ASSESSING THE ROLE OF SCALE ECONOMIES AND IMPERFECT COMPETITION IN THE CONTEXT OF AGRICULTURAL TRADE LIBERALISATION: A CANADIAN CASE STUDY

François Delorme and Dominique van der Mensbrugghe

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INTRODUCTION

One of the key characteristics of the WALRAS model [as described in Burniaux et *al.* (1989)] is that it assumes that all markets are perfectly competitive and production takes place under constant returns to scale. In this case, supply curves are flat[1], although they shift as input prices change. Until recently, this modelling strategy was adopted by most applied general equilibrium (AGE) modellers, since such models are relatively easy to build and their properties are well understood. Simulations of trade liberalisation with such models tend to show rather "small" welfare gains, typically of the order of 1 per cent of GNP or less.

The relevance of these results has been questioned on the grounds that the assumptions of perfect competition and absence of scale economies are unrealistic, leading to the omission of a potentially important additional source of welfare gains[2]. In many sectors, industrial structure is better characterised by a small number of key firms instead of many firms which individually have no influence on market prices. Under such circumstances, trade liberalisation, by strengthening competitive pressures and lowering entry barriers, can yield additional efficiency gains via rationalisation of the industrial structure. This leads to efficient firms moving down their average cost curves to exploit scale economies, while inefficient firms either reorganise their production or exit from the industry.

However, implementing industrial structure characteristics in AGE models is not a straightforward task. First, there is no general theory of price determination in oligopolistic industries. Some firms may collude tacitly or explicitly. Even in the absence of collusion, the outcome depends on the choice of the strategic variable (output or price) and assumptions about other firms' reactions. Many scenarios are possible in elaborating the firm's pricing strategies, and different assumptions regarding entry and exit have critical consequences for the behaviour of firms and thus aggregate industry output. Finally, the presence or absence of product differentiation at the firm level also has major implications for the results.

This paper reports on the results of some experiments with the implementation of industrial organisation characteristics in the WALRAS model. This version is hereafter referred to as WALRAS-SE (WALRAS incorporating Scale Economies). The Canadian model was chosen to carry out these experiments on the grounds of data availability. Scale economies are implemented in six Canadian manufacturing industries only; they are not implemented in the two primary agricultural industries (livestock and other agriculture) because the evidence suggested that scale effects are negligible in these sectors, at least at the level of sectoral aggregation chosen in WALRAS. The remaining non-manufacturing sectors (construction and services) are likewise not assumed to exhibit scale economies. Scale economies have not at this stage been incorporated in the other five countries/regions contained in the WALRAS model, though this is a possible extension of the present work that could be implemented if the required data can be assembled.

In the non-competitive industries, selling prices are a function inter *alia* of an endogenous mark-up on marginal costs. The choice of how the mark-up is set is crucial for the results. To demonstrate this point, simulation results are presented for different commonly-used pricing rules under the assumption of free entry/exit of firms. While results relaxing the latter assumption are not presented here, the model can also be simulated under an imperfect competition regime without entry.

Section I of the paper describes the specification of the WALRAS-SE model. It outlines the determination of the scale parameters as well as the derivation of the pricing rules. Simulation results, including an evaluation of their sensitivity to different pricing strategies, are presented in Section II. The final section draws some lessons from the simulation results for the modelling of scale economies and imperfect competition in the WALRAS model.

I THE IMPLEMENTATION OF SCALE ECONOMIES IN WALRAS

WALRAS-SE contains two categories of industries:

i) those with constant or decreasing returns to scale where perfect competition is assumed to prevail (competitive industries); and
ii) those with increasing returns to scale which are characterised by imperfect competition (non-competitive industries).

Based on Canadian econometric evidence on the prevalence of plant-level scale economies, six of the seven manufacturing sectors in WALRAS were characterised as non-competitive. The list of industries is presented in Table 1 (Section II). The one remaining manufacturing industry, meat products, and all other sectors were characterised as being competitive industries[3]. In the model, the size of scale economies determines the maximum cost reduction that firms can potentially achieve[4].

Table 1. Structural indicators (1981) and policy instruments (1986-88)

Per cent

	Share of gross output[a]	Share of value-added[a]	Share of exports'	Share of imports[a]	Import penetration[b]	Export orientation[b]	Capital-labour ratio[c]	Land value-added ratio	Intermediate inputs/ output	Import tax	Export subsidy	Production input subsidy	Subsidy on food consumption
Livestock	1.8	1.2	0.8	0.4	3.3	7.2	1.18	30.3	3.8	3.2	1.4	13.5	0.0
Other agriculture	2.3	2.9	5.7	1.7	15.7	39.1	3.60	36.6	11.8	0.3	4.4	23.8	0.0
Other primary industries	6.6	7.7	15.2	12.8	31.6	36.0	1.93	0.0	6.8	0.0	0.0	0.0	0.0
Meat products	1.5	0.5	0.9	0.5	5.0	8.9	0.29	0.0	4.2	31.5	9.4	0.0	0.0
Oairy products	0.8	0.4	0.4	0.2	3.5	7.0	0.61	0.0	2.5	159.7	148.8	0.0	0.0
Other food products	2.6	1.5	2.9	2.5	15.3	17.4	0.63	0.0	12.5	1.7	0.4	0.0	0.0
Beverages	0.7	0.6	0.7	0.6	14.0	15.3	0.92	0.0	9.3	0.0	0.0	0.0	0.0
Chemicals	2.6	1.6	3.2	4.5	25.1	19.6	0.83	0.0	16.2	0.0	0.0	0.0	0.0
Petroleum and coal	3.6	0.3	2.1	1.3	5.7	9.3	0.10	0.0	43.6	0.0	0.0	0.0	0.0
Other manufacturing	23.2	18.6	55.3	67.7	41.7	37.5	0.40	0.0	29.4	0.0	0.0	0.0	0.0
Construction	10.5	9.6	0.0	0.0	0.0	0.0	0.31	0.0	13.0	0.0	0.0	0.0	0.0
Wholesale and retail trade	8.9	13.4	2.7	1.2	2.1	4.8	0.30	0.0	4.2	0.0	0.0	0.0	0.0
Other private services	35.0	41.7	10.2	6.6	2.9	4.6	0.93	0.0	10.4	0.0	0.0	0.0	0.0

a) Share of the sectoral variable in the aggregate.
b) As a proportion of sectoral output.
c) Levels.
Source: Structural indicators are calculated from *The Input-Output Structure of the Canadian Economy,* 1981, Statistics Canada, 15-201.

Two distinct pricing hypotheses have been chosen to describe the imperfect competition behaviour of firms, and each industry may follow one or a combination of them. In the standard version of WALRAS, as well as in the competitive industries in the SE version, prices are determined as the weighted sum of all (marginal) costs of production i.e. labour, capital, land and intermediate inputs. In the non-competitive industries, prices are determined by a non-constant mark-up over marginal costs. The determination of the mark-up depends on the assumptions used to model oligopolistic behaviour.

The selection of the two pricing strategies used here – Chamberlinian monopolistic competition and "focal pricing" – is guided by robustness and tractability. Monopolistic competition is the most commonly-used pricing assumption found in the theoretical literature on imperfect competition[5]. All AGE models incorporating non-competitive market structure characteristics make at least some use of it. The other pricing strategy, the focal pricing rule[6], assumes a cartel of oligopolists who collude tightly around a target price, taken to be the world price inclusive of the tariff.

After a brief review of the derivation of the scale-economy parameters, the remainder of the section is devoted to a discussion of these two key strategies.

