TARIFF POLICIES IN A SMALL

OPEN SPATIAL ECONOMY*

by

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ABSTRACT

This paper considers tariff policies in a small open economy in which consumers are spatially distributed. The production technology of the manufacturing sector is assumed to exhibit increasing returns to scale, and its product incurs costs in transportation. Examples are constructed which demonstrate that imposition of an import tariff on this sector can lead to an improvement in welfare, despite the fact that a monopoly position is created for some firm in the protected industry, and even though it incurs higher production costs than do importers.

1. INTRODUCTION

In the late 1960's, a resurgent nationalistic movement in Canada called for increased tariffs to promote growth of domestic manufacturing industries, and to reduce reliance on foreign (especially American) imports. (In the late 1970's, a similar movement has surfaced in the U.S.) In response, Eastman and Stykolt (1967) and Wonnacott and Wonnacott (1967) published studies that, not surprisingly, found that previous tariff barriers had led to inefficient production in the Canadian manufacturing sector, with unit costs about 15 percent higher than corresponding American industries, to an oligopolistic market structure in the protected industries, and indeed to an increased amount of foreign (especially American) direct investment. These results are not surprising if one accepts the (quite reasonable for Canada) hypothesis of the presence of economies of scale in manufacturing production, as well as the hypothesis that the Canadian market is of inadequate size to realize these economies, so that firms producing only for the domestic market must operate at suboptimal capacity. The contention of this paper is that, while these predictions of the effect of tariffs in a small open economy are correct, they do not necessarily imply that a tariff will lead to lower total welfare. In fact, in the models of this paper, in a spatial economy (i.e. where consumers are spatially distributed), an increased tariff rate can lead to an improvement in welfare even though a monopoly position is created for some firm in the protected industry, and even though it incurs higher production costs than do importers.

The intuition underlying this result is quite simple. If there are significant economies of scale, and the domestic market is small enough, then a non-negative profit constraint will potentially be a binding one for domestic industries, so that no domestic firms produce. The imposition of a tariff may then allow a single firm to enter the market and earn a positive profit. As a result, a small movement in a tariff rate may cause a significant increase in competition. In a spatial economy with transport costs, the firm will tend to locate near the center of its potential market area. As a result, those consumers who then purchase from the domestic monopolist will face a lower price, reflecting lower transport costs, while those buying imported goods will pay more. Under some circumstances, those consumers who gain could more than compensate those who are worse off.

Section 2 discusses more formally models with exogenously given import prices, in which the prospect of an improvement in total welfare is possible. Both a partial equilibrium model and a two-sector model are presented, where in the latter case the country in question can alternatively produce another good (for domestic consumption or export) at constant returns to scale, which does not incur costs when transported. In Section 3, foreign and domestic producers set their prices at Nash equilibrium levels. Section 4 contains a brief summary and mentions possible directions for future research.

There are four features of the models of the following sections which are essential to obtaining the desired results. First, the economy has a spatial structure, where transportation of goods within the economy is costly. Secondly, there are economies of scale in domestic production.

Next, firms are restricted to f.o.b. pricing, and so cannot price discriminate with respect to consumer location. Finally, the points of entry of imported goods are exogenously given (perhaps by geography), and so cannot adjust in response to the entry of domestic firms. To the extent that these features are characteristic of some industries in an open economy, the conclusions of this paper may be of interest. All other assumptions, in particular those of functional form, are only made to keep the examples of the paper as simple as possible.

The idea that a tariff may lead to increased welfare is not unique to this sort of model. For example, Newbery and Stiglitz (1979) show that a similar conclusion holds when countries face uncertainty in production. Nor is the study of the effect of trade on an oligopolistic industry very new. In fact, there has recently been a profusion of articles which model open economies with a monopolistically competitive sector. (Johnson (1967) discusses possible reasons for the lack of impact of the "monopolistic competition revolution" on international trade theory through the 1960's.) Based on the model of Dixit and Stiglitz (1977), in which consumers have a taste for variety for its own sake, Krugman (1979, 1980, 1981) has shown that the opening of trade between two identical economies will lead to trade and increased welfare as consumers are offered a greater diversity of products. Lancaster (1979, Chapter 10) obtains similar results in a linear economy, where the spatial dispersion of consumers across types of goods arises from a distribution of tastes in his "characteristics of goods" approach. A problem with these papers is that, like the partial equilibrium models presented below, an economy with only one sector is considered, and general equilibrium impacts ignored. However, Helpman (1980) and Lancaster (1980) have shown that these results stand up in an economy with two sectors, one monopolistically competitive and one competitive. None of these papers, however, examine the possible effects of tariffs, nor is there any suggestion that a partial restriction of trade may lead to a welfare improvement.

2. EXOGENOUS IMPORT PRICES

In this section, the import price of the good in question is assumed to be exogenously given. The model of the first subsection is a partial equilibrium one, in which there is only one good in the economy. This model is generalized in the next subsection, in that another sector is introduced which exhibits constant returns to scale in production and no transport costs.

