

The Review of Economic Studies Ltd.

A New Approach to Evaluating Trade Policy

Author(s): James E. Anderson and J. Peter Neary

Source: *The Review of Economic Studies*, Vol. 63, No. 1 (Jan., 1996), pp. 107-125

Published by: [The Review of Economic Studies Ltd.](#)

Stable URL: <http://www.jstor.org/stable/2298117>

Accessed: 29/11/2010 15:09

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/action/showPublisher?publisherCode=resl>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



The Review of Economic Studies Ltd. is collaborating with JSTOR to digitize, preserve and extend access to *The Review of Economic Studies*.

<http://www.jstor.org>

A New Approach to Evaluating Trade Policy

JAMES E. ANDERSON
Boston College

and

J. PETER NEARY
University College Dublin

First version received April 1993; final version accepted September 1995 (Eds.)

This paper introduces a new index number, 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 permits international and intertemporal comparisons. The index is operational and we provide two empirical examples to illustrate its applicability and to show its superiority to commonly used measures.

1. INTRODUCTION

How should we measure the restrictiveness of a country's trade policy? This important question arises repeatedly in international trade negotiations, in discussions of World Bank loan conditionality and in the new literature relating openness to growth. It is distinct from but related to the question: how should we measure the welfare cost of a country's trade policy? Both questions have simple answers in the case where a single good is subject to an import tariff: on the one hand, the restrictiveness of trade policy is trivially and unambiguously measured by the height of the tariff; on the other hand, the welfare cost of trade policy is measured by the Marshallian triangle, the area under the compensated import demand curve. (The questions are distinct, since the same tariff could produce a different welfare cost in two different economies if their elasticities of import demand differed; conversely, the same welfare cost could be produced by two different tariffs.)

With more than one tariff, matters become more complicated. The welfare cost measure is now a well-known matrix expression (generalized in equation (5) below) and an extensive literature has developed which explores its theoretical properties and the short-cuts needed to operationalize it.¹ In contrast, the literature contains no theoretically based measure of trade restrictiveness in the realistic case where trade in many commodities is restricted, analogous to the height of the tariff in the one-good case.² For want of a

1. See Corden (1984) and Dixit (1986) for overviews.

2. An exception is the work of Leamer (1988) and Edwards (1992). They start from the maintained hypothesis that trade patterns under free trade are fully explained by the Heckscher–Ohlin theorem. Hence, the residuals from Heckscher–Ohlin equations measure the restrictiveness of trade policy. While this approach is of theoretical interest, it suffers from the drawback that any misspecification of the model will affect the residuals and so appear as an effect of trade policy. Krishna (1991) and Pritchett (1991) review this and other methods of measuring openness and trade restrictiveness.

better alternative, analysts have usually calculated trade-weighted average tariffs or (in the case of quotas) average tariff equivalents. However, these measures have no welfare foundation. A symptom of this problem is that highly restricted imports which "should" get a high weight in the index are likely to have low levels of imports and so get a low weight. Hence there is currently no good answer to the aggregation or index number question of how to measure the restrictiveness of realistic trade policies. This paper aims to provide one.

The solution we propose is the *uniform* tariff which is equivalent (in a welfare sense) to a given protective structure.³ We call this scalar the *Trade Restrictiveness Index* or TRI. In Section 2 of the paper we derive the TRI, show that it has the desirable properties of an index number and that it is related to, but distinct from, the usual measure of the cost of protection. Moreover, we show that the proportionate rate of change of our index equals the standard measure of the cost of tariff protection, normalized by the marginal cost of a uniform proportional rise in protection. By contrast, most existing studies normalize the cost of protection by some other deflator, frequently the level of GDP. Our measure has the advantage of normalizing in a manner which is intuitively appealing and which can be given a rigorous welfare interpretation.

A further advantage of our approach is that it takes account of quantitative trade restrictions 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.⁴ From a theoretical point of view, our paper links this recent literature with the work on scalar "distance function" measures of efficiency by Debreu (1951), Deaton (1979), Diewert (1985) and Anderson and Neary (1990).

Turning from theory to application, since our measure is a uniform tariff equivalent index, it permits comparisons of the restrictiveness of trade policy across countries and across time periods. From a practical point of view, we show that our measure can be made operational and in Sections 3 and 4 we illustrate its use in two different contexts. The first of these is a partial equilibrium application to measuring the restrictiveness of Voluntary Export Restraints on U.S. imports of textiles and apparel from Hong Kong. The second constructs a fully-specified computable general equilibrium model which is applied to measure the change in restrictiveness of Colombian trade policy between 1989 and 1990. The results of both applications are dramatic. In almost all cases, our measure of trade restrictiveness has opposite implications to those of the commonly-used (and theoretically unfounded) measures.

2. THE THEORY OF THE TRADE RESTRICTIVENESS INDEX

In this section, we begin by reviewing the theory of the cost of protection when trade is restricted by both tariffs and quotas, drawing on and extending the results of Anderson and Neary (1992). We then show how this can be related to the TRI.

3. 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 necessarily welfare-superior to a non-uniform tariff structure with the same average tariff level. For contrasting views on the optimality of uniform tax and tariff structures, see Fukushima and Hatta (1989) and Stern (1990); and also Lopez and Panagariya (1992).

4. See Cordon and Falvey (1985), Dixit (1986), Falvey (1988), Neary (1988, 1995) and Anderson and Neary (1992).

2.1. *The trade expenditure function and the cost of protection*

We wish to derive a scalar index of trade policy restrictiveness for a competitive small open economy which imposes tariffs on some traded goods and quotas on others. Net imports of tariff-constrained goods are denoted by the vector m and their domestic and world prices by π and π^* , respectively, where $t = \pi - \pi^*$ is the tariff vector.⁵ For the quota-constrained goods, q is the vector of permitted trade volumes, p^* the world prices and p the endogenous domestic prices.⁶ Markets for non-traded goods are assumed to be undistorted, with their market-clearing prices denoted by h .⁷

A convenient way of summarizing the behaviour of this economy is by the *trade expenditure function*, which equals the excess of household expenditure (given by an expenditure function) over production (given by a GNP function):⁸

$$E(p, \pi, u, \gamma) \equiv \text{Max}_h [e(h, p, \pi, u, \gamma) - g(h, p, \pi, \gamma)]. \quad (1)$$

Here, u is the utility of the aggregate household sector (so that issues of distribution are ignored); γ is a vector of exogenous parameters (such as the levels of factor endowments, tastes, world prices, etc., all assumed constant until Section 2.4 below); and the economy's technology and factor endowments are subsumed in the GNP function. The first-order conditions from (1) imply that the markets for non-traded goods clear in the background. The function E has the standard properties of an expenditure function: it is concave in (p, π) and, by Shephard's Lemma, its price derivatives are the economy's net import demand functions: $E_p(p, \pi, u, \gamma) = q(p, \pi, u, \gamma)$ and $E_\pi(p, \pi, u, \gamma) = m(p, \pi, u, \gamma)$.

The trade expenditure function is the appropriate tool to use when tariffs are the only form of trade distortion, and it provides an essential benchmark which we use below. However, when the q -goods are subject to quotas, a slightly different approach is needed. Following Anderson and Neary (1992), this involves working with a related function, the *distorted trade expenditure function*, which equals net expenditure on the tariff-constrained goods conditional on the quota levels:

$$\tilde{E}(q, \pi, u, \gamma) \equiv \text{Max}_p [E(p, \pi, u, \gamma) - p'q]. \quad (2)$$

The function \tilde{E} is convex in q and concave in π . From Neary and Roberts (1980) its derivatives with respect to q give minus the domestic market-clearing prices, or "virtual prices", of the quota-constrained goods: $\tilde{E}_q(q, \pi, u, \gamma) = -p(q, \pi, u, \gamma)$; and, by Shephard's Lemma, its derivatives with respect to π give the net import demand functions for the tariff-constrained goods (conditional on the quota levels): $\tilde{E}_\pi(q, \pi, u, \gamma) = \tilde{m}(q, \pi, u, \gamma)$.

