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A NEW APPROACH TO EVALUATING TRADE POLICY

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A NEW APPROACH TO EVALUATING TRADE POLICY

ABSTRACT

This paper introduces a new measure, the Trade Restrictiveness Index, which measures the restrictiveness of a system of trade protection. The index is a general equilibrium application of the distance function and answers the question: "What uniform set of trade restrictions is equivalent (in welfare terms) to the initial protective structure?" The index is applicable to both tariffs and quotas and allows international and intertemporal comparisons. The index is operational and we provide an empirical example to illustrate its applicability and to show its superiority over commonly used measures.

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I Introduction

How should we measure the welfare cost of trade protection? And how is this cost related to the level of tariffs or the restrictiveness of quotas? These two questions are distinct in the simplest case where a single good is subject to a tariff: the height of the tariff is an unambiguous concept and its welfare cost equals the "Harberger triangle," the area under the compensated import demand curve. However, in the realistic case where trade in many commodities is restricted, matters are not so clearcut. Even the concept of the "average tariff" is ambiguous: it is common to use import weights to calculate such an average, but this suffers from the problem that highly restricted imports which "should" get a high weight in the index have low levels of imports and so get a low weight. As for the measure of the cost of tariff protection, it is well known that with many goods subject to tariffs it is a complicated expression involving cross-derivatives of the import demand functions and that arbitrary tariff cuts may *reduce* welfare.[1]

There is, however, one case where the simplicity of the one-dimensional analysis is preserved no matter how many tariffs are in place: this is where tariff cuts are *uniform* or equiproportionate across all goods. In this paper, we propose a solution to the aggregation or index number problem for tariffs which builds on this insight. Essentially, it asks "What *uniform* tariff structure is equivalent (in a welfare sense) to a given tariff structure?"[2] The answer is a scalar measure of the overall protective

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[1] The expression in question is given in equation (2.3) below. See Neary (1989) for specific examples of welfare-reducing tariff cuts in well-behaved models.

[2] Corden (1966) is an early paper which considers the possibility of calculating the "uniform tariff equivalent" of a non-uniform tariff structure. Note that our analysis does not imply that uniform tariffs are

impact of an arbitrary tariff structure. Moreover, the proportionate rate of change of our index turns out to be equal to the standard measure of the cost of tariff protection, normalised by what we call the "shadow value of distorted trade." By contrast, most existing studies normalise the cost of protection by some other deflator, frequently the level of GNP. Our measure has the advantage of normalising in a manner which is intuitively appealing and which can be given a rigorous welfare interpretation. Its most important advantage is practical: since our measure is a uniform tariff equivalent index, it permits comparisons of the restrictiveness of trade policy across countries and across time periods.

A further advantage of our approach is that it can be extended to incorporate quantitative restrictions on trade as well as tariffs. Such restrictions are increasingly important in world trade but the theory of protection has been extended to take account of them only relatively recently.[3] From a theoretical point of view, our paper therefore serves to link this recent literature with the work on scalar "distance function" measures of efficiency in production or consumption by Debreu (1951), Deaton (1979), Diewert (1985) and Anderson and Neary (1990). From a practical point of view, we also argue that our measure can be made operational and in Sections VI and VII we illustrate its use with an application to measuring the restrictiveness of U.S. Voluntary Export Restraints on textile imports from Hong Kong.

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necessarily welfare superior to a non-uniform tariff structure with the same average tariff level. For contrasting views on the optimality of uniform tariff structures, see Fukushima and Hatta (1987) and Stern (1990); and also Lopez and Panagariya (1991).

[3] See Corden and Falvey (1985), Dixit (1987), Falvey (1988), Neary (1988, 1989) and Anderson and Neary (1992).

II The Trade Restrictiveness Index with Tariffs Only

In this section we begin by reviewing the standard theory of the cost of protection in an economy where tariffs are the only form of trade restriction. We then show how this can be related to our measure, the "Trade Restrictiveness Index" or TRI.[4]

We consider a competitive small open economy, producing tradeable goods only,[5] in which specific tariffs t_i drive a wedge between the domestic prices (π_i) and the world prices (π^*_i) of goods which are indexed by i. In vector notation, $\pi = \pi^* + t$.[6] The behaviour of the economy is most conveniently summarised in terms of the *trade expenditure function*, which equals the difference between the value of consumption (given by a standard expenditure function) and production (given by a GNP function):[7]

$$(2.1) \qquad E(\pi,u) \equiv e(\pi,u) - g(\pi).$$

Here u is the utility of the aggregate household sector (so that issues of distribution are ignored) and the economy's technology and factor endowments are subsumed in the g(.) function. The function E has the standard properties of an expenditure function: it is concave in π and, by Shephard's Lemma, its derivatives with respect to π are the economy's net (i.e., import) demand functions. We assume that all tariff revenue is redistributed costlessly to the household sector, so that in equilibrium the trade expenditure function must equal the sum of tariff revenue and the trade

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[4] In Anderson and Neary (1990), we used the term "coefficient of trade utilisation" to reflect the relationship between our index and the "coefficient of resource utilisation" of Debreu (1951).

[5] Non-traded goods can be subsumed into the background so long as their prices are determined competitively.

[6] We adopt the convention that π is the vector of all goods prices (or, from Section III onwards, of the prices of all goods not subject to quotas). The numeraire good can then be thought of as a good with a zero tariff; and if good i is exported then t_i is an export subsidy.

[7] The properties of these functions are set out in Dixit and Norman (1980).

surplus β, if any (assumed throughout to be exogenous):

$$E(\pi,u) = t'm + \beta. \tag{2.2}$$

Here a prime (′) denotes a transpose and m is the vector of import demand functions for imports subject to tariffs, equal to $E_\pi(\pi,u)$. Differentiating (2.2) leads to the standard result for the welfare effect of a small change in tariffs:

$$(1-t'x_I)E_u du = t'm_\pi dt. \tag{2.3}$$

The left-hand side is the change in utility, converted to numeraire units by the term E_u (the inverse of the marginal utility of income) and multiplied by $(1-t'x_I)$, which is the inverse of the "tariff multiplier" or "shadow price of foreign exchange."[8] Following standard convention, we shall assume that this term is positive. This leaves the right-hand side as the standard cost-of-tariff-protection measure. As is well-known, this depends on all the terms in the matrix of price derivatives of the import demand functions m_π (which equals $E_{\pi\pi}$) and it cannot be signed unambiguously in general. The one exception is the case of a uniform change in tariffs: $dt = td\alpha$, where $d\alpha$ is a positive or negative scalar. In this case we can call α the average level of tariffs and the welfare effect of a change in α equals $t'm_\pi t$, which is a scalar quadratic form in a negative definite matrix and so is negative.[9]

We now want to show how any tariff structure can be made equivalent (in welfare terms) to a proportionate tariff structure. To do so, it is convenient to switch from the vector of specific tariffs, t, to the vector of *tariff factors*, ϕ, which equal the proportional mark-ups over world prices: $\pi_i = \pi^*_i\phi_i$; or in matrix notation: $\pi = \Pi^*\phi$. (Π^* is a diagonal matrix with

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[8] See Neary (1988, 1989) for further discussion.