2.1 A Partial Equilibrium Model

Consider an economy whose consumers are uniformly distributed on a line of finite length with density one. In the model of this subsection, we shall concentrate solely on their consumption of a manufactured good whose shipment is costly. This good is available from importers located at the endpoints of the line segment which defines the economy, and at a finite number of exogenously given interior points. The price charged by these importers, m, is (in this section) predetermined and, for simplicity, assumed to be the same at all import points. If transport costs vary linearly with distance travelled, say at a constant rate t, and there are no fixed costs of transportation, then a consumer located a distance of x away from an import point must pay a delivered price of $m + tx$ for each unit of the good purchased from that importer.

Suppose that the maximum distance between any adjacent pair of import points is $2L$. We shall focus our attention, without loss of generality, on the line segment connecting these two points. Consumers located at the midpoint of this line would then pay $m + tL$ for each unit of the imported good. We shall denote the midpoint as the origin, and the line segment $[-L, L]$. It is assumed that consumers will buy one (and only one) unit of this good as long as the price they pay is less than some reservation price, which in turn is assumed to exceed $m + tL$. Then changes in consumer surplus at a given location associated with delivered price movements will be equal to (minus) the change in total expenditure on the good in question, which in turn will equal (minus) the change in delivered price paid.

Consider now domestic firms. Their production technology is described by a cost function of the form

$$C(Q) = cQ + F,$$

where Q is output produced, c the constant marginal cost, and F fixed cost. It will typically be assumed that $c > m$, so that domestic firms incur marginal costs of production equal to or greater than the freight-on-board (f.o.b.) import price. As a result, domestic firms will never choose to locate at import points, in the absence of tariffs or other restrictions on trade. Instead, they are assumed to consider location at the midpoint of the line segment $[-L, L]$. (Because of the nature of consumers' demand curves, their uniform distribution, and the linear transport cost function, this location will be no more profitable than others in its immediate neighborhood, but considering only location at the midpoint permits less cumbersome calculations with no loss of generality.) We shall consider the case in which, in the absence of tariffs, no domestic firm can operate profitably.

Consider a consumer located at x, a point on the interval $[0, L]$. If a domestic firm charges an f.o.b. price of p, and an ad valorem tariff rate of θ is imposed on imported goods, then this consumer will purchase from the domestic firm only if its good is offered at a lowered delivered price, so that

$$p + tx < m(1 + \theta) + t(L - x).$$

Given p and θ, we can define the consumer $\ell(p, \theta)$ who is indifferent between purchasing imported and domestic goods by

$$p + t\ell(p, \theta) = m(1 + \theta) + t(L - \ell(p, \theta)),$$

which implies that

$$\ell(p, \theta) = \begin{cases} 0 & \text{if } p > m(1 + \theta) + tL \\ \dfrac{m(1 + \theta) - p + tL}{2t} & \text{if } m(1 + \theta) - tL < p < m(1 + \theta) + tL \\ L & \text{otherwise.} \end{cases}$$

A domestic firm located at the origin and charging p will then face total demand of

$$Q(p, \theta) = 2\int_0^{\ell(p, \theta)} dx$$

$$= 2\ell(p, \theta),$$

and so earns profits

$$\pi(p, \theta) = 2(p - c)\ell(p, \theta) - F.$$

The profit maximizing price given a tariff of θ, $p(\theta)$, is then defined implicitly by $\pi_p(p(\theta), \theta) = 0$, where the p subscript denotes the first derivative of the function π with respect to its first argument, and the firm will choose to operate if $\pi(p(\theta), \theta)$ is non-negative.

It is easy to show that

(1) $p(\theta) = (m(1 + \theta) + c + tL)/2$

(2) $\ell(\theta) \equiv \ell(p(\theta), \theta) = (m(1 + \theta) - c + tL)/4t$,

and

(3) $\pi(\theta) \equiv \pi(p(\theta), \theta) = (m(1 + \theta) - c + tL)^2/4t - F$.

If no firm could operate profitably in the absence of a tariff, $\pi(0)$ is negative, and so

(4) $F > (m - c + tL)^2/4t$.

This assumption places a lower bound on the size of fixed costs.

Now suppose that the government of this country considers a movement away from free trade. We shall examine the imposition of tariff which just permits a single domestic firm to break even. If this tariff is denoted by $\tilde{\theta}$, then in terms of the model outlined above, $\tilde{\theta}$ is defined implicitly by $\pi(\tilde{\theta}) = 0$. Before working through the algebra, it may be helpful to describe the welfare effects in terms of a diagram. Figure 1 depicts the situation in question, where OG is the price charged by the domestic firm when the tariff is θ. If marginal cost is OJ, then equation (1) shows that GK equals JG, i.e. the price charged is the average of the marginal cost of production, c, and the delivered price of the imported good at the origin, m + tL or OK. This model is completely symmetric about the origin, so that if a tariff of θ is imposed, and the domestic firm chooses to produce, then consumers located on the intervals $[-L, -\ell(\theta)]$ and $[\ell(\theta), L]$ will continue to purchase the import good, at the higher f.o.b.