The distorted trade expenditure function summarizes the behaviour of the private sector and it only remains to specify public sector behaviour, which is purely redistributive. All tariff revenue is redistributed in a lump-sum manner to the aggregate household but a fraction ω_j of the quota rents on each good j is lost to the domestic economy. Total

5. We adopt the convention that "tariff-constrained goods" refer to all goods not subject to binding quotas. Hence our "tariffs" may include export taxes. Export and import subsidies are considered in Section 2.5.

6. Goods which are subject to both tariffs and quotas should be counted as falling in the q group, if the quota constraints bind at the margin. The only effect of such a tariff is to increase the share of quota rents on these goods which accrues to the domestic economy. For illustrations of this, see Sections 3 and 4 below.

7. The effects of distortions in markets for non-traded goods are considered by Anderson, Bannister and Neary (1995).

8. The properties of the expenditure and GNP functions are set out in Dixit and Norman (1980). The term "trade expenditure function" was introduced by Neary and Schweinberger (1986).

quota rents retained at home and redistributed to households therefore equal $(p - p^*)'(I - \hat{\omega})q$, where I is the identity matrix and a circumflex over a vector denotes the corresponding diagonal matrix (so $\hat{\omega}$ is a diagonal matrix with the rent-loss shares on the principal diagonal). In equilibrium, net expenditure on tariff-constrained goods (2) plus net expenditure on quota-constrained goods $p'q$ must equal retained quota rents plus tariff revenue $t'm$ plus the (exogenous) trade deficit β . We define a new function, the *distorted balance of trade function*, as the deviation from such an equilibrium:

$$\tilde{B}(q, \pi, u, \gamma) \equiv \tilde{E}(q, \pi, u, \gamma) + p'q - (p - p^*)'(I - \hat{\omega})q - t'm - \beta, \quad (3)$$

where β is subsumed into γ . Minus the derivatives of the \tilde{B} function with respect to the policy variables give the standard measures of the marginal cost of protection, which we call the *shadow prices of quotas* and the *marginal cost of tariffs* respectively:

$$-\tilde{B}'_q = (p - p^*)'(I - \hat{\omega} - \hat{q}\omega_q) - q'\hat{\omega}p_q + t'\tilde{m}_q, \quad (4)$$

$$-\tilde{B}'_\pi = -(p - p^*)'\hat{q}\omega_\pi - q'\hat{\omega}p_\pi + t'\tilde{m}_\pi. \quad (5)$$

These formulae generalize the results of Anderson and Neary (1992) to allow for rent-share parameters which differ across commodities and which are endogenously related to trade policy. (The matrices ω_q and ω_π denote the responsiveness of the rent-share parameters to changes in the trade policy instruments.) Examples of the form which such endogeneity might take are considered in Sections 3 and 4 below.

2.2. The Trade Restrictiveness Index

The problem of measuring trade restrictiveness can now be stated compactly: we wish to find a scalar index of the change in trade policy between two periods denoted "0" and "1", in each of which equilibrium prevails such that:

$$\tilde{B}(q^0, \pi^0, u^0, \gamma^0) = \tilde{B}(q^1, \pi^1, u^1, \gamma^1) = 0. \quad (6)$$

In order to motivate the TRI, it is helpful to begin by noting the analogy with the true cost-of-living index in consumer theory. This is usually defined as the scalar, ϕ , which equals the cost of attaining a reference utility level u^* at the new prices, $e(\pi^1, u^*)$, scaled by the cost of u^* at the old prices, $e(\pi^0, u^*)$:

$$\phi(\pi^1, \pi^0, u^*) \equiv e(\pi^1, u^*)/e(\pi^0, u^*). \quad (7)$$

Since the expenditure function $e(\pi, u)$ is homogeneous of degree one in π , we can divide both sides of (7) by ϕ to rewrite it in a less conventional way:

$$\phi(\pi^1, \pi^0, u^*) \equiv [\phi: e(\pi^1/\phi, u^*) = e(\pi^0, u^*)]. \quad (8)$$

This allows a distance function interpretation: the true cost-of-living index gives the uniform deflator which must be applied to the new prices to allow the consumer to attain the reference level of utility at the same cost as at the old prices. In the same way, we may define a true index of trade restrictiveness as the uniform deflator which must be applied to the new trade policy instruments to allow the economy to attain the reference level of utility with the same balance of trade surplus or deficit as at the old instruments.⁹ In practice, it is convenient to take u^0 as the reference level of utility, since from (6) the trade expenditure function evaluated at u^0 and the initial instruments is zero.

9. Because of the presence of trade restrictions, the balance of trade function is not homogeneous of degree one in prices, and so there is no step which is analogous to (7) in the general equilibrium derivation.

A problem with this approach is that it makes little sense to apply a uniform deflator to all the trade policy instruments, since they comprise quantities for quota-constrained goods and prices for tariff-constrained goods. To allow us to work with prices for both classes of goods, we define the *undistorted balance of trade function*:

$$B(p, \pi, u, \gamma) \equiv E(p, \pi, u, \gamma) - (p - p^*)(I - \hat{\omega})q - t'm - \beta. \quad (9)$$

The comparison between the two equilibria which was characterized in terms of the distorted balance of trade function in (6), can now be alternatively characterized in terms of the undistorted function (9) by noting that the two will coincide when the domestic prices for quota-constrained goods equal their virtual prices, evaluated at the old utility level and at the new policy instruments:

$$\tilde{B}(q^1, \pi^1, u^0, \gamma^0) = B(\tilde{p}, \pi^1, u^0, \gamma^0) \quad \text{when} \quad \tilde{p} \equiv -\tilde{E}_q(q^1, \pi^1, u^0, \gamma^0). \quad (10)$$

We can now define the TRI as the factor of proportionality Δ by which period-1 prices (actual prices for tariff-constrained goods and virtual prices for quota-constrained goods) must be deflated to ensure that equilibrium prevails when utility is at its period-0 level:

$$\Delta(q^1, \pi^1, u^0, \gamma^0) \equiv [\Delta: B(\tilde{p}/\Delta, \pi^1/\Delta, u^0, \gamma^0) = 0]. \quad (11)$$

Since Δ deflates period-1 prices to attain period-0 utility, it is a compensating variation type of measure, an increase in Δ corresponding to an increase in trade restrictiveness.

The fact that the TRI uses utility as benchmark suggests that it is related to the standard measure of the cost of protection. Indeed, the TRI bears the same relation to the welfare cost of protection as the true cost-of-living index bears to the true measure of welfare change in consumer theory. To see the relationship between the TRI and the compensating variation measure of the cost of protection, recall that the latter may be defined in this model as:

$$C(q^1, \pi^1, q^0, \pi^0, u^0, \gamma^0) = \tilde{B}(q^0, \pi^0, u^0, \gamma^0) - \tilde{B}(q^1, \pi^1, u^0, \gamma^0). \quad (12)$$

Using (6), (10) and (11), this may be rewritten as follows:

$$C(q^1, \pi^1, q^0, \pi^0, u^0, \gamma^0) = B(\tilde{p}/\Delta, \pi^1/\Delta, u^0, \gamma^0) - B(\tilde{p}, \pi^1, u^0, \gamma^0), \quad (13)$$

$$= \int_1^{1/\Delta} B_{1/\delta}(\tilde{p}/\delta, \pi^1/\delta, u^0, \gamma^0) d\left(\frac{1}{\delta}\right). \quad (14)$$

Compare this with the standard formula (in our notation) for the cost of protection in the presence of a single tariff:

$$C(\pi^1, \pi^0, u^0, \gamma^0) = B(\pi^0, u^0, \gamma^0) - B(\pi^1, u^0, \gamma^0) = \int_{\pi^1}^{\pi^0} B_\pi(\pi, u^0, \gamma^0) d\pi. \quad (15)$$

Thus we have expressed the cost of protection with many distortions as an integral over the scalar TRI inverse in exactly the same way as the cost of protection with a single tariff equals an integral over the price of the tariff-restricted good. This shows that the TRI is indeed a correct measure of the average height of trade restrictions.

