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A COMPARISON OF SOME EFFECTIVE RATE OF PROTECTION CALCULATIONS WITH THE RESULTS OF A GENERAL EQUILIBRIUM MODEL

by

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1. INTRODUCTION

Until the nineteen-seventies, effective rates of protection (hereafter ERPs) were expected to identify the resource movements associated with tariff reforms. Despite the addition of several sophisticated modifications aimed at introducing general equilibrium concepts, by 1971 it was generally recognized in the theoretical literature[1] that ERPs are merely price indicators and therefore could be expected to provide no more information than any other price variable. At an empirical level the question remains as to how much information is conveyed by this price variable. Specifically, are the results from ERP calculations empirically well-correlated with resource movements? It is important to answer this question because despite recognition of the limitations of ERPs in current literature, they still retain great popularity: considerable time and money has been spent upon generating ERPs for the establishment and review of policy guidelines.[2] This paper shows that ERP calculations are not well-correlated with the results of a general equilibrium model which, by utilising more information, is expected to do better than ERPs.

The structure of this paper is as follows. The theory of effective protection is set out in Section 2 and the importance of each underlying assumption is assessed. The assumptions are relaxed only if theoretical and empirical considerations permit. This discussion leads to an ERP formula which can be estimated using input-output data and information on nominal tariff rates by industry. The industry ERP estimates are presented in Section 3 together with a brief comparison with nominal rates of protection.

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* I am grateful for the guidance and helpful comments of Peter Dixon. Thanks are also due to Dennis Sams who provided the necessary computer expertise.

1 For example, Corden (1971) and Johnson (1971).

2 Most notably, the Industries Assistance Commission's routine use of ERPs in their inquiries.

Section 4 introduces the ORANI general equilibrium model and sets up the experiment whereby the ORANI results may be compared with the ERP calculations. Section 5 provides a descriptive analysis of the results. It includes a discussion of three simple statistical relationships which give some insight into the factors not covered by the ERP concept. A summary of the principal conclusions is given in Section 6.

6. CONCLUSION

No claim is made in this paper that ORANI tells the whole story about the effects of protection. Among possibly important factors omitted from the current generation of economy-wide models are substitution between different material inputs and economies of scale. The use of the ORANI model to simulate the effects of Australia's structure of protection suggests, nevertheless, the importance of factors which are left out of account by ERPs but which are covered in the model. Substitution elasticities between imported and domestic supply sources, import shares of domestic markets, export sector linkages, and capital intensities are factors that play significant roles. To use ERPs as resource-pull indicators is to misrepresent the consequence of tariff reform because they ignore all those factors. Moreover, this experiment has shown it is not necessarily correct to assume that ERPs are an accurate representation of resource-pull in the general equilibrium model even at high levels of protection. It has shown that ERPs result in a ranking that is widely out of line with the general equilibrium approach for (1) certain highly protected and import competing industries, as well as for (2) several non-traded industries and (3) nearly the entire export sector. Where a general equilibrium model like ORANI is available it is difficult to justify the continued use of this much more limited ERP technique.

These three regressions tell a simple but very clear story. Insofar as industry responses to changes in protection can be represented by general equilibrium projections of changes in industry output, the ERP measure provides a very poor degree of explanatory power. It would appear that other factors besides those recognised within the ERP formula are important in the explanation of protection induced resource allocation. Substitution elasticities between imported and domestic supply sources, the import shares of domestic markets, imported input shares of industry costs, export sector linkages and capital intensities all play a considerably important role in the determination of inter-industry resource pulls. By ignoring these influences we effectively lose more than two thirds of the explanatory power, leading to a mis-representation of the relative industry consequences of a tariff change.

2. THE EFFECTIVE RATE OF PROTECTION

The concept of effective protection originated in the works of Barber (1955), Corden (1963), Travis (1964), Balassa (1965) and Johnson (1965). An article by Corden (1966) generated widespread interest and produced a flurry of articles, both theoretical and empirical. The following section summarises the effective rate of protection (ERP), its implications and some limitations.

Tariffs enable industries to charge a higher price for their products than would otherwise be possible. In this paper the nominal rate of protection (t) of an industry is defined as the proportionate change in the unit price of the industry's output:

$$t = (p'-p)/p, \qquad (1)$$

where p' and p refer to unit prices with and without tariffs respectively. The nominal rate of protection measures the increase in the price of the industry's output but it does not give a good indication of the assistance provided to the industry by the tariff. What is required is a measure of the increase in the industry's value added resulting from the protection, which takes into account tariffs on both the industry's outputs and its inputs.

The effective rate of protection (g) usually is defined as the proportionate change in an industry's value added per unit output:

$$g = (v'-v)/v, \qquad (2)$$

where v' and v refer to value added per unit output with and without tariffs respectively. The ERP is determined by the nominal rate of protection for the industry's output, the nominal rate for its inputs and the industry's production function. If the industry has a fixed production technology, so that its input requirements per unit output are constant, the production function can be represented by a single input coefficient - the share of value added in the total price. Corden (1971, Ch 6) has shown that when there is substitution between primary factors and traded inputs it is necessary to define the rate of effective protection as:

$$g = (p'_v - p_v)/p_v, \qquad (3)$$

where p'_v and p_v refer to the price of value added (effective price) under protection and free trade respectively. The ERP formula then derived is a function of a range of input coefficients rather than of a single parameter. In the remainder of this paper it is assumed that industries have fixed production technologies.

Consider an importable commodity j with many importable inputs i (i = 1,...,n). Assume that:

(1) no other taxes or subsidies have been imposed,
(2) there are no exportable or non-traded intermediate inputs,
(3) all tradeable goods remain traded in the protection framework so that the foreign price plus tariff sets the domestic price of each importable (no 'water-in-the-tariff'),
(4) physical proportions of material input to output are constant (fixed input-output coefficients),
(5) primary factors are internationally immobile and therefore considered to be in finite supply,
(6) export elasticities of demand and import elasticities of supply are all infinite, and
(7) imported goods and domestically produced goods are perfect substitutes.

Let

v_j = value added per unit of output of good j in the absence of tariffs,
v'_j = value added per unit of output of good j in the presence of protection,
g_j = ERP for the activity of industry j in its production of good j,
p_j = price of a unit of j in the absence of tariffs,
a_{ij} = share of i in the cost of j in the absence of tariffs,
t_j = nominal tariff rate on good j, and
t_i = nominal tariff rate on good i.

In Chapter 4 of Dixon et al. (1977), p. 255, the authors define a variable which they label V_{10} and which is supposed to reflect the competitive advantage/disadvantage against imports which accrue to an industry from changes in tariffs. This variable incorporates the information recognised by ERPs such as tariffs on output and on inputs, but in addition it considers the influence of import shares and of elasticities of substitution between imported and domestic sources of supply. Using the estimated values for V_{10} that were published in Dixon et al. (Appendix 1), an improved fit was obtained with the regression:

$$X_i = \underset{(13.4)}{0.733V_{10i}} - \underset{(-4.2)}{0.011}, \qquad i = 1,\ldots,109,$$
$$R^2 = 0.63.$$

Here 63 per cent of the variation in output is explained by movements in (a) nominal tariffs on output, (b) shares of total costs that are attributed to imported inputs, (c) shares of domestic markets that are supplied by imports, and (d) substitution elasticities between imported and domestic supply sources.

