to calculate real domestic product). The formula for total Quebec shipments is

$$S_i(1K) = S_{Di}(1K) + S_{RXi}(1K) + S_{WXi}(1K)$$

$$= (1 + \dot{S}_{Di})S_{Di}(0) + (1 + \dot{S}_{RXi})S_{RXi}(0)$$

$$+ (1 + \dot{S}_{WXi})S_{WXi}(0) \qquad (69).$$

Real shipments are then converted into real domestic product (net output), for period 1, by multiplying by the ratio of net output to shipments in period 0:

$$Y_i(1K) = S_i(1K) \frac{Y_i(0)}{S_i(0)} \qquad (70).$$

Total Quebec real domestic product in period 1 is

$$Y(1K) = \sum_i Y_i(1K) \qquad (71).$$

RDP in period 0 is calculated from formulae like (70) and (71), but using actual period 0 shipment flows.

The formula used for $Y_i(1K)$ implies that prices of material inputs and output change by the same proportion. This is clearly not generally going to be true. A more accurate, but much more involved, procedure would be to calculate directly the real value of period 1 material inputs, using Input-Output coefficients and the price changes for each input generated by the model.

For period 1 shipments valued in period 1 prices we have, for example,

$$S_{Di}(1) = (1 + \dot{p}_{Di})\ (1 + \dot{S}_{Di})\ S_{Di}(0) \qquad (72).$$

In the implementation of the model, this was simplified to

$$S_{Di}(1) = (1 + \dot{p}_{Di} + \dot{S}_{Di})\ S_{Di}(0) \qquad (73),$$

in order to avoid non-linearities. Equation (73) differs from (72) by the omission of the term in $\dot{p}_{Di}\dot{S}_{Di}$. Since neither proportional changes in price nor in real shipments exceeds 0.1 (10%) more than occasionally, the error in (73) will normally be less than 1%.

Equivalent expressions for the other shipment flows are

$$S_{RXi}(1) = (1 + \dot{p}^S_{RXi})\ (1 + \dot{S}_{RXi})\ S_{RXi}(0) \qquad (74)$$

$$S_{WXi}(1) = (1 + \dot{p}^S_{WXi})\ (1 + \dot{S}_{WXi})\ S_{WXi}(0) \qquad (75)$$

$$S_{RMi}(1) = (1 + \dot{p}_{RMi})\ (1 + \dot{S}_{RMi})\ S_{RMi}(0) \qquad (76)$$

$$S_{WMi}(1) = (1 + \dot{p}_{WMi})\ (1 + \dot{S}_{WMi})\ S_{WMi}(0) \qquad (77)$$

These shipment flows are measured in Quebec currency at the values received by Quebec producers or paid by Quebec consumers.

The balance of trade of an industry is defined, in general, as

$$B_i = S_{RXi} + S_{WXi} - S_{RMi}\ (1 - t_{QRi}) - S_{WMi}\ (1 - t_{QMi}) \qquad (78)$$

For the Quebec economy the aggregate balance of trade is then

$$B = \sum_i B_i \qquad (79).$$

If B is non-zero, there must be exactly off-setting flows on the sum of the invisible trade account, the capital account, and transfers to and from other regions.

The balance of trade formula (79) is computed using current-price values of shipments in either period 0 or 1, as it is the current-price balance that is relevant to balance of payments policy. However, to calculate real 'absorption' -- the real value of the goods and services available to Quebec, we need a constant-price measure of the net flows of goods across the Quebec border. Thus, the 'real' balance of trade in period 1 is measured by

$$B(1K) = \sum_i B_i(1K) \quad (80),$$

where

$$B_i(1K) = S_{RXi}(1K) + S_{WXi}(1K) - S_{RMi}(1K)\,(1 - t_{QRi}) - S_{WMi}(1K)\,(1 - t_{QWi}) \quad (81).$$

Then we compare absorption, A, in period 0:

$$A(0) = Y(0) - B(0) \quad (82),$$

with real absorption in period 1:

$$A(1K) = Y(1K) - B(1K) \quad (83)$$

Equations (68) for total employment, (79) for the balance of trade, and (83) for real absorption, are the target or performance variables that will be used to assess the impact on Quebec of changes in tariff arrangements, exchange rates, and wage rates -- the 'instruments' of economic policies. Given the simplification described by equation (73), and using base period values as denominators when calculating proportional rates of change in the formulae of Section III[15], each target is a linear function of the instruments.[16]

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[15] This is not possible in equations (8), (31), (32), (34), (59), (60) and (61) which include terms in t_{RQ} or t_{QR} which are zero in period 0. So long as any divergence between interregional and international tariffs was some fixed number δ for each commodity, we can write $t_{RQi} = \delta_i t_{WQi} = \delta(1+\dot{t}_{WQi})t_{WQi}(0)$, and similarly for t_{QR}.

[16] Equations (41) and (42), and (54) and (55) for manufacturing domestic and regional export shipments and employment have a non-linearity at $\dot{p} = \dot{c}$. Avoiding

The big advantage of linearity is not in the solving of (68), (79) and (83) for given instrument values -- non-linear expressions could easily enough be dealt with -- but that it allows these expressions easily to be rearranged to give instruments as functions of target variables.

If, for example, the proportional changes in tariffs and wage rates are constrained to be the same for all industries and if other-region tariffs and exchange rate are given, (68), (79) and (83) are three equations in three unknowns (change in Quebec tariffs, wage rate and exchange rate) and so could be solved to give the instrument levels needed to achieve given employment, absorptions, and balance of payments targets.

In the study reported here, the tariff structure in period 1 was always given as an initial institutional constraint (e.g. 'free trade', 'balkanisation', 'customs union'), and two types of computations were performed.

First, the direct impact on the target variables of the change in tariff structure was calculated by assuming no change in wage or exchange rate. Then it was assumed that wage and exchange rates would be adjusted so as to restore either period 0 employment and balance of payments, or levels of these variables that would be forced upon Quebec by other aspects of the institutional change, such as loss of Federal Equalization Payments (inter-provincial transfers), and the resulting level of real absorption was calculated and used as a measure of the welfare effect on Quebec of the institutional change.[17]

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[16] this involved guessing in advance the sign of $\dot{p}-\dot{c}$ in each industry and then using only the relevant segment of the equation. At most, this could have required a few iterations before a correct solution to the model was achieved.