2.3. Interpretation of the Trade Restrictiveness Index

If trade policy does not change between the two periods ($q^0 = q^1$, $\pi^0 = \pi^1$), Δ equals one. If free trade prevails in period 1, π^1 equals π^* and \tilde{p} can be replaced by p^* . In that case,

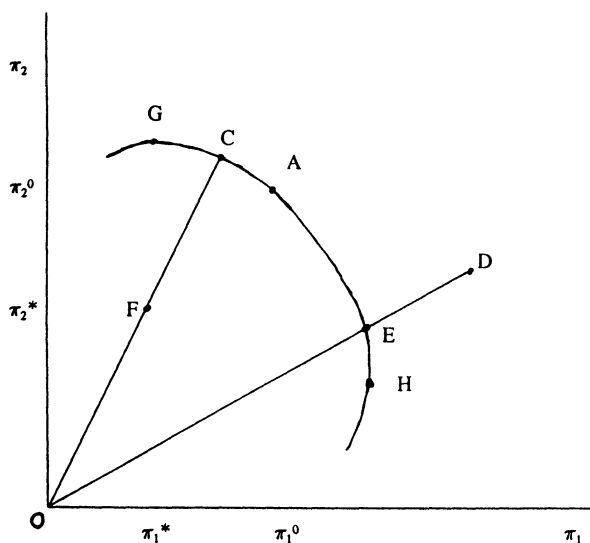


FIGURE 1

The Trade Restrictiveness Index with tariffs

Δ equals the inverse of the uniform tariff factor (i.e., one plus the uniform *ad valorem* tariff rate) which would have yielded the same level of welfare as the initial policy instruments. Generally, Δ equals the inverse of the uniform tariff surcharge factor (i.e., one plus the uniform change in domestic prices) which would compensate for the change in trade policy from (q^0, π^0) to (q^1, π^1) . For a given initial equilibrium, characterized by (q^0, π^0, u^0) , a change in the period-1 instruments (q^1, π^1) towards free trade causes Δ to fall below one (and, conversely, a move away from free trade causes Δ to rise above one). Thus a *rise* in Δ means that trade policy has become *more* restrictive.

Figure 1, drawn in price space for the case where there are no quotas and only two goods are subject to tariffs, illustrates the interpretation of Δ . Point A, with coordinates (π_1^0, π_2^0) , is the initial protected equilibrium. Through this point is drawn an iso-welfare locus, representing those combinations of prices of the two goods which yield the same level of welfare as A and also preserve balance of payments equilibrium.¹⁰ Consider first the comparison with free trade, represented by F (with coordinates (π_1^*, π_2^*)). The ray from the origin through F meets the iso-welfare locus through A at point C. Thus, OC/OF is the uniform tariff factor (one plus the uniform tariff rate) which would compensate for the abolition of the initial tariffs (the move from A to F). Following our convention, the value of the TRI is therefore the ratio of OF to OC.

Keeping A as the reference equilibrium, consider next the comparison with an arbitrary protected equilibrium, represented by point D. To compensate for the policy change from A to D requires an equi-proportionate reduction in domestic prices along the ray OD towards point E. Tariffs are not uniform along this ray (since it does not pass through the free-trade point F) so we describe this move as the imposition of a uniform tariff factor surcharge equal to the ratio of OE to OD. Our convention therefore implies that

10. The properties of this locus may be established by expanding the right-hand side of (5) and they are considered in detail in Neary (1995). 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 ray OF.

the value of the TRI for this case is the ratio of OD to OE, which is clearly a welfare-consistent measure of the restrictiveness of trade policy at D relative to A.

Both the interpretation and the potential applicability of the TRI are enhanced by considering small changes in the period-1 instruments (q^1, π^1). Totally differentiating the equation which implicitly defines Δ in (11), holding u^0 and γ^0 constant, yields:

$$\Delta B'_p d\tilde{p} + \Delta B'_\pi d\pi - (B'_p p + B'_\pi \pi) d\Delta = 0, \quad (16)$$

where:

$$d\tilde{p} = \tilde{p}_q dq + \tilde{p}_\pi d\pi. \quad (17)$$

This can be simplified by using (10) to relate the derivatives of the distorted and undistorted trade expenditure functions:

$$\tilde{B}'_q = B'_p \tilde{p}_q \quad \text{and} \quad \tilde{B}'_\pi = B'_p \tilde{p}_\pi + B'_\pi. \quad (18)$$

Substituting from these into (16), the proportional change in Δ may be written as:

$$\hat{\Delta} = \frac{\tilde{B}'_q dq + \tilde{B}'_\pi d\pi}{B'_p p + B'_\pi \pi}. \quad (19)$$

This equates the change in the TRI to a weighted sum of changes in quota levels plus a weighted “average” of changes in prices of tariff-constrained goods. (Not all weights need be positive but the latter weights sum to unity since, from (18), $\tilde{B}'_\pi \pi = B'_p p + B'_\pi \pi$.)

In order to interpret (19), it is again helpful to draw the analogy with the true cost-of-living index ϕ , defined in (7). As a result of an arbitrary price change $d\pi$, the proportional change in ϕ equals $e'_\pi d\pi / e'_\pi \pi$. This gives the change in expenditure required to support the initial utility level following the actual price change ($e'_\pi d\pi$), deflated by $e'_\pi \pi$, the additional expenditure needed to support the initial utility level following a uniform 1% rise in all prices. Similarly, the right-hand side of (19) gives the change in foreign exchange required to support the initial utility level following a change in trade policy ($\tilde{B}'_q dq + \tilde{B}'_\pi d\pi$), deflated by $B'_p p + B'_\pi \pi$, the additional foreign exchange needed to support the initial utility level when all domestic prices of quota- and tariff-constrained goods rise by 1%. Thus the proportional change in Δ , for a small perturbation of the new equilibrium, equals the conventional measure of the cost of an arbitrary change in protection, normalized by the marginal cost of a uniform change in protection.

Finally, the case of constant quotas provides another interpretation of the change in Δ : it equals a weighted average of the changes in prices of tariff-constrained goods, where the weights, $\tilde{B}'_i \pi_i / (B'_p p + B'_\pi \pi)$, equal the shares of each good in the cost of a uniform increase in trade restrictiveness. This may be compared with the conventional *ad hoc* measures of changes in tariff restrictiveness, which are averages of tariff changes weighted by the shares of each good in trade ($E_i \pi_i / E'_\pi \pi$) or in domestic production ($g_i \pi_i / g'_\pi \pi$). Thus the superiority of the TRI lies in the fact that it uses appropriate marginal shares rather than average shares as weights.