[9] The trade expenditure function is concave in prices and so the matrix of price derivatives must be negative semi-definite. Provided we assume that there is some substitutability between the numeraire good and the goods subject to tariffs, we can go further and assert that this matrix must be negative definite.

world prices on the principal diagonal.) For later use, the relationship between the levels of and changes in t and ϕ are as follows:

$$(2.4) \qquad t = \Pi^*(\phi - \iota) \qquad \text{and} \qquad dt = \Pi^* d\phi,$$

where "ι" denotes a vector of ones. Now, rewrite the equilibrium condition (2.2) in terms of ϕ, and define a new function, the *Balance of Trade Function*, as a measure of the extent to which the economy diverges from balanced trade equilibrium:

$$(2.5) \qquad B(\phi, u; \gamma) \equiv E(\Pi^*\phi, u) - (\phi - \iota)'\Pi^* m - \beta.$$

Here the parameter γ represents all the exogenous variables other than trade policy (such as the levels of factor endowments, world prices,the trade surplus β, tastes, etc.). We do not need to assume that these remain constant, although changes in them raise some specific issues in the presence of quotas, which we postpone until Section V.

We now wish to compare the restrictiveness of trade policy in two periods, denoted "0" and "1" respectively. The economy must be in equilibrium in both periods, so:

$$(2.6) \qquad B(\phi^0, u^0; \gamma^0) = B(\phi^1, u^1; \gamma^1) = 0.$$

We define the Trade Restrictiveness Index as the factor of proportionality Δ by which period-1 tariff factors must be scaled up or down in order to reach period-0 utility:[10]

$$(2.7) \qquad \Delta(\phi^1, u^0; \gamma^0) \equiv [\Delta : B(\Delta\phi^1, u^0; \gamma^0) = 0].$$

If trade policy does not change between the two periods ($\phi^0 = \phi^1$), Δ equals one. If free trade prevails in period 1, so that ϕ^1 is a vector of ones, Δ

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[10] Since this asks how the "new" tariff factors must be scaled to attain the "old" level of welfare, it is a compensating variation type of welfare measure. We assume that Δ is single-valued. This requires that the denominator of equation (2.9) (or, more generally, that of equation (4.10) in Section IV) does not change sign. We assume that this is the case throughout the theoretical discussion, and consider possible exceptions in the empirical application in Section VII.

equals (one plus) the uniform tariff rate which would have yielded the same level of welfare as the initial non-uniform vector of tariff factors ϕ^0. In other cases, Δ equals (one plus) the uniform tariff *surcharge* rate which compensates for the differentiated change in the tariff structure from ϕ^0 to ϕ^1. As the period-1 tariff factor vector ϕ^1 varies from ϕ^0 towards free trade, Δ rises above one. Thus a *rise* in Δ means that trade policy has become *less* restrictive.[11]

Figure 1, drawn in tariff factor space, illustrates the interpretation of Δ. Assuming that only two goods are subject to tariffs, point F, with coordinates (1,1), corresponds to free trade and point A is an arbitrary initial protected equilibrium. To compare these two points, we draw through A an iso-welfare locus, which represents those combinations of tariff factors on the two goods which yield the same level of welfare as A and also preserve balance of payments equilibrium.[12] The ray from the origin through F meets this locus at point C, and so the Trade Restrictiveness Index equals the ratio of OC to OF. Keeping A as the reference equilibrium, successive moves of the new equilibrium towards free trade lead to rises in Δ.

Both the interpretation and the potential applicability of the Trade Restrictiveness Index are enhanced by considering small changes in the period-1 tariff factor vector ϕ^1. Totally differentiating the equation which implicitly defines Δ in (2.7), holding u^0 and γ^0 constant, yields:

$$(2.8) \qquad B'_{\phi}\phi d\Delta \; + \; \Delta B'_{\phi}d\phi \;\; = \;\; 0.$$

This may be solved for the proportional change in Δ, denoted by $\hat{\Delta}$:

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11 This slight potential source of confusion could be avoided by the use of an equivalent variation measure $[\Delta : B(\Delta\phi^0,u^1;\gamma^1) = 0]$. However, this is not necessarily defined for all parameter values and, even when it is, it is not as easily implementable as (2.7), unless the analyst has access to a computable general equilibrium model.

12 The properties of this locus may be established by expanding the right-hand side of (2.3) and they are considered in detail in Neary (1989). It is shown there that, provided all goods are substitutes, the points of inflection of the locus, G and H, must lie to the north-east of F and must lie on either side of the 45-degree line OF.

$$(2.9) \qquad \hat{\Delta} = -\frac{B'_\phi d\phi}{B'_\phi \phi} = -\frac{t' m_\pi dt}{t' m_\pi \phi} = -\Sigma\, \sigma_i \hat{\phi}_i .$$

Each of these three alternative expressions throws light on the interpretation of changes in Δ. From (2.5), the term B_ϕ measures the transfers needed to compensate for an increase in tariffs. It equals:

$$(2.10) \qquad B_\phi = -\Pi^* m_\pi \Pi^* (\phi - \iota) = -\Pi^* m_\pi t .$$

The term $B'_\phi \phi$ in the denominator of (2.9) may therefore be interpreted as the total welfare cost of the initial tariff structure, which we call the "shadow value of distorted trade." The numerator is the cost of an arbitrary change in tariffs, as derived in (2.3). Thus the proportional change in Δ, for a small change from the initial equilibrium, equals the conventional measure of the cost of tariff protection, normalised by the shadow value of distorted trade. The final expression in (2.9) suggests how this might be operationalised: it equals a weighted average of the changes in tariff factors, where the weights, σ_i, are the contribution of each protected good to the total shadow value of distorted trade:

$$(2.11) \qquad \sigma_i = \frac{B_i \phi_i}{B'_\phi \phi} .$$

We will return to the issue of operationalising the Trade Restrictiveness Index in Section VI. First, we turn to consider quantitative trade restrictions.

