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Measuring the Restrictiveness of Trade Policy

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This article provides an introduction to the trade restrictiveness index (TRI), which equals the uniform tariff that is welfare equivalent to a given pattern of trade protection. Unlike standard measures of trade restrictiveness, the TRI has a solid theoretical basis, can incorporate both tariffs and quantitative restrictions, and can be adapted to construct the trade policy equivalent of domestic distortions. The article compares a number of applications and describes procedures for operationalizing the TRI on a personal computer. The authors conclude that the TRI has considerable potential in empirical work.

The influence of trade policy on a country's economic well-being is one of the most widely debated topics in economics. Yet the question of how trade restrictiveness should be measured has received little attention in the past. In practice, restrictiveness is typically gauged using an ad hoc measure such as the trade-weighted average tariff, the coefficient of variation of tariffs, or the nontariff-barrier coverage ratio. But all these measures lack any theoretical foundation and are subject to theoretical and practical drawbacks. Some researchers, such as Papageorgiou, Michaely, and Chokski (1991), have attempted to construct subjective country-specific measures of trade restrictiveness. These have the advantage of incorporating important local considerations, but they are inherently difficult to replicate for countries or time periods other than those for which they were designed.

The problem of how trade restrictiveness should be measured is not severe in the world of textbooks, where trade barriers take a single and well-defined form. But in most real-world situations, especially in developing countries, actual systems of trade intervention are pervasive and highly complex. This poses a challenge for analysts and policymakers alike. In the face of a bewildering array of tariffs and quantitative restrictions, it can be extremely difficult to assess the true orientation of a country's trade policy or to evaluate the thrust of a package of policy changes that encourage trade in some product lines but

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discourage it in others. Traditional analysis provides little guidance on methods of aggregating restrictions across different markets. This makes it difficult to evaluate proposals for trade liberalization that form part of a stabilization package or to assess the progress made in moving toward less-restricted trade. A further reason for seeking a framework within which trade policies can be compared consistently is of analytical as well as practical importance. Because the case for free trade is ultimately a scientific hypothesis, theoretically sound but potentially false, some measure of trade restrictiveness is needed to test the impact of trade on growth and economic performance.[1]

This article describes a theoretically satisfactory yet practically implementable approach, developed by the authors, to measuring the restrictiveness of trade policy. Two relatively recent developments have made this approach possible. At a theoretical level, the normative theory of international trade has been formalized in a systematic way and extended to take account of trade policies other than tariffs.[2] At a practical level, the rapid increase in availability of cheap computing power has made it possible to implement models with a disaggregated structure that come closer than ever before to the complexity of real-world protective structures.

Section I provides a nontechnical introduction to the issues, discussing the conceptual problems in measuring trade restrictiveness, the drawbacks of commonly used measures, and the rationale for our proposed alternative measure, the trade restrictiveness index (TRI). Section II then sketches the analytical foundation of the TRI, and section III shows how it can be extended to include quantitative restrictions on trade, as well as tariffs. Subsequent sections review some applications of the TRI that have been carried out to date. Section IV discusses the application of the TRI to measuring the restrictiveness of the Multi-Fibre Arrangement, and section V shows how the TRI has been adapted to measure the trade restrictiveness of domestic policies, specifically, the reform of Mexican agricultural subsidies. Both of those studies are of a partial equilibrium kind; section VI describes a computable general equilibrium model that implements the TRI and that has been applied to an evaluation of Colombian trade policy reform. Section VII gives details of how the TRI can be calculated on a personal computer with only modest data requirements, and section VIII provides conclusions. More technical detail on the calculation of the TRI and on its application to the Multi-Fibre Arrangement is given in our companion article in this issue (Anderson and Neary 1994).

I. MEASURING TRADE RESTRICTIVENESS IN THE PRESENCE OF TARIFFS

What do we mean by a measure of "trade restrictiveness"? In principle, we mean some scalar index number that aggregates the trade restrictions in individ-

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1. Leamer (1988) and Edwards (1992) propose and implement tests along these lines, adopting the Heckscher-Ohlin explanation of trade patterns as a maintained hypothesis. Krishna (1991) and Pritchett (1991) review this and other approaches to measuring openness and trade restrictiveness.

2. Dixit (1986) and Anderson (1988; 1994) provide overviews of recent work in the field.

ual markets. Whether a particular method of aggregation is satisfactory depends on the intended uses of the measure of restrictiveness. In a context of trade negotiations, for example, restrictiveness might be defined with reference to the volume of trade in restricted categories. Alternatively, trade restrictiveness might be defined in terms of the effect of domestic trade policies on the welfare of the country's trading partner; such an application is considered in section IV. In many applications, however, the appropriate index number is one that relates trade restrictions to their effect on domestic welfare.

The simplest context in which trade restrictiveness can be measured is when tariffs are the only form of trade policy. The left-hand side of figure 1 illustrates the market for a single good whose world price (assumed given) is π_1^* and whose home import-demand curve is $m_1(\pi_1)$. Domestic producers and consumers face a price that is raised by the tariff to π_1^0. Adopting a partial equilibrium perspective for the moment, the resulting deadweight loss, or cost of protection, is measured by the Marshallian triangle DCE. The restrictiveness of trade policy in this one-good context can obviously and unambiguously be measured by the height of the tariff, given by the distance AB.