2.4. Changes in the restrictiveness of quota policy in the presence of growth

As equation (11) shows, the TRI is evaluated at γ^0 , the initial values of exogenous variables other than trade policy, since otherwise some of the effects of changes in γ would be attributed to changes in trade policy. However, in the presence of quotas, we need to be careful in interpreting the phrase “changes in trade policy” when other exogenous variables

are also changing. For example, if real growth takes place in the economy, constant quota levels imply an increased restrictiveness of trade policy.¹¹ It is still possible to calculate Δ from equation (11), 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 formalize these ideas, we define the *compensated* TRI, Δ^c , as the equiproportionate change in trade policy which would return the economy, not to the initial utility level u^0 , but to the hypothetical “equi-restrictive quota policy” level u^c :

$$\Delta^c(q^1, \pi^1, u^c, \gamma^1) \equiv [\Delta^c: B(\tilde{p}/\Delta^c, \pi^1/\Delta^c, u^c, \gamma^1) = 0]. \quad (20)$$

Equation (20) is identical to the definition of the uncompensated TRI, (11), except that it is evaluated at the compensated utility level u^c rather than at u^0 and at the new exogenous variables γ^1 rather than the old γ^0 . In turn, u^c is defined as the level of utility which would be attained in equilibrium if trade policy were to remain “constant” in the sense of preserving (by adjustments in q) the initial prices p^0 following growth:¹²

$$B(p^0, \pi^0, u^c, \gamma^1) = 0. \quad (21)$$

Assuming a scalar γ for convenience and linearizing (20) around the initial equilibrium, changes in Δ^c reflect changes in u^c and γ^1 as well as changes in trade policy:

$$\hat{\Delta}^c = \hat{\Delta} + \frac{\tilde{B}_u u^c}{B'_p p + B'_\pi \pi} \hat{u}^c + \frac{\tilde{B}_\gamma \gamma^1}{B'_p p + B'_\pi \pi} \hat{\gamma}^1, \quad (22)$$

where the change in Δ is exactly as in (19).

Equations (20) and (22) can be calculated in any particular case given assumptions about the nature of growth. One simple set of assumptions is that of “neutral growth”: homothetic tastes plus “balanced” technical progress, in the sense that all sectors would grow at the same rate if prices were constant. It is shown in the Appendix that under these assumptions equation (22) becomes:

$$\hat{\Delta}^c = \hat{\Delta} - \frac{\tilde{B}'_q q}{B'_p p + B'_\pi \pi} \hat{\gamma}^1. \quad (23)$$

Comparing this with (19), the coefficient of the change in γ^1 is equal and opposite in sign to the coefficient relating the change in Δ to a uniform relaxation in quotas. Thus, compensating for the increased restrictiveness of quotas as a result of growth at *given* quota levels requires that the change in the uncompensated TRI be adjusted “as if” all quotas had been reduced by the rate of growth. Since the coefficient of the change in γ^1 in (23) is presumptively positive, the compensation takes the form of *adding* a term in the growth rate of real income. The reason is that, if trade policy parameters are given, then growth renders the quota regime *more* restrictive.

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

12. It is not necessary to make explicit the hypothetical compensating quota vector itself, q^c , which is defined by the following: $p(q^c, \pi^0, u^c, \gamma^1) = p(q^0, \pi^0, u^0, \gamma^0)$.

2.5. *Alternative indices*

The approach we have proposed starts from a vector of *independent variables*, the trade policy instruments q and π ; it fixes as a *reference point* the level of utility u ; and it uses a variant of the distance function to map into a scalar *aggregate*, the TRI. Different choices of independent variables, reference points or aggregates lead to a whole family of indices. In this section we briefly consider some other members of this family.

Consider first alternative *independent variables*. One important category is *trade subsidies*, including import and export subsidies and binding *minimum* export quotas (known as “export performance requirements”: see Rodrik (1987)). Such subsidies may be incorporated straightforwardly into the model we have used so far. However, the TRI itself does not take account of them: it would not be appropriate to combine subsidies and restrictions symmetrically in an index of trade restrictiveness. Instead, we may construct a *Trade Subsidization Index*. Suppose, for simplicity, that there are no quantitative restrictions and let p_R and p_S denote the prices of goods subject to trade restrictions and trade subsidies respectively. Then the Trade Subsidization Index is defined by:

$$\Delta^S(p_R^1, p_S^1, u^0, \gamma^0) \equiv [\Delta^S: B(p_R^1, \Delta^S p_S^1, u^0, \gamma^0) = 0]. \quad (24)$$

Thus, Δ^S gives the uniform subsidy factor which compensates for a given structure of subsidies.

A different set of independent variables which may be of interest are *domestic* taxes and subsidies. In Anderson, Bannister and Neary (1995), we show how the TRI can be extended to measure the uniform tariff which would compensate for a given set of *domestic* as well as trade distortions. This allows a quantitative assessment within a consistent welfare-theoretic framework of the trade effects of domestic policies, an issue much discussed in recent negotiations on U.S.–EC and U.S.–Mexico trade.

Consider next alternative *reference points*. We have taken welfare as our reference point throughout since this seems the natural criterion to economists. But policy-makers and trade negotiators may be more concerned with some other reference point, such as employment, output or imports in a particular category. Consider, for example, the reference point of a constant value (at world prices) of distorted imports. For this reference point (ignoring quotas) we can define a “Mercantilist” TRI:

$$\Delta^m(\pi^1, M^0, \gamma^0) \equiv [\Delta^m: \pi^* E_\pi(\pi^1 / \Delta^m, u^m, \gamma^0) = M^0], \quad (25)$$

where u^m is the level of utility which ensures that the M^0 constraint is consistent with general equilibrium at the adjusted prices π^1 / Δ^m . It is defined implicitly by:

$$E(\pi^1 / \Delta^m, u^m, \gamma^0) = (\pi^1 / \Delta^m - \pi^*)' E_\pi(\pi^1 / \Delta^m, u^m, \gamma^0) + \beta. \quad (26)$$

An index along these lines was proposed by Leamer (1974). Clearly, all the techniques of this paper can now be applied to Δ^m .

Finally, we may consider alternative *aggregates* to the uniform equivalent tariff. One obvious candidate is to calculate the uniform equivalent *quota* which yields the same level of utility as a given vector of trade policy instruments. This leads to a quantity index in the tradition of the distance function measures of Debreu (1951), Deaton (1979) and Diewert (1985). If we wish to aggregate over both price and quantity instruments, such an index is the dual of the TRI and is of more theoretical than practical interest. However, it is the natural index to use when we wish to aggregate over quotas only. This was the focus of our earlier work (Anderson and Neary (1990) and Anderson (1991)), where we

called this index the Coefficient of Trade Utilization, paralleling Debreu's coefficient of resource utilization. The index may be defined as follows:

$$\Delta^q(q^1, \pi^0, u^0, \gamma^0) \equiv [\Delta^q: \tilde{B}(\Delta^q q^1, \pi^0, u^0, \gamma^0) = 0], \quad (27)$$

and in the next section we present a case study of how it is calculated and interpreted.

3. OPERATIONALIZING THE TRI: COMPUTING LOCAL CHANGES IN PARTIAL EQUILIBRIUM

When we turn to consider how the TRI may be operationalized, we have a clear choice. On the one hand, we may already have access to a fully-fledged computable general equilibrium (CGE) model of the economy, in which case the level of the TRI provides a convenient method of summarizing the model's results, permitting consistent cross-country and intertemporal comparisons. Section 4 presents an application along these lines. On the other hand, if a CGE model is unavailable, the change in the TRI may still be calculated provided a number of analytic short cuts are taken. The most useful short cut is to calculate linear approximations such as (19) to the change in the TRI. For the quantity version of the TRI, (27), the change in the index may be written as a weighted average of the quota changes:

$$\hat{\Delta}^q = \sum \sigma_j \hat{q}_j \quad \text{where} \quad \sigma_j \equiv \frac{B_j q_j}{B'_q q}. \quad (28)$$

To operationalize this, we need to estimate the B_j terms which are defined in (4). In the remainder of this section, we outline how we did this in order to apply the TRI to measuring the restrictiveness of U.S. quotas on textile imports from Hong Kong.

3.1. *Tariffs as a rent-sharing mechanism*

A key aspect of operationalizing the TRI is the choice of assumptions about the disbursement of quota rents, i.e., about how the ω parameters in (3) are determined.¹³ Fortunately, in the present case study, there are institutional features which allow us to specify exactly how the rent share is determined. On the one hand, Hong Kong exports of textiles and apparel to the U.S. are subject to binding export quotas or "Voluntary Export Restraints" (VER's) under the Multi-Fibre Arrangement (MFA). On the other hand, not all of the rents accrue to Hong Kong exporters since the U.S. levies *ad valorem* tariffs on such imports.¹⁴ This implies that the share of rents accruing to the U.S. varies both with q and across commodities within the quota-constrained group.

