Partial Equilibrium Measures of Trade Restrictiveness

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Abstract

This paper examines the new partial equilibrium form of the Trade Restrictiveness Index recently used by the World Bank to measure the average level of tariffs and other restrictions on imports into a country, and the partial equilibrium form of the Mercantilist Trade Restrictiveness Index. The analysis is extended in two directions. First, we consider how non-tariff measures should be incorporated in the indices. This requires new concepts of the welfare-equivalent tariff rate and the import-equivalent tariff rate. Second, we look at the bias due to the neglect of general equilibrium effects. Australian and Japanese tariff data are used to illustrate the computation of the indices.

functions eliminate all cross-market demand and supply effects of tariffs but it is an index which can be readily calculated without the use of a computable general equilibrium model. Anderson and Neary (2005) develop the analogous partial equilibrium form of the MTRI. The MTRI is the uniform tariff rate that yields the same level of imports as the differentiated structure of restrictions.

Recently, a group of economists at the World Bank has used this form of the TRI to calculate new measures of the TRI for 88 countries in the 1990s (Kee, Nicita and Olarreaga, forthcoming b). This is an audacious but inspired approach to the measurement of the TRI. Following this method, Irwin (2007) has calculated a time series of TRI for the US economy over the period from 1859 to 1961. Although these calculations do neglect general equilibrium effects, nevertheless, they result in measures which are a substantial improvement over standard measures of the average tariff level because they properly measure the welfare loss in own markets of each tariff. Kee, Nicita and Olarreaga (forthcoming b) also estimate the partial equilibrium form of the MTRI.

Section I reviews the partial equilibrium forms of the TRI and the MTRI. Section II shows how the TRI and MTRI should be extended to cover non-tariff measures. This requires new concepts of the welfare-equivalent tariff rate and the import-equivalent tariff rate. Section III presents an expression for the difference between the partial equilibrium and the general equilibrium forms of the TRI. Some of these results are illustrated using Australian and Japanese data in Section IV. Section V summarises the findings.

I

To calculate an average of differentiated levels of trade restrictiveness, we require a scalar index which combines the levels of restriction in all markets. The first issue that must be resolved is the purpose of the index. Is the index intended to measure the average level of restriction of international trade, or the effect on production or the total cost to consumers and producers of the tariffs which distort the border prices? In most countries the debate has been about the costs of protection to the economy. Consequently, the logical choice is a measure which indexes the welfare costs to the economy of a differentiated structure of restrictions, the TRI. However, if the focus is on the effects of the restrictions on other countries, the appropriate measure is the MTRI.

Consider first the partial equilibrium form of the TRI and assume that all trade restrictions are *ad valorem* tariffs restricting imports of at least some of the importable commodities. Assume too that all import demand functions are linear functions of own price alone. Under these assumptions, Feenstra (1995, p. 1562) showed that the TRI reduces to the simple form

$$T = [\sum_{i=1}^{n} t_i^2 w_i]^{\frac{1}{2}} \quad \text{where } w_i = (p_i^{*2} \mathrm{d}m_i / \mathrm{d}p_i) / (\sum_i p_i^{*2} \mathrm{d}m_i / \mathrm{d}p_i) \qquad (1)$$

i indexes the goods subject to tariff distortions and t_i is tariff rate on good i. The weights, w_i, are positive and sum to unity. They reflect the shares in the changes in the value of imports induced by the tariffs. It is usual to rewrite the weights as

$$w_i = \varepsilon_i^* (p_i^* m_i^*) / \sum_i^n \varepsilon_i^* (p_i^* m_i^*) \qquad (2)$$

where $\varepsilon_i^* < 0$ are the point elasticities of the import demand function in the free trade situation and (p_i

where $\overline{t}^{2}$

this follows immediately by regarding the square of the TRI as the mean of squares of the tariff rates

$$T^2 = [\sum_{i=1}^{n} t_i^2 w_i] = E[t_i^2] = E^2[t] + Var[t]$$

If, however, we assume that the import dema country, the appropriate index is the MTRI. The partial equilibrium form, *I*, is defined implicitly by the equation

$$\sum_{i=1}^{n} p_i^* m_i(p_i^*[1+t_i]) = \sum_{i=1}^{n} p_i^* m_i(p_i^*[1+I]) \qquad (12)$$

Assume again that the import demand function is a linear function of own price $m_i = \alpha_i - \beta_i p_i$, with $\alpha_i > 0, \beta_i > 0$. Substituting this equation in (12) and solving for *I*, we have

$$[\ {}^{n}_{1}\ \ ] \quad \text{where} \quad (\ \ {}^{*2}\ \ )/(\ \ {}^{*2}\ \ )$$

$$a_i = (\mathrm{d}x_i / \mathrm{d}p_i)/(\mathrm{d}m_i / \mathrm{d}p_i) \text{ and } b_i = -(\mathrm{d}y_i / \mathrm{d}p_i)/(\mathrm{d}m_i / \mathrm{d}p_i)$$

Thus, the welfare-equivalent tariff rate is the mean of order two of the producer price and consumer price distortions, the weights being their share of the import response to the change in price.