A. Scale-economy parameters

In the non-competitive industries, a distinction must be made between industries and firms. It is assumed that all firms within an industry are identical and each firm is characterised by increasing returns to scale up to an optimal plant size. The basic assumption is that it takes a minimum amount of labour and capital for the firm to be in operation. The firm's technology is then characterised by indivisibility. Therefore, the firm will be better off if it can overcome these indivisibilities either by increasing production or by using inputs more efficiently (more specialised equipment or greater division of labour). The presence of fixed costs is the result of the existence of such indivisibilities. Note that these fixed costs are assumed to be recurrent rather than "sunk". Such costs cannot be avoided, even in the long run. They can be interpreted as the necessary costs that must be borne independent of the level of output[7]. Since variable costs are assumed to be constant per unit of output (for given input prices), the average cost (AC) function will fall as output increases and asymptotically approach unit variable costs (VC) as output becomes large and eventually reaches the minimum efficient scale of production (q_s) where all scale economies are exhausted (Figure A). The total cost function of the representative firm in an industry can be written as:

$$TC_i\ (w_i,\ r_i,\ P_{ji}) = FC_i\ (w_i,\ r_i) + VC_i\ (w_i,\ r_i,\ P_{ji}) * q_i \qquad [1]$$

Where

TC_i	:	total costs
W_i	:	wage rate
r_i	:	rental rate of capital
P_{ji}	:	price of intermediate input j
FC_i	:	fixed costs
VC_i	:	unit variable costs
q_i	:	output per firm

Equation [1] states that, in addition to variable costs, the firm's technology is characterised by fixed labour and capital costs (the first term of [1]). The major difference compared with the neoclassical formulation of [1] is that the industry's demands for labour and capital will now include as additional arguments the number of firms as well as average output per firm. The importance of increasing returns to scale is determined by the size of the fixed-cost term relative to variable costs (or total costs).

The additional data needed to implement scale economies in the WALRAS Canadian data base are taken mainly from Robidoux and Lester (1988)[8]. Fixed costs were calculated using their estimates of the minimum efficient scale of

FIGURE A

RELATIONSHIP BETWEEN UNIT VARIABLE COST AND AVERAGE COST

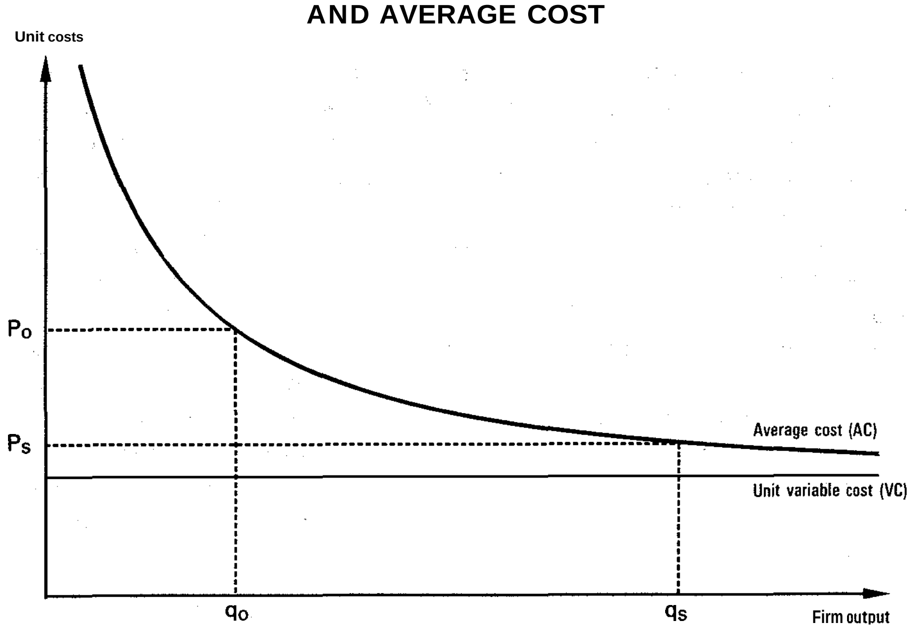
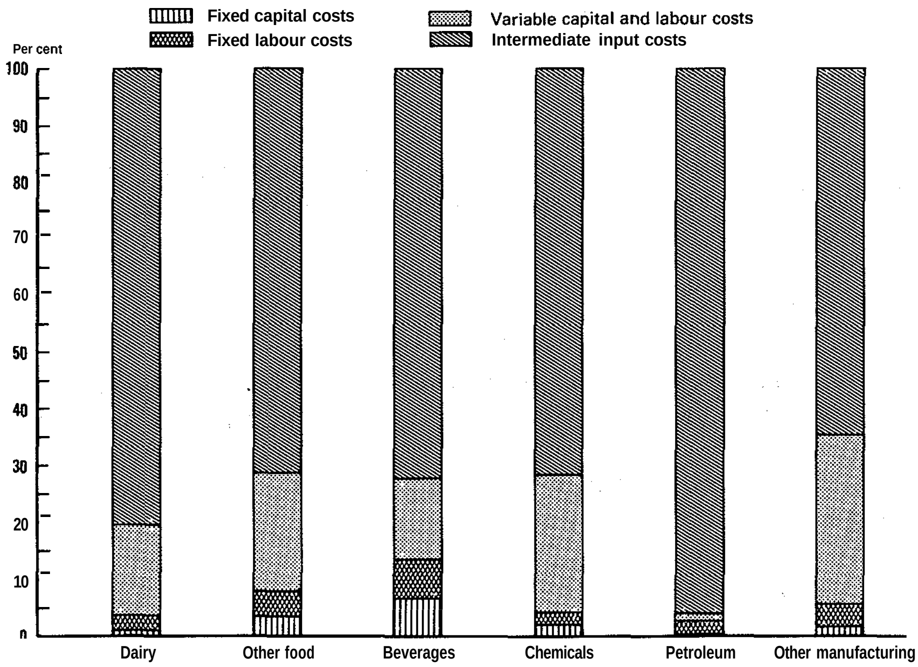


FIGURE B

FIXED AND VARIABLE COST DISTRIBUTION



production and cost savings achievable. The latter parameter quantifies the cost reductions that would result if a firm were to increase its output from its actual level to its efficient scale of production. More importantly, their estimates take into account the size distribution of plants within an industry.

The actual cost structure of these non-competitive industries is depicted in Figure B. Beverages has the largest share of fixed costs, peaking at about 13 per cent of total costs. Petroleum has the lowest share of fixed costs, with intermediate inputs[9] constituting the most important component of costs in this sector.

B. Pricing strategies

a) The monopolistic competition pricing rule

The first pricing rule used in WALRAS-SE, the monopolistic competition pricing (MCP) rule, is based on the Lerner mark-up formula[10]. The latter states that each firm sets a mark-up over marginal (or unit variable) costs according to the perceived price elasticity of demand for its product.

The basic equation which determines production prices can be written as:

$$P_i = \delta_i * VC_i \quad [2]$$

where δ_i is the mark-up of the representative firm in industry *i*. Mark-ups under the MCP rule can be derived by assuming that the firm faces an iso-elastic demand curve:

$$d_i = aP_i^{-e_i} \quad [3]$$

where d_i is the iso-elastic perceived demand curve facing the representative firm, P_i is its selling price, a is a scale parameter and e_i is the firm's perceived elasticity of demand[11].