III The Trade Restrictiveness Index with Quotas Only

When we turn to quantitative restrictions on trade, it is necessary to disaggregate the net import vector. Henceforward, we let q represent the permitted trade volumes in the quota-restricted product group, with foreign prices p^* and domestic prices p. For the unrestricted group, m is the trade volume and π is the domestic price vector, equal (until Section IV) to world prices π^*. Of course, the domestic prices p of the quota-constrained goods are not exogenous but must adjust to ensure that the quota levels (which we assume are always binding) equal domestic excess demands.

To derive the cost of protection in this case, it is convenient to consider an alternative expression for the trade expenditure function defined in (2.1):[13]

$$(3.1) \qquad E(p,\pi,u) \equiv \min_{q,m} \{p'q+\pi'm \mid U(q,m)=u\}.$$

Here U is a Meade trade utility function defined over the trade vector (q,m). This function is appropriate when prices (p,π) are given so that the trade vector is endogenous. When quotas are in force so that q is fixed, it is more convenient to characterise the aggregate consumer as choosing expenditure on the tariff-restricted product group only. This leads to the *distorted trade expenditure function*:

$$(3.2) \qquad \tilde{E}(q,\pi,u) \equiv \min_{m} \{\pi'm \mid U(q,m)=u\}.$$

The relationship between the two functions is straightforward:

$$(3.3) \qquad \tilde{E}(q,\pi,u) = \max_{p} \{E(p,\pi,u)-p'q\}.$$

Since E is concave in p, the first-order conditions from (3.3) give the prices which equate demand $E_p(p,\pi,u)$ with supply q. The first derivative properties of $\tilde{E}$ are therefore:

$$(3.4) \qquad \tilde{E}_\pi(q,\pi,u) = E_\pi[p(q,\pi,u),\pi,u] = \tilde{m}(q,\pi,u),$$

$$(3.5) \qquad \tilde{E}_q(q,\pi,u) = -p(q,\pi,u).$$

The first property follows from Shephard's Lemma: the price derivatives of the distorted trade expenditure function equal the import demand functions for the unconstrained goods (with the ˜ over the "m" indicating that these demands are conditional on given levels of the quotas rather than on given

[13] The results which follow draw on Anderson and Neary (1992) and are related to results in the theory of consumer rationing; see Neary and Roberts (1980).

levels of p). The second property, (3.5), equates the quantity derivatives of the distorted trade expenditure function to the economy's marginal willingness to pay for, or the "virtual prices" of, the quota-constrained goods. (See Neary and Roberts (1980).) $\tilde{E}$ is concave in π and convex in q, by its minimum in m and maximum in p properties. We assume, with only mild loss of generality , that the matrix of quantity derivatives of the virtual price functions p_q (equal to $\tilde{E}_{qq}$ or E_{pp}^{-1}) is negative definite.

Equilibrium is now easily described using the distorted trade expenditure function:

$$(3.6) \qquad \tilde{E}(q,\pi,u) + p'q \quad = \quad (p-p^*)'q \ + \ \beta.$$

The left-hand side equals net domestic expenditure on all goods (from the definition of $\tilde{E}$ in (3.2)); and in equilibrium this must equal the sum of total quota rents and the trade surplus, given by the right-hand side. (In the next section we will allow for the possibility that not all quota rents accrue to domestic residents.) Differentiating (3.6) yields a simple expression for the welfare cost of changes in quota levels:[14]

$$(3.7) \qquad \tilde{E}_u du \quad = \quad (p-p^*)'dq.$$

As before, it is desirable to obtain a scalar measure of the severity of an arbitrary system of quotas. To do this, we proceed as in the last section. We first define a balance of trade function, equal to the deviation of equation (3.6) from equilibrium:

$$(3.8) \qquad B(q,u;\gamma) \quad \equiv \quad \tilde{E}(q,\pi,u) + p'q - (p-p^*)'q - \beta.$$

The Trade Restrictiveness Index for quotas can now be defined as the proportionate change in period 1 quotas required to reach period 0 utility:

$$(3.9) \qquad \Delta(q^1,u^0;\gamma^0) \quad \equiv \quad [\Delta : B(q^1/\Delta,u^0;\gamma^0) = 0].$$

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[14] This result is derived and discussed in Corden and Falvey (1985) and Neary (1988).

This is illustrated in Figure 2, where point A represents an arbitrary initial equilibrium and point F a new equilibrium (which may, but need not be, identified with free trade). The value of Δ is the distance OF/OC, where point C lies on the same iso-utility locus as A.

Proportionate changes in Δ can once again be identified with the welfare effect of arbitrary quota changes normalised by the total welfare cost of the initial quota vector:

$$(3.10) \qquad \dot{\Delta} = \frac{B_q'dq}{B_q'q} = \frac{(p-p^*)'dq}{(p-p^*)'q} = \Sigma \sigma_j \hat{q}_j ,$$

where:

$$(3.11) \qquad B_q = p-p^* \qquad \text{and} \qquad \sigma_j = \frac{B_j q_j}{B_q'q}.$$

The interpretation is identical to that of equation (2.9), with the additional convenience that the denominator of (3.10), $(p-p^*)'q$, equals the actual value of total quota rents at the initial equilibrium. Once again, an increase in Δ, starting from the reference equilibrium u^0, implies that trade policy has become *less* restrictive.

IV The Trade Restrictiveness Index with Tariffs and Quotas

We now wish to consider the realistic case where trade is restricted by both tariffs and quotas. As before, q and m represent the trade volumes in the quota- and tariff-restricted groups, respectively.[15] In addition, we assume that a fraction ω of quota rents accrues to foreigners.[16] This is consistent with awarding the fraction ω of all quota licenses to foreigners,

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15 Some of the items in the q group may be subject to *both* tariffs and quotas. Such goods should be counted as falling in the quota-restricted group, since the quota constraints bind at the margin. The effect of the tariff is then to increase the share of rents on these goods which accrues to the domestic economy. For an illustration of this, see Section VII below.

16 We continue to assume that all tariff revenue $t'm$ is retained at home and accrues to the private sector, an assumption which can easily be relaxed.

or with voluntary esport restrictions (VER's) where foreigners return a fraction $(1-\omega)$ of the rents to domestic residents, or with a tariff on quota-controlled imports at the specific rate $(1-\omega)(p-p*)$.[17] For concreteness we will use the former convention. We will also assume that the rent share is uniform across commodities and that it is fixed by a process which is independent of q and t.[18] With these assumptions, the equilibrium condition therefore becomes:

$$(4.1) \qquad \tilde{E}(q,\pi,u) + p'q \quad = \quad t'm + (1-\omega)(p-p*)'q + \beta.$$

The right-hand side of this differs from that of (3.7) in two respects: consumers now receive tariff revenue as well as quota rents; and they receive only a fraction of the latter, with $\omega(p-p*)'q$ accruing to foreigners.