Finally, we add two other variables which represent features of the general equilibrium model. These are V_8 and V_9 (both described fully in Chapter 4 of Dixon et al.) which portray the influence of capital intensity and the degree of linkage with the export sector respectively. The resulting regression was estimated by Dixon et al. as:

$$X_i = \underset{(5.0)}{0.012V_{8i}} - \underset{(-9.8)}{0.010V_{9i}} + \underset{(15.8)}{0.583V_{10i}} - \underset{(-1.8)}{0.003}, \qquad i = 1,\ldots,109,$$
$$R^2 = 0.87.$$

That is, 87 per cent of the variation in output can be explained by movements in those factors which are symbolised as V_8, V_9 and V_{10}. It is recognised that the addition of any extra variable to a regression will usually raise the explanatory power. What such an addition less frequently achieves, however, is a rise in the coefficient of determination adjusted for degrees of freedom (the case here). The coefficients of the additional variables V_8 and V_9, moreover, are both highly significant.

Group B comprises those industries with a large positive ERP but whose projected performance on an output basis is only just positive. These industries are all high tariff industries which suffer little or no import competition (the import shares varying between zero and 7 per cent). Policy makers need to take into account that further protection for a heavily protected industry may be of little help if it has already been insulated from import competition.

Group C contains those industries whose total benefit obtained from a protection environment is greatly underestimated by their respective ERPs. All three industries are import competing. Industries 28 and 29 have high import shares and significant elasticities of import substitution. Furthermore they both supply almost their entire output to industries 31, 32, 33, 34, 35 and 77 - all high tariff or import competing industries which expand their output under the framework of protection. Industry 65 faces a more moderate import share but has the second highest elasticity of import substitution of all the industries. A policy of uniform tariff reduction is likely to harm these three industries more than any other - certainly to a greater extent than indicated by their ERP rankings.

5.3 Regression Analyses

Regression analysis is capable of providing information on the relative explanatory power of ERPs, as against selected general equilibrium influences, to predict changes in industry output consequent upon protection. Consider, firstly, the linear regression of output change against ERPs. The equation obtained was:

$$X_i = \underset{(5.95)}{0.054}(ERP_i) - \underset{(-2.20)}{0.008}, \qquad i = 1,\ldots,109,$$
$$R^2 = 0.25,$$

where X equals the percentage change in ORANI output between the free trade and the protection environments and R^2 is the coefficient of determination. The t statistics are presented in brackets under the respective parameter coefficients. Only 25 per cent of the variation in output can be explained by differences in the levels of ERPs.

Then, the free trade value added is

$$v_j = p_j \, [1 - \sum_{i=1}^{n} a_{ij}], \qquad (4)$$

the protected value added is

$$v'_j = p_j \, [(1+t_j) - \sum_{i=1}^{n} a_{ij} \, (1+t_i)], \qquad (5)$$

and

$$g_j = ERP_j = (v'_j - v_j)/v_j = (t_j - \sum_{i=1}^{n} a_{ij} \, t_i)/(1 - \sum_{i=1}^{n} a_{ij}). \qquad (6)$$

This is the formula derived from Corden (1966), from which by inspection:

(i) the higher the nominal rate the higher the ERP,
(ii) the smaller the duty on imported inputs the higher the ERP,

and, in most instances,

(iii) the smaller the value added the higher the ERP.

The assumptions behind the derivation of the ERP formula may be relaxed provided due consideration is given to the consequences. But in some cases this may be either not possible, not practical, or not desirable. Let us consider each assumption in turn.

Begin by relaxing assumption (1) and allow for the existence of taxes and subsidies other than those on trade (e.g., taxes on the production or domestic consumption of tradeables). Production taxes on commodities are equivalent to import subsidies and therefore lower protection, but production taxes on inputs, although reducing the input's ERP, have no effect on the ERP for the activity which uses that input. Conversely, consumption taxes on inputs are equivalent to tariffs on inputs and therefore lower the ERP of the utilizing process while consumption taxes on final goods do not affect the protection of production activity. The formula is therefore easily modified with 'tariffs' on inputs and goods redefined to include consumption and production taxes and subsidies.

In practice however, there is no need to relax this assumption. Although sales and other indirect taxes on inputs act to offset assistance provided for industries in the same way as tariffs on inputs, this effect is minimal because in Australia sales taxes are not usually levied on intermediate goods - most are levied on consumer goods at the wholesale stage and therefore have no influence on any activity's effective protection. The nominal tariff rates used in this study were those provided by the Industries Assistance Commission to the IMPACT Project for use in the ORANI model and these rates, by making necessary adjustments, have allowed for those cases where an indirect tax discriminates between imported and domestically produced goods. Non-tariff assistance was found to be insignificant for most industries[1] in the year of interest (i.e., 1968-69), so no attempt was made for it to be measured.

The first element of assumption (2) is easily relaxed. Redefine inputs and final commodities so as to include exportables as well as importables. Then since an export subsidy (or export tax) affects domestic industry in a manner similar to a tariff (or import subsidy), the derived ERP formula will still provide useful estimates, with t now symbolising the rate of export subsidy.

The second element of assumption (2) causes more difficulties. Allow inputs into the production of tradeables to include non-traded inputs (such as construction and the utilities). The question arises as to whether non-traded inputs be treated similarly to tradeable inputs or to primary factors. The former approach is supported by the argument that in order to obtain value-added, all produced inputs whether traded or non-traded must be excluded (as in Balassa (1965) and Basevi (1966)). The latter approach was suggested by Corden (1966) with the rationale that:

> "protection for an activity producing a traded product represents not only protection for those primary factors intensive in that activity but also protection for those industries producing non-traded inputs in which that activity is intensive and thus, indirectly, protection for the primary factors intensive in these non-traded input industries."[2]

1 See IAC Annual Report 1973-74, pp. 57-58.
2 This argument is expanded in Corden (1966), p. 228. See Ethier (1971), pp. 34-35 for a contrary position. Corden reaffirms his original position in Kenen (1971), pp. 63-64, but admits that the theory is not complete in this area.

TABLE 3 : GROUPINGS OF INDUSTRY OUTPUT CHANGES AND EFFECTIVE RATES OF PROTECTION

	Industry			
No.	Code	Description	Output change	ERP
			%	%
GROUP A (Output falls, but ERP close to zero or positive)				
1	1.01	Sheep	- 5.1	- 2.6
2	1.02	Cereal Grains	- 4.6	- 2.6
3	1.03	Meat Cattle	- 6.7	- 2.6
7	2.00	Services to Agriculture	- 3.5	- 0.4
9	4.00	Fishing, Trapping, Hunting	-12.6	- 2.4
11	11.02	Other Metallic Minerals	- 5.7	- 2.3
12	12.00	Coal and Crude Petroleum	- 9.8	- 2.3
15	21.01	Meat Products	- 6.8	5.3
22	21.08	Food Products, nec	- 8.4	35.4
46	27.01	Chemical Fertilisers	- 2.9	9.0
60	29.01	Basic Iron and Steel	- 6.3	23.0
61	29.02	Other Basic Metal Products	- 7.1	13.7
67	32.03	Locomotives, Rolling Stock	- 1.9	37.3
73	33.05	Agricultural Machinery	- 3.9	28.0
GROUP B (High ERP, but small increase in output)				
23	21.09	Soft Drinks, Cordials, etc.	0.0	90.8
34	24.01	Knitting Mills	2.4	92.9
35	24.02	Clothing	2.9	138.1
42	26.02	Fibreboard, Paper Containers	1.2	171.6
63	31.02	Sheet Metal Products	0.9	87.4
GROUP C (High output increase, but small ERP)				
28	23.02	Man-made Fibres, Yarn, etc.	10.9	32.4
29	23.03	Cotton, Silk, Flax Yarns, etc.	13.7	61.5
65	32.01	Motor Vehicles and Parts	12.8	46.8

SOURCE: See text.