To see how these assumptions alter the expression for the shadow price of quotas (4), we assume that, for any individual quota-constrained import, indexed by j , international arbitrage equates the U.S. import price p_j to the Hong Kong export price p_j^* , plus the price of a Hong Kong export license ρ_j , grossed up by the *ad valorem* U.S. tariff rate τ_j :¹⁵

$$p_j = (1 + \tau_j)(p_j^* + \rho_j). \quad (29)$$

13. While we endogenize the determination of the ω parameters, we assume that they are set deterministically rather than as the outcome of a bargaining process. For different approaches to modelling bargaining, see Anderson and Neary (1992, Section 2.5) and Krishna, Erzan and Tan (1994).

14. Since the quotas always bind, the goods are quota-constrained throughout and so these tariffs (unlike t) serve solely as a rent-sharing mechanism.

15. 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, $p_j = (1 + \tau_j)p_j^* + \rho_j$, are available on request.

The effect of U.S. tariff policy is thus to divide up the total rent per unit import, $p_j - p_j^*$ such that only the license price ρ_j accrues to Hong Kong and the balance, $p_j - p_j^* - \rho_j$, accrues to the U.S. Summing over all the quota-constrained goods, the rents accruing to the U.S. equal the total rents $(p - p^*)'q$ less Hong Kong license revenue $\rho'q$. Using (29) to simplify and substituting into the distorted balance of trade function (3):¹⁶

$$[\tilde{B}(q, \pi, u, \gamma)]_{US} \equiv \tilde{E}(q, \pi, u, \gamma) + p'(I + \hat{\tau})^{-1}q - t'm - \beta. \quad (30)$$

Differentiating with respect to q and simplifying yields, instead of (4), the following expression for the shadow price of quotas from the U.S. point of view:

$$[-\tilde{B}_q]_{US} = p' \hat{\tau} (I + \hat{\tau})^{-1} - q' (I + \hat{\tau})^{-1} p_q + t' \tilde{m}_q. \quad (31)$$

Comparing this with (4), our assumptions about partial rent-sharing are seen to affect the expression for the shadow price of quotas in two ways. Firstly, relaxing the quota on good j by one unit yields a direct gain which, in the general case of (4), equals the price differential, $p_j - p_j^*$, dampened by the fraction of rents lost ω_j and by any change in ω_j . Under the present specification, this gain simplifies to the price differential less the rent ρ_j which accrues to the exporter; from (29), this equals $\tau_j p_j / (1 + \tau_j)$. Secondly, such a relaxation tends to alter the domestic prices p of all quota-constrained goods, so altering the fraction $1/(1 + \tau_j)$ of rents on each good j which is lost to foreigners.

3.2. Separability assumptions

The general theoretical framework of Section 2 assumed that the analysis is to be carried out at the level of the economy as a whole. However, in many applications we may be interested in only a few markets. In such circumstances we may define a *partial* TRI, defined over the trade policy instruments applicable to the markets of interest only. Moreover, if these markets comprise only a small portion of the economy, it is natural to specialize the analysis to a partial equilibrium context. This implies that changes in trade policy do not affect the prices of non-traded goods and factors and that the goods to be considered are *separable* from others in excess demand. In our application to Hong Kong–U.S. trade, all the goods examined were subject to binding export quotas, so separability is a restriction on the cross-relationships between quota-constrained and other goods. This imposes a specific structure on the trade expenditure function:

$$E(p, \pi, u) = \xi[\mu(p, u), \psi(\pi, u), u]. \quad (32)$$

The implications of this specification have been examined in Anderson and Neary (1992). (See especially Lemmas 1 and 2.) In particular, two complicated matrix terms in the expression for the shadow price of quotas, equation (31), are greatly simplified. Firstly, the term $-q'p_q$ (measuring the change in total rents arising from the effect of a quota relaxation on home prices) is replaced by $-p'/\varepsilon$, where ε (a negative scalar) is the aggregate elasticity of demand for quota-constrained goods. For this result to be useful, we must assume in addition that U.S. tariffs on textile imports are uniform: $\tau_j = \tau$, all j .¹⁷ This implies that the term $-q'(I + \hat{\tau})^{-1}p_q$ in (31) is replaced by $-[(1 + \tau)\varepsilon]^{-1}p'$. Secondly, the term $t'\tilde{m}_q$ (measuring the change in tariff revenue arising from a quota relaxation) is

16. In this case, the share of rents lost is: $\omega_j = \{p_j - (1 + \tau_j)p_j^*\} / \{(1 + \tau_j)(p_j - p_j^*)\}$.

17. This assumption is necessary since we do not have detailed estimates of the substitution matrix p_q . An alternative approach, adopted in Anderson and Neary (1994), is to assume a particular structure of demand, allowing the term $-q'(I + \hat{\tau})^{-1}p_q$ to be calculated explicitly.

replaced by $-\tau^m p'$, where τ^m is the import-weighted average *ad valorem* tariff on the tariff-constrained m goods. With these simplifications, equation (31) for a single good j becomes:

$$[-\tilde{B}_j]_{US} = \left[\frac{1}{1+\tau} \left\{ \tau - \frac{1}{\varepsilon} \right\} - \tau^m \right] p_j. \quad (33)$$

Since the U.S. tariffs on Hong Kong exports of textiles and apparel (τ_j) are of the order of 20% whereas the U.S. average tariff on other goods (τ^m) is only about 4%, the shadow prices of quotas are likely to be positive for the U.S.

3.3. 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. 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.¹⁸ However, a simpler approach which is appropriate in this partial equilibrium application is to subtract from the expression for the shadow price of quotas (now taking the Hong Kong rather than the U.S. point of view) the effect on quota rents retained of changes in the quota licenses arising from a change in quota levels: $q'(dp/dq)$. From (29), this equals $q'(I + \hat{\tau})^{-1} p_q$. Since this is also the second term in (31), our procedure amounts to treating the terms of trade *gain* to the U.S. of a quota relaxation as equalling the *loss* to Hong Kong. The other two terms in the expression for the shadow price of quotas are easily modified. Since Hong Kong exporters receive only the license price, the first term is simply ρ ; and since Hong Kong does not impose tariffs on other goods, the t vector is zero and the third term vanishes. The vector of quota shadow prices from Hong Kong's perspective is therefore:

$$[-\tilde{B}'_q]_{HK} = \rho + q'(I + \hat{\tau})^{-1} p_q. \quad (34)$$

As in the U.S. case, assuming separability and uniform U.S. tariffs yields for good j :

$$[-\tilde{B}_j]_{HK} = \rho_j + \frac{1}{(1+\tau)\varepsilon} p_j. \quad (35)$$

Depending on the size of ε these shadow prices may be positive or negative.

3.4. The restrictiveness of VER's on U.S. textile imports from Hong Kong

We turn finally to our empirical application, which calculates a partial index for the restrictiveness of Voluntary Export Restraints on U.S. 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. (These refer to average license prices, so implicitly assuming that quota allocations are fully utilized.) 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.