To derive the welfare effects of different policy changes, we now need to differentiate equation (4.1). To do so, it is convenient once again to introduce the balance of trade function, defined as the deviation of (4.1) from equilibrium, and with tariff factors ϕ replacing tariff levels t:

$$(4.2) \qquad B(q,\phi,u;\gamma) \quad \equiv \quad \tilde{E}(q,\Pi*\phi,u) + p'q - (\phi-\iota)'\Pi*m - (1-\omega)(p-p*)'q - \beta.$$

Differentiating this yields, after some simplifications (making use of the properties of the $\tilde{m}$ and p functions (3.4) and (3.5) given in Appendix A):

$$(4.3) \qquad B_u du \quad = \quad -B'_\phi d\phi - B'_q dq.$$

where:

$$(4.4) \qquad B_u \quad = \quad (1-t'\tilde{m}_I+\omega q'p_I)\tilde{E}_u,$$

$$(4.5) \qquad -B'_\phi \quad = \quad (t'\tilde{m}_\pi-\omega q'p_\pi)\Pi*,$$

$$(4.6) \qquad -B'_q \quad = \quad t'\tilde{m}_q-\omega q'p_q+(1-\omega)(p-p*)'.$$

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[17] Alternatively, this is the result of an *ad valorem* tariff set equal to $(1-\omega)$ times $(p-p*)/p$. In either case, the tariff must change when p changes if ω is to remain constant. We will assume here that this change occurs, so that quota reform does not alter the rent share. See Anderson and Neary (1992) for further discussion.

[18] Relaxation of these assumptions is discussed in Anderson and Neary (1992).

The term B_u equals the inverse of the marginal utility of income, $\tilde{E}_u$, multiplied by the shadow price of foreign exchange, which differs from unity to the extent that there are income effects on the demands for tariff- or quota-constrained goods. As always, we will assume that the distortions are not so severe as to render this term negative[19] and shall not consider it further. As for the coefficients $-B_\phi$ and $-B_q$, they measure the *marginal cost of tariffs* and the *shadow prices of quotas* respectively. Clearly, the simultaneous presence of tariffs and quotas complicates the expressions considerably relative to the special cases considered in Sections II and III. However, in principle they are still computable, an issue to which we will return in Section VI.

We are now ready to define the Trade Restrictiveness Index for this general case. We wish to have a single scalar measure of the severity of a given protective structure. To do this, it is necessary as in Section II to switch from specific tariffs to tariff factors. Moreover, it is convenient to go further and to work with the inverse of the tariff factors. This allows us to define "liberalisation factors" λ_i, which equal quota levels for quota-constrained goods and the inverse of tariff factors for tariff-constrained goods:

$$(4.7) \qquad \lambda_i \equiv \begin{cases} q_i & \text{for quota-constrained goods} \\ 1/\phi_i & \text{for tariff-constrained goods} \end{cases}$$

We may now define the full Trade Restrictiveness Index in terms of these liberalisation factors:

$$(4.8) \qquad \Delta(\lambda^1,u^0;\gamma^0) \equiv [\Delta : B(\lambda^1/\Delta,u^0;\gamma^0) = 0].$$

The value of Δ has the interpretation of the equal proportionate *tightening* of all quota levels and *raising* of all tariff factors which would be

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19 If they were, then there would be a welfare gain from disposing of some of the economy's factor endowment, and so the policy reform issue would be trivial.

equivalent in welfare terms to a given initial protective structure with any arbitrary pattern of quotas and tariffs. As before, a rise in Δ corresponds to a move towards a new equilibrium with trade policy λ^1 which is *less* restrictive relative to the initial equilibrium with trade policy λ^0. Differentiating the index gives the effects on the measure of a small change in trade policy relative to the initial equilibrium:

$$(4.9) \qquad \hat{\Delta} = \Sigma \sigma_i \hat{\lambda}_i,$$

or, writing out the weights in full for quotas and tariffs (the difference in sign between the two reflecting the fact that trade restrictiveness rises with *lower* quota levels but with *higher* tariff factors):[20]

$$(4.10) \qquad \hat{\Delta} = \sum \frac{B_j q_j}{B_q' q - B_\phi' \phi} \hat{q}_j - \sum \frac{B_i \phi_i}{B_q' q - B_\phi' \phi} \hat{\phi}_i .$$

Since all the terms in this expression can be calculated from (4.5) and (4.6), we have thus derived a scalar operational measure of the overall change in restrictiveness as a result of any change in trade policy. Once again, the denominator of the expression for $\hat{\Delta}$ is the shadow value of distorted trade, this time equal to the sum of each quota times its shadow price and each tariff factor times its marginal cost.

V Changes in the Restrictiveness of Quota Policy in the Presence of Growth

As already noted, our measure of trade restrictiveness does not require that exogenous variables other than trade policy (as summarised in the γ vector) remain constant.[21] However, if trade is restricted in part by quotas, we need to be careful in interpreting the phrase "change in trade policy" when other exogenous variables are also changing. For example, if

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[20] *Henceforward, wherever the context permits it without ambiguity, we use* subscripts "i" and "j" to refer to individual tariff factors and quotas respectively. Thus B_i gives the derivative of B with respect to ϕ_i, etc.

[21] It is straightforward to adapt our methods to develop a measure of the welfare effects of changes in γ, but this is not our concern.

real growth takes place in the economy, maintaining constant quota levels amounts to an *increased* restrictiveness of trade policy.[22] It is still possible to calculate Δ from equation (4.8), of course, but it must be interpreted as an *uncompensated* index, measuring the restrictiveness of trade policy relative to a benchmark equilibrium with fixed quotas. By contrast, for many purposes it may be more appropriate to calculate a *compensated* index, which corrects for changes in exogenous variables by taking an alternative benchmark equilibrium in which the domestic prices of the quota-constrained goods are kept constant. (These considerations are familiar to policy-makers, who frequently build in automatic adjustments to quotas in line with economic growth).