Matters are not so simple, however, when tariffs apply to more than one good. The right-hand side of figure 1 shows the import demand curve for good 2. Demand for good 2 is less elastic than demand for good 1, and good 2 is subject to a higher tariff. The total welfare loss from the two tariffs is the sum of the Marshallian triangles DCE and IHJ. But how should the "average" level of trade restrictiveness across these two markets be measured? The easiest approach, and the one typically adopted in practice, is to aggregate the two tariffs by weighting them by the imports (valued at border prices) of the two goods, AC and FH. (For ease of exposition, the world prices of the two goods are assumed to be equal to one.) This leads to the average tariff, denoted by $\bar{t}$. However, this approach immediately runs into difficulties. Consider a change in trade policy that leads to the situation illustrated in figure 2, where the import demand functions are the same as in figure 1 but the configuration of tariff levels is reversed. Now the correlation between demand elasticities and tariff levels is positive rather than negative. On the left, imports of the high-elasticity good 1 are almost eliminated, so its high tariff receives a very low weight in the average tariff. On the right, the low tariff on the low-elasticity good 2 receives a high weight. As a result, the calculated average tariff (again denoted by $\bar{t}$) is low— considerably lower than that in figure 1. Yet it seems intuitively obvious that trade is more restricted in figure 2 than in figure 1, since both welfare (measured by minus the sum of the deadweight loss triangles) and the volume of trade have fallen. The standard index has thus moved in the wrong direction after a change in trade policy.

Another measure of trade restrictiveness that is often used in conjunction with the trade-weighted average tariff is the coefficient of variation of tariffs. This measure is rationalized on the grounds that uniform tariffs minimize the welfare cost of a given constraint on the value of imports, although on other grounds

Figure 1. *Measuring Trade Restrictiveness in the Presence of Tariffs. Negatively Correlated Tariff Rates and Import Demand Elasticities*

Price of good 1, π_1 Price of good 2, π_2
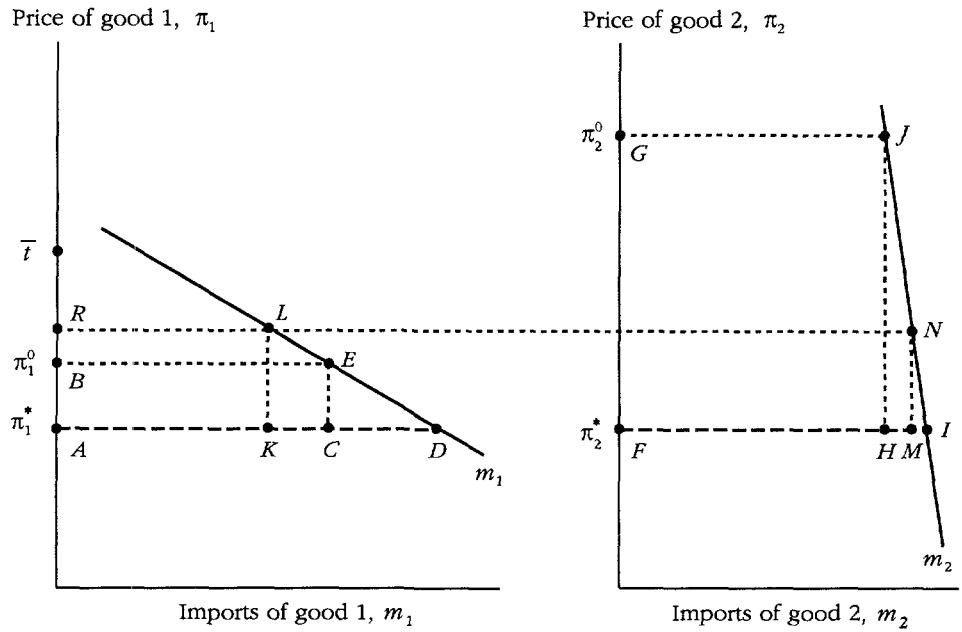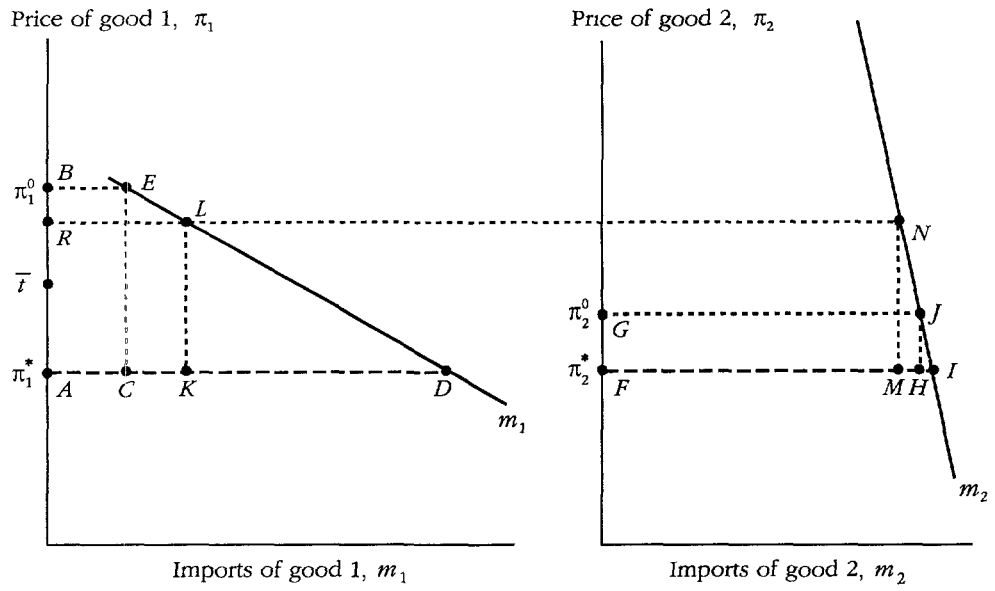

Imports of good 1, m_1 Imports of good 2, m_2

Figure 2 *Measuring Trade Restrictiveness in the Presence of Tariffs. Positively Correlated Tariff Rates and Import Demand Elasticities*

Price of good 1, π_1 Price of good 2, π_2

Imports of good 1, m_1 Imports of good 2, m_2

uniform tariffs are not necessarily desirable (see Anderson 1988; Stern 1990). The coefficient of variation is no more satisfactory a measure of trade restrictiveness than the trade-weighted average tariff. For reasonable parameter values, the coefficient of variation of tariffs may even be lower in figure 2 than in figure 1, suggesting once again that trade is less restricted, whereas intuitively this is not the case.