5.2 Absolute Percentage Changes in Output and Effective Rates of Protection

Having now discussed the ORANI and ERP rankings for each industry we have some idea of the industries for which the effect of protection is projected significantly differently by the two analyses. A clearer picture can be obtained by consideration of the actual size of the differences.

The industry results can be plotted on a scatter diagram, with the ERP on one axis and the output change, as computed by ORANI, on the other. As before if an industry's ERP was a good proxy for its output change then the points would lie close to a straight line. The overall impression from the scatter diagram is of some correlation between the two measures. A large group of industries have a small absolute ERP and a small absolute change in output and so are clustered around the origin of the diagram[1]. Most of the other industries lie in a band around a straight line through the origin. Three smaller groups of industries, however, stand out for attention[2].

The 3 industry groups are listed in Table 3. There are no hard and fast rules for the classification of an industry to a particular group. Group A comprises those industries which experience a non-negligible fall in output in the ORANI simulation although their ERP's are positive or at worst, only slightly negative. They receive no stimulus from their protection. All of the industries in this group are substantial exporters or linked to export industries, and only five such industries are not included in the group.

Policy makers who make decisions on the basis of ERP calculations can underestimate greatly the harm that befalls the export sector as a result of protection. The reasons for this detrimental effect upon the export sector have been discussed in Sub-section 5.1.

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1 This makes the diagram difficult to read unless a very large scale is used and so it has not been reproduced in this paper.
2 Industry 109, Business Expenses also stands out from all other industries but it is a dummy industry using no primary inputs which was created to meet the requirements of the structure of the ABS input-output tables. A zero nominal tariff is assumed for its output, but tariffs are levied on some of its inputs, resulting in a large negative ERP.

In the exercise reported in Sections 3 and 5, exportables, importables, and non-traded goods were all treated identically. Although there is certainly a case for treating non-tradeables in the Corden manner - even if merely for purposes of comparison - the conclusion of a large number of studies is that ERP rankings are not sensitive to the treatment of non-tradeables.[1]

Assumption (3) when relaxed, allows for some redundancy in the tariff to exist. It may be thought that only the utilised portion of the tariffs should be considered in ERP estimates. However lack of information often precludes this. Wilkinson (1971) suggests that the correct procedure for dealing with tariff redundancy depends upon the purpose of the calculations: some purposes would require the ERP to indicate the maximum proportionate change in value-added that is made possible by the tariff structure so that both final products and inputs are priced up to the tariff. Because lack of data precluded the alternative, the assumption of no 'water-in-the-tariff' was maintained for this study.

Now consider relaxing assumption (4). If changes in input coefficients occur as a result of input substitution after tariff-induced relative price movements, then the ERP will be a result of a change in both the quantity of primary factors per unit output as well as the price of primary factors. Because nominal rates are concerned solely with a price change, it has been argued that for comparability, effective rates should exclude the quantity effect. Corden (1966) has proposed that the ERP should indicate the direction of resource pull generated by the tariff structure. Since the effects of these resource shifts are irrelevant to the initial resource pull direction, the ERP concept should abstract from their consideration by eliminating the quantity effects of the substitution undergone. That is, we are interested in the rise in the rate of return to a factor before any resources move in response to the rise, not to actual rises after the tariff change.[2]

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1 See, for example, Balassa and Associates (1971), especially pp. 16-18.
2 In much of the journal literature and empirical work researchers have continued to use ERPs in this early interpretation as a resource-pull concept. Corden, however, later recognised ERPs as price indicators only which give no information as to quantity movements (Corden, 1971). Corden 'eliminates' the quantity effect by redefining the ERP in terms of the price of value-added.

Balassa et al. (1971, Ch 3) found that ERP rankings of industries were not sensitive to changes in the basis of measurement for input coefficients. This conclusion is to be expected if, despite significant substitution amongst material inputs, there is little or no substitution between material inputs as a whole and primary factors as a whole. In this case, because the movement in value-added is of principal concern, the variability of the input coefficients is irrelevant. However where there does occur substitution between primary factors as a whole and traded inputs as a whole then Corden (1971) found two results. Firstly, substitution increases the ERP relative to what it would have been under fixed coefficients. Secondly, this increase will be overstated or understated according to whether data from the protection or from the free trade situation are used. Because the extent of the error in this case is not proportional to the size of the measured ERP but differs between industries according to substitution elasticities, the ERP industry rankings will no longer be insensitive to changes in the input coefficients.

Assumptions (5) and (6) imply that extra quantities of primary factors would come forth only at higher prices while traded inputs are in infinitely elastic supply. Having already relaxed assumption (2), non-traded inputs can be grouped with primary factors if their supply is less than infinitely elastic or with traded inputs if their supply is infinitely elastic. A tariff on a final good then raises the returns per unit only to the primary factors and those non-traded inputs not in infinitely elastic supply.

The relaxation of assumption (5) suggests the grouping together with the tradeable inputs of any factor which is in infinitely elastic supply. Then the ERP is calculated for the remaining inputs. Corden (1966) considered the case where labour was in infinitely elastic supply in some less developed nations because of an untapped subsistence hinterland or else an unrestricted flow of immigrants. In a two factor world (labour and capital) this analysis would result in an ERP for capital (see Wilkinson (1977)). Alternatively the treatment of capital as a material input results in an ERP for labour (see Basevi (1966)). Wilkinson suggests that empirical evidence does not support the idea that returns to capital are equalised in the long run and therefore there is no rationale for

5.1.3 Industries with Low ERP Rankings and Higher ORANI Rankings

Turning now to the industries whose output rankings are considerably higher than their ERP rank we find ten industries as yet unmentioned. The output of one of these, 102 (Defence), is effectively exogenous in ORANI. The others are 57 (Ready-mixed Concrete), 84 (Residential Buildings), 85 (Building n.e.c. and Construction), 88 (Motor Vehicle Repairs), 89 (Other Repairs), 94 (Communication), 107 (Restaurants, Hotels, Clubs), 108 (Personal Services), and 109 (Business Expenses). The element these industries have in common is their non-tradeability. The obvious question outstanding is why do these (and indeed most other) non-traded industries actually perform better than as anticipated by the ERP measure? The ERP of non-tradeables is low because they have little tariff protection yet have many protected inputs[1]. ORANI on the other hand shows a better picture for non-tradeables primarily because it recognises the extent of forward linkage to the expanding import competing sector as well as the benefits gained by substitution by consumers towards the relatively cheaper non-tradeable goods and services. Other non-tradeable industries lie close to but usually above the main diagonal. They do not perform quite as well as the ten industries just listed.

As an example, consider the reason why the transport industries, 90 (Road), 91 (Rail), 92 (Water) and 93 (Air), rank lower than other non-tradeables. Having zero tariffs on output, positive and sometimes large tariffs on material inputs, and a large value-added component, the ERPs of the transport industries are relatively low. ORANI also ranks the output change of the transport sector low in contrast to other non-tradeables, because of its extensive linkages with the export industries 6, 15, 22, 60 and 61. The Road Transport industry is hit particularly hard by increases in the costs of its inputs from 65 (Motor Vehicles and Parts) and 77 (Rubber Products). Both are high tariff industries with significant import penetration of their markets. Similarly Air Transport is squeezed by cost increases from the import competing industry 68 (Aircraft Building).

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1 It would appear that non-tradeables also have, on average, a much smaller materials-output ratio than manufacturing or industry in general.

industries. These are 3 (Meat Cattle), 6 (Other Farming), 7 (Services to Agriculture), 46 (Chemical Fertilizers), and 73 (Agricultural Machinery). One other industry that is found here is 67 (Locomotives, Rolling Stock). Though not supplying the export sector directly, its biggest customer is 91 (Railway and Other Transport) which derives much of its business from the transport of export produce to the ports.