To formalise these ideas, we write $\tilde{q}^0$ for the vector of quotas which would compensate for a change in an exogenous variable in the sense of maintaining domestic prices p constant. This quota vector is implicitly defined by the following:

$$(5.1) \qquad p(\tilde{q}^0,\pi^0,\tilde{u}^0,\gamma^1) \quad = \quad p(q^0,\pi^0,u^0,\gamma^0),$$

where γ^0 is the initial value and γ^1 the new value of the exogenous variable, assumed henceforward to be a scalar. In equation (5.1), $\tilde{u}^0$ is the level of utility which would be attained in equilibrium if trade policy were to remain constant in this sense:

$$(5.2) \qquad B(\tilde{q}^0,\phi^0,\tilde{u}^0,\gamma^1) \quad = \quad 0.$$

We may now define the compensated TRI, $\tilde{\Delta}$, as the equiproportionate change in trade policy which would return the economy, not to the initial utility level u^0, but to the hypothetical "equirestrictive quota policy" level $\tilde{u}^0$:

$$(5.3) \qquad \tilde{\Delta} \quad \equiv \quad [\tilde{\Delta} : B(q^1/\tilde{\Delta},\tilde{\Delta}\phi^1,\tilde{u}^0,\gamma^1) \ = \ 0].$$

This is identical to the definition of the uncompensated TRI, (4.8), except

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[22] Growth may also alter the welfare cost of tariff protection, but we would not wish to say that it makes given tariffs *more* restrictive.

that it is evaluated at the compensated utility level $\tilde{u}^0$ rather than u^0 and at the new exogenous variables γ^1 rather than γ^0. Changes in $\tilde{\Delta}$ must then take account of changes in $\tilde{u}^0$ and γ^1 as well as of changes in trade policy:

$$(5.4) \qquad \hat{\tilde{\Delta}} = \hat{\Delta} + \frac{B_u u}{B_q' q - B_\phi' \phi} \hat{\tilde{u}}^0 + \frac{B_\gamma \gamma}{B_q' q - B_\phi' \phi} \hat{\gamma}^1,$$

where $\hat{\Delta}$ is simply $\Sigma \sigma_i \hat{\lambda}_i$, as in (4.9) (although evaluated at a different point).

A particularly simple form of (5.4) results if tastes are homothetic and growth is "balanced" in the sense that all sectors grow at the same rate at constant prices. We will refer to this combination of assumptions as "neutral growth"; note that $\hat{\gamma}$ can then be interpreted as the rate of growth. It can now be shown (details are given in Appendix B) that the balance of trade function is homogeneous of degree one in (q,u,γ):[23]

$$(5.5) \qquad B_q q + B_u u + B_\gamma \gamma = B.$$

This implies that the solution to (5.1) and (5.2) takes the particularly simple form:

$$(5.6) \qquad \tilde{u}^0 = \frac{\gamma^1}{\gamma^0} u^0 \quad \text{and} \quad \tilde{q}_j^0 = \frac{\gamma^1}{\gamma^0} q_j^0.$$

Hence it follows that:

$$(5.7) \qquad \hat{\tilde{u}}^0 = \hat{\tilde{q}}_j^0 = \hat{\gamma}.$$

In words, "compensating" for neutral growth requires that all quota levels, and the growth-compensated reference utility level itself, rise at exactly the rate of growth. Substituting from (5.5) and (5.7) into (5.4) yields finally:

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[23] It is convenient to assume henceforward that the trade balance β is initially zero. Alternatively, Appendix B implies that (5.8) also holds if β rises at the rate of economic growth.

$$(5.8) \qquad \hat{\tilde{\Delta}} = \hat{\Delta} - \frac{B_q q}{B_q' q - B_\phi' \phi} \hat{\gamma}^1 .$$

Thus, compensating for the increased restrictiveness of quotas as a result of growth at *given* quota levels requires that the standard TRI be reduced by the rate of growth times the contribution of quota restrictions to the shadow value of distorted trade. The reason why we must *subtract* a term in the growth rate of real income is that, if trade policy parameters are given, then growth renders the quota regime *more* restrictive.

VI Operationalising the Trade Restrictiveness Index

When we turn to consider how the TRI may be operationalised, we have a clear choice. On the one hand, the analyst may already have a fully-fledged computable general equilibrium (CGE) model of the economy, in which case the *level* of the TRI provides a convenient method of summarising the model's results, permitting consistent cross-country and intertemporal comparisons. On the other hand, the *change* in the TRI may be calculated without a CGE if a number of analytic short cuts are taken. In principle, the use of a CGE model is the ideal procedure. However, in practice, CGE models are typically based on a relatively small number of goods with inappropriate aggregation of the fine structure of trade restrictions. By contrast, the payoff to the local approximation approach is that we can devote more attention to the detailed commodity-by-commodity structure of protection.[24] In this section, we outline the simplifications which were made in our own application of the TRI to U.S.-Hong Kong trade in textiles, described in Section VII.

A. Separability Assumptions

The general theoretical framework has assumed that the analysis is to be

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[24] In spirit, our approach resembles the "local" general equilibrium analysis of Deardorff and Stern (1986).

carried out at the level of the economy as a whole. However, in many applications the analyst may be interested in only a few markets. In such circumstances it is natural to define a *partial* Trade Restrictiveness Index, defined over the trade policy instruments applicable to the markets of interest only. For example, if only quota-constrained markets are being considered, the partial index is, instead of (4.8):

$$(6.1) \qquad \Delta(\phi^0,q^1,u^0;\gamma^0) \quad \equiv \quad [\Delta : B(q^1/\Delta,\phi^0,u^0;\gamma^0) = 0].$$

In addition, it is very convenient in this case to assume that the goods to be considered are *separable* from others. In our Hong Kong applications, all the goods examined were subject to binding U.S. import quotas, so separability can be viewed as a restriction on the cross relationships between quota-constrained and other goods. This amounts to imposing a specific structure on the trade expenditure function:

$$(6.2) \qquad E(p,\pi,u) \quad = \quad \mathcal{E}\,[\mu(p,u),\psi(\pi,u),u].$$

The implications of this specification for the derivatives of the balance of trade function have been examined in Anderson and Neary (1992). In particular, the expression for the shadow price of quotas, equation (4.6), simplifies in this case to:

$$(6.3) \qquad -B_q' \quad = \quad -\bar{\tau}p' \quad - \quad \frac{\omega}{\varepsilon}\,p' \quad + \quad (1-\omega)(p-p^*)'.$$

Comparing this with (4.6), we see that separability has allowed us to simplify two complicated matrix expressions. The term $t'\tilde{m}_q$ (measuring the change in tariff revenue arising from a quota relaxation) is replaced by the much simpler term $-\bar{\tau}p'$, where $\bar{\tau}$ is the import-weighted average *ad valorem* tariff on the m goods; and the term $-\omega q'p_q$ (measuring the change in rents accruing to foreigners arising from the effect of a quota relaxation on home prices) is replaced by the term $-(\omega/\varepsilon)p'$, where ε is the aggregate elasticity of demand for quota-constrained goods.