The mark-up can be derived from the solution of the firm's profit maximisation problem[12]:

$$\delta_i = e_i / (e_i - 1) \quad [4]$$

The empirical determination of equation [4] requires the evaluation of the firm's perceived elasticity of demand. The technical annex describes its derivation when the model is characterised by product differentiation at the firm level. The additional assumptions that have to be made in order to evaluate the firm's perceived elasticity of demand in the absence of such product differentiation are also discussed. When product differentiation at the firm level is not incorporated in the model, we have first to calculate an "industry" elasticity of demand. The derivation of this elasticity is also described in the annex. From the industry elasticity of demand, it is possible to derive the firm's perceived elasticity by making special assumptions about oligopolistic firm behaviour. A first category of oligopolistic behaviour considered in this paper is to suppose that firms behave noncooperatively, that is, they take the actions of other firms as given. Another type of oligopolistic behaviour assuming tacit collusion (hence cooperative behaviour) is discussed in the next section.

A first model of noncooperative behaviour is the Cournot model of competition in quantities (sometimes referred as a Nash equilibrium in quantities). Broadly speaking, the Cournot model assumes that each firm equates its own marginal revenue to its marginal cost, taking the ***outputs*** of other firms as given[13]. A more realistic model of oligopolistic behaviour is the Bertrand hypothesis (a Nash equilibrium in prices) where each firm sets its price to maximise its profit, given the other firms' ***prices.***

Under the Cournot model, the firm's perceived price elasticity of demand is determined from the "industry" demand elasticity (E^M) by the following relationship:

$$e_i = n_i E_i^M \qquad [5]$$

where n_i is the number of firms in industry i. The resulting mark-up is therefore determined by:

$$\delta_i = (n_i E_i^M) / (n_i E_i^M - 1) \qquad [6]$$

Under a generalised Nash equilibrium in prices, which allows for imperfect substitution between products of different firms, the firm's perceived elasticity of demand can be expressed as:

$$e_i = - \theta_i + [1 + (n_i - 1) \alpha_i] * [(\theta_i - \beta_i) + (\beta_i - 1) S_i] * (1/n_i) \qquad [7]$$

where 8, is the elasticity of substitution between the products of the different firms, β_i is the elasticity of substitution between domestic and imported commodities, S, is the market share of domestic production in total consumption spending, and α_i is a conjectural variation parameter which specifies the reaction of a given firm with respect to the price variations of other firms within a given industry. In the specific case of the Bertrand model where competitors' prices are assumed to be fixed, this parameter is equal to **zero**[14].

The Bertrand competition model fits nicely in a framework in which product differentiation at the firm level is introduced explicitly (θ_i in equation [7]) – as in Harris (1984), Horridge (1987), Nguyen and Wigle (1987), Wigle (1988), Brown and Stern (1988a, b), Gunasekera and Tyers (1989) and Norman (1989)[15]. In that context, equation [7] shows that the firm's perceived elasticity is obtained directly on each market by having the number of firms and the conjectural variation parameter both entering explicitly in the determination of the perceived demand elasticity. When product differentiation is not incorporated explicitly – as is the case in WALRAS-SE, the argument for using the Bertrand hypothesis in empirical implementation is less compelling. The problem comes from the fact that under this oligopolistic behaviour, the market elasticity of demand plays no role in the determination of the firm's perceived elasticity of demand. Instead, as shown by [7], it is the elasticity of substitution between the different products which plays the key role in affecting firms' perceptions.

A pragmatic solution proposed by Harris (1988) is to assume arbitrarily that the market elasticity is the sole determinant of the firm's perceived elasticity. In particular, his suggestion boils down to setting e = E^M and therefore the mark-up is determined by substituting E^M for e in equation [4]. As discussed in the annex, the Harris approach can be derived from a generalised Nash equilibrium in prices by assuming that *i)* all firms in the industry follow similar pricing rules (unitary conjectures in [7]); *ii)* the firms' market shares remain constant; and *iii)* the elasticity of substitution between firms' products is equal to the elasticity of substitution between domestic and imported commodities.

As an alternative to modelling oligopoly as a (static or dynamic) uncooperative game, use is sometimes made of the less pure but convenient concept of "aggregate conjectural variations"[16]. In a static context, oligopolistic firms are modelled as conjecturing the existence of a relationship between their own output choices and those of their rivals. The conjectural variation parameter (ψ_i) is therefore the rate of change of other firm's output with respect to a given firm's output. In terms of perceived elasticities, the conjectural variation model can be expressed as:

$$e_i = \psi_i \cdot E_i^M \qquad [8]$$

The aggregate conjectural variation model encompasses many equilibria[17]; e_i becomes larger as the oligopoly becomes more competitive. The MCP rule used in this paper is based on the aggregate conjectural variation approach. The parameter ψ_i is determined such that the zero-profit condition holds. Indeed, because of the different ways in which the firm's perceived elasticity of demand can be computed and the level of scale economies introduced in the model via fixed costs, nothing ensures that the zero-profit condition (i.e. that price equals average cost with free entry/exit) will be consistent with the pricing strategy (i.e. price determined by an endogenous mark-up over marginal cost). Solving for ψ_i as a "residual parameter" ensures the consistency between the two equations governing the imperfect competition model.

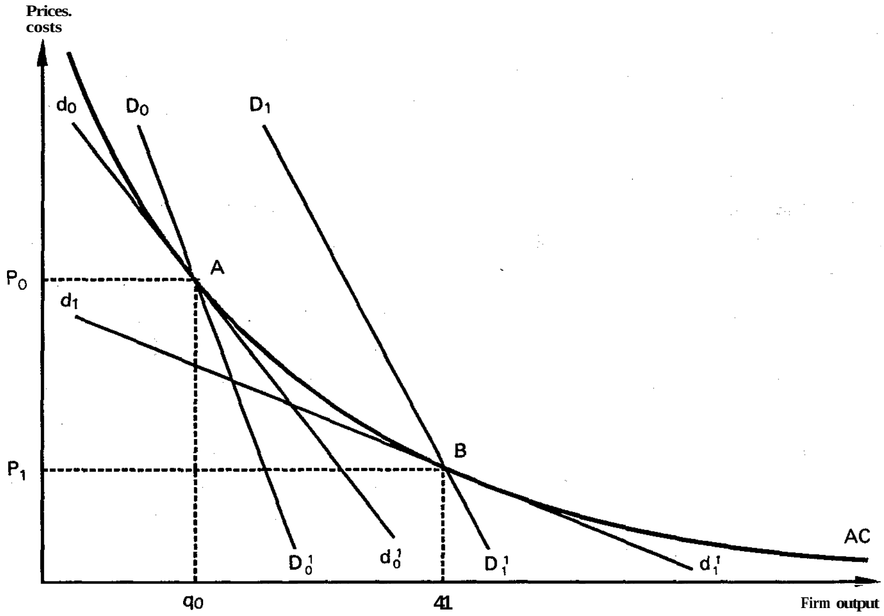
Despite its obvious simplicity compared with game-theoretical models such as those presented above, the aggregate conjectural variation approach has one important drawback; it does not spell out explicitly the sequence of actions and reactions embedded in the parameter ψ_i. Besides, the concept is not rooted in any specific maximising behaviour. For example, in a static game, each firm's choice is independent of those of other firms. Time dimension and information structure preclude the reactions of firms to each other. Thus, any conjecture about a given firm reaction that differs from no reaction is not rational.

Although the aggregate conjectural variation approach is problematic on theoretical grounds, many commentators agree that it may be justified to use this "reduced-form" approach as a short cut. This may be particularly true if, as in the present paper, the question of how the equilibrium is maintained is not key to the modelling exercise.