price $m(1 + \theta)$. Their consumer surplus loss will be $2x(ABCD)$. But this is exactly equal to the tariff revenue collected, so that they can be compensated by a lump-sum payment. Consumers on the interval $[-\ell(\theta), \ell(\theta)]$ will now buy from the domestic firm (if it operates), some gaining $2x(EFG)$ and some losing $2x(CDE)$, for a net gain of $2x((EFG) - (CDE))$. The profit of the domestic firm will be $2x(GHIJ)$, less its fixed costs. If a tariff of $\tilde{\theta}$ is imposed, these profits will be zero by construction, and so the net welfare change will be given by $2x((EFG) - (CDE))$. (There is an implicit assumption that the domestic firm chooses to operate if it earns zero profits.) Thus the imposition of the tariff rate $\tilde{\theta}$ will be welfare improving as long as EFG is larger than CDE, which is clearly true of the economy depicted in Figure 1. In this situation, those consumers who gain could more than compensate those who are worse off. (Recall that we are just considering the longest line segment between adjacent import points. If $\tilde{\theta}$ is the tariff rate, then it can be shown that it will not pay for a domestic firm to locate at the midpoint of a line segment shorter than 2L. The consumers located on segments such as this will then pay a higher f.o.b. price, $m(1 + \tilde{\theta})$, but can be compensated exactly in a lump sum payment by the tariff revenue collected from them.)

Algebraically, the change in consumer surplus of imposing a tariff rate θ, $2x((EFG) - (CDE))$ in Figure 1, is given by

$$cs(\theta) - cs(0) = 2\int_0^{\ell(\theta)} [m + t(L - x) - p(\theta) - tx]dx$$

$$= (m(1 + \theta) - c + tL)(m(1 - 3\theta) - c + tL)/8t,$$

where I have employed equations (1) and (2) to substitute for $p(\theta)$ and $\ell(\theta)$ respectively. If we assume that $m + tL > c$ (in Figure 1, that OF exceeds OJ), so that the delivered price of the imported good at the midpoint of the line segment exceeds domestic marginal costs, then $cs(\theta) > cs(0)$ if $m - c + tL > 3m\theta$. In terms of Figure 1, the distance FJ must exceed 3x(AB), or equivalently 3x(CD).

At $\tilde{\theta}$, profits are zero and so there is a welfare improvement if $cs(\tilde{\theta}) > cs(0)$, which occurs when $m - c + tL > 3m\tilde{\theta}$. From equation (3), if $\pi(\tilde{\theta}) = 0$ then

$$4tF = (m(1 + \tilde{\theta}) - c + tL)^2$$

or

$$(5) \quad m\tilde{\theta} = 2\sqrt{tF} - (m - c + tL).$$

Then $cs(\tilde{\theta}) > cs(0)$ as long as

$$(6) \quad m - c + tL > (3/2)\sqrt{tF}\ .$$

Rewriting equation (4), which follows from $\pi(0) < 0$, yields

$$(7) \quad (m - c + tL) < 2\sqrt{tF}\ .$$

We can combine equations (6) and (7) to give the restrictions on fixed costs which guarantee that welfare will increase if a tariff rate of $\tilde{\theta}$ is imposed, namely

$$F_0 < F < F_1,$$

where $F_0 = (m - c + tL)^2/4t$ and $F_1 = 4(m - c + tL)^2/9t$. If $F < F_0$, then a domestic firm can successfully operate without tariff protection, while if $F > F_1$, then fixed costs are sufficiently large that no welfare improvement is possible. Note that $F_1 - F_0$ is an increasing function of m and L, and a decreasing function of c and t. Of course the difference between F_0 and F_1 may be so negligible that the likelihood of tariff imposition resulting in welfare improvement is very small. The point, however, is that there are circumstances under which a tariff can increase welfare in this model, and the same may be true of more general models. Note that this result occurs even though marginal (and hence average) production costs exceed the import price, as long as $c < m + tL$, the delivered price at the origin.

At this point, a natural question is whether there is some optimal tariff level greater than $\tilde{\theta}$, given that it pays to impose a tariff of $\tilde{\theta}$ (i.e., given that $F_0 < F < F_1$). Again it is useful to look at the issue diagramatically. Figure 2 depicts, for the interval $[0, L]$, the effect of an increase in tariff from $\tilde{\theta}$ to θ. Consumers on $[\ell(\theta), L]$ will witness an import f.o.b. price increase of $m(\theta - \tilde{\theta})$, which will be exactly matched by increased tariff revenues from sales to them. Consumers on $[0, \ell(\tilde{\theta})]$ will pay a higher f.o.b. price for the domestic good of $p(\theta) - p(\tilde{\theta})$, which is exactly equal to the increased profits of the domestic firm at points on this interval. As a result, we can confine our attention to the interval $[\ell(\tilde{\theta}), \ell(\theta)]$, where consumers buy the domestic good when θ is imposed, but bought the imported good when $\tilde{\theta}$ was the tariff rate. (From equation (2), we know that $\ell(\theta)$ is an increasing function, and so $\ell(\theta) > \ell(\tilde{\theta})$ if $\theta > \tilde{\theta}$.) Because of the switch in purchasing patterns, tariff revenues of DEIJ are lost. Consumer welfare loss is measured by EFGI. However, the domestic firm gains profits of ACKM. Here the component of revenue BCKL exactly equals the area of EFGH. Thus the net welfare change, taking into account the interval $[-\ell(\theta), -\ell(\tilde{\theta})]$, is 2x(ABLM) less 2x(EHI) and less 2x(DEIJ), or 2x((ABLM) - (DEHJ)). Thus there is a welfare gain from increasing tariff from $\tilde{\theta}$ to θ if ABLM exceeds DEHJ. The optimal tariff, say θ^*, should be chosen to maximize this gain subject to the constraint that the tariff exceed $\tilde{\theta}$.