B. Tariffs as a Rent-Sharing Mechanism

A key aspect of operationalising the TRI is obtaining estimates of the rent share parameter ω. Hong Kong exports of textiles and apparel to the U.S. are subject to binding VER's under the Multifibre Arrangement (MFA). However, not all of the rents accrue to Hong Kong exporters since the U.S. levies an *ad valorem* tariff of around 20%.[25] This implies that the rent share ω is not fixed but varies with q and also that it varies across commodities. Naturally, this alters the expression for the shadow price of quotas. To see how, we assume that international arbitrage equates U.S. import prices p to Hong Kong export prices p*, plus the price of a Hong Kong export license ρ, grossed up by the U.S. import tariff τ_q (which is the same for all goods):[26]

$$(6.4) \qquad p = (1+\tau_q)(p^* + \rho).$$

The rents accruing to the U.S. equal the total rents $(p-p^*)'q$ less Hong Kong license revenue $\rho'q$. Using (6.4) to simplify, this becomes:

$$(6.5) \qquad (p-p^*)'q - \rho'q = \frac{\tau_q}{1+\tau_q} p'q.$$

Substituting into the balance of trade function (4.2) and simplifying gives:

$$(6.6) \qquad B(q,\phi,u;\gamma) \equiv E(q,\Pi^*\phi,u) + \frac{1}{1+\tau_q} p'q - t'm - \beta.$$

Differentiating and simplifying yields, instead of (4.6), the following expression for the shadow price of quotas from the U.S. point of view:

$$(6.7) \qquad -B_q' = t'm_q' - \frac{1}{1+\tau_q} q'p_q + \frac{\tau_q}{1+\tau_q} p'.$$

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25 Since the quotas always bind, the goods are quota-constrained throughout and the tariff serves solely as a rent-sharing mechanism.

26 We follow other researchers in assuming that the license price is included in the FOB price and so is subject to the tariff. Estimates based on the alternative assumption, $p = (1+\tau_q)p^* + \rho$, are available on request.

Finally, imposing the separability restrictions discussed in Section VI.A gives the following simple expression:

$$(6.8) \qquad -(B_q^{US})' = -\bar{\tau}p' + \frac{1}{1+\tau_q}\left[\tau_q - \frac{1}{\varepsilon}\right]p'.$$

Since the U.S. tariff on Hong Kong exports of textiles and apparel (τ_q) of about 20% exceeds the U.S. average tariff ($\bar{\tau}$) of about 4%, the shadow price of quotas is positive for the U.S.

C. Market Power

In this application we assume plausibly that the U.S. is a small open economy: it faces constant marginal costs of Hong Kong textiles and apparel so p* is fixed in the relevant range of exports. However, the same cannot be assumed of Hong Kong, since it faces downward-sloping demand curves in the U.S. Strictly speaking, this should be taken into account in our theoretical derivation.[27] However, a simpler approach is to view the terms of trade loss to the U.S. of a quota change, measured in (6.8) by $-[1/\varepsilon(1+\tau_q)]p'$, as equalling the gain to Hong Kong. The other two terms in the expression for the shadow price of quotas are easily modified. Since Hong Kong does not impose tariffs on other goods, the term $\bar{\tau}$ is zero and the first term vanishes; and since Hong Kong exporters receive the full license price, the third term is simply ρ. The shadow price of quotas from Hong Kong's perspective is therefore:

$$(6.9) \qquad -(B_q^{HK})' = \frac{1}{1+\tau_q}\frac{1}{\varepsilon}p' + \rho'.$$

A final complication in the case where a country has monopoly power in trade is that the adjustment to quota policy to compensate for economic growth should be modified. As we saw in Section V, when tastes are homothetic and growth is balanced, a growth-compensated quota policy in a

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[27] See Neary (1989) and Anderson and Neary (1992), Section II.4, for further details.

small open economy is one whereby all quotas rise at the rate of growth. When prices are variable, we would expect the required changes in quota levels to be smaller in absolute value, since some of the welfare gain from growth is offset by a worsening of the terms of trade, necessitating a smaller growth in quotas to maintain the same level of trade restrictiveness. However, attempts to take account of this in the empirical application have so far proved unsuccessful, so we have simply imposed the value of minus one in the results reported below.

VII An Application: U.S. Textile Imports from Hong Kong

We turn finally to our empirical application, which calculates a partial index for the restrictiveness of U.S. quota policy on imports from Hong Kong under the MFA. Our sample consists of exports of twenty seven categories of textiles and apparel from Hong Kong to the U.S. over the six years 1983 to 1988. The choice of coverage was determined by the availability of data on Hong Kong export quota licence prices, ρ; for these we used data collected by Carl Hamilton supplemented by World Bank estimates. Data on export prices and quantities and U.S. tariffs in each category were extracted from the World Bank's MFA data base; and changes in real income for the two countries were measured by the growth rates in real disposable income.

Estimates of the price elasticity of U.S. demand for Hong Kong imports were not available. We assumed that imports from Hong Kong are perfect substitutes for other textile imports. This implies that the elasticity we require, ε, equals the elasticity of U.S. demand for all textile imports, $\bar{\varepsilon}$, divided by the Hong Kong import share. The latter fluctuated around .15 during the period considered; the exact values are given in Table 1. We present results for three values of $\bar{\varepsilon}$, -0.5, -1 and -2, with the unitary case being the literature's consensus.

The results are presented in Table 2. For each year and each value of $\bar{\varepsilon}$, we give the calculated changes in the uncompensated and compensated TRI's from the U.S. and Hong Kong points of view (using the formulae in equations (6.8) and (6.9)).[23] These are compared with the changes in the average tariff equivalent, calculated in the conventional manner as a trade-weighted average of the implicit tariffs, ρ_i. The levels of this measure are given in Table 1.