This example suggests that once we move away from the simple one-good case, purely statistical measures such as the trade-weighted average tariff or the coefficient of variation of tariffs bear no necessary relation to the welfare cost of trade policy. This in turn suggests that the distinction between the welfare cost of protection and the restrictiveness of the protective structure should not be maintained. Any satisfactory measure of trade restrictiveness must take account of the welfare costs imposed on the economy by the pattern of tariffs.

A more satisfactory approach to measuring trade restrictiveness is to find the uniform tariff that would be equivalent—in the sense of yielding the same welfare loss—to the actual tariffs applied.[3] In figure 1, this uniform tariff is equal to AR: by construction, the increase in the tariff on good 1 from AB to AR yields a welfare loss equal to the area $KCEL$, which is equal to the welfare gain of $HMNJ$ arising from the reduction of the tariff on good 2. In figure 2 the uniform tariff AR now implies a lowering of the tariff on good 1 and an increase in that on good 2. The welfare equivalent uniform tariff is higher in figure 2 than in figure 1 because the welfare cost of restricting trade is higher in figure 2. In both cases, the welfare-equivalent uniform tariff is closer to the actual tariff on the high-elasticity good 1. This result accords with the intuition that tariffs on relatively elastic goods are more restrictive than tariffs on relatively inelastic goods.

II. The Trade Restrictiveness Index

The concept of the welfare-equivalent uniform tariff can be extended to more general cases than the diagrammatic and partial equilibrium illustration in figures 1 and 2. In principle, the uniform tariff could be defined for any model of the economy, no matter how complex. In practice, our work to date has concentrated on models of perfectly competitive economies, although with very general specifications of technology and factor markets.

To generalize the welfare-equivalent uniform tariff, we make use of recent developments in the theory of trade policy, and especially of some technical tools introduced in Anderson and Neary (1992b; 1992c). Chief among these is the balance-of-trade function, which summarizes in implicit form the general equilibrium of a competitive multigood economy. This function, written as $B(\pi, u)$, is equal to the net transfer required to reach a given level of aggregate national

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3. Corden (1966) is an early exploration of this approach.

welfare, denoted by u, for an economy with a given vector of domestic prices π.[4] Implicit in the function are all the variables that characterize the general equilibrium of the economy, including taste and technology parameters, exogenous foreign transfers, the level of world prices, and the price of the numeraire good. The requirement that the economy be in equilibrium is imposed by setting the value of the function equal to zero. Hence, if we wish to compare two situations, indexed by 0 and 1, respectively, the equilibrium conditions in each may be written compactly as

$$(1) \qquad B(\pi^0, u^0) = B(\pi^1, u^1) = 0.$$

In some applications, the period 1 equilibrium may be identified with free trade, so that $\pi^1 = \pi^*$, but the techniques discussed here also allow for more general comparisons between two trade-distorted equilibria.

To motivate the derivation of the welfare-equivalent uniform tariff measure using the B function, it is helpful to draw an analogy with the derivation of the true cost of living index for a consumer. This is typically defined as the expenditure needed to attain the utility level of period 0 facing the prices of period 1, $e(\pi^1, u^0)$, scaled by expenditure in the base period, $e(\pi^0, u^0)$:

$$(2) \qquad \phi = e(\pi^1, u^0)/e(\pi^0, u^0).$$

Because the expenditure function is homogeneous of degree one in π, we can divide both sides of equation 2 by ϕ to rewrite it in a less conventional way:

$$(3) \qquad \phi = [\phi: e(\pi^1/\phi, u^0) = e(\pi^0, u^0)].$$

The interpretation is that the true cost of living index gives the uniform scaling factor by which period 1 prices must be deflated to compensate the consumer for the change in prices from π^0 to π^1.

Now, by analogy with equation 3,[5] the TRI is defined as the uniform scaling factor Δ by which period 1 prices must be deflated to compensate the aggregate consumer for the change in prices from π^0 to π^1:

$$(4) \qquad \Delta = [\Delta: B(\pi^1/\Delta, u^0) = 0].$$

The larger Δ is (for given period 0 prices), the more restrictive is the new tariff regime. In the case of a move to free trade ($\pi^1 = \pi^*$), Δ is less than one, and its inverse equals one plus the uniform tariff rate, which compensates for the abolition of period 0 tariffs. More generally, the inverse of Δ is the factor of proportionality by which period 1 prices must be multiplied in order to compensate for the change in tariffs. We call this the uniform tariff surcharge factor.

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4. More precisely, the balance-of-trade function gives the excess of domestic expenditure, given by an expenditure function $e(\pi, u)$, over domestic income, or $B(\pi, u) = e(\pi, u) - g(\pi) - (\pi - \pi^*)'m - \beta$, where $g(\pi)$ is gross national product, $(\pi - \pi^*)'m$ is tariff revenue, imports m equal $e_\pi(\pi, u) - g_\pi(\pi)$, and β is any net transfer from abroad (which may include an exogenous balance of payments deficit).

5. Because of the presence of trade restrictions and the fact that there is an implicit numeraire good, the balance-of-trade function is not homogeneous of degree one in π, and so there is no step that is analogous to equation 2 in the general equilibrium derivation.

