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A Trade Restrictiveness Index of the Level of Protection in Australian Manufacturing

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Abstract

In this paper we provide a new 31 year time series of the level of protection in the Australian Manufacturing Sector. The index used is the partial equilibrium form of the Trade Restrictiveness Index recently developed by the World Bank. This is the theoretically correct welfare-based average of levels of nominal protection provided to sub-industries. The paper outlines the index and its properties. The method of calculation uses series of the mean level of protection and its dispersion, which have been published by the Productivity Commission. Some comments are made on the insights gained from the new series.

A Trade Restrictiveness Index of the Level of Protection in Australian Manufacturing

1. Introduction

Australia is better served with estimates of the levels of protection of import-competing producers than any other country. Since 1968-69 the Tariff Board and its successor authorities have provided annual estimates of the average level of nominal and effective assistance received by producers. These now give us a time series covering over 35 years.

Recent developments in international trade theory have indicated that the indices that have been used are not theoretically correct. Anderson and Neary (1994 and 2005) showed that the correct measure of the welfare costs of assistance measures is the Trade Restrictiveness Index (TRI). The TRI is the uniform (nominal) tariff which yields the same utility as the differentiated structure of tariffs and other measures. This index of the average level of trade restrictions is a true (utility-constant) index and a general equilibrium measure which takes account of all relationships across markets in both demand and supply, including input-output relations.

However, this measure requires a computable general equilibrium model for each year in the series and, since we do not have a sequence of cge models over time, a time series is not feasible. More recently, a group of economists at the World Bank have shown how a partial equilibrium form of the TRI can be used to calculate estimates of the TRI (Kee, Nicita and Olearraga, forthcoming, a and b). Irwin

(2007) has used this method to calculate a time series of the average tariff for the US economy over the period 1859 to 1961.

In this paper we use the partial equilibrium form of the TRI to recompute the time series of the average levels of nominal assistance going to producers in the Manufacturing Sector of Australia over the period 1973-74 to 2003-04. The Manufacturing Sector is used because it is the import-competing sector with only a small proportion of its output exported and its imports account for 90-95 per cent of total imports over the period. Section 2 outlines the TRI index and its properties. Section 3 reports the new estimates of the average level of nominal assistance in the Manufacturing Sector and Section 4 comments on the insights from the new series.

2. The Trade Restrictiveness Index

The conception by Anderson and Neary of the TRI was a major breakthrough in the theory of tariffs. In fact, the index is a weighted arithmetic mean of the tariff rates with the weights being the marginal welfare losses associated with a change in the tariff on each good. An increase in the index implies a loss of welfare. It provided the welfare-based index that international economists had long been seeking.

A second breakthrough was made with the development of the partial equilibrium form of the index by Feenstra (1995). It is the special case of the TRI in which all cross-price effects are zero and the import demand functions, as functions of own price alone, are linear. This index can also be derived form partial equilibrium theory (see Lloyd and MacLaren, 2007). In this paper, only those features of the index which are needed for the calculation of the series are provided. Anderson and Neary (2005) give a full treatment of the general equilibrium form of the TRI.

While the TRI index was devised to measure the restrictiveness of distortions in the whole import-competing sector, it can equally be used to measure the restrictiveness of distortions in any sub-sector, say, import-competing manufactures. In this case, it is the uniform (nominal) tariff rate which yields the same utility as restrictions in this sub-sector, holding constant all restrictions in other sectors. In this paper, we apply the index in this way.

In the case of zero cross-price effects, 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. t_i are the nominal ad valorem rates of tariffs, p_i^* are the world prices and m_i are the import demand functions. w_i are the weights attached to the square of the tariff rate for each good. They are proportional to the marginal responses of imports to changes in prices and the associated loss of welfare. The derivation and properties of this index are discussed in Lloyd and MacLaren (2007).

To make the index operational, it is usual to rewrite the weights as

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

ε_i^* (< 0) are the elasticities of the import demand function in the free trade situation. $(p_i^* m_i^*)$ are the values of imports in the free trade situation. Alternatively, it is possible to rewrite the weights in terms of the elasticities and the values of imports in the protected trade situation. Using the relation between the domestic price and the world price to the world price, $p_i = p_i^*(1+t_i)$, and the definition of the elasticities, the weights in Equation (1) can be rewritten as

$$w_i \;=\; [\varepsilon_i/(1+t_i)](p_i^* m_i)/\sum_i^n [\varepsilon_i/(1+t_i)](p_i^* m_i) \qquad (3)$$

Here ε_i and ($p_i^* m_i$) are the elasticities and the values of imports in the protected trade situation (at world prices). This expression for the weights has the considerable advantage that the import values are the observed values.