Consider first the results from the U.S. point of view. Our measure suggests that over the period there was a marked increase in the protectiveness of the trade regime. Although the uncompensated index rose slightly in all years except 1984, it did so by less than the growth rate of real income, so that the value of Δ fell in five of the six years, with a cumulative fall (representing an effective tightening of the quotas) of 14.9%. By contrast, the traditional measure, the average tariff equivalent, fluctuated widely over the same period, with an average annual rate of increase of about 6.3%. While this has the same qualitative implication (an increased restrictiveness of the quota regime) as our estimates of changes in the true measure, its variability from year to year is highly implausible. Moreover, in four out of six years, the average tariff equivalent has the opposite implication for the change in trade restrictiveness as our index. This dramatic finding, similar to that in Anderson (1991), reveals the serious practical inadequacy of the standard measure of trade restrictiveness. Note that our estimates are not at all sensitive to different assumptions about the elasticity of demand, $\bar{\epsilon}$. Although, from (6.9), all shadow prices rise as the elasticity falls, this tends to affect all categories uniformly in both the numerator and denominator of Δ and so does not significantly alter the estimated change in Δ.

Turning to the results from the Hong Kong point of view, they reveal

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[23] The formulae for Δ are for local changes whereas the data refer to discrete intervals. To allow for this, the changes given are Divisia indices, calculated using the arithmetic averages of the parameters in two successive periods.

further interesting properties of the TRI approach. The estimates are much more sensitive to the value of the elasticity than were those for the U.S. Moreover, in four years when $\bar{\varepsilon}$ is at its low value, most or all of the estimated quota shadow prices are negative, with the result that the shadow value of distorted trade, $-B_q'q$, is itself negative. This implies that a *fall* in Δ is welfare-improving; i.e., that in those cases Hong Kong's monopoly power in trade is so great that the actual quota levels are *above* their optimal values.[29] If we confine attention to the central case ($\bar{\varepsilon}$ = -1), Δ fell in five of the six years, implying that Hong Kong as well as the U.S. has been losing from the direction of policy. Once again, the implications of our measure are very different from those of the crude change in the average tariff equivalent.

VIII Conclusions and Suggestions for Further Research

In this paper, we have presented a new approach to measuring the restrictiveness of a protective structure. The measure we propose, the Trade Restrictiveness Index, has a firm welfare-theoretic basis yet can be implemented fairly readily. In the case of tariffs, the TRI equals the uniform tariff which is equivalent to (in the sense of yielding the same level of aggregate welfare as) a given tariff structure. We have shown how this approach can be extended to allow for quotas as well as tariffs and to encompass partial rent-sharing, which arises, for example, from voluntary export restraints. Implementing the TRI requires more data than calculation of standard measures of protection such as the trade-weighted average tariff equivalent. However, the latter is quite unsatisfactory as a summary measure of trade restrictiveness. Moreover, our empirical application in Section VII has shown that, with appropriate additional assumptions, the TRI

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[29] Trela and Whalley (1990) also find that a reversion to free trade hurts Hong Kong, because of its large terms of trade loss, although their results are not fully comparable with ours.

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can be readily implemented and that it yields very different conclusions from the standard approach.

In further work we hope to carry out more empirical applications of the TRI to demonstrate its usefulness in both international and intertemporal comparisons. Further theoretical refinement would also be desirable to improve the treatment of neutral quota policy in the presence of real income growth and to incorporate terms of trade changes. Finally, the TRI can in principle be extended to represent the uniform level of trade restrictiveness which would be welfare-equivalent to a given set of domestic as well as trade distortions. This would allow a quantitative assessment within a consistent welfare-theoretic framework of many of the issues concerning the trade effects of domestic policies which have been raised in negotiations on US-EC and US-Mexico trade.

APPENDIX A: DERIVATIVES OF THE IMPORT DEMAND AND DOMESTIC PRICE FUNCTIONS

Throughout the paper, we make extensive use of the derivatives of the *direct* demand functions for tariff-constrained imports, $\tilde{m}(q,\pi,u)$, and the *inverse* demand functions for quota-constrained imports, $p(q,\pi,u)$. These can be expressed in terms of the derivatives of *either* the distorted trade expenditure function $\tilde{E}(q,\pi,u)$ *or* the standard trade expenditure function $E(p,\pi,u)$. The former simply involves differentiating (3.4) and (3.5); while the latter involves differentiating the direct demand functions for both goods and inverting the total differential of $E_p=q$ to solve for dp. (See Neary and Roberts (1980) and Neary (1989) for further details and discussion.) Equating corresponding terms yields for the substitution effects:

$$\text{(A.1)} \qquad \begin{bmatrix} \tilde{m}_\pi & \tilde{m}_q \\ -p_\pi & -p_q \end{bmatrix} = \begin{bmatrix} \tilde{E}_{\pi\pi} & \tilde{E}_{\pi q} \\ \tilde{E}_{q\pi} & \tilde{E}_{qq} \end{bmatrix} = \begin{bmatrix} E_{\pi\pi}-E_{\pi p}E_{pp}^{-1}E_{p\pi} & E_{\pi p}E_{pp}^{-1} \\ E_{pp}^{-1}E_{p\pi} & E_{pp}^{-1} \end{bmatrix}$$

and for the income effects:

$$\text{(A.2)} \qquad \tilde{m}_I = \tilde{E}_{\pi u}\tilde{E}_u^{-1} = (E_{\pi u} - E_{\pi p}E_{pp}^{-1}E_{pu})E_u^{-1} = m_I - E_{\pi p}E_{pp}^{-1}q_I,$$

$$\text{(A.3)} \qquad p_I = -\tilde{E}_{qu}\tilde{E}_u^{-1} = -E_{pp}^{-1}E_{pu}E_u^{-1} = -E_{pp}^{-1}q_I.$$

Here, we have used m_I and q_I to denote the income derivatives of demand in the absense of quotas and $\tilde{m}_I$ to denote the income derivatives of demand for tariff-constrained goods in the presence of quota constraints.

APPENDIX B: NEUTRAL GROWTH AND THE BALANCE OF TRADE FUNCTION

If tastes are homothetic, the household expenditure function $e(p,\pi,u)$ may be written, without loss of generality, as $u\bar{e}(p,\pi)$. Similarly, if growth can be represented by a scalar parameter γ and if it is "balanced" (in the sense that all sectors grow at the same rate when prices are given), then the GNP function $g(p,\pi,\gamma)$ can be written, without loss of generality, as $\gamma\bar{g}(p,\pi)$. Combining these assumptions, the trade expenditure function in the absence of quota distortions becomes:

$$(B.1) \qquad E(p,\pi,u,\gamma) \equiv u\bar{e}(p,\pi) - \gamma\bar{g}(p,\pi).$$

This is clearly homogeneous of degree one in (u,γ).