Algebraically, the welfare gain of imposing a tariff θ rather than $\tilde{\theta}$ is equal to

$$W(\theta) - W(\tilde{\theta}) = 2\int_{\ell(\tilde{\theta})}^{\ell(\theta)} [p(\tilde{\theta}) - c]dx$$

$$-2\int_{\ell(\tilde{\theta})}^{\ell(\theta)} [p(\tilde{\theta}) + tx - (m + t(L - x))]dx,$$

where the first integral is 2x(ABLM) and the second is 2x(DEHJ). The first derivative of this expression, $d(W(\theta) - W(\tilde{\theta}))/d\theta$, or $W'(\theta)$, is just

$$W'(\theta) = [4t\ell(\theta) - 2(m + tL + c)]\ell'(\theta).$$

Taking into account equation (2), this reduces to

$$W'(\theta) = m[m\theta - (m + tL + 3c)]/4t.$$

If $W'(\tilde{\theta}) < 0$, then $\tilde{\theta}$ maximizes $W(\theta) - W(\tilde{\theta})$ subject to $\theta \geq \tilde{\theta}$. But $W'(\tilde{\theta}) < 0$ only if $m\tilde{\theta} < m + tL + 3c$. If we employ equation (5) this is equivalent to $m + tL + c > \sqrt{tF}$. But if $F < F_1$, then $\sqrt{tF} < 2(m + tL - c)/3$, which is a more restrictive inequality since

$2(m + tL - c)/3 < m + tL + c$ as long as m, t, L and c are positive constants. Then the optimal tariff will just be $\tilde{\theta}$ if $F_0 < F < F_1$. (If $F < F_0$ or $F > F_1$, then the optimal tariff is zero.)

We can summarize the discussion of this section with the following proposition.

Proposition 2.1: If $m + tL > c$ and $F_o < F < F_1$, the domestic government can maximize welfare by imposing a tariff rate of $\tilde{\theta}$, the level at which a single firm can operate at the midpoint of $[-L,L]$ and earn zero profits. If $m + tL < c$, $F < F_o$ or $F > F_1$, the optimal tariff is zero.

Note that when fixed costs lie within the range (F_0, F_1), the tariff rate $\tilde{\theta}$ maximizes national welfare subject to the constraint that domestic firms earn non-negative profits. Thus the optimal tariff rate represents the solution to a constrained welfare maximization problem. Alternatively, the government could force domestic firms to price at marginal cost and then subsidize their losses to cover fixed costs. For certain levels of fixed costs, this scheme would attain an unconstrained welfare optimum, but it suffers from the drawback that domestic firms would have an incentive to deviate from cost minimizing behavior (implicit in the formulation of their cost function, $C(Q)$), as well as from the marginal cost pricing rule. The imposition of the optimal tariff, while introducing distortions into the economy, avoids these incentive compatability problems.

Recall that the import points are also being taken as exogenous in this model. This would be the case if they were geographically fixed in a location model. In a quality choice model, since the country is small, foreign producers will not take the country's demand into account when deciding the quality of good to produce, and so their "locations" (and so import points) could be taken as given by domestic firms. This will also be the case when it is sufficiently costly to relocate. Further, since domestic production costs exceed the price of the import good, domestic producers have no incentive to export, and so do not consider foreign demand when making their decisions.

2.2 A Two-Sector Model

In this subsection we introduce another sector, say agriculture. We shall again confine our attention to the line segment $[-L, L]$. The agricultural good is assumed to have a production technology which exhibits constant returns to scale. It can be transported costlessly for domestic or foreign sales. As a result, if we normalize the marginal cost of production to be unity, competitive forces will ensure that its price is unity. It is assumed that the world price is also unity, and that the domestic country is small in the sense that it faces perfectly elastic demand for its product by the rest of the world at that price.

Suppose that the domestic country faces a total resource constraint, in that there are Y units of a factor of production available for use in either the agricultural or manufacturing sectors. If the manufacturing sector faces a tariff rate of θ, and producers find it profitable to operate, then this sector will employ $2c\ell(\theta) + F$ units of the factor of production, as this is just the total cost of producing $2\ell(\theta)$ units of the manufactured good. If $Z(\theta)$ units of the agricultural good are produced at that tariff rate (at a total cost of $Z(\theta)$), then

$$Y = Z(\theta) + 2c\ell(\theta) + F .$$

Denote by $Z_c(\theta)$ and $Z_x(\theta)$ the amounts of the agricultural good which are consumed domestically and exported, respectively.

If the tariff is zero, then no domestic firm can operate profitably, and so 2L units of the manufactured good are imported at cost 2mL. Balance of payments equilibrium requires that $Z_x(0) = 2mL$. Then $Z_c(0) = Y - 2mL$.