To illustrate further the intuition behind the TRI, consider the effect on Δ of a tariff change that causes a small change in period 1 prices, holding fixed the reference level of utility in period 0. Totally differentiating the expression on the right-hand side of equation 4 that implicitly defines Δ gives the proportional change in the TRI, $\hat{\Delta}$:

$$(5) \qquad \hat{\Delta} = \Sigma\, \sigma_i \hat{\pi}_i.$$

Equation 5 gives the proportional change in the TRI as a weighted average of the proportional changes in domestic prices caused by the tariff changes. The weights depend on the partial derivatives of the balance-of-trade function with respect to prices, or the "marginal costs of tariffs," B_i:

$$(6) \qquad \sigma_i = B_i \pi_i / \Sigma_j\, B_j \pi_j,$$

which are related to the slopes of the general equilibrium import demand functions.[6] Like the change in the trade-weighted average tariff, the change in the TRI is also a weighted average of domestic price changes. The difference is that the weights used, given by equation 6, are marginal welfare weights rather than actual trade shares, $m_i \pi_i / \Sigma_j m_j \pi_j$. This gives another perspective on the theoretical superiority of the TRI: not only does it derive from an explicitly specified model of the economy and so has a firm basis in welfare economics, but changes in it are measured by an aggregate of individual price changes using appropriate marginal welfare weights (as opposed to the ad hoc aggregation by actual trade shares of the trade-weighted average tariff).

Having set up the general theory of the TRI, empirical implementation requires a more precise specification of the model of the economy, which has so far been subsumed inside the black box of the B function.[7] Before proceeding with this, however, we extend the theory of the TRI to include quantitative restrictions, which are a common method of protection in developing countries.

III. Measuring Trade Restrictiveness with Quotas and Tariffs

The case in which trade is restricted only by quotas lends itself easily to the development of a scalar index of trade restrictiveness. A natural way of posing the problem in this case is, "What is the uniform proportionate change in quotas that would compensate in welfare terms for a given change in quotas?" This

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6. From footnote 4, the typical price derivative B_i equals $-\Sigma_j(\pi_j - \pi_j^*)\partial m_j/\partial\pi_i$.

7. For example, in the special case of linear demands illustrated in figures 1 and 2, it is easier to work directly with the (approximate) welfare function given by the sum of the Marshallian triangles rather than with the B function. For any domestic price vector π, the welfare cost is $u = -\Sigma\,\gamma_i(\pi_i - \pi_i^*)^2$, where γ_i is the slope of the import demand curve for good i. Hence, the welfare equivalent ad valorem tariff (equal to $\Delta^{-1} - 1$, when π^1 equals π^*) is given by the square root of $\Sigma\,\gamma_i(\pi_i - \pi_i^*)^2/\Sigma\,\gamma_i(\pi_i^*)^2$. Anderson (1992) shows that, in general, the TRI with tariffs only can be written as a function of a weighted average tariff and the generalized variance of tariffs. If all goods are substitutes, the weights are non-negative. If the trade expenditure function is Cobb-Douglas, the weights reduce to trade weights, and the generalized variance collapses to the trade-weighted variance.

question leads to an index that is defined over quantities rather than over prices.[8] The technical development makes use of another function, the distorted balance-of-trade function, which is the analogue of the balance-of-trade function presented in the last section, modified to take account of quota distortions. (See Anderson and Neary 1992b and 1992c for details.) The distorted balance-of-trade function, denoted $B^d(q, u)$, is defined over the permitted import levels of the quota-constrained goods q and the level of utility u. As before, a great deal is hidden inside the black box, including the world prices p^* of the quota-constrained goods. The quantity-based TRI for quotas can now be defined as the proportionate change in period 1 quotas required to reach period 0 utility:

$$(7) \qquad \Delta^q(q^1, u^0) \equiv [\Delta^q: B^d(\Delta^q q^1, u^0) = 0].$$

For the case of two goods, this index is illustrated in figure 3, drawn in quota space. Point A, with coordinates (q_1^0, q_2^0), represents the base-period equilibrium, and point D, with coordinates (q_1^1, q_2^1), represents the period 1 equilibrium (which may be, but need not be, identified with free trade). The curve through A is an iso-utility locus, and it intersects the ray OD from the origin to D at point E. The value of Δ^q is the distance OE/OD. As in the case of tariffs, the larger is Δ^q (for given period 0 quota levels), the more restrictive is the period 1 quota regime.

Finally, we must consider the realistic case in which trade is restricted by both tariffs and quotas. Two alternative approaches are now possible, differing in their intuitive appeal and in their data requirements. The first approach is simply to combine the individual indexes already developed for the cases of tariffs and quotas alone, leading to a mixed quantity- and price-based index:

$$(8) \qquad \Delta^\lambda(q^1, \pi^1, u^0) \equiv [\Delta^\lambda: B^d(\Delta^\lambda q^1, \pi^1/\Delta^\lambda, u^0) = 0].$$

The value of Δ^λ is the equal proportionate relaxation of all quota levels and reduction of all tariff-inclusive prices that would be equivalent in welfare terms to a given initial protective structure with an arbitrary pattern of quotas and tariffs. As before, a rise in Δ^λ corresponds to an increase in trade restrictiveness.

The great advantage of the hybrid index is computational: although the level of this index depends on world prices for quota-constrained goods, p^*, changes in the index between two distorted situations can be computed without knowledge of these prices (data on which are notoriously difficult to obtain). However, the index has the disadvantage of combining changes in quantities for quota-constrained goods with changes in prices for tariff-constrained goods. This is not a meaningless mixture because the value of the index is a pure number and because changes in the index are a weighted average of changes in the tariffs-only and quotas-only indexes, with the weights measuring the relative contribu-

8. In this form, the TRI is seen to descend from a family of "distance function" measures developed, among others, by Debreu (1951) and Deaton (1979). In our early work, which for the most part considered quota distortions only (Anderson and Neary 1990; Anderson 1991), we called our index the "coefficient of trade utilization," echoing Debreu's "coefficient of resource utilization."