[17] Boadway and Treddenick use a 'true welfare' index' -- the ratio of Cobb-Douglas utility functions -- to assess changes in welfare. Such an index could be calculated for this model, but, being non-linear, would spoil the simple inversion process whereby 'target' equations are obtained.

It can be assumed that wage and exchange rate adjustment takes place either due to explicit policy actions by the Quebec government (Incomes Policy, de- or re-valuation), or by market forces acting to restore 'full' employment and balance of payments equilibrium.

Other experiments could be carried out with this model. For example, Linear Programming methods could be used to maximize real absorption given employment and balance of payments constraints, with wage rate, exchange rate and tariffs (the latter differing across industries, if desired) as instrumental variables. A more sophisticated framework might predict reactions by other regions to changes in Quebec's tariffs and exchange rate.

VI. DATA AND PARAMETERS

1. Data

The model was implemented with data for the year 1974 culled from various Statistics Canada publications. The year chosen was the most recent for which a survey of inter-regional shipments of manufactured goods had been carried out (the previous survey was for 1967). The database is shown in Table 1. Sources for each of the variables are as follows:

(a) Output

Value Added data from the *Survey of Production* (Statistics Canada catalogue number 61-202) and the *Census of Manufacturers* (31-203) were used as measures of Quebec gross domestic product in "goods producing" (Primary, Manufacturing Construction) industries. Domestic product of Services was then calculated residually as the difference between the sum of goods-producing industries value added and total Quebec gross domestic product at factor cost as given in the *Provincial Economic Accounts* (13-213).

(b) Employment

For Primary and Construction industries, 1974 Quebec total employment numbers were found in the various annual industry reports (25-201, 24-201, 26-213, 26-201, 64-201).

Manufacturing employment data are given in the *Census of Manufacturers*. Services employment was calculated residually as the difference between total goods-producing employment and the "All Industries" figure given in *The Labour Force*, (71,001, July 1975, Table S-1).

(c) Shipments

Regional modelling is usually afflicted with a lack of data on inter-regional trade, and the present study is no exception. The situation is considerably improved by the availability, for 1974, of the results of a survey of inter-provincial and export shipments by manufacturing (31-522) industries, but even these data have some gaps (at the II-digit level), and provide no information on imports. The following procedures were adopted:

(i) for each *primary* industry total Canadian demand (final and intermediate consumption) was calculated from the national data on trade flows and shipments. Quebec's share of this consumption was then estimated by applying input-output coefficients from the 1971 Canadian input-output tables (15-506), which were the latest available at the time, to the level of the Quebec activities (including final consumption) using the primary industry's commodity. This allows a figure for the net trade balance to be calculated and assigned either to 'exports' or 'imports' depending on its sign. No disaggregation was attempted into regional or foreign trade balances.

(ii) for each *manufacturing* industry, the net Quebec trade balance was calculated as for primary industries. Exports were taken from the interprovincial shipments survey (and adjusted so that provincial totals matched the national foreign trade data), as were shipments between Quebec and the rest of Canada. Imports were then computed as a residual.

(iii) Since it was assumed that there are no extra-regional movements of *Construction and Services* industries output, there were no shipment flows to calculate.

Data for each of the twenty-seven industries into which the Quebec economy was disaggregated are shown on Table 1. This shows Quebec to have been an importer in all five primary industries. The world imports column also has negative values for four manufacturing industries. These can occur because imports are calculated as a residual, and must be due to errors in the other shipment flows data, and/or in the imposition of the structure of demand implied by the national input-output tables on the Quebec economy. Clearly, more work needs to be done on regional shipments flows data, though a sensible trade-off might involve accepting a higher level of aggregation at least of manufacturing industries in return for more reliable numbers. Of course, these data problems would not normally arise in the application of the model to a national economy for which trade flows and input-output coefficients are well-recorded.

2. Parameters

With the exception of cross-price elasticities, which are derived from own-price and market share data according to a formula described in the Appendix, all the parameter values needed to solve the model are given in Table 2. These are all calculated from national Canadian data, so that using them for Quebec implies similarities of demand and production conditions between Quebec and the rest of Canada which may not always be justifiable.

The *capacity* elasticities, measuring the extent to which establishments in an industry fail to cover variable costs when prices fall or wages rise, were derived from cost distribution functions estimated for the author by Statistics Canada using their (confidential) data on the returns made by individual establishments in the 1974 Census of Manufacturers. Capacity elasticities are not relevant for primary industries in which costs can be reduced by reducing output, and Construction and Services, in which capital market constraints keep prices moving in response to changes in costs so as to maintain profit margins constant.

Marginal cost elasticities are set arbitrarily at 0.667 for primary industries and at zero for the other sectors, in which the assumption is made of constant returns to scale. The primary industry elasticity numbers could now be improved by industry-specific information (*cf.* Ramin and Hazledine, 1980).

The *employment-capacity* elasticities of manufacturing industries were also computed from distribution functions estimated by Statistics Canada: these fitted a distribution to the ratio of employees to shipments for establishments ranked by increasing ratio of variable costs to shipments. As noted in Section IV, the proportional response of employment to changes in the shipments of surviving firms was assumed to be equal to the proportional change in shipments in all industries except Agriculture, for which no employment change was allowed.

Estimates of own-price *demand* elasticities were generated by averaging (then rounding to the nearest 0.25) econometric estimates from two sources

-- Hassan and Johnson (1977), and unpublished estimates by T. Schweitzer and Bobbi Cain of the Economic Council of Canada CANDIDE modelling group . In most cases the two sources agreed (at the level of precision chosen).

The *rate of tariff protection* is tariff protection (net of protection of inputs for manufacturing industries) as a proportion of selling price. The manufacturing data are aggregated by shipment-shares from the III-digit figures calculated by Dauphin (1978, Table 3-2, pp. 50-55).