As an example, suppose the production of a good is assisted only by an output-based subsidy. Then the welfare-equivalent rate will be less than the producer price-equivalent rate (= the *ad valorem* subsidy rate). If, further, the domestic demand and supply curves have the same slope (ignoring sign), with a tariff $\mathrm{d}m_i / \mathrm{d}p_i = \mathrm{d}x_i / \mathrm{d}p_i - \mathrm{d}y_i / \mathrm{d}p_i = -2\mathrm{d}y_i / \mathrm{d}p_i$. The welfare-equivalent rate is $t_i^E = (½s^2)^{½}$ $=\sqrt{(1/2)}a$ or 0.71 per cent of the subsidy rate. As a second example, suppose a good is assisted by a combination of a 20 per cent tariff and a subsidy of 20 per cent in *ad valorem* terms. The consumer price increases by 20 per cent and the producer price by 40 per cent. If, again, the domestic demand and supply curves have the same slope, the welfare-equivalent rate is 31.62 ($=\{0.5(0.2)^2+0.5(0.4)^2\}^{1/2}$) per cent. This is 79 (31.62/40) per cent of the producer price effect.

The welfare-equivalent rate is less than the producer price-equivalent rate (= the *ad valorem* subsidy rate) in these examples because the tariff reduces welfare both through the increase in the producer price and the associated production loss and through the increase in the consumer price and the associated consumption loss.

Note that, in the second example, the effects of both measures on the producer price is additive. In symbols, let u_i denote the subsidy rate, expressed as a percentage of the world price. Then $p_i = p_i^*(1 + u_i + t_i) = p_i^*(1 + s_i)$ where $s_i = u_i + t_i$ is the proportional rate of change of the producer price. This is the *producer price-equivalent* rate. It is exactly the sum of the separate effects of the subsidy and the tariff rate.

In other cases, the costs of the distortions are not additive. For example, suppose now that the producers are assisted by a 10 per cent tariff and a quota that if applied alone would raise producer and consumer prices by 20 per cent. Now the combined effect of these two measures on producer and consumer prices is only 20 per cent.[3]

If, instead, the tariff rate on the same good is high enough, the quota will not be binding and producer and consumer prices rise only by the margin of the tariff. In still other cases, one measure or a combination of measures may be trade-prohibitive. In these cases, the relevant rate is the prohibitive tariff rate, $t_i^{\dagger}$.

The TRI in the presence of both tariffs and ntms can now be obtained by putting these welfare-equivalent tariff rates and prohibitive tariff rates into Equation (11). That is, Equation (11) can now be read with the tariff rates being t_i in the case of a good protected solely by a tariff, or t_i^E in the case of a good protected by one or more measures or $t_i^{\dagger}$ in the case of a good protected by a prohibitive tariff or ntm, as appropriate.

A similar procedure can be used to derive the import-equivalent tariff rate, t_i^I. When the market is distorted by a combination of measures that distort the consumer and producer prices differentially, the change in imports is

$$\Delta M_i = p_i^{*2} r_i dx_i / dp_i - p_i^{*2} s_i dy_i / dp_i \qquad (17)$$

with $r_i \neq s_i$. The import-equivalent tariff is defined by the equality

$$p_i^{*2}(dx_i / dp_i) r_i - p_i^{*2}(dy_i / dp_i) s_i = p_i^{*2}(dm_i / dp_i) t_i^I$$

Hence,

$$t_i^I = a_i r_i + b_i s_i \qquad a_i = (\mathrm{d}x_i / \mathrm{d}p_i)/(\mathrm{d}m_i / \mathrm{d}p_i) \text{ and}$$

$$b_i = -(\mathrm{d}y_i / dp_i)/(dm_i / dp_i) \qquad (18)$$

Thus, the import-equivalent tariff rate is a weighted mean of the rates of distortion of consumer and producer prices.

In the first example in which a good is assisted only by an output-based subsidy and the demand and supply curves have the same slope, we find again that the import-equivalent tariff rate is not equal to the producer price-equivalent tariff rate. In fact, $t_i^I = ½a$. It is exactly one half this rate. The explanation is simple. The import tariff affects both the domestic demand and the domestic supply whereas the subsidy affects on the supply side of the market.