The export or export-related industries which appear outside this grouping of industries are 10 (Iron), 27 (Prepared Fibres), 4 (Milk Cattle and Pigs), 5 (Poultry) and 14 (Services to Mining). The ERP of industry 10 is relatively low because the formula recognises the zero tariff on industry 10's output and the increased tariffs on some of its inputs (e.g., from the import-competing industry 52 (Chemical Products n.e.c.)). What it fails to reflect is the fact that most of the output goes overseas or into industry 60, a substantial share of whose output also is exported. These two industries cannot raise their prices, say as a result of tariff induced increases in input costs, without losing export sales, due to their high export demand elasticities. Therefore the general equilibrium projection for industry 10 has a lower ranking than that given by ERP calculations. The reason for the ranking not being as low as that of other export industries is due to the high capital intensity of the Iron industry which inhibits short run fluctuations in supply.

Industries 4 and 5 perform better than indicated by the ERP estimation because although supplying the contracting export industries 15 and 16, they both achieve significant relative cost reductions in their purchases from export and export-related industries. Industry 5 purchases heavily from industry 22, while industry 4 purchases from industries 2, 6, 7, 22 and 46. Since the cost of these inputs does not rise in line with the domestic price level, industries 4 and 5 gain a competitive advantage in the domestic consumption market. Industry 27 gets its "kick" above the diagonal from selling two fifths of its output to the high tariff/import competing industries 28, 29 and 30. Additionally, the price of its inputs from industries 1 and 6 become more favourable. Finally, industry 14 maintains a reasonable output rank primarily for an artificial reason. The ORANI data base allocates most of 14's sales to the exogenous, non-contracting government sector, rather than directly to the declining mining industry (see Dixon et al. 1977, Section 16.4.2(c)).

computing an ERP for labour.[1] In measuring the effect of protection on the returns to capital instead, Wilkinson uses a discounted present value approach.[2] In this exercise, assumption (5) has been maintained because no evidence could be found for the infinite supply of any factor in Australia.

Assumption (6) is less restrictive for a small economy like Australia's than for, say, the United States. Thus the assumption was not relaxed.[3] Assumption (7) could not be relaxed without using all the information required for a general equilibrium model such as substitution elasticities of each industry for each commodity and import shares of the domestic market. It was therefore maintained for this experiment.

On the basis of the arguments presented above, the ERP estimates in this paper were calculated as:

$$ERP_j = \frac{t_j - \sum_{i=1}^{n} a_{ij}\, t_i\, (1+t_j)/(1+t_i)}{1 - \sum_{i=1}^{n} a_{ij}\, (1+t_j)/(1+t_i)}, \qquad (7)$$

1 Wilkinson suggests that risk and monopoly factors are barriers to entry of international capital flows. One might argue, however, that there is likely to be long run stability in terms of differentials of risk and other factors.

2 At the GATT Conference (Geneva, 1970) Sussman, in commenting on Wilkinson's approach, argued that in order to calculate the present value of tariff reductions one would have to estimate the expected duration of the tariff reduction - an effort which would amount merely to guess work (Grubel and Johnson (1971), p. 211).

3 Leith (1968) finds three possible consequences of changing this assumption: (1) the domestic price is raised by less than the tariff, (2) the subsidy effect of a tariff protecting an output is not received entirely by the primary factors because the price of the input rises, and (3) the taxing effect of an input tariff is not borne entirely by the primary factors because the output price rises.

where

t_j is the nominal tariff rate on the output of industry j,

a_{ij} is the input-output coefficient under protection[1], and

a_{ij} $(1+t_j)/(1+t_i)$ is the free trade input-output coefficient[2].

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1 The input-output coefficients, a_{ij}, were calculated from the ORANI data base. Using the notation of Figure 2 in Dixon et al. (1977), p. 114;

$$a_{ij} = \frac{\text{Sum of the } ij^{th} \text{ element of } \tilde{A} + \tilde{F}}{\text{Sum of the } j^{th} \text{ column of } \tilde{A} + \tilde{F} + \ldots + \tilde{K}_{g+1} + \tilde{P}_{g+1} + \tilde{U} + \tilde{V} + \tilde{W} + \tilde{X}}$$

Because tariffs are applied to basic values rather than purchasers' prices the a_{ij} must show the input of 'i' at basic values per unit of 'j'. Hence no margins are included in the numerator.

2 The deflation of the input-output coefficient under protection by the ratio of the power of the tariffs is necessary to ensure that input shares of total cost are valued on a free trade basis. The problem would not arise if input-output tables could be measured in some homogeneous physical quantity rather than in dollars. This is, of course, empirically impossible. The deflation to free-trade coefficients does not imply that any adjustment has taken place to compensate for tariff induced substitution between inputs. The calculation is still on the basis of fixed physical input quantities, i.e., on the assumption of constant input-output coefficients.

In some cases the ORANI ranking has been much higher than the ERP ranking because of the combined interaction of a high import share and a high elasticity of import substitution. This occurs with industries 29 (Cotton, Silk, Flax), 33 (Textile Products n.e.c.), and 65 (Motor Vehicles and Parts) which have import shares of 53 per cent, 28 per cent and 31 per cent and elasticities of 2.4, 2.4, and 5.0 respectively.

Much of the lower ranking by ERP's for industries 28, 29, 47 and 65 can be attributed to the ignoring of industry linkages on the sales side. The first three supply predominantly highly protected and import competing industries (i.e., those experiencing an expansion of output under the increased protection). Specifically, 28 and 29 supply 31 (Textile Finishing), 32 (Textile Floor Covering), 33 (Textile Products n.e.c.), 34 (Knitting Mills) and 35 (Clothing), while 47 supplies 28, 48 (Paints, Varnishes, Lacquers), 52 (Chemical Products n.e.c.), 72 (Electrical Machinery n.e.c.), 77 (Rubber Products) and 78 (Plastic Products). Industry 65, while not supplying expanding sectors, obtains additional benefit from more competitive input prices: its principal inputs come from the contracting export industries 60 (Basic Iron and Steel) and 61 (Other Basic Metal Products).

5.1.2 Industries with Low ERP rankings and Lower ORANI rankings

Leaving the upper right quadrant we now turn to the industries for which the ERP measure diverges widely from the ORANI results, commencing with those industries in the bottom right quadrant and in the bottom right portion of the bottom left quadrant.

ORANI predicts a much poorer performance for these industries than do ERPs. They mainly consist of export industries and the increased protection raises the costs of material inputs and labour while there is no increase in foreign demand for the export sector's output. The export industries in this region comprise industries 1 (Sheep), 2 (Cereal Grains), 9 (Fishing, Trapping, Hunting), 11 (Other Metallic Minerals), 12 (Coal and Crude Petroleum), 15 (Meat Products), 22 (Food Products n.e.c.), 60 (Basic Iron and Steel), and 61 (Other Basic Metal Products). Also in this region are industries supplying a large proportion of their output to export to be such large output changes as predicted by ERP[1]. Industry 63 has an import share of less than 2 per cent which helps to account for the difference of 34 rank places between the ERP and ORANI estimates. Industry 23 has an import share less than 0.2 per cent and consequently a difference between the two models of 45 rankings.

Amongst the import competing industries in the upper triangular region of the quadrant there are several at a significant vertical distance from the diagonal. ORANI finds other factors besides the tariff on inputs and output that are important for these industries.