The Herfindahl index, defined as the sum of the squared market shares of the firms in an industry, is published by Statistics Canada at the III/IV-digit level (31-402, 1972, Table 3). These data were aggregated to the II-digit level with the shares in II-digit industry shipments of each member III/IV-digit industry used as weights.

Relative Canada/U.S. manufacturing cost data were calculated by James Frank (1977) for 33 III/IV-digit industries. II-digit data were calculated as shipment-weighted averages of the Frank numbers, when available and the average Canada/U.S. cost ratio (=1.10), from Frank's sample for those III/IV-digit industries excluded from it.

The domestic market mark-up on the world price is calculated as a function of net protection, the Herfindahl, and relative costs according to equation (20):

$$p_{Di} = \frac{p_{Wi}}{r_Q} (0.436 + 3.94 H_i t_{QWi} + 0.547 c_i') \qquad (20).$$

VII. RESULTS

The model was solved for several 'options', representing alternatives to Quebec's actual situation in 1974. These were:

Option 1a: tariffs the same as the present Canadian tariffs imposed on trade between Quebec and the rest of Canada. No adjustments made to wages or exchange rates.

Option 1b: as for 1a, except that adjustments to wage and exchange rates are made by amounts given by the 'policy equations' (*cf.* section V), so that total employment stays at its actual 1974 level and the Quebec balance of trade is equal, as a proportion of GDP, to that of Canada as a whole in 1974.

Option 2 : unilateral free trade (all tariffs abolished). No adjustment of Quebec wages or exchange rates.

Option 3 : Quebec maintains free trade with the rest of Canada, and then keeps 1974 tariff on world imports. The rest of Canada declares unilateral free trade. No adjustment of Quebec wages or exchange rates.

These 'options' by no means exhaust the set of conceivable alternatives to Quebec's present situation in Canada. Option 1a is not proposed as likely in itself -- no doubt a separate Quebec would adjust the tariff structure to suit its particular purposes -- but can be seen as a frame for evaluating the *allocative* effects of Quebec's membership in the Canadian customs union as it stood in 1974. The results of modelling Option 1b give us some idea of the *distributive* impact on Quebec of the present customs union. The balance of trade requirement implies that Quebec has to do without the net interregional transfers that it actually received in 1974 under the equalization payments system. Holding employment at its 1974 level, we will look at the change in Quebec total *absorption* (GDP plus net imports) as a measure of the change in the economic well-being that would follow adoption of Option 1.

Option 2 enables us to answer the interesting question of the impact on Quebec of unilateral free trade. Since this is hardly likely to be a choice of an independent Quebec economy, no attempt is made to specify adjustments in Quebec wages or the value of the currency.

Option 3 represents a scenario under which, after Quebec separation, the increased relative power of the Western provinces in the new Canada results in the abolition thereof tariffs on imports, though Quebec keeps the 1974 tariffs on its imports from the rest of the World.

A summary of the results of implementing each option is given in Table 3. Industry-by-industry rates of change are shown on Tables 4, 5, 6 and 7. We will focus here on the macro-economic numbers of Table 3.

Option 1a would increase the balance of trade deficit by more than $700 million -- about 2-1/2% of Quebec GDP. Employment would fall slightly, by about 21,500. The changes all take place in manufacturing, since the primary sector is already pricing up to the tariff and is not affected by Option 1a, and construction and services industries are assumed not to trade at all.

Table 4 reveals that all Quebec manufacturing industries lose some capacity as a result of having their supply price to the rest of Canada squeezed by the imposition of tariffs, and lose sales in this market due to the higher demand price. To some extent this is countered by a fall in manufacturing imports into Quebec from the rest of Canada, but, since Quebec had a substantial surplus on its 1974 manufactured goods trade with the rest of Canada, its industry loses more than it gains from the erection of tariff walls.

Under Option 1b it is assumed that an independent Quebec has made the necessary adjustments to maintain employment levels and to enable it to pay its way without inter-regional transfers. The particular adjustments of the exchange rate by -9.3% and wages by -0.6% were deduced from the 'policy equations' corresponding to the Option 1 tariff structure, which are:

$$B(1) = -1.495 - 19.100\dot{r}_Q - 4.354\dot{W} \quad (84)$$

$$E(1) = E(0) - 0.533 - 0.482\dot{r}_Q - 1.422\dot{W} \quad (85),$$

where $\dot{W}$ is the percentage change applied to all wage rates.

The required trade balance was set at $0.301 billions, which is equivalent as a proportion of GDP (about 1%) to the Canada trade balance in 1974, and the change in employment set at zero. The policy instrument values implied by (54) and (85) in fact do not quite achieve the targets -- the balance of trade is too small under Option 1b, and employment overshoots the 1974 mark. These errors may be due to the negative world import numbers noted in Table 1 for some manufacturing industries.

The cost of these adjustments is a $1.4 billion drop in real absorption -- about 4-1/2% of Quebec GDP. The total increase in real resources committed to balancing trade is about $2 billion ($1.4 billion plus the $0.66 billion increase in GDP), which is greater than the $1.7 billion change in the trade balance achieved -- due to the worsened-terms-of-trade effect of devaluation, it costs about $1.18 to reduce the deficit by $1.

The effect on Quebec of unilateral free trade (Option 2) is less than that of separation-with-tariffs. Neither balance of trade nor employment fall by as much as under Option 1a. The real value of exports by Quebec to the rest of Canada actually *increases*. This is because the demand-boosting effects of the lower prices Quebec manufacturers must charge when tariffs are removed from foreign imports are greater than the capacity-reducing effect of lower prices on high-cost fringe producers in enough industries for the net effect to be positive.

(The only region of Canada which benefits from unilateral free trade is the Prairies, with its small manufacturing base.)

Option 3 also results in an increase in Quebec's trade deficit, though not by as much as Option 2. This is as one would expect, since neither world nor regional imports into Quebec increase from their 1974 levels.