As the second example, the good is assisted by a combination of a 20 per cent tariff and a subsidy of 20 per cent in *ad valorem*

Consider first the TRI. In the partial equilibrium form, the import demand functions are a function of own price alone, $m_i = m_i(p_i, u)$. Equation (7) above gives the exact area of the triangular shape under the import demand curve for one good. With n importable goods subject to some level of tariff, the aggregate loss is

$$L = -\sum_{i=1}^{n} \int_0^{t_i} p_i^{*2} \tau_i \mathrm{d}m_i / \mathrm{d}p_i \mathrm{d}\tau_i \tag{19}$$

In the general equilibrium form, the general equilibrium import demand functions are

$$m_i = m_i(p, u) \tag{20}$$

where $p = (p_1, \ldots, p_n)$ is the vector of prices of the n goods and u is the chosen utility level. When the prices of tradeables change because of a regime of tariffs, the generalised surplus measure is the line integral

$$L = -\int_0^{t} \sum_{i=1}^{n} p_i^{*2} \tau_i \mathrm{d}m_i / \mathrm{d}p_i \mathrm{d}\tau_i \tag{21}$$

where the upper limit of the integration, t, is the set of tariff rates in the tariff-distorted situation.

This line integral in Equation (21) can be compared with the sum of the integrals for the independent dem

rate required to equate the right-hand sides of the two equations. Hence, the general equilibrium form of the TRI can be written as

$$G = \left(\sum_{i=1}^{n} e_i t_i^2 w_i \right)^{1/2} \qquad (24)$$

e_i = e_i/e is the normalised difference between the general equilibrium assessment of the effect on the market for h r

$$E[t] + Cov[t] \quad \text{if } E[e\ ]\ \ 1 \qquad (28)$$

In the case of the MTRI, it is the tariff rates, not the tariff rates squared, that enter the index. The bias due to the neglect of general equilibrium effects will, therefore, depend on the covariance between the understatement or overstatement of the effects on imports in each market and the tariff rates.

IV

The use of the partial equilibrium forms of the TRI and the MTRI can be illustrated from data on tariff rates. Computation of the partial equilibrium forms requires data on imports and duty collected by tariff level and the elasticities of import demand. The tariff revenue and import data should be disaggregated to the level of the tariff line, which is the level at which the tariff classification determines the tariff rate that is applied. If the data are collected at a more aggregated level, the TRI will be underestimated as it will omit the intra-group variance of tariff rates.

As an example, Australia publishes import data at the tariff item level. Currently the level at which the tariff rates are specified is the 8-digit level of the Harmonised System. To examine the effect of using a TRI in place of the standard arithmetic mean index of tariff levels, we consider the data for one year, 2001-2002.

The relative frequency distribution of tariff rates is shown in Figure 1. The distribution is bimodal. The first and highest mode is the zero rate; 58 per cent of imports by value entered duty-free in that year (2001-02). The second mode is 5 per cent which accounts for 22 per cent of imports by value.

For this year we compute various estimates of the average level of tariffs in this distribution. We start with the usual statistic of the average duty, obtained by dividing the total duty collected by the total value of all actual import clearances and expressing the quotient as a percentage.[6] By simple rearrangement of terms, this is

situation weights, we can isolate the effects of changing the weighting system from those of changing the formula for the mean.

Four estimates of the average rate of duty for all imports into Australia in the year 2001–02 were calculated (Table 1). The estimate in row 1 of 2.7 per cent is the crude statistic calculated by simply dividing total duty collected by the total value of all import clearances. This is the figure usually cited for the average tariff.

With both adjustments, the average tariff in row 4 is now 5.0 per cent. This is a much higher number. Although their calculations differ in some respects from those in Table 2, Kee, Nicita and Olarreaga (forthcoming b) and Irwin (2007) also obtained TRI estimates which were much larger than the conventional arithmetic mean measures.

The other rows allow us to break this difference into a component due to the tariff adjustment of the weights and a component due to the use of the mean of order 2 rather than the mean of order 1. Row 2 provides the arithmetic mean calculated using the tariff-adjusted protected trade weights (i.e., the estimated free trade weights) rather than the actual protected trade weights. The estimate is 2.5 per cent. Thus, using the tariff-adjusted (or corrected) distorted trade weights makes little difference.

This adjusted rate is actually the MTRI. The MTRI is closely approximated by the standard measure of the average tariff level.