Behaviour under the MCP rule is depicted in Figure C. The starting point is an initial long-run tariff-ridden equilibrium where no profit is earned by any domestic or foreign firm, price equals average cost and output is determined at the point

FIGURE C

COMPARATIVE STATICS UNDER THE MONOPOLISTIC COMPETITIVE PRICING RULE



where the marginal revenue curve intersects the marginal cost curve (not shown in the diagram). This equilibrium is at point A where the perceived demand curve $d_0d'_0$ is tangent to the average cost curve, implying that total revenue is equal to total cost. The effective demand ($D_0D'_0$) curve, which takes into account identical output variations of all the other firms in the industry, also crosses the firm's perceived demand curve at point A.

Removing tariff protection in that situation leads to falling prices and losses for domestic firms, since consumers substitute away from the domestic product. Firms will exit the market until a new zero-profit situation is restored in the industry. Whether this new equilibrium is one with firms producing more output per firm, and hence at lower costs, depends on how the removal of tariff protection influences the perceived elasticity of demand. This cannot be determined a *priori.* In Figure C, the shift in the demand curves is drawn such that firms exit the industry. Hence, the representative firm can sell more output at any given price, and both demand curves move to the right.

A careful examination of equations [1] to [4] in the technical annex shows that there are two types of shares that determine the price elasticity of demand for the output of a given industry: *i)* the share of the relevant market accounted for by domestic, as opposed to foreign, suppliers, and *ii)* the share of each relevant final demand category (i.e. consumption, intermediate demand and exports) in total final demand. The combined impact of variations of the two shares is not clear and can work in opposite directions. For example, a cut in an export subsidy would tend to reduce the share of world demand accounted for by Canadian suppliers and this would by itself increase the market elasticity (as can be seen from equation [3] in the annex). However, at the same time, the share of exports in the total supply of the good in question would fall with a corresponding rise in the share of output sold on the domestic market. If demand elasticities on the domestic markets are low relative to those on export markets, then this shift would tend to reduce the aggregate industry elasticity (as can be seen from equation [4] in the annex). The total effect is thus ambiguous a priori.

In practice, derationalisation on the domestic market is likely to outweigh pro-rationalisation effects originating from the world market when an export subsidy is abolished. Canadian exports in general represent a marginal share of world **exports**[18], but they are an important source of total demand for certain domestic industries such as the "other agriculture sector" or "other primary industries" or "other manufacturing" where the share was around 40 per cent in 1981[19]. The removal of an export subsidy, by putting upward pressure on export prices, is likely to engender a decline in the world market share as well as in the share of exports in total final demand of the industry. Since the former is typically small, it is the latter which is likely to have the most significant impact. It follows that the world market share of a given industry has to be significant in order to reap the rationalisation benefits from the unilateral elimination of a tariff or an export subsidy.

The important point to bear in mind is that, contrary to the focal rule described below where a fall in a tariff will always lead to rationalisation in the directly-affected industry, the market demand elasticity has to increase under the MCP rule, in order to obtain rationalisation. However, the behaviour of the demand elasticity in each market, as well as the variations in the different shares, can increase, decrease or leave unchanged the aggregate market elasticity.

The extent to which firms exit (in response to liberalisation under the MCP rule) depends on the reaction of the demand curves. If removing protection leads demand to become more elastic (e.g. point B on $d_1d'_1$), the mark-up of price over marginal cost will fall and output per firm will rise from q_0 to q_1. At point B, the representative firm is producing more at lower costs in an industry with less competitors. As noted above, however, if the perceived demand elasticity is not affected by abolition of the protective barriers and hence there is no change in the mark-up and the production price, the firm's demand will return to its initial position. This leads to an important conclusion: if the policy experiment does not affect the firm's perceived elasticity of demand, there will be no rationalisation effects.

b) The focal pricing rule

The focal pricing (FP) rule is a "tariff-limit" pricing rule where domestic prices are set at the world price plus the tariff. The origin of this pricing strategy comes from empirical work by Eastman and Stykolt *(1967)* who showed that a given industry protected by a tariff, in which domestic consumption is small relative to the industry's minimum efficient scale of production (MES), is likely to be characterised both by a high number of plants of suboptimal capacity and excessive product diversification. This pricing strategy is also found in the industrial organisation literature where it is argued that domestic prices are set to match the price of foreign competitors. The lack of effective price competition in the domestic market is viewed as the natural outcome of a collusive oligopoly's desire to avoid price competition. Given entry barriers, collusion may produce persistent long-run profits. However, with free entry, this would just be a temporary phenomenon.

This pricing rule is based on three key assumptions[20]:

i) collusion between incumbent firms;
ii) potential entrants suppose that established firms will hold output constant in the face of entry (Cournot conjecture);
iii) existing firms set prices to discourage entry.

A number of commentators (e.g. Deardorff, ***1986,*** Brown and Stern, **1988*a*)** have questioned the realism of the focal pricing rule on the grounds that the assumed collusive behaviour might not be sustainable with free entry. However, as noted by Globerman **(1988),** explicit collusion among domestic firms is not a necessary assumption for focal pricing. If each firm assumes that other domestic firms will quickly match any price reduction, the firm's perceived demand elasticity could be quite low. The expected profits may be too small to justify the risks associated with investing in rationalisation and possibly triggering a price war through substantial price reductions. ***Implicit*** price collusion is then facilitated by the target price.

Despite the shaky theoretical foundations of this proposition, econometric studies (e.g. Hazledine, **1988*a*,** and Karikari, ***1988)*** show that monopolistic competition (which puts the emphasis on domestic costs) ***and*** focal pricing (where the domestic price matches any reductions in the import price) are both statistically significant determinants of Canadian domestic prices. Under this pricing strategy, the mark-up is determined as:

$$\delta_i = P_i^w \,(7 + t_i\,) \,/\, VC_i \qquad [9]$$

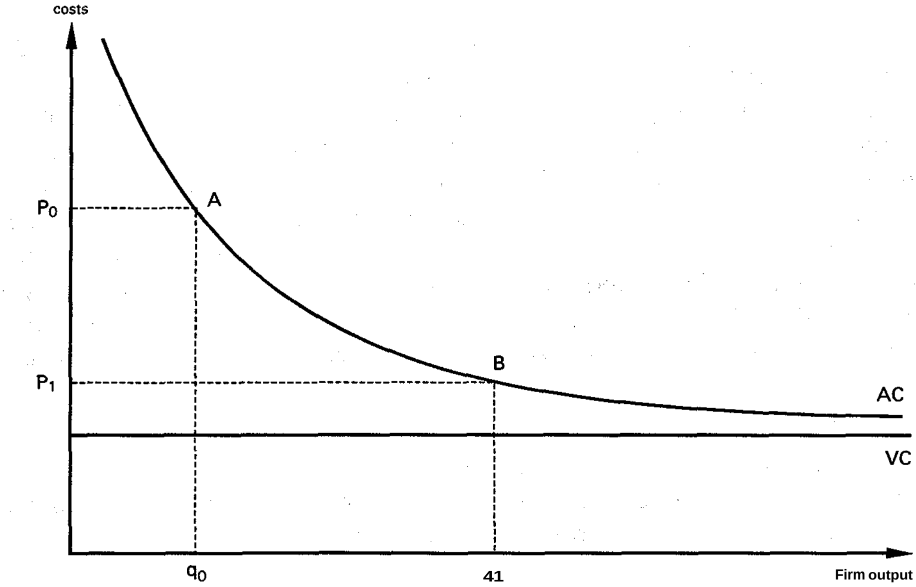
where

$P^w{}_i$: **World price in industry *i***

t_i : **Tariff rate in industry *i***

FIGURE D

**COMPARATIVE STATICS
UNDER THE FOCAL PRICING RULE**



Firm behaviour under the focal pricing rule is illustrated in Figure D. Under this rule, the mark-up is a function of the world price cum tariff (P_0). At the initial situation (point A), profits are zero and hence the average cost is equal to P_0 at the level of output per firm q_0. When the tariff is eliminated, there is a fall in demand for the output of domestic producers, and there is pressure to decrease the mark-up by the same rate as the tariff. This lowers producer prices in import-competing industries to P_1. Sales per firm fall and firms incur losses. They must then reduce production costs in order to restore zero profits. The industry will rationalise as firms exit and output per firm rises from q_0 to q_1. This generates a new equilibrium where the remaining firms once again earn zero profits. The extent to which costs are reduced depends on the importance of scale economies.