By considering import shares the general equilibrium model recognises the extra benefit obtained from an increase in protection by those industries who suffer considerable import competition. ERP techniques attribute no more advantage to the industry where imports supply 40 per cent of domestic sales than to those where only 5 per cent of the domestic market is supplied externally. The majority of industries in the upper triangular region have an import share greater than 20 per cent. Industries 28 (Man-made Fibres) and 47 (Industrial Chemicals n.e.c.), which are under-ranked by the ERP measure, have import shares as high as 47 per cent and 44 per cent respectively.

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1 Here we must be careful with the simplifications occurring in ORANI. Import shares are held constant, which is a satisfactory approach for small changes in the tariff. However, where the import share is partly a function of the level of protection the constant share assumption is no longer adequate. (See footnote 1, p.17.) The low import share of the industries listed in the text may be a result of high or 'made to measure' protection, and in such a case a large change in the tariff (e.g., as in the current experiment) may distort the real picture of the consequences. A moderating influence, however, is provided when the elasticity of import substitution, σ_m, is low:

$\sigma_m = 1$ implies the import share remains constant,

$\sigma_m < 1$ implies the import share actually rises after an increase in tariffs (since the price increase more than offsets the quantity decrease).

Only with $\sigma_m > 2$ (say), are the results likely to be significantly misleading in the large tariff change case.

3. INDUSTRY NOMINAL AND EFFECTIVE RATES OF PROTECTION

Effective rates of protection were calculated for the 109 industries distinguished in the 1968-69 Input-Output Tables (ABS (1977)). The same industry classification is used by the ORANI model. The ERPs are shown in Table 1. They ranged from -77.6 per cent for (dummy) industry 109 (Business Expenses) to 171.6 per cent for industry 42 (Fibreboard, Paper Containers). As a measure of relative industry assistance a rather uneven distribution of protection was demonstrated. Forty five industries had negative ERPs. The majority of these comprised rural, mining and service industries which had a nominal output tariff of zero[1]. Indeed every industry with a zero nominal tariff on output was included in this group. Other factors resulted in negative ERPs for some industries. For example, industry 20 (Bread, Cakes and Biscuits) had an ERP of -1.7 per cent because of its high value added, low output tariff and higher tariffs on its inputs. However the influence of these other factors was negligible in comparison with that of the output tariff. Of the remaining sixty-four industries, those with high nominal tariffs on their output and minimal tariffs on their inputs were, as expected, clustered at the end showing the greatest positive effective rates. Again, the influence of the nominal tariff on output was predominant. In fact the ranking of industries by ERPs - while purported by some authors to give an insight into the likely pattern of production and resource-flow relative to the situation of free trade - was little different to the ranking by nominal rates. This result has occurred in many studies[2] and raises the question of the utility of calculating ERPs when nominal tariffs appear to be adequate proxies.

The Spearman rank coefficient of correlation between the two rankings of industries (by ERPs and by nominal tariffs) was computed to be 0.95[3]. A regression of ERPs onto nominal rates suggested that variation of nominal tariffs across industries explained 86 per cent of the variation in

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1 The nominal tariff rates used in this study are given in Dixon et al. (1977), Table 13 (b), p. 210.
2 For example, Cohen (1969) and also Guisinger and Schydlowsky (1970).
3 For an explanation of the Spearman rank coefficient see Siegel (1956).

ERPs[1,2]. Given the high correlation between nominal and effective rates, it is not surprising that ERPs did not perform significantly better than nominal rates in an experiment to predict the industry output changes generated by ORANI (see Section 5).

1 The regression was estimated to be:

$$ERP_i = 2.07(NT_i) - 0.081 \quad , \quad i = 1, \ldots, n ,$$
$$(25.9) \qquad (-4.35)$$
$$R^2 = 0.86 ,$$

where NT refers to nominal tariffs.

2 Balassa (1971, Ch 3) found that the rank correlation coefficients between nominal and effective rates for seven countries varied between 0.59 (Pakistan) and 0.95 (Brazil). The highest correlations were found in countries where there was a high degree of aggregation of input-output tables (Brazil) or a small degree of dispersion of nominal tariff rates (Norway).

Alternatively the lower ranking may result because ORANI assumes less than infinite elasticities of substitution between domestic and foreign inputs[1]. For example, industry 74 (Construction Equipment) has a high tariff rate of 31 per cent and the import share of its domestic market is also high at 0.38. In common with other capital goods, however, the elasticity of substitution between domestic and imported construction equipment is assumed to be only 0.5 thus limiting the benefit obtained by this industry from increased protection.

The lower ORANI ranking may also occur principally because of a low import share[2]. Industries which are significantly below the diagonal and have an import share of less than 7 per cent are 31 (Textile Finishing), 34 (Knitting Mills), 35 (Clothing), 40 (Furniture, Mattresses, Brooms), 45 (Commercial and Job Printing), 48 (Paints, Varnishes, Lacquers), 62 (Structural Metal Products), and most noticeably, 63 (Sheet Metal Products) and 23 (Soft Drinks, Cordials). These industries benefit from an increase in protection to a lesser extent than attributed to them by ERP analysis because their import share is already low and therefore there are unlikely

1 Although ERP formulae assume infinite elasticity of import substitution, in ORANI the elasticities vary across industries so that those with an elasticity greater than 2.0 have a relatively greater potential to expand after tariff increases.

2 The CES formulation of import/domestic substitution possibilities yields demand functions of the following form:

$$x_{i1j} = x_{ij} - \sigma_i S_{i2j}(p_{i1j} - p_{i2j})$$

where

x_{isj} is the percentage change in the demand for input i from source s (s=1, domestic; s=2, imports) by user j;

p_{isj} is the percentage change in the price paid for i from source s by user j;

x_{ij} is the percentage change in user j's 'total' demand for i;

σ_i is the relevant elasticity of substitution;

and

S_{isj} is the share of source s in j's total usage of i.

quadrant is explained both by its large value added component and its significant purchases from import competing industry 41 (Pulp, Paper) - both effects being captured equally by the ERP and by ORANI.

In much of the literature on effective protection it has been claimed that the ERP measure would be relatively more appropriate for the more heavily protected industries.[1] The scattergram in Figure 1 presents a different story. The correlation between ORANI and ERP rankings appears no better in the two right hand side quadrants than it is in the two left side quadrants. The effects of changes in factor prices, when combined with consideration of import shares and the various substitution elasticities that are built into ORANI, are therefore shown to be important even at this high level of protection.

The seemingly random scatter of industries within the top right hand quadrant falls neatly into two categories. With only two exceptions, the high tariff industries are in the lower triangular region on the right of the diagonal while those industries with noticeable import competition are in the upper triangular region on the left of the diagonal. The two exceptions are industries 36 (Footwear) and 80 (Other Manufacturing) but since their rankings by ORANI and ERP calculations are so close (i.e., they lie just off the main diagonal) there is no need to select them as 'out of the ordinary'.

The precise division of the two industry groupings by the diagonal within this quadrant is explicable. It follows naturally from the fact that the ERP method will assign a high rank to any industry with a high nominal tariff that is not greatly offset by tariffs on inputs or by the proportion of value added to material input. ORANI ranks these industries lower for one or more of several possible reasons. For example, it considers linkages with export industries. Therefore industry 63 (Sheet Metal Products), which supplies export industries 22 (Food Products n.e.c.), 15 (Meat Products) and 17 (Fruit and Vegetable Products), suffers a relative fall in output when its customers in the export sector are harmed by the increase in protection.