18. See Anderson and Neary (1992, Section II.4), and Neary (1995) for further details.

TABLE 1

Changes in the Trade Restrictiveness Index: Hong Kong exports of textiles and apparel to the U.S., 1982–1988

	U.S. point of view			Hong Kong point of view			Change in average tariff equivalent
	Change in Δ^q	Change in real income	Change in Δ^{qc}	Change in Δ^q	Change in real income	Change in Δ^{qc}	
$\varepsilon: -2.5$							
1983*	-2.6	3.9	1.3	-4.1	5.4	1.3	84.4
1984*	4.1	6.8	10.9	3.7	10.6	14.3	-8.1
1985*	-1.9	3.2	1.3	-0.5	2.5	2.0	-39.2
1986	-6.5	2.8	-3.7	0.0	8.6	8.6	42.2
1987	-1.1	2.9	1.8	8.0	12.7	20.7	12.0
1988*	-0.8	4.5	3.7	0.9	6.4	7.3	-53.0
1983–1988	-8.8	26.6	15.7	7.8	55.6	66.1	-22.9
$\varepsilon: -5.0$							
1983	-2.8	3.9	1.1	-2.4	5.4	3.0	84.4
1984	4.2	6.8	11.0	5.4	10.6	16.0	-8.1
1985	-1.7	3.2	1.5	-3.9	2.5	-1.4	-39.2
1986	-6.6	2.8	-3.8	-3.9	8.6	4.7	42.2
1987	-1.0	2.9	1.9	-0.9	12.7	11.8	12.0
1988	-0.9	4.5	3.6	0.1	6.4	6.5	-53.0
1983–1988	-8.8	26.6	15.7	-5.8	55.6	46.9	-22.9
$\varepsilon: -10.0$							
1983	-3.0	3.9	0.9	2.7	5.4	8.1	84.4
1984	4.3	6.8	11.1	4.6	10.6	15.2	-8.1
1985	-1.6	3.2	1.6	-3.0	2.5	-0.5	-39.2
1986	-6.7	2.8	-3.9	-5.1	8.6	3.5	42.2
1987	-0.9	2.9	2.0	-1.1	12.7	11.6	12.0
1988	-1.1	4.5	3.4	-0.1	6.4	6.3	-53.0
1983–1988	-9.0	26.6	15.4	-2.3	55.6	52.1	-22.9

Notes. All figures are percentage changes.

* Denotes cases in which the marginal quota deflator was negative from Hong Kong's point of view.

Estimates of ε , the price elasticity of U.S. demand for Hong Kong imports, were not available so Table 1 presents results for three alternative values -2.5 , -5.0 and -10.0 .¹⁹ For each year and each value of ε , we give the changes in the uncompensated and compensated TRI's from the U.S. and Hong Kong points of view. Our estimates for the change in the uncompensated TRI are calculated from equation (28), using the expressions for the shadow prices of quotas in equations (33) and (35) for the U.S. and Hong Kong respectively.²⁰ We also estimate the change in the compensated TRI, assuming that growth is neutral. A series of derivations similar to those in the Appendix yields:

$$\hat{\Delta}^{qc} = \hat{\Delta}^q + \hat{p}^1. \quad (36)$$

In this case, compensating for growth simply requires adding the growth rate to the change in the uncompensated TRI. The changes in Δ^q and Δ^{qc} are compared with the changes in

19. These values reflect the fact that imports from Hong Kong are relatively close substitutes for other textile imports. If the two categories of imports are additively separable in U.S. demand, then ε equals the elasticity of U.S. demand for all textile imports, ε' , divided by the Hong Kong import share. The latter equalled 20% in 1983, so our chosen values for ε correspond to values for ε' of -0.5 , -1.0 and -2.0 , with the unitary case being the literature's consensus. See Trela and Whalley (1990).

20. The formula for changes in Δ^q refers to 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.

the average tariff equivalent, calculated in the conventional manner as a trade-weighted average of the implicit tariffs, $p - p^*$.

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 Δ^q fell slightly in all years except 1984, it did so by less than the growth rate of real income, so that the value of the compensated index Δ^{qc} rose in five of the six years, with a cumulative rise (representing an effective tightening of the quotas) of 15.7%. By contrast, the traditional measure, the average tariff equivalent, fluctuated widely over the same period, with a cumulative fall of 22.9%. The year-to-year variability of this measure is highly implausible. Moreover, in four out of six years and over the period as a whole, 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 U.S. estimates are not at all sensitive to different assumptions about the elasticity of demand, ε . Although, from (33), all shadow prices rise as the elasticity falls, this tends to affect all categories uniformly in both the numerator and denominator of the expression for the change in Δ^q and so does not significantly alter the estimated change.

Turning to the results from the Hong Kong point of view, they reveal further interesting properties of the TRI approach. The estimates are much more sensitive to the value of the elasticity than were those of the U.S. Moreover, in four years when ε is at its low value, most or all of the estimated quota shadow prices are negative, with the result that the marginal quota deflator, $-\hat{B}'_q q$, is itself negative. This implies that a rise in Δ^q 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.²¹ If we confine attention to the central case ($\varepsilon = -5$), Δ^{qc} rose in five of the six years, implying that Hong Kong as well as the U.S. has been experiencing policy changes in the direction of greater restrictiveness. Once again, the implications of our measure are very different from those of the crude change in the average tariff equivalent.

4. OPERATIONALIZING THE TRI: COMPUTING GLOBAL CHANGES IN GENERAL EQUILIBRIUM

We turn next to our general equilibrium application, which uses a simple Computable General Equilibrium (CGE) model. Typical CGE models allow for a few dozen sectors but use trade-weighted average tariffs and tariff equivalents to summarize trade policy for each sector. By contrast, our model has a much simpler production structure but allows for an indefinitely large number of trade categories (close to a thousand in the application below), each subject to different trade distortions.

4.1. *The CGE model*

The economy produces two final composite goods, an exportable not consumed at home and a non-traded good. This structure has been studied by Jones (1974) and is equivalent to applying the Armington (1969) assumption to both imports and exports. The rationale for the Armington assumption of no domestic consumption of the export is that packaging, safety and other requirements differentiate it from home goods, while the absence of

21. Trela and Whalley (1990) also find that the terms of trade loss from a reversion to free trade hurts Hong Kong, although their results are not fully comparable with ours.

domestic production of imports is due to other dimensions of product differentiation. Exports and non-traded goods are jointly produced with a constant elasticity of transformation (CET) production function. The inputs include a bundle of non-traded factors of production in fixed supply, hence reducible to a single input; a vector of imported inputs subject to binding quota constraints; and a vector of imported inputs subject to tariffs but not subject to quotas. A constant elasticity of substitution (CES) production function relates the inputs to the joint output. The technology exhibits constant returns to scale and exports are chosen as the numeraire.

As for consumption, the representative consumer's tastes are represented by a CES expenditure function. The final goods consumed are a vector of final imports subject to tariffs but not quotas, a vector of final imports subject to binding quota constraints, and the nontraded good.

All tariff revenue is assumed to be redistributed to the representative consumer. This includes tariff revenue collected on quota-constrained goods, which serves to retain a portion of the quota rents. Otherwise the economy is assumed to lose all quota rents, either to rent-seeking or to foreigners via the bargaining power they may have in narrow product lines.²² Hence, as in Section 3, the rent-retention parameters ω are endogenous. The economy is assumed to be "small", facing fixed international prices. In general equilibrium, the consumer's real income (utility) is determined by the balance of trade constraint, simultaneously with market clearance for nontraded goods and factors.