VIII. CONCLUSIONS

The main purpose of this paper is to propose a model of pricing and output which builds upon assumptions in market structure and behaviour in trading economies apparently more realistic than those underlying the traditional neoclassical approach. The secondary purpose of the paper is to apply this model to the analysis of the consequences for Quebec of changes in the economic institutions, linking it with the rest of Canada; however, the margin of error of the quantitative analysis is increased by various weaknesses, noted below, in the model at its present stage of development.

The main features of the model are:

1. It distinguishes three categories, into one of which all market activity is assumed to fall. *Primary* industries produce homogeneous products under conditions of increasing costs and trade them on world markets. *Manufacturing*

industries produce heterogeneous (differentiated) products under conditions of constant unit costs. These products are, in general, traded. *Construction and Services* industries produce differentiated products, not usually traded, under conditions of constant unit costs and with capital markets constraining prices to yield only a 'competitive' rate of return.

2. The most drastic departure from orthodox practice is in the specification of market behaviour in manufacturing. The phenomenon of intra-industry trade suggests the assumption of product heterogeneity, but this could be easily modelled using extant models of pricing in imperfectly competitive markets in which a seller facing a downward-sloping demand curve choose jointly price and quantity so as to maximize profits. In fact, however, the empirical evidence, cited above, on pricing, demand elasticities, and employment adjustment, does not appear to support the assumption of joint price-quantity setting. The model developed here has price determined independently of quantity in the short-run, as an aggregation of costs and competing-import prices, with weights determined by the market structure of the industry, reflecting the degree to which seller co-ordination and barriers to entry of new firms allow existing sellers to maintain price-cost margins at higher than competitive levels. Quantities sold at these prices are then determined according to demand elasticities.

3. The model can deal with trade patterns in manufacturing industries disaggregated to more than one trading partner.

4. The model is linear and was solved to give equations setting values of the 'instruments' of economic policy (or of market adjustment) -- wages and exchange rates -- in terms of 'target' levels of employment and the balance of trade.

Linear programming methods could be applied to find the values of exchange rates, wages and tariffs which maximize domestic 'absorption' subject to the achievement of target employment and balance of trade levels.

The major weaknesses perceived by the author and others of the model as it presently stands are:

1. The model of pricing in manufacturing, though possibly more realistic, is not theoretically as well developed as orthodox models of imperfectly competitive market behaviour.
2. The model does not allow for the changes in an industry's costs that result from the changes in the output prices of its input-providing industries. Given information on input-output coefficients, there would be no analytical difficulties in including input price changes.
3. The model should probably be imbedded in a macro-model so that the multiplier effects of changes in incomes and of fiscal policies can be dealt with. This is not so important for an economy like Quebec, in which the presence of both unemployment and a trade deficit require expenditure-*switching* policies such as changes in costs or exchange rates to divert demand to domestic industries, but for economies experiencing unemployment along with trade *surpluses* (such as Ontario and Alberta, in Canada), expenditure-*increasing* policies, such as a fiscal stimulus, are appropriate.
4. No account is taken of the effects of changes in the prices of an industry relative to the prices of other industries. (The incorporation of intra-industry cross-price elasticities does mean that *some* price-related variability in market shares in both final and intermediate markets is allowed for, in contrast to models in which input-output coefficients are assumed

to be constant, such as Polenske (1970). Since all prices in the model are determined independently of changes in outputs, incorporating relative price changes would raise no analytical difficulties.

5. Although the model does predict the elimination of some capacity in manufacturing industries subjected to a squeeze in their profit margins, it does not have anything to say on the determinants of additions to capacity -- fixed, capital formation. It shares this defect with the 'neo-classical' models discussed in Section II. There are plenty of econometric studies on the determinants of investment at the national level, from which appropriate equations could possibly be culled for use in a national model. For an intra-national region, such as Quebec, explicit account should be taken of the easy intra-national mobility of capital (compared to international capital flows), which may mean that inter-regional shares of in vestment spending fluctuate more (in response to inter-regional variations in demand and rates of return) than does the national total. There is recent work on this for the U.S., by Treyz, *et. al.*(1980); for Canada, *cf.* Hazledine *et. al.* (1980).

6. The model is 'general equilibrium' with respect to the region on which it focuses, but only 'partial equilibrium' with respect to the world. If there are grounds for expecting the region's trading partners to respond to changes in tariffs and exchange rates some attempt should be made to model these reactions. A multi-regional linkage of regional models would be of interest in itself, too.

7. Modelling below the national economy level is likely always to be beset by data problems. In the Canadian context, it might be appropriate, in recog-

nition of the data inadequacies, to work with a more aggregated data-base. Manufacturing might best be treated as a single industry, or broken into just two or three components (such as 'durables' and 'nondurables').

TABLE 1: 1974 QUEBEC DATA ($000, Except 'Employment')