1 See, for example, Evans, H.D., in Grubel and Johnson (1971).

TABLE 1 : INDUSTRY RESULTS

Input-Output industry				ORANI change in output		ORANI output rank
No.	Code	Description	ERP		ERP rank	
			%	%		
1	1.01	Sheep	- 2.57	- 5.08	22	9
2	1.02	Cereal Grains	- 2.61	- 4.58	21	10
3	1.03	Meat Cattle	- 2.64	- 6.65	20	6
4	1.04	Milk Cattle and Pigs	- 4.39	- 2.25	14	16
5	1.05	Poultry	- 21.68	- 1.95	2	18
6	1.06	Other Farming	60.05	- 0.01	88	44
7	2.00	Services to Agriculture	- 0.35	- 3.45	40	13
8	3.00	Forestry and Logging	- 3.80	- 0.76	16	30
9	4.00	Fishing, Trapping, Hunting	- 2.37	-12.56	26	1
10	11.01	Iron	- 1.36	- 0.90	35	26
11	11.02	Other Metallic Minerals	- 2.30	- 5.74	27	8
12	12.00	Coal and Crude Petroleum	- 2.28	- 9.76	28	2
13	14.00	Non-metallic, nec	- 2.42	- 0.76	25	29
14	16.00	Services to Mining	- 11.01	- 0.92	7	24
15	21.01	Meat Products	5.33	- 6.79	47	5
16	21.02	Milk Products	12.58	0.17	54	57
17	21.03	Fruit and Vegetable Products	9.44	0.72	50	66
18	21.04	Margarine, Oils and Fats	21.83	1.52	61	78
19	21.05	Flour and Cereal Products	11.16	- 0.35	52	33
20	21.06	Bread, Cakes and Biscuits	- 1.70	0.05	33	54
21	21.07	Confectionery Products	69.31	3.41	96	94
22	21.08	Food Products, nec	35.41	- 8.35	72	3
23	21.09	Soft Drinks, Cordials, etc.	90.78	0.22	104	59
24	21.10	Beer and Malt	40.46	0.74	77	67
25	21.11	Alcoholic Beverages, nec	117.07	8.24	107	104
26	22.01	Tobacco Products	36.80	0.47	73	61
27	23.01	Prepared Fibres	- 14.72	- 3.71	3	12
28	23.02	Man-made Fibres, Yarns, etc.	32.38	10.85	69	106
29	23.03	Cotton, Silk, Flax Yarns, etc.	61.49	13.69	90	109
30	23.04	Wool and Worsted Yarn, etc.	70.39	2.74	97	87
31	23.05	Textile Finishing	65.86	2.61	92	85
32	23.06	Textile Floor Covering	24.34	3.57	63	95
33	23.07	Textile Products, nec	27.11	3.72	65	96
34	24.01	Knitting Mills	92.86	2.44	105	84
35	24.02	Clothing	138.14	2.92	108	89
36	24.03	Footwear	98.55	10.45	106	105
37	25.01	Sawmill Products	16.28	0.96	58	71
38	25.02	Plywood, Veneers and Boards	66.32	4.11	93	100
39	25.03	Joinery and Wood Products	34.07	0.96	70	70
40	25.04	Furniture, Mattresses, Brooms	50.96	1.49	85	76
41	26.01	Pulp, Paper and Paperboard	16.59	2.25	59	82
42	26.02	Fibreboard, Paper Containers	171.58	1.15	109	73
43	26.03	Paper Products, nec	65.67	1.60	91	80
44	26.04	Newspapers and Books	2.08	- 0.41	46	32
45	26.05	Commercial and Job Printing	73.23	1.32	98	74
46	27.01	Chemical Fertilisers	9.01	- 2.90	49	14
47	27.02	Industrial Chemicals, nec	25.59	5.34	64	101
48	27.03	Paints, Varnishes, Lacquers	67.92	2.87	95	88
49	27.04	Pharmaceuticals and Chemicals	45.33	2.33	79	83

TABLE 1 - continued

No.	Code	Description	ERP	ORANI change in output	ERP rank	ORANI output rank
			%	%		
50	27.05	Soap and Other Detergents	37.50	0.61	75	65
51	27.06	Cosmetic, Toilet Preparations	78.38	1.57	100	79
52	27.07	Chemical Products, nec	31.17	3.95	68	98
53	27.08	Petroleum and Coal Products	8.14	- 0.24	48	36
54	28.01	Glass and Glass Products	14.73	2.73	56	86
55	28.02	Clay Products	34.71	0.80	71	68
56	28.03	Cement	11.31	- 0.56	53	31
57	28.04	Ready-mixed Concrete	- 5.72	0.11	12	56
58	28.05	Concrete Products	10.47	0.09	51	39
59	28.06	Non-metallic Mineral Products	29.18	0.98	67	72
60	29.01	Basic Iron and Steel	22.99	- 6.29	62	7
61	29.02	Other Basic Metal Products	13.73	- 7.08	55	4
62	31.01	Structural Metal Products	80.82	1.39	102	75
63	31.02	Sheet Metal Products	87.38	0.90	103	69
64	31.03	Metal Products, nec	67.47	6.66	94	102
65	32.01	Motor Vehicles and Parts	46.83	12.79	82	108
66	32.02	Ship and Boat Building	46.53	0.02	81	51
67	32.03	Locomotives, Rolling Stock	37.25	- 1.88	74	19
68	32.04	Aircraft Building	15.65	0.57	57	64
69	33.01	Scientific Equipment, etc.	21.04	1.52	60	77
70	33.02	Electronic Equipment	75.05	12.07	99	107
71	33.03	Household Appliances, nec	80.31	3.22	101	90
72	33.04	Electrical Machinery, nec	50.10	3.94	84	97
73	33.05	Agricultural Machinery	28.00	- 3.93	66	11
74	33.06	Construction, etc. Equipment	41.47	0.54	78	62
75	33.07	Other Machinery, Equipment	56.22	2.19	87	81
76	34.01	Leather Products	51.00	7.28	86	103
77	34.02	Rubber Products	40.43	3.36	76	91
78	34.03	Plastic and Related Products	46.48	3.97	80	99
79	34.04	Signs, Writing Equipment, etc.	49.53	3.38	83	93
80	34.05	Other Manufacturing	60.63	3.37	89	92
81	36.01	Electricity	- 0.83	- 0.11	38	38
82	36.02	Gas	- 1.28	0.54	36	63
83	37.01	Water, Sewerage and Drainage	- 1.93	- 0.20	31	37
84	41.01	Residential Buildings	-13.59	0.00	4	46
85	41.02	Building, nec, Construction	-12.15	- 0.24	6	60
86	46.01	Wholesale Trade	- 1.70	- 0.91	32	25
87	48.01	Retail Trade	- 1.65	- 0.32	34	34
88	48.02	Motor Vehicle Repairs	- 9.81	- 1.31	8	21
89	48.03	Other Repairs	- 9.14	- 1.05	9	23
90	51.01	Road Transport	- 3.14	- 1.87	18	20
91	52.01	Railway and Other Transport	- 7.17	- 2.88	11	15
92	53.01	Water Transport	- 2.89	- 1.25	19	22
93	54.01	Air Transport	- 3.45	- 2.02	17	17
94	55.01	Communication	- 7.76	- 0.84	10	28

greater than 30 per cent), an import-competing industry (high import share of domestic sales or a lower import share accompanied by high elasticity of substitution of demand between local and imported products), or an industry which supplies a significant proportion of its output to highly protected or import competing industries.