II. EMPIRICAL RESULTS

Whether scale economies are likely to be quantitatively significant or not depends on whether *i)* protection leads to a situation where firms or farms are too small or insufficiently specialised to minimise costs of production or abnormal profitability has been generated; and *ii)* removing protection induces certain industries to rationalise their operations.

In most Canadian food-processing industries, Robidoux and Lester (1988) found evidence of suboptimal plant size. Their results suggested that the cost reductions achievable ranged from 7.3 per cent in "other food" industries to 12.2 per cent in beverages. In the Canadian agriculture sector, it is also possible that output per farm is too low with respect to the minimum efficient scale of production. The literature identifies two regulated agricultural industries, dairy and poultry, where this appears to be the case. The existence of production quotas in these two industries has led to high average costs due to inefficient scales of production and highly regulated prices. Studies by Borcherding and Dorosh (1981) and Moshini (1988) suggest that the potential cost savings may reach 7 and 9 per cent in dairy and poultry farms, respectively. Given the sectoral aggregation adopted in WALRAS-SE, this would be equivalent to potential cost reductions of 2.5 per cent for the livestock sector and about 1 per cent for the two agricultural sectors combined. Given the limited evidence for scale economies as well as the highly competitive nature of these sectors, increasing returns to scale and imperfect competition were not assumed for agriculture[2].

Some structural indicators for the Canadian economy, as well as data on the structure of agricultural protection, are given in Table 1. The results of the simulations using the model are presented in Tables 2 to 5. The model is run in

Table 2. Summary of economy-wide effects from unilateral elimination of 1986-88 levels of agricultural protection

Per cent changes compared with benchmark year

	Perfect competition	Focal pricing	Monopolistic competition pricing
Real income	1.2	1.3	1.9
Producer price	−1.2	−1.2	−1.1
Rental rate of capital	−2.6	−2.5	−1.9
Wage rate	−1.0	−0.9	−0.3
Land price	−79.3	−78.3	−76.9
Terms of trade	−1.1	−1.1	−1.4
Export volumes	3.6	3.3	4.6
Import volumes	7.4	6.4	8.2
GDP deflator at factor cost	−4.4	−4.3	−3.6
Cost savings achievable:			
Initial level	..	5.4	5.4
Post-simulation level	..	5.0	4.7
Cost reductions realised[a]	..	7.4	13.0

a) Proportion (in percentage) of cost reductions realised as a proportion of potential cost reductions.

unlinked mode because scale economies have been implemented for Canada only, not for the other countries/regions. The policy experiment conducted was a full ***unilateral*** removal of Canadian agricultural assistance from the levels prevailing around 1986-88 taking world prices as given[22]. In Canada, more than 80 per cent of the total support to farmers, as measured by the producer subsidy equivalent (PSE), is accounted for by input subsidies which are applied exclusively in the two farm sectors. In contrast, border measures (tariffs and non-tariff barriers) are applied mainly in the dairy and the meat products sectors.

A. Perfect competition

This scenario assumes that all sectors are perfectly competitive. In this case, the removal of a tariff on agricultural imports will, ***ceteris paribus,*** lead to a fall in demand for domestically produced goods. This shift will be especially important if the substitution elasticities are high. In the case of an export subsidy, the channels are more direct; they affect export prices exclusively and the indirect impact on domestic prices depends mostly on the elasticity of demand for exports. Since Canadian agriculture is protected mainly via input subsidies, setting the subsidy rate to zero will depress the demand for factors employed in agriculture, and output in agriculture and related sectors will fall as a consequence.

All these measures will have important consequences for the trade account. Because the current account balance is exogenous in the model closure selected for the base case, the real exchange rate will have to adjust in order to re-equilibrate the current account[23]. For instance, in case of an induced trade deficit the real exchange rate has to depreciate to restore equilibrium.

The simulation results under the assumption of perfect competition (PC) are presented in the first column of Table 2. These results are somewhat different from the unilateral simulations presented in Martin ***et al.*** (1989) since the version of the WALRAS model used for the latter study incorporates some differences in model specification as compared with WALRAS-SE. In particular, WALRAS-SE does not allow for partial mobility of labour and capital between the agricultural and non-agricultural sectors nor does it incorporate the assumption that domestic output and exports are imperfect substitutes.

The results show that agricultural landowners tend to benefit from agricultural protection at the expense of lower wages and returns on capital services. Another general conclusion is that liberalisation is welfare-improving. Despite a significant deterioration in the terms of trade, consumers' real income increases by over 1 per cent.

Tables 3 and 4 show the sectoral results of the abolition of agricultural support under perfect competition. The results suggest that agricultural protection taxes export-oriented industries in manufacturing, reducing their production,

Table 3. **Summary of sectoral results for unilateral elimination of agricultural protection**[a]

Per cent changes compared with benchmark year

	Grass output			Employment			Exports			Imports		
	PC	FP	MCP	PC	FP	MCP	PC	FP	MCP	PC	FP	MCP
Primary agriculture	−42.9	−41.4	−40.8	−53.5	−51.9	−51.3	−76.4	−78.5	−81.2	12.8	14.1	23.2
Food processing	−20.2	−16.0	−3.9	−17.7	−18.2	−14.8	−22.8	−11.7	56.0	214.5	183.5	205.4
Manufacturing	3.6	3.4	3.1	3.1	3.0	2.4	9.3	8.5	6.8	−1.4	−1.2	−0.5
Services	1.4	1.6	1.8	0.7	0.8	1.0	16.7	15.9	10.4	−0.5	−0.8	1.3

	Producer prices			Input prices			Export prices			Import prices		
	PC	FP	MCP	PC	FP	MCP	PC	FP	MCP	PC	FP	MCP
Primary agriculture	4.7	5.1	5.3	23.0	22.9	22.4	8.2	8.7	9.5	−1.0	−1.0	−0.9
Food processing	−0.4	−1.9	−5.6	−1.0	−1.3	−2.4	9.4	7.8	0.9	−39.0	−37.2	−41.3
Manufacturing	−1.3	−1.2	−0.9	−1.1	−1.1	−0.8	−1.3	−1.2	−0.9	0.0	0.0	0.0
Services	−1.6	−1.5	−1.0	−2.0	−1.9	−1.7	−1.6	−1.5	−1.0	0.0	0.0	0.0

	Gross output			Exports			Imports			Producer prices			Export prices		
	PC	FP	MCP	PC	FP	MCP	PC	FP	MCP	PC	FP	MCP	PC	FP	MCP
Meat products	−25.6	−25.5	−24.2	−87.8	−87.9	−87.2	383.3	387.4	395.1	2.3	2.3	2.0	11.9	11.9	11.6
Dairy products	−80.4	−70.2	−81.1	−100.0	−100.0	−100.0	3616.3	3027.8	3734.0	−1.0	−12.2	0.3	146.3	118.3	149.5
Other food products	−5.8	0.6	31.8	8.6	28.6	148.5	−0.8	−6.8	−25.8	−1.3	−3.0	−9.9	−0.9	−2.7	−9.5
Beverages	2.1	2.4	3.9	12.7	12.9	17.4	−6.3	−6.2	−6.7	−1.5	−1.5	−2.0	−1.5	−1.5	−2.0

employment and net exports. Removing protection has a major impact on the agricultural sector and, to a lesser extent, on the food-processing industries. Higher domestic prices in response to the abolition of input subsidies allow agricultural imports to become more competitive. Output in agriculture and food processing falls by 43 and 20 per cent, respectively. Land prices fall by 80 per cent. On the other hand, output and employment in other industries and private services increase. In response to the changes in production patterns, agricultural exports decline by 76 per cent and imports increase by about 13 per cent. The rise in imports in agriculture and food processing reflects the relatively high elasticity of substitution between domestic and foreign goods in consumer demand. Similarly, higher demand elasticities on world markets than on domestic markets explain the radical contraction of agri-food exports.