		Shipments (S_i)	Dom. Shipments (S_{Di})	Imports, World (S_{WMi})	Imports, ROC (S_{RMi})	Exports, World (S_{WXi})	Exports, ROC (S_{RXi})	Gross Domestic Product (Y_i)	Employment (E_i)
Agriculture	1	1301295.	1301295.	819122.	0.	0.	0.	667582.	112000.
Forestry	2	433527.	433527.	239370.	0.	0.	0.	267792	16115.
Fishing	3	14230.	14230.	103593.	0.	0.	0.	14230.	2400.
Petroleum & Nat. Gas	4	27.	27.	320331.	0.	0.	0.	104.	72.
Other Inedible Crude Mat.	5	1099773.	1099773.	61920.	0.	0.	0.	696097.	25139.
Food and Beverage	6	4399090.	3237353.	275793.	1093126.	244246.	917491.	1200865.	56840.
Tobacco Products	7	319608	110738	24944.	134962.	1516.	207354.	170347.	5818.
Rubber & Plastics	8	471179.	237115.	13984.	346573.	16265.	217799.	219316.	13822.
Leather Products	9	266251.	122182.	40430.	66392.	10781.	133287.	133157.	12564.
Textiles	10	1357623.	781331.	472707.	359369.	28695.	547597.	577918.	39044.
Knitting Mills	11	411968.	234623.	-82466.	40649.	11658.	165687.	178394.	16026.
Clothing	12	1449495.	762848.	54712.	68207.	99624.	587023.	660598.	67139.
Wood Industries	13	825911.	501225.	-173595.	222481.	118687.	205999.	370581.	24771.
Furniture, Fixtures	14	504509.	256608.	47839.	63795.	23433.	224468.	255632.	20051.
Paper & Allied	15	2615715.	1058436.	184191.	128604.	1295987.	261292.	1195122.	45367.
Printing, Etc.	16	791645.	578515.	247175.	79584.	34897.	178233.	488971.	25289.
Primary Metals	17	2489998.	879383.	577705.	149280.	1342693.	267922.	690790.	30267.
Metal Fabricating	18	1521836.	881393.	-93360.	415127.	109203.	531240.	747833.	39161.
Machinery	19	615393.	277518.	1335963.	211156.	187381.	150493.	320088.	17487.
Transportation Equip.	20	1448542.	397938.	1269505.	1172570.	558883.	491721.	500014.	30006.
Electrical Prod.	21	1256833.	474644.	425544.	664227.	137073.	645116.	634633.	33692.
Non-Metallic Minerals	22	665413.	511117.	-125885.	140092.	38016.	116280.	345597.	15545.
Petrol. & Coal Products	23	1721215.	1297146.	-142554.	0.	175094.	248975.	348676.	3254.
Chemicals & Products	24	1648500.	778927.	561817.	415642.	280395.	589178.	742499.	26779.
Miscel. Mfrs.	25	593224.	258504.	470720.	190120.	75594.	259126.	263815.	18578.
Construction	26	2621979.	2621979.	0.	0.	0.	0.	734925.	47383.
Services, Etc.	27	17676720.	17676720.	0.	0.	0.	0.	17676720.	1682391.

Sources: cf. Section VI

TABLE 2: PARAMETERS

	Capacity Elasticity ($\epsilon^{AC}_{X_i}$)	Marginal Cost Elasticity ($\epsilon^{MC}_{X_i}$)	Employment -Capacity Elasticity ($\epsilon^{Xi}_{E'_{oi}}$)	Domestic Demand Price Elasticity	Import Demand Price Elasticity	Export Demand Price Elasticity	Rate of Tariff Protection (t_{QWi})	Herfindahl Index (H_i)	Canada/U.S. Relative Costs (C'_i)	Domestic Markup on World Price
1	-	0.667	-	-0.50	-0.50	-1.00	-	-	-	-
2	-	0.667	-	-0.50	-0.50	-0.75	-	-	-	-
3	-	0.667	-	-0.75	-0.50	-1.00	-	-	-	-
4	-	0.667	-	-0.75	-0.50	-0.50	-	-	-	-
5	-	0.667	-	-0.50	-0.25	-1.00	-	-	-	-
6	1.399	0.0	0.951	-0.50	-0.50	-1.00	0.055	0.090	1.07	1.041
7	1.454	0.0	1.419	-0.50	-0.50	-1.00	0.169	0.299	1.31	1.352
8	1.079	0.0	1.148	-0.75	-1.00	-1.00	0.059	0.070	1.10	1.054
9	1.008	0.0	1.066	-0.75	-1.25	-1.00	0.158	0.057	1.10	1.073
10	1.084	0.0	1.156	-0.75	-1.25	-1.00	0.105	0.125	1.08	1.078
11	1.231	0.0	0.981	-0.75	-1.25	-1.00	0.152	0.031	1.01	1.007
12	1.140	0.0	1.062	-0.75	-1.50	-1.00	0.121	0.016	1.17	1.084
13	0.824	0.0	0.969	-0.75	-1.25	-1.00	0.039	0.038	1.03	1.005
14	0.723	0.0	1.091	-1.00	-1.25	-1.00	0.101	0.019	1.11	1.051
15	1.496	0.0	1.248	-0.75	-1.00	-0.75	0.045	0.055	1.24	1.124
16	0.671	0.0	1.225	-1.00	-1.25	-1.00	0.052	0.033	1.10	1.045
17	1.524	0.0	0.888	-0.50	-0.50	-0.75	0.027	0.321	1.03	1.033
18	1.038	0.0	1.065	-0.75	-0.75	-1.00	0.077	0.049	1.21	1.113
19	1.216	0.0	0.999	-1.00	-1.00	-0.75	0.020	0.045	1.14	1.063
20	1.712	0.0	1.066	-0.75	-0.75	-0.75	0.007	0.226	1.03	1.005
21	1.157	0.0	1.144	-0.75	-1.25	-1.00	0.078	0.129	1.10	1.077
22	0.969	0.0	1.194	-0.75	-1.00	-0.75	0.050	0.146	1.10	1.067
23	1.946	0.0	1.033	-0.75	-0.50	-0.50	0.081	0.167	0.92	0.993
24	1.012	0.0	0.986	-0.75	-1.00	-0.75	0.048	0.089	1.15	1.082
25	1.143	0.0	1.092	-0.75	-1.00	-1.00	0.074	0.097	1.10	1.066
26	-	0.0	-	-1.00	-1.00	1.00	-	-	-	-
27	-	0.0	-	-0.75	-0.75	0.50	-	-	-	-

Sources: cf. Section VI

TABLE 3: SUMMARY OF RESULTS

	1974	Option 1 (a) $\dot{r} = 0.00$ $\dot{w} = 0.00$	Option 1 (b) $\dot{r} = -0.093$ $\dot{w} = -0.006$	Option 2 $\dot{r} = 0.00$ $\dot{w} = 0.00$	Option 3 $\dot{r} = 0.00$ $\dot{w} = 0.00$
Balance of Trade	-774,048	-1,496,009	229,743	-1,175,625	-943,569
Employment	2,427,000	2,405,435	2,440,280	2,422,342	2,425,985
Absorption, separation prices	30,876,345	31,141,152	30,516,570	31,034,684	30,451,224
Absorption, 1974 prices	30,876,345	30,777,667	29,379,648	31,556,668	30,351,067
Wage Bill	19,739,000	19,565,131	19,754,042	19,698,619	19,733,436
Profits	10,363,296	10,080,012	10,992,278	10,160,440	10,304,705
Gross Domestic Product, separation prices	30,102,296	29,645,142	30,746,320	29,859,059	30,038,140
Gross Domestic Product, 1974 prices	30,102,296	29,780,973	30,376,129	30,057,185	30,114,293