The next step is to consider the distorted trade expenditure function:

$$(B.2) \qquad E(q,\pi,u,\gamma) = \underset{p}{\text{Max}} \{E(p,\pi,u,\gamma)-p'q\}.$$

This will be homogeneous of degree one in (q,u,γ) provided that the domestic price function $p(q,\pi,u,\gamma)$ is homogeneous of degree zero in (q,u,γ). But this must be the case, since the first-order condition from (B.2) is:

$$(B.3) \qquad q = u\bar{e}_p(p,\pi) - \gamma\bar{g}_p(p,\pi).$$

Since the left-hand side is homogeneous of degree one in q and the right-hand side is homogeneous of degree one in (u,γ), it follows that $p(q,\pi,u,\gamma)$, which is defined implicitly by (B.3), must be homogeneous of degree zero in (q,u,γ). Hence the distorted trade expenditure function $E(q,\pi,u,\gamma)$ must be homogeneous of degree one in (q,u,γ), as required.

Finally, we must ask what this impies for the balance of trade function:

$$(B.4) \qquad B(q,\pi,u,\gamma) \equiv E(q,\pi,u,\gamma) + p(q,\pi,u,\gamma)'q - (\pi-\pi^*)'m(q,\pi,u,\gamma) - (1-\omega)[p(q,\pi,u,\gamma)-p^*]'q - \beta.$$

From Shephard's Lemma, $m(q,\pi,u,\gamma)$ equals $E_\pi(q,\pi,u,\gamma)$ and so is homogeneous of degree one in (q,u,γ). It follows that each individual term on the right-hand side of (B.4), and hence the expression as a whole, is homogeneous of degree one in (q,u,γ,β).

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Year	Hong Kong Share of US Imports of Textiles and Apparel	Average Tariff Equivalent
1982	0.194	0.126
1983	0.200	0.309
1984	0.162	0.285
1985	0.143	0.192
1986	0.144	0.294
1987	0.131	0.332
1988	0.132	0.193

Table 1: Hong Kong Share in U.S. Imports and Average Tariff Equivalents of U.S. Voluntary Export Restraints, 1982-88

	U.S. Point of View			Hong Kong Point of View			% Change in Average Tariff Equivalent
	% Change in Uncompensated TRI	% Change in Real Income	% Change in Compensated TRI	% Change in Uncompensated TRI	% Change in Real Income	% Change in Compensated TRI	
psilon = -0.50							
1983*	1.8	0.9	-1.0	1.1	5.4	-1.3	34.4
1984*	-4.1	6.3	-10.3	-0.7	-10.8	-14.3	-3.1
1985*	1.9	3.1	-1.3	1.8	1.8	-0.0	-33.1
1986	6.8	2.3	3.7	0.0	0.8	-0.6	42.0
1987	1.1	0.9	-1.3	-0.1	12.7	-10.7	12.0
1988*	1.3	4.5	-0.7	-0.9	6.4	-7.3	-53.0
psilon = -1.00							
1983	1.8	0.9	-1.1	1.4	5.4	-3.0	34.4
1984	-4.1	6.3	-11.1	-5.4	10.8	-13.0	-3.1
1985	1.7	3.1	-1.5	0.0	1.8	1.4	-33.1
1986	6.8	2.3	0.8	[illegible]	0.8	[illegible]	42.0
1987	1.1	0.9	-1.3	[illegible]	12.7	-11.8	12.0
1988	1.3	4.5	-0.8	0.1	6.4	-6.5	-53.0
psilon = -2.00							
1983	3.0	0.9	-1.9	-1.7	5.4	-3.1	34.4
1984	-4.3	6.3	-11.1	[illegible]	-10.8	-15.1	-3.1
1985	1.8	3.1	-1.8	0.0	1.8	0.8	-33.1
1986	6.7	2.3	0.9	0.1	0.8	-0.8	42.0
1987	1.9	2.9	-2.0	1.1	12.7	-11.8	12.0
1988	1.1	4.5	-0.4	0.1	6.4	-6.1	-53.0

* Denotes a negative shadow value of distorted trade from Hong Kong point of view

Table 3: Changes in the Trade Restrictiveness Index:
Hong Kong and United States M.F.A. Shipments, 1983-88

Figure 1

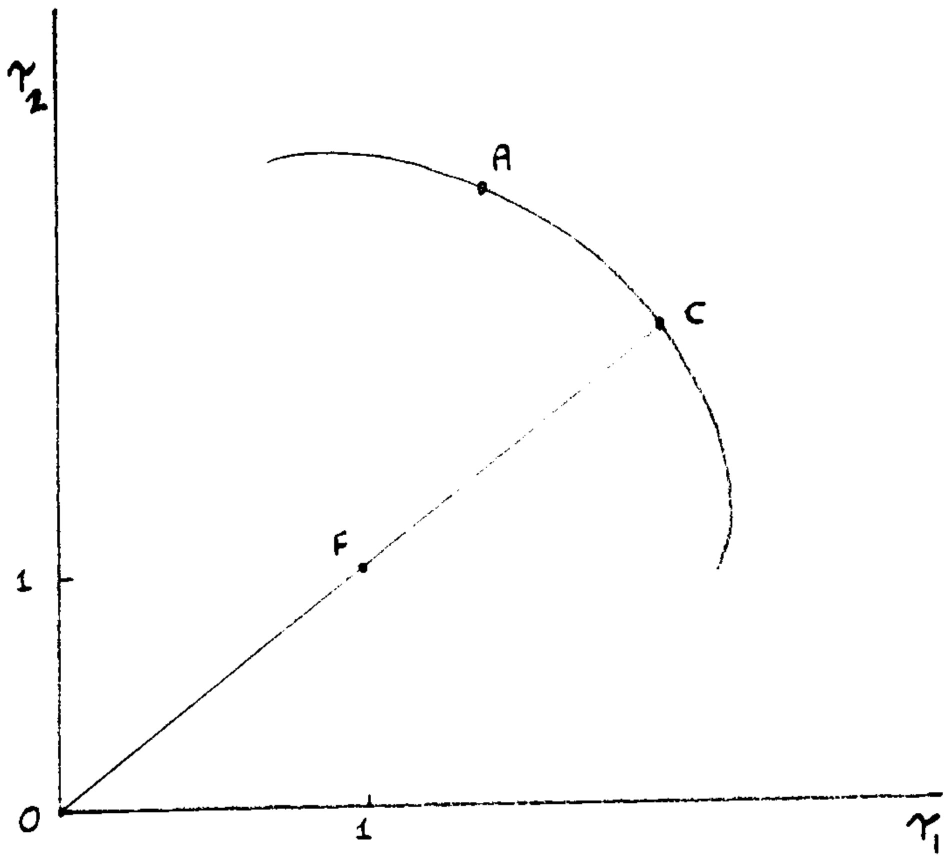

Figure 2