These results are not particularly interesting in themselves. Indeed, a number of restrictive assumptions and the fact that these simulations are in unilateral mode, make these results less relevant than those presented in the Martin et ***al.*** (1989) paper in this volume. These results, however, are relevant as a benchmark for assessing the different effects of introducing oligopolistic behaviour into the WALRAS model.

B. Scale economies and oligopolistic behaviour

How does the introduction of scale economies and imperfect competition alter the patterns described above? Not surprisingly, the answer is conditioned by the choice of pricing rule. Variants of the two rules discussed above can be selected. For example, different industries could be assumed to adopt different pricing strategies, or the pricing rule could be a weighted average of the two rules. The abolition of input subsidies and imperfect competition does not interact directly since the two farm sectors are assumed to be perfectly competitive.

However, scale economies and imperfect competition are likely to have indirect general equilibrium effects on livestock and the other agriculture sector. In the case where rationalisation effects dominate in imperfectly competitive industries, the fall in production prices will be transmitted to other sectors such as agriculture through lower costs of inputs. Furthermore, expansion of industries characterised by scale economies will have positive effects on the remaining sectors through stronger intermediate demand.

a) Focal pricing rule

The second column of Table 2 presents the aggregate results under the focal pricing rule. Protection via tariffs applies in livestock, other agricultural industries, meat products, dairy products and other food products, the last two being non-competitive industries. Only in these latter two industries will the mark-up be affected by this pricing. The results show that the focal price assumption leads to a similar welfare gain (1.3 per cent) to that achieved under perfect competition. The change in industrial structure is shown in Table 4, and the additional rationalisation effects can be seen in Table 5. The first column of Table 5 presents the potential scale economies. The "cost savings achievable" are the average cost reductions possible between observed output per firm (the initial point) and the minimum efficient scale of production – where economies of scale are fully exploited.

In the non-competitive industries, the decline in the tariff forces the affected industries initially to decrease their production prices by the full amount of the tariff cut in order to preserve their market share. At this new price, all firms are making losses. The only way to restore equilibrium is to exploit scale effects. This leads some firms to exit, an increase in output per firm and a corresponding fall in average costs of production due to the decline in fixed costs. At the final equilibrium, the industry is more efficient and the average size of firms has increased.

The simulation results are exactly in line with these predictions in the cases of dairy products and other food industries. As shown in Table 5, cost savings are fully realised in the dairy products industry. This means that all economies of scale are exploited in this industry (as shown in the fourth column of Table 5). Table 4 shows that imports and exports of dairy products change considerably following

Table 5. Rationalisation effects in non-competitive industries: unilateral elimination of agricultural protection

	Base cost savings achievable'	Remaining potential cost reductions after elimination of agricultural protection		Proportion of cost savings achieved[b]	
		Focal pricing	Monopolistic competition pricing	Focal pricing	Monopolistic competition pricing
Dairy products	10.5	0.0	12.0	100.0	–14.3
Other food products	7.3	5.7	0.0	21.9	100.0
Beverages	12.2	12.2	12.2	0.0	0.0
Chemicals	3.6	3.5	3.6	2.8	0.0
Petroleum and coal	1.3	1.3	1.3	0.0	0.0
Other manufacturing	5.5	5.5	5.3	0.0	3.6

the removal of protection, and output contracts by 70 per cent. Moreover, output per firm increases strongly in response to the 11 per cent drop in the mark-up. The extent of these effects is weaker in other food products.

The significance of scale economies can be better understood by examining what happens to domestic producer prices in these two industries (Table 4). Under perfect competition, domestic prices fall by 1 per cent in dairy products and decline by 1.3 per cent in other food products. Under the focal pricing strategy, domestic prices drop by 12 and 3 per cent, respectively, in these two industries. These lower prices stimulate domestic demand and exports in these industries, thereby offsetting part of the output contraction despite their relatively low export orientation (the share of exports in gross output is 7 and 18 per cent, respectively, in the two industries). In the other non-competitive industries, there is no scope for tariff cuts which would trigger rationalisation effects.

b) Monopolistic pricing

The results under focal pricing can be contrasted with those under monopolistic pricing behaviour. In the latter case, the mark-ups are affected by all policy instruments since each of these can in principle affect the market shares. Changes in market shares will affect the firm's perceived elasticity of demand which will in turn alter the mark-up in each industry. This scenario is presented in the third column of Tables 2 to 4. The results are strikingly different from those of the focal-pricing simulation. The welfare gain is larger under the MCP rule *(2* per cent) than under either the perfect competition or the focal pricing scenarios. The fall in non-land factor prices is slightly less important, thereby producing smaller decreases in product prices. Under the MCP rule, the terms of trade deteriorate by 1.4 per cent; this stimulates total exports which increase by almost 5 per cent compared with 3.5 per cent under perfect competition and focal pricing. These results can be better understood by looking at the effects of the policy instruments on the mark-ups at the industry level.

A comparison of the outcomes under the two pricing rules at the sectoral level in Tables 4 and 5 shows two completely different pictures emerging from agricultural liberalisation. Under the MCP rule, the dairy products industry de-rationalises following the shock since firms in this industry move up along their average cost curve. Instead of falling, as happens when firms rationalise, the cost savings variable increases (from 10.5 to 12 per cent), meaning that firms are moving away from the minimum efficient scale of production. The other sectors gain in efficiency, especially other food products, where all potential scale economies are exploited, following the sharp decline in producer prices (almost 10 per cent). In dairy products, the drop in the perceived elasticity of export demand due to a sharp fall in the export/output ratio offsets the rise in the perceived elasticities observed for consumption and intermediate demand. For other food products, the removal of the tariff leads to a rise of the perceived demand elasticities for consumption and intermediate demand as well as for export demand. This contributes to the increased market elasticity of demand and the associated fall of 8 per cent in the corresponding mark-up.

The magnitude of the reduction of the mark-up is surprising given the level of support provided to the other food products industry. This drastic movement in the mark-up is rooted in the definition of the pricing rule which, coupled with high elasticity values on world markets, tends to generate dramatic changes in the perceived elasticity of demand on export markets. An alternative simulation, assuming a Cournot conjecture (not shown), produced results more in line with the perfect competition scenario. Hence, this scenario should be considered as yielding an upper range for the rationalisation effects under the MCP rule.

The bottom part of Table 2 shows the extent to which economies of scale are exploited at the aggregate level. The aggregate cost savings achievable is 5.4 per cent, implying that average costs of production in the economy cannot be reduced by more than 5.4 per cent by a shift from actual output per firm to the minimum efficient scale of production. Under focal pricing, 7.4 per cent of this potential for cost reduction is realised compared with **13** per cent under the MCP rule.