TABLE 4: QUEBEC RESULTS, OPTION 1A

[1974 CANADIAN TARIFF IMPOSED ON TRADE BETWEEN QUEBEC AND REST OF CANADA; NO EXCHANGE RATE OR WAGE RATE ADJUSTMENTS]

	PERCENTAGE CHANGE IN SHIPMENTS CAPACITY	PERCENTAGE CHANGE IN DOMESTIC SHIP MENTS	PERCENTAGE CHANGE IN WORLD EXPORTS	PERCENTAGE CHANGE IN REGIONAL EXPORTS	PERCENTAGE CHANGE IN WORLD IMPORTS	PERCENTAGE CHANGE IN REGIONAL IMPORTS	PERCENTAGE CHANGE IN EMPLOYMENT
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	-0.013	0.013	0.0	-0.106	0.026	-0.032	-0.012
7	-0.154	0.117	0.0	-0.324	0.092	-0.109	-0.227
8	-0.032	0.084	0.0	-0.204	0.077	-0.080	-0.056
9	-0.038	0.060	0.0	-0.231	0.055	-0.089	-0.090
10	-0.031	0.048	0.0	-0.269	0.035	-0.081	-0.061
11	-0.052	0.023	0.0	-0.256	-0.031	-0.083	-0.089
12	-0.043	0.010	0.0	-0.188	0.037	-0.067	-0.073
13	-0.007	0.017	0.0	-0.079	0.183	-0.040	-0.009
14	-0.023	0.031	0.0	-0.196	0.052	-0.091	-0.073
15	-0.008	0.006	0.0	-0.133	0.018	-0.045	-0.013
16	-0.004	0.005	0.0	-0.056	0.007	-0.031	-0.010
17	-0.005	0.004	0.0	-0.067	0.004	-0.018	-0.005
18	-0.021	0.034	0.0	-0.162	0.089	-0.069	-0.038
19	-0.008	0.036	0.0	-0.114	0.007	-0.050	-0.012
20	-0.005	0.011	0.0	-0.030	0.005	-0.011	-0.008
21	-0.033	0.080	0.0	-0.195	0.044	-0.073	-0.074
22	-0.007	0.011	0.0	-0.089	0.402	-0.041	-0.008
23	-0.002	0.0	0.0	-0.021	0.0	-0.006	-0.003
24	-0.012	0.027	0.0	-0.106	0.018	-0.042	-0.025
25	-0.024	0.051	0.0	-0.170	0.019	-0.065	-0.054
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	-0.0	0.0

TABLE 5: QUEBEC RESULTS, OPTION 1A

[1974 CCANADIAN TARIFF IMPOSED ON TRADE BETWEEN QUEBEC AND REST OF CANADA; EXCHANGE RATE DEVALUED BY 9.3%, WAGE RATE REDUCED BY 0.6%]

	PERCENTAGE CHANGE IN SHIPMENTS CAPACITY	PERCENTAGE CHANGE IN DOMESTIC SHIP MENTS	PERCENTAGE CHANGE IN WORLD EXPORTS	PERCENTAGE CHANGE IN REGIONAL EXPORTS	PERCENTAGE CHANGE IN WORLD IMPORTS	PERCENTAGE CHANGE IN REGIONAL IMPORTS	PERCENTAGE CHANGE IN EMPLOYMENT
1	0.0	0.064	0.0	0.0	-0.221	0.0	0.0
2	0.0	0.064	0.0	0.0	-0.246	0.0	0.064
3	0.0	0.066	0.0	0.0	-0.088	0.0	0.066
4	0.0	0.066	0.0	0.0	-0.070	0.0	0.066
5	0.0	0.063	0.0	0.0	-1.997	0.0	0.063
6	0.0	-0.005	0.047	0.008	0.046	0.0	0.001
7	-0.105	0.129	0.047	-0.206	0.120	-0.036	-0.132
8	-0.006	0.100	0.047	-0.034	0.117	-0.127	0.035
9	-0.012	0.073	0.047	-0.067	0.029	-0.123	0.001
10	-0.009	0.071	0.047	-0.054	-0.015	-0.074	0.019
11	-0.026	-0.071	0.047	-0.122	-0.174	-0.040	-0.088
12	-0.019	-0.014	0.047	-0.078	-0.040	0.135	-0.037
13	0.0	-0.077	0.047	0.029	0.460	-0.012	-0.033
14	-0.006	0.008	0.047	-0.049	0.034	-0.477	-0.017
15	-0.000	-0.015	0.035	-0.005	-0.019	-0.061	0.011
16	0.0	-0.007	0.048	0.039	-0.053	0.001	0.006
17	0.0	-0.001	0.035	0.021	-0.017	0.042	0.021
18	-0.002	-0.001	0.047	-0.017	0.173	0.012	-0.003
19	0.0	0.095	0.036	0.071	-0.057	-0.115	0.071
20	0.0	0.072	0.035	0.063	-0.022	-0.020	0.055
21	-0.002	0.150	0.047	-0.013	0.008	-0.023	0.055
22	0.0	-0.054	0.035	0.016	0.945	-0.074	-0.037
23	0.0	-0.040	0.023	0.035	-0.007	-0.879	-0.023
24	0.0	0.047	0.035	0.040	-0.009	0.037	0.043
25	0.0	0.102	0.047	0.007	-0.029	-0.018	0.054
26	0.0	0.002	0.0	0.0	0.0	-0.034	0.002
27	0.0	0.004	0.0	0.0	0.0	0.0	0.004
						0.0	

TABLE 6: QUEBEC RESULTS, OPTION 2

[NO TARIFF ON WORLD IMPORTS INTO CANADA OR ON INTER-REGIONAL TRADE; NO EXCHANGE RATE OR WAGE RATE ADJUSTMENTS]