If a tariff of $\tilde{\theta}$ is imposed, then a total manufacturing cost of $2c\ell(\tilde{\theta}) + F$ is incurred. The import bill will then be $2m(L - \ell(\tilde{\theta}))$, and so agricultural exports are $Z_x(\tilde{\theta}) = 2m(L - \ell(\tilde{\theta}))$. Then aggregate domestic consumption of agricultural goods will be

$$Z_c(\tilde{\theta}) = Y - 2m(L - \ell(\tilde{\theta})) - 2c\ell(\tilde{\theta}) - F .$$

In this model individual consumers always consume one (and only one) unit of the manufacturing good. Then it seems reasonable to measure changes in national welfare by movements in the aggregate consumption of the agricultural good. If $Z_c(\tilde{\theta}) > Z_c(0)$, then the imposition of a manufacturing tariff of $\tilde{\theta}$ will permit an allocation of the agricultural good which Pareto dominates the allocation when the tariff rate was zero. But

$$Z_c(\tilde{\theta}) - Z_c(0) = 2\ell(\tilde{\theta})(m - c) - F \quad ,$$

which can be positive only if $m > c$. But the converse was assumed to be true in the previous subsection. Thus, in this model, no welfare improvement can result from a tariff imposition. In summary,

Proposition 2.2: If export prices are exogenous, and $m < c$, then the optimal tariff is zero, in the two sector model of this section.

In the models of this paper, consumers have perfectly inelastic demands for manufactured goods. In a partial equilibrium world, they only care about price changes in that they can buy more of some unspecified other good. In the two-sector model, we can be more specific about the resource costs of domestic manufacturing, and find that if these exceed the cost of importing, then the optimal tariff is zero. (This may not be true if there are decreasing returns to scale in agriculture.) In the next section, we find that this is not necessarily true when foreign manufacturers alter their prices in response to tariff changes.

3. NASH EQUILIBRIUM PRICES

In this section, foreign and domestic firms set their prices at Nash equilibrium levels. Here foreign firms do not compete among themselves, but rather choose the import price which maximizes their joint profits given the price charged by domestic firms. As was the case in the second section of this paper, both partial equilibrium and two-sector models are presented in turn.

3.1 A Partial Equilibrium Model

In the context of the economy of section 2.1, if foreign firms reduce their f.o.b. prices in response to tariff increases, then the possibility of these increases leading to a welfare improvement is greater. Since foreign profits are not accounted for in welfare calculations, their reactions should lead to increases in consumer surplus, and in some cases domestic profits. The model of this subsection confirms this intuition, and that of the next subsection demonstrates that this result can also arise in our two-sector model.

We now assume that foreign firms are free to set the f.o.b. price they charge. Our attention will be concentrated on noncooperative equilibria of this game of potential entry by domestic firms. (Nti and Shubik (1981) have characterized these equilibria in a standard oligopoly model.)

We retain the basic structure of the economy outlined in section 2.1. A domestic firm which considers entry on the line segment $[-L,L]$ will again do no better than by locating at the origin (assuming its costs exceed those of foreign firms, absent tariffs). Its market boundary, given its price p, and the import f.o.b. price when the tariff rate is θ, $m(1 + \theta)$, will be

$$\ell(p, m(1 + \theta)) = (m(1 + \theta) - p + tL)/2t,$$

when the right-hand side of this equation is on the interval $[0, L]$. Its profits are then

$$\pi_D(p, m(1 + \theta)) = 2(p - c)\ell(p, m(1 + \theta)) - F .$$

Maximizing this expression with respect to p, taking m as given, yields

(8) $p = (m(1 + \theta) + c + tL)/2$.

Profits will then be positive if

$$(m(1 + \theta) - c + tL)^2 > 4tF .$$

If not, no firm can enter the market profitably.

For computational simplicity, assume that foreign firms incur no costs. They must choose between charging $m^*(\theta)$, the Nash equilibrium price when entry has occurred, and $\bar{m}(\theta)$, the price at which no domestic firm can profitably enter. Then

$$\max_p \pi_D(p, \bar{m}(\theta)(1 + \theta)) = 0.$$

It is easy to show that

(9) $\bar{m}(\theta) = (2\sqrt{tF} + c - tL)/(1 + \theta)$.

When the domestic firm operates, foreign firms will choose m to maximize

$$\pi_F(p, m, \theta) = 2m[L - \ell(p, m(1 + \theta))]$$

given p. The solution to this problem is

(10) $m = (p + tL)/2(1 + \theta)$.

Combining equations (8) and (10) yields the Nash equilibrium prices when both firms operate,

$$m^*(\theta) = (c + 3tL)/3(1 + \theta)$$

and

$$p^* = (2c + 3tL)/3 \ .$$

Note that p^* is independent of θ. This arises because $m^*(\theta)(1 + \theta)$ does not depend on the tariff rate. In this case

$$\ell(p^*, m^*(\theta)(1 + \theta)) = (3tL - c)/6t \ ,$$

so that the domestic firm will not obtain a positive market share if c exceeds $3tL$. Given these prices, foreign firms earn profits

$$(11) \quad \pi_F(p^*, m^*(\theta), \theta) = (c + 3tL)^2/9t(1 + \theta) \ ,$$

which we denote $\pi_F^*(\theta)$, and the domestic firm earns

$$\pi_D(p^*, m^*(\theta)(1 + \theta)) = (3tL - c)^2/9t - F \ ,$$

denoted π_D^*. Note that π_D^* is independent of θ.