Comparing Row 3 with Row 1, or Row 4 with Row 2, the effect of using the mean of order 2 rather than the mean of order 1 can be seen. In the first comparison (with protected trade weights) the average is almost doubled and in the second (with protected trade shares adjusted for the tariff rates) it is doubled. Thus, the adjustment for the formula used to calculate the average produces the larger changes in the average tariff levels. This calculation shows the vital importance of entering the tariff rates properly.

The difference between these two components is to be expected. In general, the mean of order two is more sensitive to errors in the rates of distortions than to errors in the weights. Indeed, partially differentiating *T* with respect to ε_i and then t_i , one finds that the elasticity of *T* with respect to t_i is twice that with respect to ε_i . Consequently, more effort should be put into calculation of the rates of distortion.

Non-tariff measures are important in several sectors of the economy but especially so in agriculture. To illustrate the insight provided through Equation (16) on the correct value of the tariff equivalent, WTO and OECD data for Japan were used. Applied tariff rates, and specific tariffs were obtained for the year 2005 on nine commodities at the HS6 level from the WTO database (WTO, 2008). From the OECD PSE/CSE database (OECD, 2008), nominal rates of protection were obtained for producers and consumers. Nominal rates of assistance were calculated using the producer support estimates from that database.[7]

A comparison of the applied tariff rates and the nominal rates of assistance provided an indication of which commodities were supported by domestic instruments in addition to tariffs. Of the nine commodities chosen, three were assisted by *ad valorem* tariffs only (beef and veal, poultry meat and mandarin oranges), one was supported by a domestic subsidy only (soyabean) and five were supported by a combination of tariffs and domestic instruments (cabbage, wheat, rice, strawberries and onions). For wheat and rice, the tariffs imposed are both *ad valorem* and specific. The latter were converted to *ad valorem* equivalents using the prevailing border prices.

The tariff equivalents of border and domestic support were calculated using Equation (16) for the five commodities subject to a mixture of tariff and ntms and the one commodity subject to a domestic instrument only. In place of the slopes of the domestic demand, supply and import functions, the corresponding elasticities were[8] used. The elasticities of the domestic functions were obtained from an UNCTAD database (UNCTAD, 2008) and the import elasticity was calculated as $\varepsilon_i = \delta_i x_i / m_i - \sigma_i y_i / m_i$, where, for the *i*th commodity, δ_i is the price elasticity of domestic demand, x_i is the quantity demanded, σ_i is the price elasticity of domestic supply, y_i is the quantity supplied and m_i is the quantity imported.

The values for r_i and s_i (in Equation (16)) were the values for the nominal rates of assistance to consumers and producers, respectively, that were calculated from the OECD database (see Table 2). The observed (distorted) values of production, consumption and imports were taken from the OECD database and adjusted using the procedure in Equation (30). The computed values of t_i^E for the six commodities, and the applied tariff, t_i, for the remaining three commodities are shown in Table 2. It should be noted, following from the discussion in section II above, that the tariff-equivalent rate for soyabean is not the domestic subsidy rate, s, of 1.11, but a rate of approximately one half of that value, namely, 0.57.

Making use of Equations (11) and (13), provides the TRI and the MTRI, respectively, for this subset of agricultural products (Table 2). The value of the TRI is 1.57. This means that the uniform, *ad valorem* tariff rate that is welfare-equivalent to all forms of intervention is 157 per cent. On the other hand, the value of the MTRI is 0.84, meaning that the uniform, *ad valorem* tariff rate that is import-equivalent to all forms of support is 84 per cent.

To investigate the sensitivity of these results to the values of the elasticities, the weights were re-calculated using Equation (31) in which the elasticities do no appear in the calculation of the weights. The resulting values for the TRI and the MTRI were 1.38 and 0.69, respectively. Hence, the TRI is more sensitive than is the MTRI to the elasticities and, thus, the weights. The more important conclusion that has been illustrated again by these data is that, if the welfare effect of intervention at the border and behind the border is the variable of interest, then it is vital to use the mean of order 2 and not the mean of order 1. The mean of order 1 grossly underestimates the welfare losses generated by the policy instruments of intervention.

V

International trade theory indicates that empirical researchers should use the TRI to measure average levels of tariffs and other trade restrictions if they are concerned with the welfare losses due to a regime of trade restrictions. They should use the MTRI if they are concerned with the effects on imports.

Other writers have shown that the partial equilibrium form of the TRI can be derived under the assumption that all import demand functions are linear. It turns out to be the mean of order two, not the arithmetic mean. This mean incorporates Harberger’s power of two, the result that the welfare loss from a tariff is proportional to the square of the tariff rate. This feature captures the much larger welfare losses asstlarger95D-.0 TD40 TD.e TD.e TD.e TD.e Te TDd differential producer and consumer price effects, the welfare-equivalent and the import-equivalent tariff rate are not the same.