	PERCENTAGE CHANGE IN SHIPMENTS CAPACITY	PERCENTAGE CHANGE IN DOMESTIC SHIPMENTS	PERCENTAGE CHANGE IN WORLD EXPORTS	PERCENTAGE CHANGE IN REGIONAL EXPORTS	PERCENTAGE CHANGE IN WORLD IMPORTS	PERCENTAGE CHANGE IN REGIONAL IMPORTS	PERCENTAGE CHANGE IN EMPLOYMENT
1	0.0	-0.012	0.0	0.0	0.023	0.0	0.0
2	0.0	-0.000	0.0	0.0	0.000	0.0	-0.000
3	0.0	-0.009	0.0	0.0	0.011	0.0	-0.009
4	0.0	-0.000	0.0	0.0	0.000	0.0	-0.000
5	0.0	-0.001	0.0	0.0	0.012	0.0	-0.001
6	-0.025	-0.002	0.0	-0.006	0.014	-0.004	-0.001
7	-0.214	-0.160	0.0	0.167	-0.120	0.061	-0.055
8	-0.016	-0.017	0.0	-0.011	0.070	0.009	-0.016
9	-0.032	-0.042	0.0	0.004	0.103	-0.047	-0.020
10	-0.051	-0.060	0.0	0.032	0.091	-0.070	-0.030
11	-0.022	0.136	0.0	-0.098	0.207	-0.426	0.039
12	-0.007	-0.012	0.0	-0.026	0.228	-0.105	-0.017
13	-0.004	0.045	0.0	-0.011	0.031	0.276	0.025
14	-0.005	-0.019	0.0	-0.006	0.143	-0.065	-0.013
15	-0.007	-0.010	0.0	-0.007	0.087	-0.056	-0.007
16	-0.004	-0.013	0.0	0.002	0.052	-0.045	-0.010
17	-0.023	-0.016	0.0	-0.021	0.009	-0.018	-0.005
18	-0.013	0.015	0.0	-0.001	0.036	0.029	0.007
19	-0.003	-0.044	0.0	-0.026	0.049	-0.041	-0.026
20	-0.006	-0.019	0.0	-0.007	0.008	-0.002	-0.008
21	-0.038	-0.095	0.0	0.024	0.066	-0.018	-0.029
22	-0.025	0.045	0.0	-0.004	-0.271	0.649	0.029
23	-0.094	0.054	0.0	-0.051	-0.038	-0.008	0.030
24	-0.013	-0.027	0.0	0.008	0.040	-0.028	-0.010
25	-0.027	-0.071	0.0	0.005	0.064	-0.047	-0.031
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 7: Quebec Results, Option 3

[NO TARIFF ON IMPORTS INTO REST OF CANADA. NO TARIFF ON QUEBEC-REST OF CANADA TRADE, BUT QUEBEC KEEPS 1974 CANADIAN TARIFF ON WORLD IMPORTS, NO EXCHANGE RATE OR WAGE RATE ADJUSTMENTS]

	PERCENTAGE CHANGE IN SHIPMENTS CAPACITY	PERCENTAGE CHANGE IN DOMESTIC SHIPMENTS	PERCENTAGE CHANGE IN WORLD EXPORTS	PERCENTAGE CHANGE IN REGIONAL EXPORTS	PERCENTAGE CHANGE IN WORLD IMPORTS	PERCENTAGE CHANGE IN REGIONAL IMPORTS	PERCENTAGE CHANGE IN EMPLOYMENT
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	-0.005	0.0	0.0	0.0	0.0	0.0	0.0
7	-0.139	0.0	0.0	-0.006	0.0	0.0	-0.001
8	-0.008	0.0	0.0	0.187	0.0	0.0	0.033
9	-0.017	0.0	0.0	-0.011	0.0	0.0	-0.006
10	-0.021	0.0	0.0	0.004	0.0	0.0	0.001
11	-0.009	0.0	0.0	0.032	0.0	0.0	0.009
12	-0.003	0.0	0.0	-0.098	0.0	0.0	-0.039
13	-0.001	0.0	0.0	-0.026	0.0	0.0	-0.011
14	-0.002	0.0	0.0	-0.011	0.0	0.0	-0.003
15	-0.001	0.0	0.0	-0.006	0.0	0.0	-0.003
16	-0.001	0.0	0.0	-0.007	0.0	0.0	-0.001
17	-0.005	0.0	0.0	0.002	0.0	0.0	0.000
18	-0.005	0.0	0.0	-0.021	0.0	0.0	-0.002
19	-0.001	0.0	0.0	-0.001	0.0	0.0	-0.001
20	-0.003	0.0	0.0	-0.026	0.0	0.0	-0.006
21	-0.022	0.0	0.0	-0.007	0.0	0.0	-0.003
22	-0.005	0.0	0.0	0.024	0.0	0.0	0.009
23	-0.015	0.0	0.0	-0.004	0.0	0.0	-0.002
24	-0.006	0.0	0.0	-0.051	0.0	0.0	-0.008
25	-0.013	0.0	0.0	0.008	0.0	0.0	0.003
26	0.0	0.0	0.0	0.005	0.0	0.0	0.001
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0

APPENDIX: INFERRING DEMAND ELASTICITIES FOR DIFFERENTIATED PRODUCTS

We are interested in the demand-price elasticity for a commodity sold in a "market" for which an aggregate demand-price elasticity has been estimated.

Call the commodity "i", and lump together all other commodities in the market over the subscript "j". We know (it is assumed) market shares w_i and w_j ($= 1 - w_i$) of i and j. The "aggregate" elasticity gives us the change in the total quantity bought $(q_i + q_j)$ when both i and j prices change by the same percentage. Call this elasticity ε_{i+j}. Then we have

$$\varepsilon_{i+j} \equiv \frac{d(q_i + q_j)}{dp} \cdot \frac{p}{(q_i + q_j)} \tag{A1}$$

where p is the "price" of i and j. We will assume that i and j charge the same prices: this is not likely to be exactly correct, of course, given that i and j are differentiated products, but the error thereby introduced in (A1) and the equations that follow will be small, so long as the differences between prices are small relative to the differences in market shares.