Formalizing this outline, we apply the model of Section 2.1. Computationally, it is necessary to calculate the relative price h of the non-traded good, so we make it explicit in the underlying consumer expenditure and gross national product functions rather than implicit in the trade expenditure function. Gross National Product (GNP) equals the value of production of the non-traded and export goods less the value of imported inputs. The distorted expenditure function is denoted by $\tilde{e}(h, q^F, \pi^F, u, \gamma)$ and the distorted GNP function by $\tilde{g}(h, q^M, \pi^M, \gamma)$; superscripts "F" and "M" denote final and intermediate goods respectively. The distorted functions are obtained from the undistorted expenditure and GNP functions given in (1) in the same way as the distorted trade expenditure function is obtained from its undistorted counterpart. They therefore inherit the analogous derivative properties, save that input demands are subtracted in the GNP function as opposed to final demands being added in the expenditure function. Thus $\tilde{g}_\pi(h, q^M, \pi^M, \gamma)$ equals minus the unconstrained input demand vector and $\tilde{g}_q(h, q^M, \pi^M, \gamma)$ equals the vector of virtual prices of quota-constrained inputs. The CES/CET assumption restricts both the distorted GNP function and the distorted expenditure function. Conveniently, it implies that there are natural price and quantity aggregates (the former for unconstrained and the latter for constrained goods) for final and intermediate imports.²³

The model is solved for the TRI in two steps. The first step is to obtain the virtual prices associated with the new instruments and the old utility. General equilibrium requires that the non-traded good market clear:

$$\tilde{e}_h(h, q^F, \pi^F, u, \gamma) = \tilde{g}_h(h, q^M, \pi^M, \gamma). \quad (37)$$

The solution to this equation, $\tilde{h}(q, \pi, u, h)$, is substituted into \tilde{e}_q and \tilde{g}_q at the point $(q^1, \pi^1, u^0, \gamma)$ to evaluate the virtual prices $\tilde{p}' = (\tilde{p}^{F'}, \tilde{p}^{M'})$ equal to $\{-\tilde{e}_q(\tilde{h}, q^{F1}, \pi^{F1}, u^0, \gamma),$

22. This extreme simplifying assumption is imposed for empirical convenience, since it avoids the need to estimate the quota rent premia.

23. The strong separability of the CES structure yields closed form solutions for the price and quantity aggregates. In practice, the very large number of elements in \tilde{p} need not be calculated, but only an index of them.

TABLE 2

Changes in the TRI and standard indices, Colombia 1989–90
(All figures are percentage changes)

Change in TRI:	–2.6
Change in welfare:	0.3
Change in average tariff:	
Tariff-constrained goods:	
Final goods	0.7
Intermediate goods	–0.1
Quota-constrained goods:	
Final goods	–2.9
Intermediate goods	2.5
Change in coefficient of variation of tariffs:	
Final goods	4.4
Intermediate goods	2.9
Change in value of quota-constrained imports:	
Final goods	12.0
Intermediate goods	12.0
Change in NTB coverage ratio:	
Final goods	–33.5
Intermediate goods	–41.6

$\tilde{g}_q(\tilde{h}, q^{M^1}, \pi^{M^1}, \gamma)\}$. The second step is to substitute \tilde{p} into the undistorted expenditure and GNP functions. Expressed in terms of derivatives of these functions, the non-traded good market clearance is now the first-order condition from equation (1):

$$e_h(h, \tilde{p}^F/\Delta, \pi^{F^1}/\Delta, u^0, \gamma) = g_h(h, \tilde{p}^M/\Delta, \pi^{M^1}/\Delta, \gamma). \quad (38)$$

This is solved for h and Δ simultaneously with the balance of payments constraint:

$$e(h, \tilde{p}^F/\Delta, \pi^{F^1}/\Delta, u^0, \gamma) = g(h, \tilde{p}^M/\Delta, \pi^{M^1}/\Delta, \gamma) + (\pi^1/\Delta - \pi^*)'(e_\pi - g_\pi) + t^q q^1. \quad (39)$$

Here, t^q is the vector of rent-retaining tariffs on the quota-constrained goods.

4.2. Results

The model is applied here to data for Colombia from 1989 to 1990. The basic trade and distortions data were concorded at the finest level possible, which in practice gave 859 trade categories (427 final and 432 intermediate). Trade, GNP and current account surplus data for 1989 were used to create the share parameters of the CES/CET functions. Elasticities of substitution were assumed (equal to 5.0 for the elasticities of transformation and final demand, and 0.7 for the input demand system). Anderson (1993) shows that the sensitivity of the results to alternative elasticity values is surprisingly low.

Table 2 presents the standard summary indicators of trade policy change between 1989 and 1990 for Colombia, along with the TRI. The results are qualitatively similar to results from our larger study of seven cases (see Anderson (1993)). The change in the TRI, $\hat{\Delta} - 1$, is the uniform tariff equivalent surcharge on the trade policy of 1990 which is required to yield the 1989 level of real income while meeting the balance of payments constraint. The surcharge rate is equivalent to a 2.6% subsidy (a negative tax).

Table 2 implies that the TRI is a significant improvement over standard indices in practice. The standard summary measures have very different implications for the direction of trade policy change. This conflict appears in every case in our larger study (see Anderson

(1993)).²⁴ By contrast, the TRI provides a theoretically consistent index which in principle resolves all such difficulties. This point is worth illustrating by drawing out the implications of Table 2 in some detail.

The tariff indicators appear to imply a rise in trade restrictiveness while the quota indicators appear to imply a fall in trade restrictiveness. In the case of tariffs, the average tariff rises for unconstrained intermediate and final goods, while the average tariff falls for quota-constrained goods. The tariff reduction on quota-constrained goods is unambiguously welfare-reducing since it means that the rent loss share rises. The rise in average tariffs on unconstrained goods is usually interpreted as trade-restricting, though it may not be. And the coefficient of variation of tariffs for both final and intermediate goods rises, which is usually interpreted as trade-restricting, though it may not be. As for quotas, the NTB coverage ratio for both final and intermediate goods falls while the 12% rate of growth of the value of quota-constrained imports far exceeds the 3.5% growth rate of GNP. Both of these are usually interpreted as trade-enhancing though they may not be. This discussion illustrates that, even if the standard measures were valid as partial measures, their conflicting implications in practice would leave us with no way of combining them for a net effect.

Finally, consider the relation of the TRI to a standard welfare measure, the change in money metric utility. For infinitesimal changes, the proportionate change in money metric utility equals $e_u du/e$. For the finite changes considered in the present model, the change in money metric utility is obtained by setting Δ equal to one and solving for the equilibrium level of utility, u , in the initial and new equilibria. Table 2 shows that the 2.6% reduction in the TRI is associated with a 0.3% increase in welfare. Dividing the second number by the first, the implied elasticity of welfare with respect to uniform trade distortions for Colombia in 1989 is -0.115 . In the larger study, this implied welfare elasticity varies widely across countries and over time, as it reflects the influence of both the economic structure and the structure of trade distortions. The TRI thus provides a standard of international comparison of the relative movement of policy, whereas the real income implications of the same policy changes typically differ widely across countries.

5. 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 applications have shown that, with appropriate additional assumptions, the TRI can be readily implemented and that it yields very different conclusions from the standard approach.

We hope to carry out more empirical applications of the TRI to demonstrate its usefulness in both international and intertemporal comparisons. Further theoretical

24. The seven cases of the larger study show a variety of patterns of changes in trade policy. As in the MFA application, the correlation of standard indices with the TRI is zero or negative, confirming the practical uselessness of standard indices.

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, as noted in Section 2.5, the TRI is just one member of a family of indices which use a distance function approach to aggregation. In Anderson, Bannister and Neary (1995), we consider another member of this family, which constructs the uniform tariff equivalent of a set of domestic taxes and subsidies. We anticipate that further applications of this general approach are likely to prove useful in many contexts.

APPENDIX: NEUTRAL GROWTH AND THE RESTRICTIVENESS OF QUOTAS

If tastes are homothetic, the expenditure function $e(h, p, \pi, u)$ may be written, without loss of generality, as $ue(h, p, \pi)$. Similarly, if technical progress is "balanced" (in the sense that all sectors grow at the same rate when prices are given), then the GNP function $g(h, p, \pi, \gamma)$ can be written, without loss of generality, as $\gamma g(h, p, \pi)$, where γ is a scalar. Combining these assumptions, the trade expenditure function (1) becomes:

$$E(p, \pi, u, \gamma) \equiv \max_h [ue(h, p, \pi) - \gamma g(h, p, \pi)]. \quad (40)$$

This is clearly homogeneous of degree one in (u, γ) , and hence so are its derivatives E_p and E_π . Thus the (undistorted) balance of trade function, (9), is homogeneous of degree one in (u, γ, β) .