Figure 3. *The Trade Restrictiveness Index with Quotas*

Quota on good 2, q_2

Quota on good 1, q_1
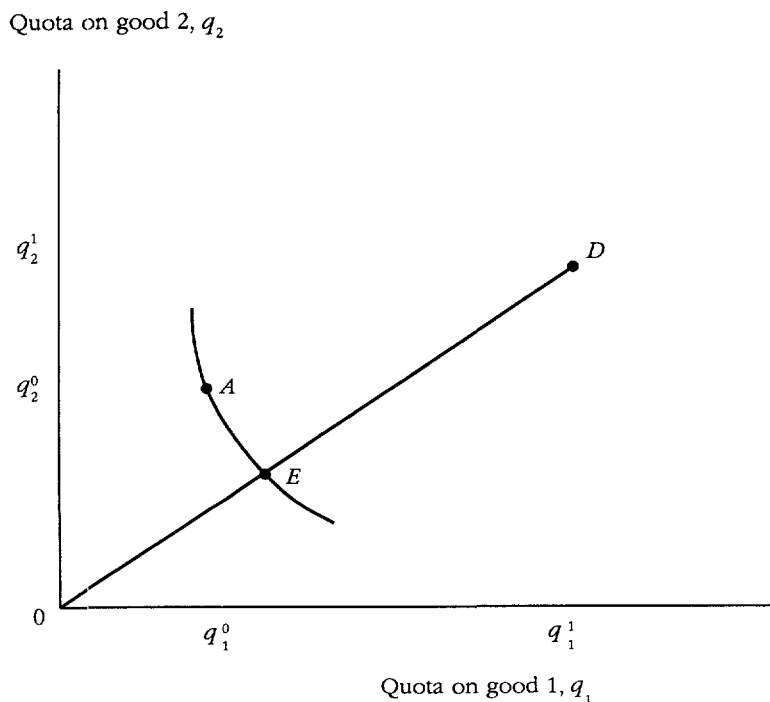
tion of tariffs and quotas to changes in welfare. Nonetheless, the hybrid index is difficult to interpret if we wish to compare the index across countries or time periods in which the mix of goods that are subject to tariffs and quotas differs.

It is desirable, therefore, to develop a second approach, leading to an index based on prices for both categories of goods. In the case of quota-constrained goods, this involves using the tariff equivalents of the quotas. The resulting index is a uniform tariff and tariff-equivalent surcharge factor. The index is the uniform proportionate change in the actual domestic prices, π, for tariff-constrained goods and the virtual prices, p^d, (that is, world prices plus tariff equivalents) for quota-constrained goods that would compensate in welfare terms for the actual change in policy instruments from (q^0, π^0) to (q^1, π^1):[9]

(9) $$\Delta(q^1, \pi^1, u^0) \equiv [\Delta: B(p^d/\Delta, \pi^1/\Delta, u^0) = 0].$$

In any application, the choice between this index and the hybrid index will depend on the quality of data available and the type of comparative exercise being undertaken.

9. The term "virtual prices" derives from the theory of rationing (Neary and Roberts 1980). For theoretical consistency, the virtual prices, like the value of Δ itself, must be evaluated at the new instruments but the old level of welfare. See Anderson and Neary (1992b) for details.

IV. Partial Equilibrium Applications of the TRI

The theoretical approach outlined in sections II and III provides a framework for computing the TRI in a wide variety of applications. To operationalize the approach, it is necessary to have a computable model of the economy under consideration. This raises a whole set of choices: the model may be partial or general equilibrium; it may be linearized around the initial equilibrium or be explicitly nonlinear; and it may be more or less disaggregated at the commodity level. In principle, the TRI can be computed for a model that adopts any combination of choices from this menu. But in practice, its focus on trade policy instruments suggests choosing a highly disaggregated model to capture the fine detail of actual protective policies. This in turn suggests implementing the TRI in either a partial equilibrium model or a general equilibrium model with a tightly specified production structure.

The first set of applications of the TRI adopted a partial equilibrium perspective with quantitative restrictions only, taking the case of imports of textiles and apparel to the United States under the Multi-Fibre Arrangement (MFA).[10] A pilot study (Anderson and Neary 1992b) considered exports from Hong Kong only. This has been extended to exports from six other countries: Bangladesh, India, Indonesia, the Republic of Korea, Mexico, and Thailand (Anderson and Neary 1994, in this issue). In each case, the year-to-year changes in the quantity-based index were estimated. Such changes are weighted averages of the changes in the quotas, where (as in the case of tariffs in equation 6) the weights depend on the quota derivatives of the constrained balance-of-trade function. The partial equilibrium context permits calculation of changes in the TRI using only readily available information on import demand elasticities. It is also straightforward to calculate separately the changes in the TRI from the perspectives of the exporting and the importing countries (the differences reflecting differences in market power and in the shares of quota rents that accrue to each country).

A key issue to be addressed in any empirical study of quantitative trade restrictions is the destination of the resulting rents. If detailed information on the mechanism whereby rents are shared between importing and exporting countries is available, it may be incorporated into the formulas for the marginal costs of tariffs and the shadow prices of quotas that are needed to calculate the change in the TRI, using the general expressions of Anderson and Neary (1992c). Typically, however, such information is not available. (Indeed, even data on export license prices are hard to come by. In the MFA study we were fortunate to have access to estimates of Hong Kong export license prices made by Carl Hamilton.) In the MFA study we assumed that all rents accrued to the exporting country, with one important exception: when the importing country imposes a tariff on a quota-constrained import, the tariff revenue is a transfer of part of the quota rents to the importing country. (Details are given in Anderson and Neary 1994, in this issue.)