The restriction on the import functions eliminates all cross-market demand and supply effects of tariffs. In particular, it leaves out all input-output relations that go into calculations of effective rates. This is a serious limitation[1] but it gives us an index which can be calculated without the use of a cge model and a times series of the protection (assistance). Using the weights in Equation (3), all of the data required for calculation of this form of the TRI is readily available.

This index is in fact the mean of order two, not the arithmetic mean (which is the mean of order one). The arithmetic mean, with the same weights, is

$$T = \left(\sum_{i=1}^n t_i w_i\right) \qquad (4)$$

The reason for using the mean of order two stems from the welfare economics of tariffs. For each good, the welfare loss from the imposition of a tariff is the area of the triangle under the (income-compensated) income demand function. The loss from a tariff is proportional to the *square* of the tariff rate. This holds because the tariff rate determines both the price change and the quantity response to this change.

The index can readily incorporate non-tariff measures (ntms). For those goods which are protected by an ntm or ntms (and possibly a tariff), we need the welfare-equivalent tariff rate, t_i^E. This is the ad valorem rate which would yield the same loss as the measure or combination of measures. As one example, suppose a good is assisted only by an output-based subsidy. Then the welfare-equivalent rate will be less than the price-equivalent rate (= the ad valorem subsidy rate). If, further, the domestic demand and supply curves have the same slope (ignoring sign), the welfare-equivalent rate is 0.71 (=√(1/2)) 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 31.2 per cent. (This the equal-weighted mean of order two of the changes in the consumer and producer prices, $\{0.5(0.2)^2+0.5(0.4)^2\}^{1/2}$.)[2]

Similarly, for a good subject to a prohibitive tariff or a prohibitive level of some ntm, the prohibitive tariff rate, $t_i^\dagger$, is entered. This is the tariff rate which would eliminate all imports.

Equation (1) 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.

One further property of the index is required for our calculations. Following Kee, Nicita and Olarreaga (forthcoming b, Equation (29)[3], we can regard the square of the TRI as the product of the two jointly distributed “random variables”, t^2 and $\tilde{\varepsilon}$ with observed values t_i^2 and $\tilde{\varepsilon}_i = \varepsilon_i / \sum_i \varepsilon_i v_i$. $\tilde{\varepsilon}$ is the normalised elasticity. Now

$$T^2 = [\sum_{i=1}^{n} \tilde{\varepsilon}_i t_i^2 v_i]$$

where

$$v_i \; = \; [(p_i^* m_i)/(1+t_i)] / \sum_i^n [(p_i^* m_i)/(1+t_i)]$$

are the trade shares, with the observed protected trade quantities valued at world prices, multiplied by a tariff factor. Taking the expectation of this function and using the definition of the covariance and variance, we have

$$T^2 = E[\;\varepsilon t^2]$$

$$= E^2[t] + Var[t] + Cov[\tilde{\varepsilon}, t^2] \qquad (5)$$

This gives us the important result that the TRI is an increasing function of the arithmetic mean (using v_i as weights) and the variance of the tariff rates and the covariance between the elasticities and the squares of the tariff rates.

The expression in Equation (5) requires that we know the elasticities of the import demand functions. If these are not known, we can make the assumption that they are all equal. In this case, the weights reduce to

$$w_i = [(p_i^* m_i)/(1+t_i)](p_i^* m_i) / \sum_i^n [(p_i^* m_i)/(1+t_i)]$$

Now,

$$T^2 = [\sum_{i=1}^{n} t_i^2 w_i] = E[t_i^2] = E^2[t] + Var[t] \qquad (6)$$

T^2 is the statistic known as the mean square and T is its square root. The covariance term is now zero.

Noting that $Var[t] \geq 0$,

$$T > E[t] \text{ iff } Var[t] > 0.$$

The expression in Equation (6) shows that the uniform tariff is an increasing function of the variance and of the arithmetic mean (using w_i as weights) of the tariff rates. This is an important result. The variance captures the role of spikes and peaks in the tariff rates. The Tariff Board and its successors have been aware that variation around the average of the nominal and effective rates of assistance imposes additional costs on the economy. This is known in Australia as the "disparities" issue. "The larger the disparities in effective assistance levels, the greater the potential for resources to be used in activities which do not maximise economic welfare." (Industry Commission, 1995, p. 39) Hitherto, it did not know, however, how to combine these "disparities" with the measures of the average.