(A1) can be expanded to

$$\varepsilon_{i+j} = \frac{dq_i}{dp} \cdot \frac{p}{q_i + q_j} + \frac{dq_i}{dp} \cdot \frac{p}{q_i + q_j} \tag{A2}$$

We can expand dq_i/dp and dq_j/dp. These are the change in demand for i and for j when the prices of i *and* j change -- that is, each incorporates an own- and a cross-price effect. Defining, in general

$$\varepsilon_k \equiv \frac{dq_k}{dp_k} \quad \frac{p_k}{q_k}, \quad \varepsilon_{kl} = \frac{dq_k}{dp_l} \quad \frac{p_l}{q_k} \tag{A3}$$

we have

$$\frac{dq_i}{dp} = \varepsilon_i \frac{q_i}{p} + \varepsilon_{ij} \frac{q_i}{p} \qquad (A4)$$

given our assumption that p_i and p_j are the same. Similarly, for j

$$\frac{dq_j}{dp} = \varepsilon_j \frac{q_j}{p} + \varepsilon_{ji} \frac{q_j}{p} \qquad (A5)$$

substituting (A4) and (A5) into (A2) gives

$$\varepsilon_{i+j} = w_i(\varepsilon_i + \varepsilon_{ij}) + w_j(\varepsilon_j + \varepsilon_{ji}) \qquad (A6)$$

where

$$w_i = \frac{pq_i}{p(q_i + q_j)}, \quad w_j = \frac{pq_j}{(p(q_i + q_j)} \qquad (A7)$$

the market shares of i and j.

We have now one equation, (A6), in the four unknown elasticities. To get some more equations, we need some more assumptions.

First, we ask how many of the customers that i would lose when it raised its price would go over to j (p_j unchanged) rather than leave the market and spend their money on some other good. If the market shares of i and j are indicators of "popularity", we might expect the proportion who go over to j would depend on j's market share. Thus if, for example, i had 90 per cent and j 10 per cent of their market, and i raised its price, we predict that most of the customers lost to i would exit from the market rather than move over to j, which evidently is a rather minority taste. The particular form in which we specify this conjecture is

$$\frac{dq_j}{dp_i} = - w_j \frac{dq_i}{dp_i} \tag{A8}$$

and, similarly

$$\frac{dq_i}{dp_j} = - w_i \frac{dq_j}{dp_j} \tag{A9}$$

that is, the proportion crossing over is assumed to equal the good's market share. The fourth expression we get by imposing a symmetry condition

$$\frac{dq_i}{dp_j} = \frac{dq_j}{dp_i} \tag{A10}$$

the customers that i loses when it, alone, raises its price return when j raises its own price by the same amount. Evidently, such a condition can only hold exactly for small price increases (since there will be an effect on total demand for i *and* j when they both have raised their prices).

We will now solve for the i and j elasticities. From (A8) and the definition (A3) of elasticities we have

$$\frac{dq_j}{dp_i} = \varepsilon_{ji} \frac{q_j}{p_i} = -w_j \frac{dq_i}{dp_i} = - w_j \varepsilon_i \frac{q_i}{p_i} \tag{A11}$$

so that

$$\varepsilon_{ji} = -w_j \varepsilon_i \frac{q_i}{p_i} \cdot \frac{p_i}{q_j} = - w_i \varepsilon_i \tag{A12}$$

Similarly

$$\varepsilon_{ij} = - w_j \varepsilon_j \tag{A13}$$

Substituting (A12) and (A13) into (A6) gives

$$\varepsilon_{i+j} = w_i \; (\varepsilon_i - w_j \varepsilon_j) + w_j \; (\varepsilon_j - w_i \; \varepsilon_i) \tag{A14}$$

Now, the symmetry condition (A10) can be expanded, using (A12) and (A13), to

$$\frac{dq_i}{dp_j} = \varepsilon_{ij} \frac{q_i}{p_j} = - w_j \varepsilon_j \frac{q_i}{p_j} = - w_i \varepsilon_i \frac{q_j}{p_i} \tag{A15}$$

With $P_i = P_j$, (A15) simplifies to

$$\frac{q_j q_i}{q_i + q_j} \;\; \varepsilon_i = \frac{q_i q_j}{q_i + q_j} \;\; \varepsilon_j$$

$$\text{or } \varepsilon_i = \varepsilon_j \tag{A16}$$

The elasticities of i and j are the same. This seems quite a strong restriction, but it may be reasonable -- we do not have any reason to expect own-price elasticities to differ systematically with market share when goods are heterogeneous.

Using (A16) in (A14) gets us to

$$\begin{aligned} \varepsilon_{i+j} &= w_i \; (\varepsilon_i - w_j \; \varepsilon_i) + w_j \; (\varepsilon_i - w_i \; \varepsilon_i) \\ &= \varepsilon_i \; (w_i + w_j - 2w_i \; w_j) \\ &= \varepsilon_i \; (1 - 2w_i w_j) \end{aligned} \tag{A17}$$

so that

$$\varepsilon_i = \frac{\varepsilon_{i+j}}{1 - 2w_i w_j} \quad (= \varepsilon_j) \tag{A18}$$

This is the formula we need to compute own-price elasticities from an estimate of the aggregate market elasticity, ε_{i+j}, and information on market shares.

Cross-price elasticities can then be computed from (A12) and (A13).

As an illustration of how (A18) would work, suppose an aggregate market elasticity of 1. If good i had a market share of 0.25, its own-price elasticity would be 1.6. If its market share were 0.5, the own-price elasticity would be 2.0 (this is the maximum ε_i can achieve). For very large or small market shares, (A18) gives an elasticity very close to the aggregate elasticity, as we would expect.

Of course, (A18) rests on some very concrete specifications of our assumptions about market behaviour, as well as some approximations. This is the price that must be paid to extract a usable formula from the available data. The formula seems "reasonable" -- it doesn't have any undesirable characteristics at extreme values -- and may therefore be of some use.

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