10. U.S. imports of cheese have also been considered by Anderson (1991).

Table 1 presents some representative results from the MFA study. These are from the perspective of the importing country (the United States) and refer to imports from Hong Kong only. The first column gives the yearly changes in the TRI. Next, we must take account of a feature peculiar to quotas: unless quotas grow at the rate of growth of domestic excess demand for imports, the severity of the quotas increases. Hence, changes in the restrictiveness of quota policy should not be evaluated in relation to a constant quota policy but rather in relation to a neutral quota policy that would allow all permitted import levels to increase at the rate of growth of excess demand for the quota-constrained goods. Under reasonable assumptions, the growth in excess demand may be approximated by the economy's rate of growth (shown in the second column).[11] This consideration gives rise to a compensated TRI, changes in which are shown in the third column. These compensated TRI changes equal the sum of the uncompensated changes in the first column and the changes in U.S. real disposable income in the second. (Real income growth is added because it increases the restrictiveness of a given set of quotas.) The final column gives the change in the trade-weighted average tariff equivalent, using U.S. import shares as weights. It is clear that changes in this measure bear little relation to those in the TRI. Although some of the assumptions made in calculating changes in the TRI are open to question, this case study clearly demonstrates that using the TRI to evaluate changes in trade restrictiveness yields substantially different results from those obtained using the trade-weighted average tariff equivalent. The superior theoretical properties of the TRI imply that the increased restrictiveness of policy that it reveals, at least when real income growth is taken into account, is a more plausible indicator of the change in trade policy over the period than is the reduction in restrictiveness suggested by the cumulative fall in the average tariff equivalent.

Table 1. *Changes in the Trade Restrictiveness Index (TRI): U.S. Imports of Textiles and Apparel from Hong Kong, 1982–88*
(percentage change)

Year	Change in TRI	Change in real income	Change in compensated TRI	Change in average tariff equivalent
1983	−2.8	3.9	1.1	84.4
1984	4.2	6.8	11.0	−8.1
1985	−1.7	3.2	1.5	−39.2
1986	−6.6	2.8	−3.8	42.2
1987	−1.0	2.9	1.9	12.0
1988	−0.9	4.5	3.6	−53.0
Cumulative	−8.8	26.6	15.7	−22.9

Source Anderson and Neary (1994).

11 For a rigorous justification of this procedure, see Anderson and Neary (1992b).

V. MEASURING THE TRADE RESTRICTIVENESS OF DOMESTIC POLICIES

A very different application of the TRI is to the evaluation of the trade restrictiveness of domestic price policies. Such policies distort trade just as much as explicitly trade-focused policies do, a fact that is increasingly recognized in trade negotiations. Domestic price policies have featured prominently, for example, in farm subsidy negotiations in the Uruguay Round and in the North American Free Trade Agreement. Attempts have also been made to quantify their impact on trade (see OECD 1991). But the measures used to do this (known as producer and consumer subsidy equivalent indexes, or PSEs and CSEs) are just as crude as trade-weighted average tariff measures and are subject to the same drawbacks. For example, CSEs are calculated by weighting different subsidy rates by the volume of domestic consumption of each good. This gives a high weight to goods with large consumption and a low price-elasticity of demand, even though a subsidy on such goods has a small effect on either trade volume or welfare.

The theoretical refinements to the TRI required to incorporate domestic policies are complicated in detail but straightforward in principle.[12] Assume that the distortions occur in the markets for traded goods. If p and q represent the domestic producer and consumer prices, respectively, we can once again write the balance of trade as a function of these prices and of the level of utility, $B(p, q, u)$. Now, in comparing two equilibria, the TRI is again defined as the uniform scaling factor that, when applied to both consumer and producer prices, would compensate for a policy change. Formally,

$$(10) \qquad \Delta(p^1, q^1, u^0) \equiv [\Delta: B(p^1/\Delta, q^1/\Delta, u^0) = 0].$$

Once again, when the period 1 equilibrium corresponds to free trade ($p^1 = q^1 = p^*$), the TRI equals the inverse of one plus the uniform tariff, which would have the same welfare effect as the base-period producer and consumer distortions.

The theoretical measure defined in equation 10 was used in Anderson and Bannister (1992) to measure the trade restrictiveness of changes in Mexican agricultural policy between 1985 and 1989 in a partial equilibrium context. This period was one of rapid policy change, with increases in some subsidies and reductions in others. The first row of table 2 shows the yearly changes in the TRI. The index shows large increases in restrictiveness in 1986 and especially 1987, followed by major reductions in restrictiveness in 1988 and 1989. The cumulative effect of these changes is a 40.9 percent fall in trade restrictiveness during the four-year period. These changes may be decomposed into changes in the producer and consumer subsidy components of the TRI, and this decomposition in turn may be compared with the conventional PSE and CSE measures. The comparisons are given in the remaining rows of the table, where Δ^p and Δ^q denote the "true" subsidy equivalent indexes for producers and consumers, re-

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12. See Anderson and Neary (1992a) for details, where the approach is also extended to distortions in the markets for both factors of production and nontraded goods.