If fixed costs of domestic production, F, exceed $(3tL - c)^2/9t$, then π_D^* is negative. But it can be shown that this restriction on F exactly ensures that $\bar{m}(\theta)$ exceeds $m^*(\theta)$. When fixed costs exceed this level, then, foreign firms will charge $\bar{m}(\theta)$, as this is the maximum price at which no domestic firm can enter profitably, and it exceeds $m^*(\theta)$. This is the non-cooperative price choice, given the entry decision rule of domestic firms (i.e., enter if $m > \bar{m}(\theta)$), and post-entry Nash price levels.

If F is less than $(3tL - c)^2 9t$, then π_D^* is positive (and $\bar{m}(\theta)$ is less than $m^*(\theta)$), and foreign firms must choose between charging $\bar{m}(\theta)$ and $m^*(\theta)$. This choice depends on the relative magnitudes of $\pi_F^*(\theta)$ and $\bar{\pi}_F(\theta)$, the profit which they obtain when they "limit price". Here $\bar{\pi}_F(\theta) = 2\bar{m}(\theta)L$. Given equations (9) and (11), $\bar{\pi}_F(\theta)$ will exceed $\pi_F^*(\theta)$ when

$$\frac{(9tL - c)^2(3tL - c)^2}{(36)^2 t^3 L^2} < F .$$

But $F < (3tL - c)^2/9t$, so $\bar{\pi}_F(\theta)$ is greater than $\pi_F^*(\theta)$ if

$$(9tL - c)^2 < 144t^2L^2 ,$$

which is violated when $c > 21tL$. Recall, however, that $\ell(p^*, m^*(\theta)(1 + \theta))$ is positive only if c is less than $3tL$, so we can rule out the case where $c > 21tL$ as economically unimportant. Since $\bar{\pi}_F(\theta)$ exceeds $\pi_F^*(\theta)$, foreign firms will maximize profits by charging $\bar{m}(\theta)$ rather than $m^*(\theta)$, independent of the tariff level, and so entry doesn't occur for any value of fixed costs. These conclusions do not depend on the level of the tariff. (This is an artifact of foreigners facing zero costs. If they incurred a positive marginal cost, then at a large enough tariff level it wouldn't be profitable for foreign firms to limit price, and so domestic entry would occur.)

Domestic consumers always purchase from foreign firms, at an f.o.b. price of

$$\bar{m}(\theta)(1 + \theta) = 2\sqrt{tF} + c - tL ,$$

which is also independent of θ. Then changes in tariffs affect neither consumer surplus nor domestic profits, which are zero. The only welfare effect of tariff rate changes is on tariff revenues, which are given by

$$T(\theta) = 2\bar{m}(\theta)\theta L$$

$$= 2L(2\sqrt{tF} + c - tL)\theta/(1 + \theta) \ .$$

Now $T(\theta)$ is an increasing function of θ, and so the optimal tariff is infinite. In this case

$$\lim_{\theta\to\infty} T(\theta) = 2L(2\sqrt{tF} + c - tL) \ .$$

As θ increases without bound, tariff revenues increase asymptotically to this level. Also, $\bar{m}(\theta)$ and so $\bar{\pi}_F(\theta)$ fall to zero as θ goes to infinity. In summary,

Proposition 3.1: If foreign firms face no production costs, and can choose prices either to prevent domestic entry or at Nash equilibrium levels given domestic production, they will choose to preclude entry. The optimal tariff is then infinite.

The optimality of an infinite tariff depends crucially on the assumption that foreigners incur no costs. If they faced positive marginal costs, the optimal tariff would be finite (at the level which just induced domestic entry) or zero, depending on the magnitude of fixed costs of domestic production. This model is not intended to yield optimal policy rules, but rather to point out, in conjunction with the model of section 2.1, that it is easy to construct examples in which increased tariffs can increase welfare if they induce either entry or import price changes in a spatial economy. Further, as is demonstrated in the next subsection, the conclusions of this model are also obtained in an economy with two sectors.

3.2 A Two-Sector Model

Consider again the model of section 2.2, in which there is a competitive agricultural sector, with domestic consumption $Z_c(\theta)$ and exports $Z_x(\theta)$. If foreign manufacturers adjust their prices in response to tariff changes, as in section 3.1, then no domestic manufacturing production is witnessed, at any tariff rate θ. If there is again a real resource constraint of Y, then

$$Z_c(\theta) = Y - Z_x(\theta) .$$

Trade balance dictates that the value of agricultural exports, $Z_x(\theta)$, equals the manufactured import bill, $2\bar{m}(\theta)L$. Then

$$Z_x(\theta) = 2L(2\sqrt{tF} + c - tL)/(1 + \theta) .$$

But then $Z_x(\theta)$ is a decreasing function of θ, and

$$\lim_{\theta\to\infty} Z_x(\theta) = 0 .$$

Thus $Z_c(\theta)$ increases with θ, and

$$\lim_{\theta\to\infty} Z_c(\theta) = Y.$$

Thus we have:

Proposition 3.2: If foreign production is costless, the optimal tariff is infinite, in the two-sector model with Nash price behavior.