The five industries appearing in this quadrant but not possessing the above characteristics comprised 24 (Beer, Malt), 39 (Joinery and Wood Products), 50 (Soap, Detergents), 55 (Clay Products), and 59 (Non-metallic Mineral Products). Their presence on the right hand side of the diagram is due to the substantial, though not high, nominal protection afforded them (namely, between 20 per cent and 30 per cent). The high ORANI ranks, bringing the five industries up to the top right quadrant, are the result of several factors. For example, industry 24 is subject to high sales taxes that are specific rather than ad valorem; therefore despite a tariff-induced price increase the relative price paid by consumers falls and so the demand for the industry's output increases. Meanwhile industries 39, 55 and 59 all supply inputs to the construction industries which benefit from the increased requirements of the capital intensive manufacturing industries as opposed to those of the export sector. Industry 50 benefits from a shift in consumer expenditure.

On the other hand, all but four highly protected or import-competing industries do appear in this quadrant. The exceptions are industries 6 (Other Farming), 44 (Newspapers and Books), 66 (Ship and Boat Building), and 67 (Locomotives, Rolling Stock). The high tariffs on the output of industries 6, 66 and 67 account for their ERP ranking. However, ORANI shows their output increases are constrained by their dependence on the export sector to which an increase in protection is detrimental. Industry 6 supplies a large proportion of its output directly to the export industry 22 (Food Products n.e.c.) while 66 and 67 supply most of their output to the transport industries 92 and 91 respectively; both these transport sectors depend heavily on exports. The difference between the ORANI and ERP rankings for industry 44 is not as serious. Its position in the lower left rather than lower right

Figure 1 : Industry Rankings

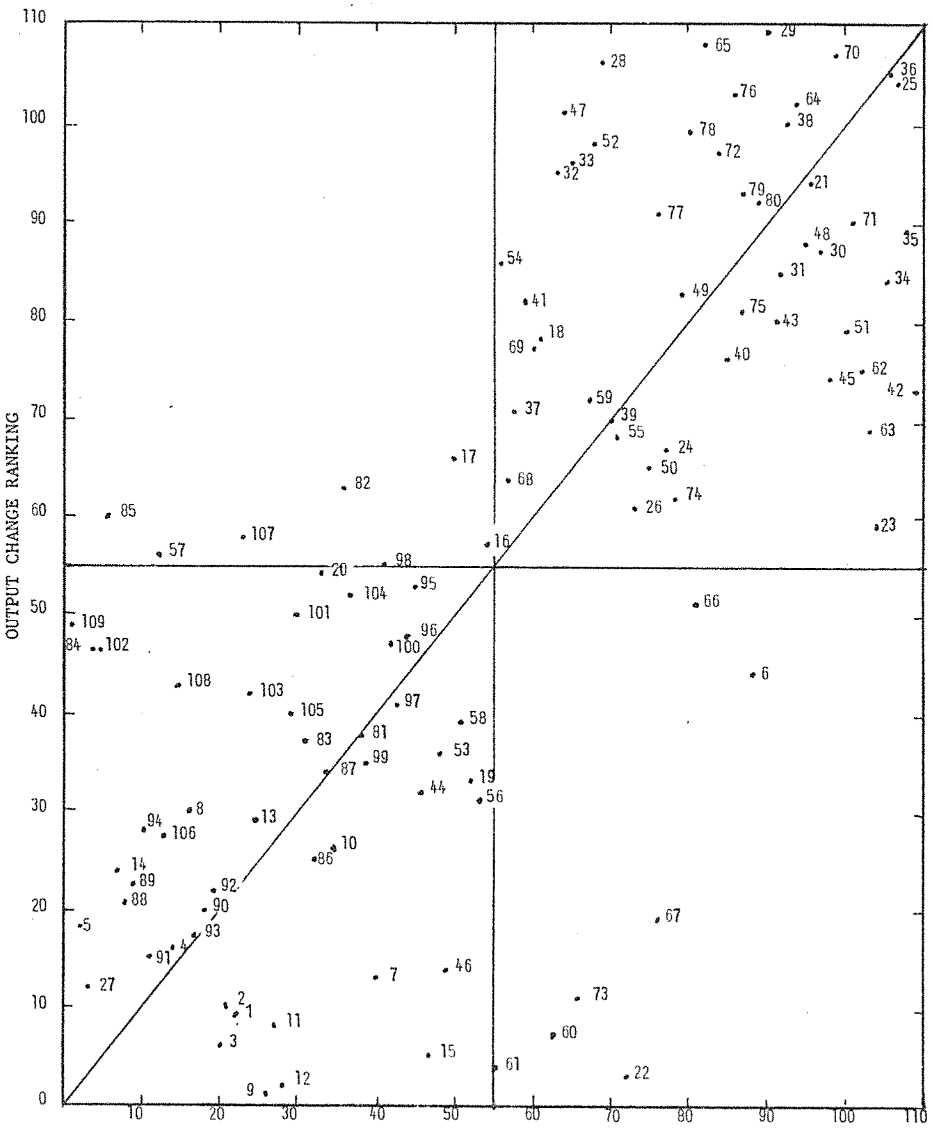

TABLE 1 - continued

Input-Output industry			ERP	ORANI change in output	ERP rank	ORANI output rank
No.	Code	Description				
			%	%		
95	61.01	Banking	- 0.03	0.02	45	53
96	61.02	Finance and Life Insurance	- 0.04	0.01	44	48
97	61.03	Other Insurance	- 0.07	- 0.03	43	41
98	61.04	Investment, Real Estate, etc.	- 0.18	0.09	41	55
99	61.05	Other Business Services	- 0.42	- 0.25	39	35
100	61.06	Ownership of Dwellings	- 0.12	0.00	42	47
101	71.01	Public Administration	- 2.07	0.01	30	50
102	72.01	Defence	- 12.38	0.00	5	46
103	81.01	Health	- 2.47	- 0.02	24	42
104	82.01	Education, Libraries, etc.	- 1.12	0.02	37	52
105	83.01	Welfare Services	- 2.13	- 0.04	29	40
106	91.01	Entertainment	- 5.26	- 0.88	13	27
107	92.01	Restaurants, Hotels, Clubs	- 2.49	0.21	23	58
108	93.01	Personal Services	- 3.88	- 0.01	15	43
109	99.01	Business Expenses	- 77.76	0.01	1	49

4. THE ORANI SIMULATION

The ORANI model was used to simulate the effects on the outputs of industries resulting from a move from free trade to the structure of protection in 1968-69. The predicted output changes could then be compared with the industry ERP estimates to determine the extent to which the latter could be used to explain the resource allocative effects of protection.

ORANI is a highly disaggregated medium term model of the Australian economy.[1] For 109 industry groups it defines the relationships between output, usage of intermediate goods and usage of the primary factors; land, labour, and capital. Forward and backward linkages between industries are catered for by the use of input-output coefficients derived from the 1968-69 input-output tables.[2] Producers compete for primary factors and for shares of consumer demand. They can substitute between material inputs from local sources and from imported sources, and also amongst primary factors. Households can substitute between imported and domestically produced consumer goods of the same class, and also generally amongst all consumer goods.

The ORANI model has previously been used to simulate the consequences of a uniform tariff change.[3] On that occasion the change considered was a 1 per cent increase in all ad valorem equivalent tariff rates. What we are interested in, however, is the effects on industry outputs resulting from a move from free trade to the structure of protection existing in 1968-69. These effects can readily be computed from the previous results because although ORANI has a non-linear structure, it is solved using an approximate form which is linear in percentage changes. The effects of a 100 per cent reduction in all tariffs (i.e., abolition of tariff protection) can be computed by multiplying the previously published results by -100. The effects of moving from free trade to the tariff regime of 1968-69 are taken

1 For a complete exposition of the ORANI model, see Volume Two of the First Progress Report of the IMPACT Project by Dixon, Parmenter, Ryland, and Sutton (hereafter Dixon et al. (1977)).
2 Australian National Accounts - Input-Output Tables 1968-69, Australian Bureau of Statistics, Canberra, 1977.
3 See Dixon et al. (1977, Ch 4) for full details of the simulation and the underlying assumptions.