The next step is to show that the distorted trade expenditure function (2) is homogeneous of degree one in (q, u, γ, β) . To show this, consider the domestic price function $p(q, \pi, u, \gamma)$, which, from (40) and (2), is defined implicitly by:

$$q = ue_p(h, p, \pi) - \gamma g_p(h, p, \pi). \quad (41)$$

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 $p(q, \pi, u, \gamma)$ must be homogeneous of degree zero in (q, u, γ) . Hence the distorted trade expenditure function $\tilde{E}(q, \pi, u, \gamma)$ must be homogeneous of degree one in (q, u, γ, β) .

Finally, what does this imply for the distorted balance of trade function, (3)? From Shephard's Lemma, $\tilde{m}(q, \pi, u, \gamma)$ equals $\tilde{E}_\pi(q, \pi, u, \gamma)$ and so is homogeneous of degree one in (q, u, γ) . It follows that each individual term on the right-hand side of (3), and hence the expression as a whole, is homogeneous of degree one in (q, u, γ, β) . Assuming that β is zero, this implies that the compensating utility and quota levels must satisfy:

$$\hat{u}^c = \hat{\gamma}^1 = \hat{q}^j, \quad \text{all } j. \quad (42)$$

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 this into (22) yields equation (23) as required.

Acknowledgements. This paper was written as part of a World Bank project on "The Cost of Protection Index" (RPO 676-49). An earlier version was circulated as CEPR Discussion Paper No. 683. Much of the paper was written while the first author was a Visiting Scholar at the Institute for International Economic Studies, Stockholm and it was revised while the second author was visiting the University of Ulster at Jordanstown. The support and stimulation of both institutions are gratefully acknowledged. Earlier versions of the paper were presented to a World Bank seminar, to ES 90 in Washington, to ERWIT 91 in Stockholm and to ESEM 91 in Cambridge. We are grateful to participants at these meetings and to Refic Erzan, Patrick Honohan, Ian Jewitt, Kala Krishna and three anonymous referees for helpful comments, to Chris Holmes for able research assistance and to Carl Hamilton for assistance with data. The second author's work on this paper forms part of the International Economic Performance Programme of the Centre for Economic Performance at the London School of Economics.

REFERENCES

- ANDERSON, J. E. (1991), "The coefficient of trade utilisation: The cheese case", in R. E. Baldwin (ed.), *Empirical Studies of Commercial Policy* (Chicago: University of Chicago Press) 221-244.
 ANDERSON, J. E. (1993), "Aggregation of trade restrictions in a simple CGE model" (mimeo., Boston College).
 ANDERSON, J. E. and NEARY, J. P. (1990), "The coefficient of trade utilisation: Back to the Baldwin Envelope", in R. W. Jones and A. O. Krueger (eds.), *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin* (Oxford: Basil Blackwell), 49-72.

- ANDERSON, J. E. and NEARY, J. P. (1992), "Trade reform with quotas, partial rent retention and tariffs", *Econometrica*, **60**, 57–76.
- ANDERSON, J. E. and NEARY, J. P. (1994), "The Trade Restrictiveness of the Multi-Fibre Arrangement", *World Bank Economic Review*, **8**, 171–189.
- ANDERSON, J. E., BANNISTER, G. E. and NEARY, J. P. (1995), "Domestic distortions and international trade", *International Economic Review*, **36**, 139–157.
- ARMINGTON, P. S. (1969), "A theory of demand for products distinguished by place of production", *International Monetary Fund Staff Papers*, **26**, 159–178.
- CORDEN, W. M. (1966), "The effective protective rate, the uniform tariff equivalent and the average tariff", *Economic Record*, **42**, 200–216.
- CORDEN, W. M. (1984), "The normative theory of international trade", in R. W. Jones and P. B. Kenen (eds.), *Handbook of International Economics, Volume 1* (Amsterdam: North-Holland), 63–130.
- CORDEN, W. M. and FALVEY, R. E. (1985), "Quotas and the second best", *Economics Letters*, **18**, 67–70.
- DEATON, A. S. (1979), "The distance function in consumer behaviour with applications to index numbers and optimal taxation", *Review of Economic Studies*, **46**, 391–405.
- DEBREU, G. (1951), "The coefficient of resource utilization", *Econometrica*, **19**, 273–292.
- DIEWERT, E. (1985), "A dynamic approach to the measurement of waste in an open economy", *Journal of International Economics*, **19**, 213–240.
- DIXIT, A. K. (1986), "Tax policy in open economies", in A. Auerbach and M. Feldstein (eds.), *Handbook of Public Economics* (Amsterdam: North-Holland), 313–374.
- DIXIT, A. K. and NORMAN, V. (1980) *Theory of International Trade: A Dual, General Equilibrium Approach* (London: Cambridge University Press).
- EDWARDS, S. (1992), "Trade orientation, distortions and growth in developing countries", *Journal of Development Economics*, **39**, 31–57.
- FALVEY, R. E. (1988), "Tariffs, quotas and piecemeal policy reform", *Journal of International Economics*, **25**, 177–183.
- FUKUSHIMA, T. and HATTA, T. (1989), "Why not tax uniformly rather than optimally?", *Economic Studies Quarterly*, **40**, 220–238.
- JONES, R. W. (1974), "Trade with non-traded goods: The anatomy of interconnected markets", *Economica*, **41**, 121–138.
- KRISHNA, K. (1991), "Openness: A Conceptual Approach" (mimeo., Harvard University).
- KRISHNA, K., ERZAN, R. and TAN, L. H., (1994), "Rent-sharing in the Multi-Fibre Arrangement: Theory and evidence from U.S. apparel imports from Hong Kong", *Review of International Economics*, **2**, 62–73.
- LEAMER, E. E. (1974), "National tariff averages with estimated weights", *Southern Economic Journal*, **41**, 34–46.
- LEAMER, E. E. (1988), "Measures of Openness", in R. E. Baldwin (ed.), *Trade Policy Issues and Empirical Analysis* (Chicago: University of Chicago Press), 147–200.
- LLOYD, P. J. (1974), "A more general theory of price distortions in open economies", *Journal of International Economics*, **4**, 365–386.
- LOPEZ, R. and PANAGARIYA, A. (1992), "On the theory of piecemeal tariff reform: The case of pure imported intermediate inputs", *American Economic Review*, **82**, 615–625.
- NEARY, J. P. (1988), "Tariffs, quotas and voluntary export restraints with and without internationally mobile capital", *Canadian Journal of Economics*, **21**, 714–735.
- NEARY, J. P. (1995), "Trade liberalisation and shadow prices in the presence of tariffs and quotas", *International Economic Review*, **36**, 531–554.
- NEARY, J. P. and ROBERTS, K. W. S. (1980), "The theory of household behaviour under rationing", *European Economic Review*, **13**, 25–42.
- NEARY, J. P. and SCHWEINBERGER, A. G. (1986), "Factor content functions and the theory of international trade", *Review of Economic Studies*, **53**, 421–432.
- PRITCHETT, L. (1991), "Measuring outward orientation in developing countries: Can it be done?" (World Bank Policy, Research, and External Affairs Working Paper WPS 556). (Washington, D.C.: The World Bank).
- RODRIG, D. (1987), "The economics of export-performance requirements", *Quarterly Journal of Economics*, **102**, 633–650.
- STERN, N. H. (1990), "Uniformity versus selectivity in indirect taxation", *Economics and Politics*, **2**, 83–108.
- TRELA, I. and WHALLEY, J. (1990), "Unraveling the threads of the MFA", in C. B. Hamilton (ed.), *Textiles Trade and the Developing Countries: Eliminating the Multi-Fibre Arrangement in the 1990s* (Washington: The World Bank), 11–45.