Table 2.   *Changes in the Trade Restrictiveness Index (TRI) and Its Components for the Mexican Agricultural Sector, 1985–89*
(percentage change)

Index	1986	1987	1988	1989	Cumulative
Changes in TRI	7.5	40.2	−40.3	−34.3	−40.9
Subsidy equivalent indexes					
Ad hoc producer subsidy, PSE	−7.4	2.4	−4.9	−5.9	−15.1
True producer subsidy, Δ^p	7.1	34.4	−31.6	−30.1	−31.2
Ad hoc consumer subsidy, CSE	−6.4	15.3	32.5	−31.0	−1.3
True consumer subsidy, Δ^q	−79.8	−11.4	69.7	−7.9	−72.0

Source: Anderson and Bannister (1992).

spectively, and PSE and CSE denote the ad hoc (average share-weighted) indexes.[13] As in table 1, there is little or no concordance between changes in the theoretically based measures and the ad hoc measures. Moreover, there is no acceptable procedure for combining the PSE and CSE to form an aggregate index, whereas this is precisely what the TRI is designed to do. Once again, the TRI seems to be a much more satisfactory method of evaluating the effects of policies on international trade.

VI. General Equilibrium Modeling of the TRI

Both of the applications discussed above have been partial equilibrium in character. Although based on a theoretically consistent framework, this procedure ignores interactions between the markets considered and the rest of the economy that are transmitted through factor markets and markets for nontraded goods. Ignoring these interactions is unlikely to present a problem if trade policy changes in a single sector or in a small group of sectors is being considered, but it is obviously unsatisfactory in the case of a wide-ranging change in trade policy. At the same time, the focus of the TRI on the fine detail of the structure of protection makes it difficult to combine with most existing computable general equilibrium (CGE) models, which tend to be highly aggregated. For example, a typical CGE model distinguishes about 20 or 30 sectors, whereas the application discussed below accommodates more than 2,000 different traded commodities. The price of this disaggregation is the need to restrict significantly the structure of intercommodity and interfactor substitution.

With these considerations in mind, and to implement the TRI in a general equilibrium context, a new CGE model was developed that uses exact functional

13. For example, the "true" producer subsidy equivalent index is defined, by analogy with equation 10, as:

$$\Delta^p(p^1, q^1, u^0) \equiv [\Delta^p: B(p^1/\Delta^p, q^1, u^0) = 0].$$

forms to calculate global changes.[14] The disadvantage of this model is that the effects of any misspecification are likely to be magnified for large changes in trade policy. The advantages are greater theoretical consistency and the ability to calculate explicitly the level of the TRI and changes in it.

The model, discussed more fully in Anderson (1993), makes a number of key assumptions. First, following Armington (1969), every traded good produced at home is assumed to be an imperfect substitute for an imported good, and domestic consumption and production are characterized by functions of the constant elasticity of substitution type.[15] By making these assumptions about the functional forms describing producer and consumer behavior, the values of only a relatively small number of key parameters need be imposed, the remainder being inferred from cross-equation constraints. Second, following Jones (1974), a single, composite, nontraded good is assumed, that good being the only one both produced and consumed at home. Thus, no exports are domestically consumed, and no imports are domestically produced. Eliminating many of the interactions between the consumption and production sides of the economy greatly simplifies the model and allows the relative price of the nontraded good to be interpreted as the real exchange rate. Third, following Jones (1971), a specific-factors structure is assumed for the domestic market: each sector uses a specific type of capital, but all draw on a pool of intersectorally mobile labor. Finally, an assumption is made concerning the destination of the rents that arise from quantitative restrictions on imports. In typical applications (unlike the MFA study discussed in section IV above) data on quota premiums are unlikely to be available. Following Krueger (1974), therefore, the convenient simplification that all the quota rents are dissipated through competitive rent-seeking is made.

Notwithstanding these assumptions, the model is in other respects very general. As noted, it can accommodate detailed information on the trade restrictions affecting a very large number of commodities, whether they are subject to tariff or quota constraints.[16] Moreover, intermediate inputs are explicitly distinguished from final goods, and they too may be subject to both tariff and quota restrictions. A further advantage of the TRI approach is that it permits the consistent aggregation of trade restrictions on final and intermediate goods in a

14 In earlier work, we experimented with a different approach, working directly with the expressions for changes in the TRI and, specifically, with the differentials of equation 8. This procedure is equivalent to calculating the TRI by linearizing the model of the economy embodied in the B function around the initial equilibrium.

15. More specifically, a constant elasticity of substitution (CES) expenditure function has been assumed for consumption; a CES cost function defined over the primary factor, labor, and intermediate inputs (both tariff-constrained and quota-constrained) has been assumed for aggregate output; and a constant elasticity of transformation production frontier has been assumed to determine the allocation of aggregate output between exports and nontraded goods. An advantage of the CES form is that it yields closed-form solutions for the virtual prices.

16. If a good is subject to both a quota and a tariff, and if the quota is binding, then the tariff is nonbinding at the margin. In this case, as already noted in section IV, the tariff serves merely to ensure that the fraction of total quota rents made up of tariff revenue is retained by the importing country.

much more satisfactory way than the traditional approach of using the effective rate of protection.

This model is used in Anderson (1993) to estimate the effects of trade reform in Colombia between 1989 and 1990. Table 3 gives the changes in Colombian trade policy between those two years, using some standard measures of trade restrictiveness. These measures show a confusing pattern. Average tariffs on all goods fell, although it should be recalled that a reduction in tariffs on quota-constrained goods reduces welfare because it lowers the share of quota rents that accrue to the domestic economy. Accompanying this was a greater dispersion of tariffs, as measured by the coefficient of variation, a significant reduction in the coverage of nontariff barriers, and an increase in the (unweighted) average level of quotas. In any case, because the composition of quota- and tariff-constrained categories changes between the two years, the standard indexes are not truly comparable. Clearly, assessing the overall thrust of the trade policy changes is extraordinarily difficult without a consistent framework for aggregating these changes.