The expression in Equation (6) provides an intuitive explanation of why it is necessary to measure tariffs at the level of the tariff line and not at a more aggregate level. It also gives us an expression which can be used to calculate the partial equilibrium form of the TRI when the arithmetic mean and variance of the tariff rates are known.

3. The New Estimates

Equation (6) provides a form of the partial equilibrium TRI that can be used to construct a series of the average level of assistance to producers in the Manufacturing Sector in Australia. The measure is

$$T = \{E^2[t] + Var[t]\}^{1/2} \tag{7}$$

The Tariff Board and its successor authorities have complied annual estimates of the rates of assistance received by Australian manufacturers since 1968-69. The relevant series is the "Average nominal rates of assistance on outputs, manufacturing industries". These estimates are made at the 4-digit level of the ASIC code and aggregated to the 2-digit Manufacturing Sub-divisions and then to the Total Manufacturing level.[4] The coverage of measures is broad. In addition to all tariffs, the estimates include assistance provided by all major non-tariff measures when applied – including quantitative import restrictions, production subsidies, local content schemes and certain export incentives – but there were some exclusions in this sector such as, all assistance provided by Commonwealth, State and local authorities through budgetary outlays and tax expenditures (see, for example, Industry Commission, 1995, chapter 2). They have also made estimates of the sector-wide mean and standard deviation of these covered measures.

Table 1 provides the Tariff Board/IAC/IC/PC estimates of the mean and standard deviation of the assistance to producers in the Manufacturing Sector from 1968-69 to 2003-04. No estimates of the variance or standard deviation were reported by the Tariff Board for the years 1969-70 to 1972-73. This gives us a 31 year series of the mean and standard deviation for the Manufacturing Sector from 1973-74 to 2003-04. An estimate of the partial equilibrium TRI, using the index in Equation (6), for this period is provided in Table 2.

This series of the TRI departs from the theoretically correct TRI in two respects. First, the conversions of the ntms to ad valorem rates are the usual price equivalent ad valorem rates, that is, the percentage change in producer prices. However, they should be welfare-equivalent tariff rates. In the case of quantitative restrictions these are the same. But in the case of subsidies, which have a direct effect only on the supply side of the market with zero effect on the demand side of the market, the welfare-equivalent rate is less than the price-equivalent rate (= the ad valorem subsidy rate), as noted above. This imparts an upward bias to the estimates of the average nominal rates and the TRI. Second, in calculating the nominal rates of assistance the authorities have used (protected situation) production weights (FOB value of outputs) (Industry Commission, 1995, p. 49) whereas the TRI calls for import weights. It is not possible to assess the bias due to this weighting.

However, the bias due to the combined effects of these procedures is likely to be small. The first factor is more important because the mean of order two is more sensitive to errors in the rates of distortions than to errors in the weights (see Lloyd and MacLaren, 2007). 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 two times that with respect to ε_i. However, the upward bias due to the incorrect use of price-equivalent tariff rates rather than welfare-equivalent tariff rates is small as estimates by the Industry Commission/Productivity Commission show that about 90 per cent of the assistance to producers comes from tariffs. The resulting TRI estimates are good estimates and much better than those available for any other country, especially with respect to the coverage of ntms and the fact that the tariff equivalents have been estimated directly by price comparisons rather than econometrically as in most countries.

The series of the arithmetic mean and the TRI measures of average nominal assistance are graphed in Figure 1. The mean level of assistance to the sector is the series of average nominal assistance to outputs calculated by the authorities. The TRI is the series we have calculated. Both series show the breaks due to the changes in the methods used by the authorities to make estimates of assistance.

Comparison of the arithmetic mean with the TRI shows the effect of moving from a mean of order 1 to a mean of order 2. As expected (from Equation (7)), the TRI series lies above the series for the average nominal rate of assistance on outputs. It also exhibits a more pronounced rise in the early eighties. This was due to an increase in the variance during that period. The TRI has declined more rapidly than the mean since the mid-eighties, indicating a more rapid gain in welfare than that suggested by the series of the mean.