The sectoral results (Tables **3** and 4) show that output in food processing contracts much less severely under the monopolistic-pricing scenario. As noted above, this is explained by the fact that under the MCP rule the other food industry (which represents more that 40 per cent of the food-processing aggregate) rationalises strongly, and its average costs and producer prices fall, stimulating output via export growth. The behaviour of other manufacturing is more or less similar under the different pricing regimes since the latter sector is not affected directly by the policy instruments considered, and because the inter-sectoral links between non-food manufacturing sectors and agriculture are relatively weak.

III CONCLUDING REMARKS

This paper has presented simulation results for a unilateral removal of agricultural support in Canada from **1986-88** levels using a scale economies/imperfect competition version of the WALRAS model. Economies of scale were implemented at the firm level in six manufacturing industries. Two pricing rules were used to demonstrate the sensitivity of the simulation results to different assumptions regarding oligopolistic behaviour.

The results show that allowing for internal economies of scale can change the results of simulating the removal of agricultural support measures, by forcing industries to rationalise via the exploitation of scale economies, a process which leads to falling average costs of production and output prices. However, as the results demonstrate, the converse effect is also possible and in these cases, the industry in question becomes less efficient.

The sensitivity of the results to the different pricing rules might cast doubt on the robustness of results obtained from **AGE** models incorporating scale economies and imperfect competition. There is obviously the delicate question of the selection of the "right" pricing rule. The two pricing rules used in this study can be regarded as representing two extremes. On the one hand, for low values of import and export demand elasticities, the MCP rule emphasises domestic costs as the main determinant of domestic prices. On the other hand, the focal pricing rule emphasises the influence of the import price on the domestic price. Under these conditions, it is natural that the latter triggers more powerful rationalisation effects when a tariff is abolished, since oligopolistic firms are assumed to fully match changes in import prices. However, the impact of the focal pricing rule would be reduced by any weakening in the collusive behaviour of domestic oligopolists.

The simulation results show that under the focal pricing rule, households benefit from important rationalisation effects in two industries, dairy products and other food products. **As** a whole, the pro-competitive effects of the abolition of protection at the aggregate level lead to over 7 per cent of potential scale economies being exploited. Under monopolistic competition pricing behaviour, the non-competitive industries also become more efficient as a whole.

Most researchers have selected the monopolistic competition pricing rule as the unique determinant of the mark-up. This may be inappropriate, however, especially in industries where import penetration is important and where tariff rates are high. In these industries, it is most likely that a change in the (gross of tariff) price will trigger scale effects. However, the focal pricing rule implicitly assumes a tight degree of collusion which is hardly realistic with respect to some industries. Other assumptions about imperfectly competitive behaviour which can be simulated with **WALRAS-SE** but which are not analysed in the paper, such as restricted entry and imperfect co-ordination between domestic firms, would undoubtedly generate different results[24].

A related topic is the correspondence between the presence of scale economies and the structure of protection. In **WALRAS,** most of Canadian agricultural protection is modelled as a production subsidy which affects only the two farm sectors where constant returns to scale are assumed. This means that the removal of these subsidies has effects neither on the mark-ups nor on profits in these two sectors, and hence there are no rationalisation effects. Obviously, the relaxation of the constant-returns-to-scale assumption could have significant effects on the industrial structure of agriculture and downstream industries if the potential scale effects were large.

An interesting finding of the simulations presented above is that, especially under model closures where the current account is exogenous, scale economies offset the impact of the terms-of-trade deterioration only if these economies are located in the industries where protection is dismantled. When this is the case, firms are forced to rationalise in order to maintain their domestic market share. Output per firm will thereby increase, giving rise to additional welfare gains. If average costs fall, the corresponding fall in domestic prices will lessen the substitution away from domestic products towards imported goods. This in turn means that the trade deficit is lower, which puts less pressure on the terms of trade as an equilibrating device.

In order to strengthen the conclusions presented in this paper, it would be important to extend the scale economies/imperfect competition specification developed for WALRAS-SE to the other countries/regions. At the present time the exploitation of scale economies in WALRAS-SE is limited to Canadian firms only because of data availability. In a context of multilateral liberalisation, any terms-of-trade losses for Canadian consumers could be mitigated by allowing rationalisation of the industrial structure to take place in other countries where there is a potential for scale economies.

NOTES

1. The sole exception is the two farm sectors in the model, where land is treated as a sector-specific factor.
2. For a review of this issue, see Helpman and Krugman (1985, 1989). See Richardson (1989) for a review of the empirical literature on the "new trade" theories. He concludes that welfare gains are usually two to three times the size of those estimated using models imposing perfect competition. Norman (1989) assesses the quantitative importance for trade policy of the "new" trade theories in an applied general equilibrium context.
3. Robidoux and Lester (1988) are our source for estimates of scale economies in Canadian industries. They found no econometric evidence of increasing returns to scale in the meat products industry.
4. A short paper explaining the complete derivation of the scale-economy parameters is available from the authors on request.
5. Useful surveys about the role of imperfect competition and economies of scale in trade theory can be found in Helpman and Krugman (1985, 1989), Venables (1985) and Richardson (1989).
6. This is also known as the Eastman-Stykolt pricing hypothesis after the work of Eastman and Stykolt (1967) on the impact of tariff protection on the Canadian manufacturing sector.
7. For example, these may be maintenance costs on a minimum-size factory or advertising costs. These fixed costs are different from the short-run Marshallian adjustment costs which occur due to the presence of a quasi-fixed input.
8. Other complementary data are taken from Robidoux (1986) and Statistics Canada, Census of *Manufactures*, SC-31-203. The cost saving parameter was revised upwards in the dairy and other food products industries in line with revised estimates supplied to the Secretariat by Lester and Robidoux.
9. Contrary to labour and capital costs, there are assumed to be no fixed costs for intermediate inputs.
10. The Lerner equation states that a firm will set its mark-up over marginal cost such that $[(P - VC)/P] = (1/e)$, where e $(e > 1)$ is the firm's "perceived" elasticity of demand. This pricing rule, which presumes noncooperative behaviour by firms, is based on Negishi's (1961) general equilibrium analysis of imperfect competition. Such pricing behaviour is rooted in the well-known Chamberlinian equilibrium theory where firms produce goods which are imperfect substitutes. Coupled with free entry and exit in the long run, this is equivalent to specifying an environment of monopolistic competition.
11. Defined as being positive and greater than unity.

12. Formally, the mark-up equation is derived from the familiar profit maximisation condition that marginal revenue equals marginal (variable) cost. This implies that $P[1 - (1/e)] = VC$. Solving this equation for P yields equation [4].

13. See Helpman and Krugman (1985), pp. 85-111, and Richardson (1989), Section II-a, for the derivation of the Cournot-Nash conjecture. Bresnahan (1988) reports evidence consistent with this behavioural hypothesis.

14. For simplicity, this formulation assumes that firms are identical and that the underlying consumer's utility function has a Cobb-Douglas functional form.

15. Brown and Stern (1988a, b), however, do not use the same modelling strategy as the others. They do not add a third stage to the two-stage budgeting process typical of the Armington framework. They claim that this way of introducing product differentiation biases the results toward intra-industry adjustment, weakens the rationalisation (or de-rationalisation) effects associated with factor intensities and unduly increases national market power and hence the optimal tariff. As a consequence, Brown and Stern (1988*a*, *b*) by-pass the Armington assumption and adopt a simple two-stage process where product varieties are differentiated. However, introducing full product differentiation in WALRAS-SE is beyond the scope of the present exercise.