The partial equilibrium form may either underestimate or overestimate the general equilibrium forms. The bias depends on the covariance between the normalised error terms and the tariff rates.

For a sample of Australian tariff data in 2001-02, adjusting the order of the mean from 1 to 2 increases the measured levels of the average tariff while adjusting the weights decreases it marginally. The effect of using the mean of order two is particularly great. Both adjustments together almost double the measured level of the average tariff compared to the arithmetic mean with actual import weights. However, the MTRI is closely approximated by the standard measure of the average tariff level. Some examples of ntms using Japanese data for selected agricultural commodities indicate that the calculation of the welfare-equivalent tariff or the import-equivalent tariff rate, as appropriate in place of the standard producer price-equivalent rate is crucial as these rates diverge considerably.

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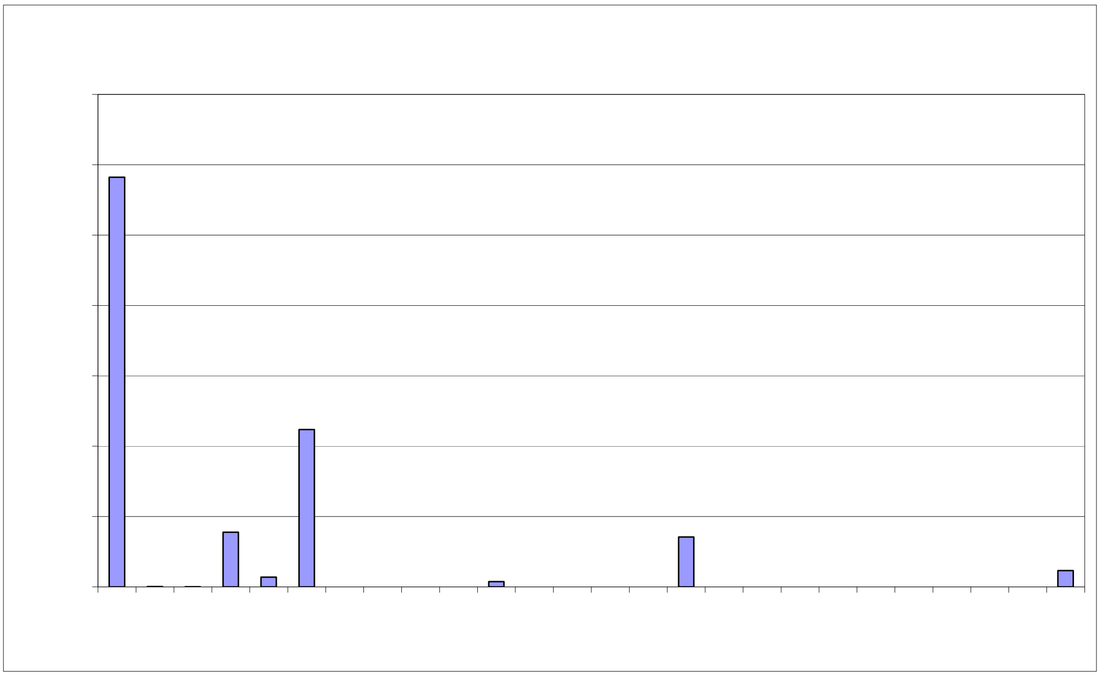

Table 1: Estimates of the Average Tariff Rate, Australia, 2001-02

		(%)
1.	Arithmetic mean (Duty collected/total import clearances)	2.7
2.	Arithmetic mean with tariff-adjusted protected trade weights (MTRI)	2.5
3.	Mean of order 2 using actual import weights	5.3
4.	Mean of order 2 using tariff-adjusted protected trade weights (TRI)	5.0

Table 2: Estimates of the Average Tariff Equivalent of Tariffs and NTMs:

Selected Agricultural Commodities in Japan

HS6 code	Product	Nature of Support	Tax/subsidy rates[a]	Welfare tariff-equivalent	Import tariff-equivalent

ENDNOTES

[1] By changing the trade weights to welfare weights, the mean of order 2 can be written as a mean of order 1. The weights in this arithmetic mean are the marginal effects on welfare of a change in the tariff rate. They are themselves an increasing linear function of the tariff rate. This is the partial equilibrium analogue of the result obtained for the general equilibrium form by Anderson and Neary (1994, Equation (6)).

[2]