As tariffs increase, consumers continue to purchase one unit of the manufactured good from foreign firms. They reduce their price, $\bar{m}(\theta)$, and so the total volume of agricultural exports necessary to maintain trade balance fails. Then more of the agricultural good is available for domestic consumption. Without this reaction by foreign firms, increased tariffs can only increase welfare in this two-sector model if domestic manufacturers incur lower production costs than foreigners, as was the case of the model of section 2.2.

4. SUMMARY

The models of this paper are open to several interpretations and extensions. First, they offer two possible explanations of intra-industry trade between countries. If two countries have different spatial distributions of consumers, then in the presence of scale economies, it may pay to produce domestically in regions where there is a relative intensity of tastes, say (or density of consumers in the location interpretation), and for consumers to purchase imports if they have comparatively esoteric tastes. Alternatively, there may be a distribution of production costs across locations. This explanation is more plausible in a locational model, where the costs may vary with proximity to productive resources.

These models may also explain why tariff increases lead to direct foreign investment. If there is a learning component in production, the lowest cost firm which will be encouraged to produce domestically may be precisely the foreign company whose sales the government is trying to curtail.

This sort of model seems most plausible in a putty-clay model of firm location, in which firms cannot move costlessly from one point to another. (In contrast, the models of Helpman, Krugman and Lancaster explicitly permit the free movement of firms in response to the opening of trade.) In particular, if there already exist firms in the industry (located spatially, and not at points of entry of imported goods), a tariff increase will only affect the market conditions of the firms located closest to the import points. Further, in this putty-clay model of location, any new firms which enter will only locate between these closest firms and the import points. Thus, in contrast to most models of spatial competition, which assume lines of infinite length or circular economies in order to avoid any end-point problems, in this model the behavior of firms at the endpoints is of paramount importance because the regions between the import points and the closest firm will be the only locations at which imports will be purchased. Further examination of models of this sort should be the subject of further research.

It should be noted that implicit in these models is a conception of the open economy as being essentially linear in that consumers are distributed along some line (as opposed to being on some surface). This seems reasonable in the Canadian case where the majority of the population lives along the American border (and where points of entry are geographically predetermined), although any serious empirical study of the Canadian economy would have to employ a model in which consumers are not distributed uniformly, and in which demand functions are more general.