16. See Dixit (1987) and Krugman (1987). The concept of aggregate "conjectural variation" is discussed in Helpman and Krugman (1989) and Tirole (1989).

17. The Cournot-Nash conjecture represents a particular case of equation [8], where $\psi = n$, the number of domestic firms. In the case of an inherently more competitive behaviour, $n < \psi < \infty$. With perfect competition, $\psi = \infty$.

18. According to the WALRAS aggregation scheme, this share never exceeds 5 per cent.

19. This share is defined as the value of sectoral exports divided by the value of sectoral gross output.

20. See Miller (1982) and Hazledine (1988*b*) for a discussion of the theoretical framework underlying the focal pricing rule.

21. This issue remains unsettled in the literature. In the case of wheat for instance, Gilmore (1982) argues that high concentration ratios for the largest exporting firms are a symptom of imperfectly competitive markets. However, Caves (1978), Thompson and Dahl (1979), Caves and Pugel (1982) and Thursby (1988) argue that easy entry and exit conditions (because of low entry barriers) mean that grain markets behave in a more or less competitive fashion. An interesting alternative would be to introduce scale economies at the industry level, hence keeping the competitive nature of the agricultural sector. See Markusen and Melvin (1981) for such a treatment.

22. The paper by Lienert (1989) in this volume describes the detailed calculations for the different policy instruments selected to characterise Canadian protection levels. The dairy quota rent was not included in the simulations reported. As shown in Martin et al. (1989) in this volume, the introduction of the dairy quota rent lowers the output contraction in agriculture and food-processing industries.

23. See Burniaux et *al.* (1989) in this volume for a more detailed discussion.

24. The literature on strategic intervention via trade policies, which is surveyed in Grossman and Richardson (1985), shows that the empirical results are very sensitive to these hypotheses.

Technical Annex

DERIVATION OF THE FIRM'S PERCEIVED PRICE ELASTICITY OF DEMAND

The industry (or market) elasticity of demand is derived as the weighted sum of the market elasticities of all final demand categories. For final consumption, the vector of market elasticities (E^c_i) is derived as:

$$E^C_i = \{ -\beta_g + (\beta_g - 1) \cdot [P^d_{cg} \cdot C^d_g / (P^d_{cg} \cdot C^d_g + P^I_{cg} \cdot C^I_g)]\} \cdot \Xi_{gi} \qquad [1]$$

Where:

- β_g : Elasticity of substitution between domestically produced and imported commodity g
- P^d_{cg} : Consumer price of domestically produced commodity g
- P^I_{cg} : Consumer price of imported commodity g
- C^d_g : Consumption expenditures on domestically produced commodity g
- C^I_g : Consumption expenditures on imported commodity g
- Ξ_{gi} : (g x i) fixed-coefficient transition matrix linking the g consumer-good classification to the i producer-good classification

A similar market elasticity can be derived for intermediate demand:

$$E^X_{ji} = -\eta_{ji} + (\eta_{ji} - 1) \cdot [P^d_{ji} \cdot X^d_{ji} / (P^d_{ji} \cdot X^d_{ji} + P^I_{ji} \cdot X^I_{ji})] \qquad [2]$$

Where:

- η_{ji} : Elasticity of substitution between domestically produced and imported intermediate inputs j used by industry i
- P^d_{ji} : Price of domestically produced intermediate input j used by industry i
- P^I_{ji} : Price of imported intermediate input j used by industry i
- X^d_{ji} : Intermediate use of domestically produced input j by industry i
- X^I_{ji} : Intermediate use of imported input j by industry i

For exports, the market elasticity is given by:

$$E^E_i = -\varepsilon_i + (\varepsilon_i - 1) \cdot [P^d_{Ei} \cdot EX^d_i / (P^d_{Ei} \cdot EX^d_i + \sum_{r=1}^{R-1} P^r_{Ei} \cdot EX^r_i)] \qquad [3]$$

Where:

- E_i : Elasticity of substitution between domestically produced and world exports of commodity i
- P^d_{Ei} : Export price of commodity i
- P^r_{Ei} : Export price of region r ($r = 1, R-1$) for commodity i
- EX^d_i : Domestic exports of commodity i
- EX^r_i : Exports of commodity i from region r ($r = 1, R-1$)

where R represents the total number of countries/ regions covered by WALRAS-SE. The market elasticities of demand relative to investment, stock changes and government expenditures are assumed to be zero in the model.

To get the aggregate (or industry) elasticity of demand (E^M), each market elasticity is weighted by the share of the respective demand category in final demand:

$$E_i^M = [PC_i^d \cdot E_i^c + EX_i^d \cdot E_i^E + \sum_j (a_{ji}^d \cdot Q_j) \cdot E_{ji}^x] \;/\; Q_i \qquad [4]$$

Where:

- PC^d_i : Personal consumption of domestic (industrial) good i
- a_{ji}^d : Unit physical requirement of domestic input j used by industry i
- Q_i : Gross output of industry i

Once the industry elasticity of demand is determined, the next step is to link it to the firm's perceived elasticity of demand. Under monopolistic conditions or an oligopolistic structure with perfect collusion, these elasticities are equal. If imperfect collusion exists, the firm's perceived elasticity of demand depends on the reactions of other firms. Under the Cournot conjecture, each firm takes the output of its competitors as given, and all firms within the industry produce a homogeneous good. The resulting equation for the mark-up is given by equation [6] in the text.

An alternative approach, based on Spence (1976) and Dixit and Stiglitz (1977), assumes that commodities produced by firms are imperfect substitutes. In this model, the firm sets the selling price for its product assuming competitors' prices as given (Bertrand hypothesis).

Within a context of product differentiation at the firm level, the firm's perceived elasticity of demand can be derived directly from a general consumer demand model in which such differentiation is explicitly incorporated. Assume, for instance, that consumption demands are derived from a utility function defined over the different commodities available to the representative consumer. Suppose for simplicity that the functional form of this function is Cobb-Douglas. For each quantity demanded, the consumer decides in what proportions to buy domestically and abroad (the so-called Armington assumption). Finally, from the domestic composite commodity, consumers choose firm-specific goods as a function of relative prices. This means that the price of a given good is a (CES) price index defined over the price of different product varieties.

From this model, the firm's perceived elasticity of demand can be derived by differentiating (in logarithmic terms) the consumption demand for a given product variety with respect to its price. As given by equation [7] in the main text, it can be shown that the perceived elasticity will be a function of the following variables: *i)* the elasticity of substitution between different varieties; *ii)* the Armington elasticity; *iii)* a conjectural variation parameter which specifies the reaction of a given firm with respect to the observed price variations of other firms within a given industry (Nash equilibrium in prices); and *iv)* the market shares.

If the model does not include product differentiation at the firm level, it is still possible to find an expression for the firm's perceived elasticity of demand by making the following restrictive assumptions on the generalised Nash equilibrium in prices (equation [7]): *i)* equality between the elasticity of substitution between different varieties and the relevant Armington elasticity; and *ii)* a unitary conjectural variation parameter. It is then implicitly assumed that firms' market shares are constant and that each firm produces a good that is a perfect substitute for other firms' products. Under these conditions, the firm's perceived elasticity of demand is equal to the market (or industry) elasticity of demand ($e = E^M$).

This restricted version of the Nash equilibrium in prices, when coupled with the aggregate conjectural variation model described in Section I, provides an acceptable pricing strategy under monopolistic competition. This is the version of the MCP rule used in this paper. The non-unitary ψ_i parameter in equation [8] weakens the implicit assumption of perfect collusion implied by the equality between the industry and the perceived firm's elasticity of demand. This pricing strategy was also used in Harris (1984) and Canada (1988).

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