The TRI calculations in table 4 attempt to provide just such an assessment, solving the problem of comparability by aggregating in a manner that is fully compatible with the underlying theory. The table gives changes in the TRI (compensated for real income growth) under different combinations of assumptions about the values of three key elasticities: the elasticity of final consumption demand, the elasticity of demand for intermediate inputs, and the elasticity of transformation.[17] The first row of the table shows a change in the TRI of -4.9

Table 3. *Indicators of Trade Reform in Colombia, 1989–90*

Item	1989	1990
Average tariff (index)		
Final goods	0.230	0.166
Tariff-constrained	0.092	0.100
Quota-constrained	0.237	0.208
Intermediate goods	0.185	0.151
Tariff-constrained	0.125	0.125
Quota-constrained	0.195	0.170
Coefficient of variation of tariffs		
Final goods	0.769	0.813
Intermediate goods	0.596	0.625
Nontariff barrier coverage ratio (percent)		
Final goods	90.8	57.3
Intermediate goods	76.3	34.7
Average (unweighted) change in quotas (percent)		
Final goods	n.a.	12.0
Intermediate goods	n.a.	12.0

n.a. Not applicable
Source: Anderson (1993).

17. Because of data constraints, the version of the TRI that is implemented is the hybrid index given in equation 8.

Table 4. *Sensitivity Analysis of the Change in the Trade Restrictiveness Index (TRI) for Colombia, 1989–90*

Elasticity of final demand	Elasticity of intermediate demand	Elasticity of transformation	Change in compensated TRI (percent)
1.5	1.0	1.5	−4.9
2.0	0.7	2.0	−4.8
2.0	0.7	5.0	−4.2
5.0	0.5	5.0	−4.4
5.0	0.7	5.0	−3.7

Source: Anderson (1993).

percent, implying that the overall effect of the policy changes was a modest liberalization, equivalent in welfare terms to a uniform cut in tariffs and a relaxation of quotas by 4.9 percent.[18] The remaining rows show that this conclusion is relatively robust to changes in the assumed values of the elasticities. This robustness has also been found in other applications of the TRI that have been carried out to date. Because it is only an empirical finding, of course, it needs to be replicated extensively on other data sets before it can be regarded as typical.

VII. Implementing the TRI on a Personal Computer

One additional feature of the CGE model described in the last section is that all the calculations were carried out on a personal computer in a manner that can easily be replicated. The appendix to Anderson (1993) gives a more complete description of how the CGE model has been implemented on an EXCEL spreadsheet. For each commodity, the user needs to enter data on the domestic price, the tariff rate, and the volume of imports, as well as two codes, one indicating whether the commodity is for final or intermediate use and the other indicating whether it is subject to a binding quantitative restriction. This information must be provided for two time periods. The spreadsheet program then calculates the change in the TRI between the two periods. In addition, standard measures such as the trade-weighted average tariff and the nontariff barrier coverage ratio are calculated for comparison. Of course, the second of the two periods for which data are supplied may be a hypothetical one. For example, if estimates are available of world prices and of the free-trade import levels of goods that are currently quota-constrained, the second period could be one in which all trade restrictions have been abolished. In that case, the program calculates the level of the TRI in the initial period.

As far as the underlying model of the economy is concerned, the program specifies default values of the key substitution parameters in production and

18. The uncompensated change in the TRI for these parameter values is −7.8 percent, which indicates that compensating for Colombia's real income growth rate of 3.5 percent significantly reduces the estimated trade liberalization.

consumption. These may be altered by the user, thus permitting an exploration of the sensitivity of the TRI estimates to changes in the underlying parameters. (Table 4 was produced in this way.) The computer program permits estimation of the degree of trade restrictiveness of a given trade policy in a consistent framework. It also makes possible other applications of the approach. For example, the program can easily be adapted to calculate the welfare cost of a given change in trade policy or the welfare cost of an equiproportionate tariff change sufficient to raise a given amount of revenue. Because the program fits on a single 720 kilobyte disk and can be used on a portable computer, it permits an easy assessment of trade restrictiveness with minimal data and computing requirements.

VIII. CONCLUSION

In this article, we have outlined a new approach to measuring the restrictiveness of trade policy. Our starting point was the observation that the appropriate method of aggregating individual trade restrictions to construct a single scalar index depended on the uses to which the index would be put. Because many applications of measures of trade restrictiveness deal with the impact of trade restrictions on domestic welfare, we argued that a satisfactory measure of trade restrictiveness must be closely related to standard measures of the welfare cost of protection. This led to our approach, which is a generalization of the welfare-equivalent uniform tariff, that is, the uniform tariff that would have the same welfare cost as a given nonuniform tariff structure. This approach is firmly based in economic theory and so avoids the ad hoc nature of the measures typically used in practice, such as the trade-weighted average tariff or the non-tariff-barrier coverage ratio. Of course, to implement our measure, it is necessary to assume a particular model of the economy: all our applications to date have assumed that the economy is perfectly competitive. Implementing our approach requires more data than traditional measures of trade restrictiveness, but we have developed some empirical procedures the data requirements of which are likely to be met in most developing countries.

Beyond the specific models we have developed, the TRI perspective draws attention to a number of key general issues that should be borne in mind in any empirical study of trade policy. One is that simple averages of tariff rates are unlikely to be helpful guides to the true extent of trade restrictiveness. Another is that the destination of the rents that arise from quantitative restrictions is an important determinant of their welfare impact and their restrictiveness. A third is that the restrictiveness of quotas depends crucially on the environment in which they apply and hence on the values of the exogenous variables that determine the economy's equilibrium. Because the methods described in this article attempt to deal with these issues in a consistent framework, we claim that these methods, however crude, represent a significant advance over any others that are available. Moreover, because of recent developments in computer technology, our methods can readily be implemented for practical problems.

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