Figure 1

The Impact of a Tariff when Import Prices are Exogenous

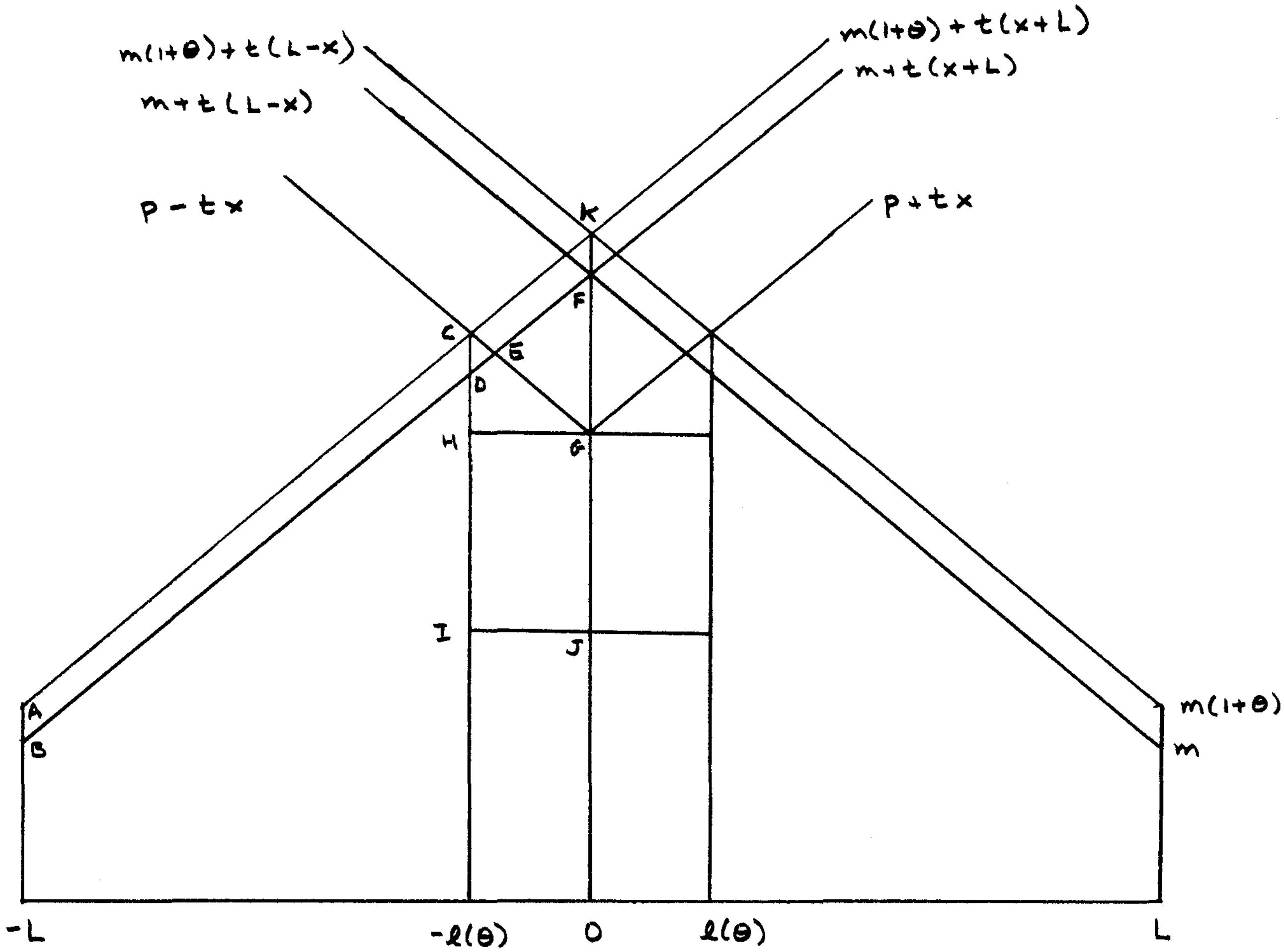
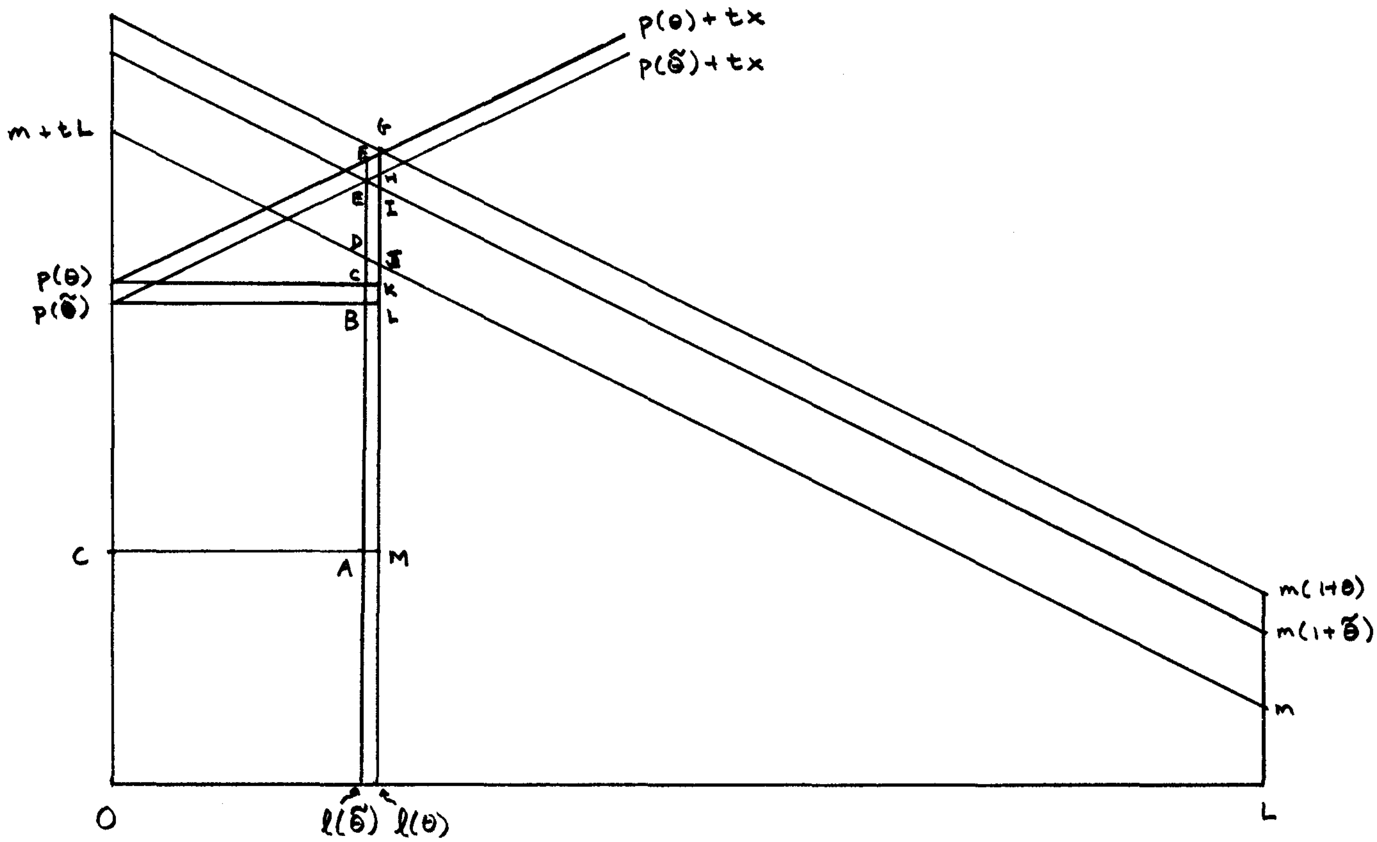


Figure 2

The Impact of an Increase in Tariff above $\tilde{\theta}$.



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