4. Insights from the New Index

There are insights to be drawn from these new estimates. First, the measures of the average levels of assistance commonly cited, though admirable by comparison with those available anywhere else, are misleading. They under-estimate the average levels considerably. This is due to the neglect of the "power of two", the higher welfare costs of high and peak levels of assistance of Australian manufacturers.

Second, the measures used in the past have not identified very clearly the turning points of the series. From the point of view of public policy, perhaps the critical question is when did the series peak? The previous series of average rate of assistance to manufacturers shows an almost uninterrupted decline since the series began in 1968-69 (Table 1). The preferable TRI series, however, rose clearly over the period from 1974-75 to 1982-83. The reason for this difference is that the average level declined during this period but the variance increased. This divergence in the direction of change in the arithmetic mean and the variance reflects the ambiguity of assistance policy during this period, with some rates being increased and some decreased. The TRI series has declined steadily from 1982-83.

The third important issue is the influence of political parties on assistance reform. Since at least the Nineties both the Coalition Government and the then Labor opposition have been committed to further reforms, with the occasional backsliding, chiefly in the TCF and Automotive industries. During the Seventies and the first half of the Eighties, however, all Australian governments were uncertain about the direction of change of industry assistance. The TRI series actually peaks in the last years of the Fraser Government. It has declined steadily since 1983-84, despite the introduction of the Button Plans for the automotive and TCF industries in 1985 and 1986 and some associated increases in tariff rates and ntms in these industries (see Productivity Commission, 2003, Appendix E).

Finally, these insights indicate that there would be high returns on more research into the TRI for Australia. The figures in Table 2 should be regarded as preliminary estimates. They have taken advantage of the estimates of the mean and variance of levels of assistance that the Productivity Commission has already published. These estimates could be refined by calculating the TRI directly from Equation (1) with the weights in Equation (3). This would require making calculations of the consumer tax rates implied by tariffs and ntms, using import weights rather than production weights and possibly using estimates of import elasticities. The Productivity Commission already has the data needed to calculate the consumer tax rates. The Productivity Commission has had to make annual estimates of nominal and effective rates of assistance. Calculating the TRIs is a natural extension of this programme. Similarly, they could calculate TRIs for the Agricultural sector and for all imports combined.

REFERENCES

Anderson, J. E. and J. P. Neary 1994, 'Measuring the Restrictiveness of Trade Policy', *The World Bank Economic Review*, vol. 8, pp. 151-169.

Anderson, J. E. and J. P. Neary 2005, *Measuring the Restrictiveness of International Trade Policy*, The MIT Press, Cambridge, Massachusetts and London, England.

Feenstra, R. C. 1995, 'Estimating the Effects of Trade Policy in *Handbook of International Economics* vol. 3, eds G. N. Grossman and K. Rogoff, Elsevier, Amsterdam.

Industry Commission 1995, *Assistance to Agricultural and Manufacturing Industries*, Information Paper, Industry Commission, Canberra.

Irwin, D. 2007, 'Trade Restrictiveness and Deadweight Losses from U.S. Tariffs, 1859-1961', National Bureau of Economic Research Working Paper No. W13450, Cambridge, Massachusetts.

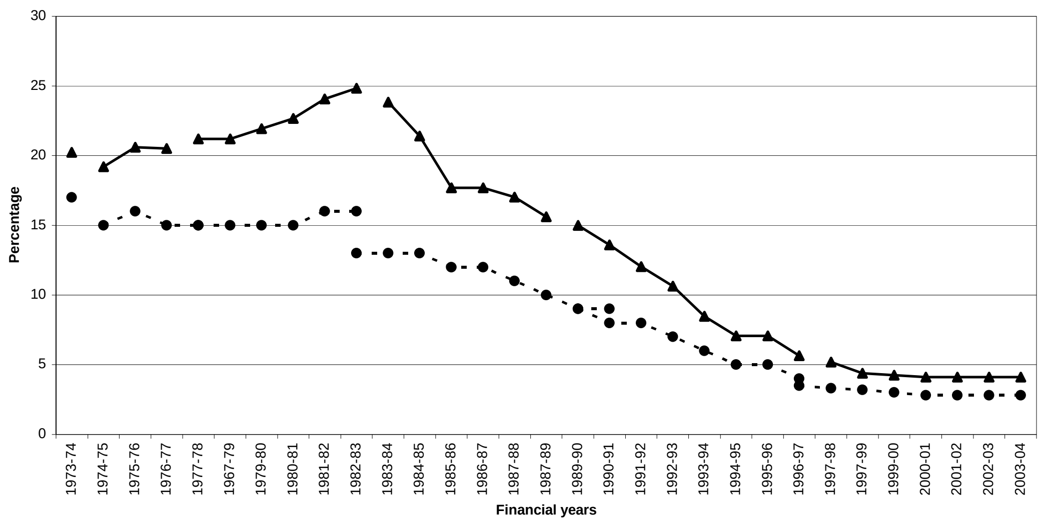
Kee, H. L., Nicita, A. and Olearraga, M. forthcoming, a, 'Estimating Trade Restrictiveness Indices', *Economic Journal*.

Kee, H. L., Nicita, A. and Olearraga, M. forthcoming b, 'Import Demand Elasticities and Trade Distortions', *Review of Economics and Statistics.*

Lloyd, P. J. and MacLaren, D. 2007, 'The Partial Equilibrium TRI', unpublished paper, University of Melbourne.

Productivity Commission 2003, *From Industry Assistance to Productivity: 30 Years of 'the Commission*, Productivity Commission, Melbourne.

Figure 1: Average Nominal Rate of Assistance to Australian Manufacturing, 1973-74 to 2003-04: Arithmetic Mean and TRI [a]



Note: *a* The upper series is the TRI and the lower one the arithmetic mean. Neither series is continuous because the Productivity Commission has revised the base period from time to time. These base periods are provided in Table 1.

Table 1: The Mean and Standard Deviation of Nominal Rates of Assistance to Australian Manufacturing

	Average Nominal Rates						Standard Deviation of the Nominal Rates					
Year	71-72	74-75	77-78	83-84	89-90	96-97	71-72	74-75	77-78	83-84	89-90	96-97
1968-69	24											
1969-70	23											
1970-71	23											
1971-72	22											
1972-73	22											
1973-74	17						11					
1974-75		15						12				
1975-76		16						13				
1976-77		15						14				
1977-78		15	15					15	15			
1978-79			15						15			
1979-80			15						16			
1980-81			15						17			
1981-82			16						18			

1982-83	16	13			19			
1983-84		13				20		
1984-85		13				17		
1985-86		12				13		
1986-87		12				13		
1987-88		11				13		
1987-89		10				12		
1989-90		9	9				12	
1990-91		9	8				11	
1991-92			8				9	
1992-93			7				8	
1993-94			6				6	
1994-95			5				5	
1995-96			5				5	
1996-97			4	3.5			4	4
1997-98				3.3				4
1997-99				3.2				3
1999-00				3.0				3

2000-01	2.8	3
2001-02	2.8	3
2002-03	2.8	3
2003-04	2.8	3

Table 2: The TRI for the Australian Manufacturing Sector, 1973-74 to 2003-04

	Average Nominal Rates						**TRI**					
Year	71-72	74-75	77-78	83-84	89-90	96-97	71-72	74-75	77-78	83-84	89-90	96-97
1973-74	17						20					
1974-75		15						19				
1975-76		16						21				
1976-77		15						21				
1977-78		15	15						21			
1978-79			15						21			
1979-80			15						22			
1980-81			15						23			
1981-82			16						24			
1982-83			16	13					25			
1983-84				13						24		
1984-85				13						21		
1985-86				12						18		

1986-87	12			18		
1987-88	11			17		
1987-89	10			16		
1989-90	9	9			15	
1990-91	9	8			14	
1991-92		8			12	
1992-93		7			11	
1993-94		6			8	
1994-95		5			7	
1995-96		5			7	
1996-97		4	3.5		6	
1997-98			3.3			5
1997-99			3.2			4
1999-00			3.0			4
2000-01			2.8			4
2001-02			2.8			4
2002-03			2.8			4
2003-04			2.8			4

Endnotes

[1] The partial equilibrium TRI may be an over-estimate or an under-estimate of the general equilibrium form (see Lloyd and MacLaren, 2007).

[2] These calculations of the welfare-equivalent rates are made by setting the area of the welfare triangle with an ntm or a combination of measures equal to the area of the triangle with an ad valorem tariff and solving for the tariff rate.

[3] Kee, Nicita and Olarreaga (forthcoming b) derive the expression for the partial equilibrium form of the TRI which uses the free trade weights but the same algebra applies to the expression using the distorted situation weights.

[4] The series are reported for separate sub-periods. There are minor differences in the methods used to make the estimates for each sub-period.