TABLE 2 - continued

ERP ranking				ORANI ranking			
	Industry				Industry		
Rank	No.	Code	ORANI ranking	Rank	No.	Code	ERP ranking
97	30	23.04	87	97	72	33.04	84
98	45	26.05	74	98	52	27.07	68
99	70	33.02	107	99	78	34.03	80
100	51	27.06	79	100	38	25.02	93
101	71	33.03	90	101	47	27.02	64
102	62	31.01	75	102	64	31.03	94
103	63	31.02	69	103	76	34.01	86
104	23	21.09	59	104	25	21.11	107
105	34	24.01	84	105	36	24.03	106
106	36	24.03	105	106	28	23.02	69
107	25	21.11	104	107	70	33.02	99
108	35	24.02	89	108	65	32.01	82
109	42	26.02	73	109	29	23.03	90

TABLE 2 - continued

ERP ranking				ORANI ranking			
	Industry				Industry		
Rank	No.	Code	ORANI ranking	Rank	No.	Code	ERP ranking
50	17	21.03	66	50	101	71.01	30
51	58	28.05	39	51	66	32.02	81
52	19	21.05	33	52	104	82.01	37
53	56	28.03	31	53	95	61.01	45
54	16	21.02	57	54	20	21.06	33
55	61	29.02	4	55	98	61.04	41
56	54	28.01	86	56	57	28.04	12
57	68	32.04	64	57	16	21.02	54
58	37	25.01	71	58	107	92.01	23
59	41	26.01	82	59	23	21.09	104
60	69	33.01	77	60	85	41.02	6
61	18	21.04	78	61	26	22.01	73
62	60	29.01	7	62	74	33.06	78
63	32	23.06	95	63	82	36.02	36
64	47	27.02	101	64	68	32.04	57
65	33	23.07	96	65	50	27.05	75
66	73	33.05	11	66	17	21.03	50
67	59	28.06	72	67	24	21.10	77
68	52	27.07	98	68	55	28.02	71
69,	28	23.02	106	69	63	31.02	103
70	39	25.03	70	70	39	25.03	70
71	55	28.02	68	71	37	25.01	58
72	22	21.08	3	72	59	28.06	67
73	26	22.01	61	73	42	26.02	109
74	67	32.03	19	74	45	26.05	98
75	50	27.05	65	75	62	31.01	102
76	77	34.02	91	76	40	25.04	85
77	24	21.10	67	77	69	33.01	60
78	74	33.06	62	78	18	21.04	61
79	49	27.04	83	79	51	27.06	100
80	78	34.03	99	80	43	26.03	91
81	66	32.02	51	81	75	33.07	87
82	65	32.01	108	82	41	26.01	59
83	79	34.04	93	83	49	27.04	79
84	72	33.04	97	84	34	24.01	105
85	40	25.04	76	85	31	23.05	92
86	76	34.01	103	86	54	28.01	56
87	75	33.07	81	87	30	23.04	97
88	6	1.06	44	88	48	27.03	95
89	80	34.05	92	89	35	24.02	108
90	29	23.03	109	90	71	33.03	101
91	43	26.03	80	91	77	34.02	76
92	31	23.05	85	92	80	34.05	89
93	38	25.02	100	93	79	34.04	83
94	64	31.03	102	94	21	21.07	96
95	48	27.03	88	95	32	23.06	63
96	21	21.07	94	96	33	23.07	65

to be the negative of the effects of abolishing the 1968-69 tariff structure[1]. Hence all that is required is to multiply the previously published results by 100. The resultant estimates of the changes in industry outputs are shown in Table 1.

Before interpreting the results of any ORANI simulation it is important to understand both the behavioural underpinnings of the model and the particular assumptions that were made for that simulation. The latter includes the important choice of endogenous and exogenous variables. For this simulation industry capital stocks were fixed (i.e., they were exogenous and the percentage change was set at zero), as was aggregate absorption (consumption, investment and government demand) and real wages. On the other hand imports were endogenous as were the exports of the main exporting industries and of course the output of all industries. Full details of the simulation are set out in Chapter 4 of Dixon et al. (1977).

The results shown in Table 1 reflect the many features incorporated in the model but particular features which had a noticeable impact included the degree of backwards/forwards linkage with the export sector, the extent of import penetration of domestic markets and the differing elasticities of import substitution across industries. The results are considered in greater detail in Section 5, which compares the industry output changes predicted by ORANI with their effective rates of protection.

1 This procedure gives only an approximation to the true free-trade solution to the (non-linear) ORANI model. Strictly, solutions to the linearized model are accurate only for 'small' changes in the exogenous variables. Approximation errors arise because throughout the simulation the linear solution method treats certain characteristics of the model's data base (the shares of imports in domestic markets for example) as fixed at their base period values. In practice, however, the linearization errors usually have been found to be small and are unlikely to vitiate conclusions drawn in this paper. A straightforward method which updates the data base in the course of the simulated change is now available for computing approximation-free solutions of ORANI under 'big' changes in its exogenous variables. This is described in Dixon, Parmenter, Sutton and Vincent (forthcoming, Chapter 5).

5. ANALYSIS OF THE RESULTS

This section falls into three parts. The first considers the relative industry rankings according to their ERP and predicted change in output. The approach is purely descriptive and it attempts to provide an intuitive rationale for the different rankings given to a particular industry by each of the two approaches to protection analysis. To obtain further insight this discussion is followed by brief consideration of the projected changes in output compared to the level of effective protection. Sub-section 5.3 looks at three simple statistical relationships which, between them, give some feeling for how much of the story is missed by ERPs, while also providing an idea as to what other factors need to be taken into account.

5.1 Relative ORANI and Effective Rate Industry Rankings

The relative rankings of industries according to their ERP and the change in output predicted by ORANI are shown in Table 2. A scatter diagram of the two rankings is shown in Figure 1. If the ERP ranking gave a perfect prediction of the ORANI rankings then we would have a Spearman rank correlation coefficient of unity and all industries would lie on the 45 degree line of the diagram. The actual Spearman correlation coefficient was calculated to be 0.71,[1] i.e., because the ERP has no mechanism to recognise the many linkages that are incorporated in the general equilibrium model we find that there is significant dispersion from the diagonal.

5.1.1 Industries with High ORANI and ERP Rankings

To further facilitate discussion of the results, Figure 1 has been divided into four quadrants. Consider, first, the top right-hand quadrant. All but five of the industries in this quadrant can be classified as either a highly protected industry (that is, a nominal tariff on output

1 We can compare this result with the Spearman rank coefficient for the correlation between nominal rates and ORANI output, viz 0.69. Using the test in Siegel (1956, p. 247), it was found that there is no significant difference between the ERP correlation with ORANI and the nominal tariff correlation with ORANI.

TABLE 2 : RANKING OF INDUSTRIES BY ERP AND BY ORANI OUTPUT CHANGE

ERP ranking				ORANI ranking			
	Industry		ORANI		Industry		ERP
Rank	No.	Code	ranking	Rank	No.	Code	ranking
1	109	99.01	49	1	9	4.00	26
2	5	1.05	18	2	12	12.00	28
3	27	23.01	12	3	22	21.08	72
4	84	41.01	45	4	61	29.02	55
5	102	72.01	45	5	15	21.01	47
6	85	41.02	60	6	3	1.03	20
7	14	16.00	24	7	60	29.01	62
8	88	48.02	21	8	11	11.02	27
9	89	48.03	23	9	1	1.01	22
10	94	55.01	28	10	2	1.02	21
11	91	52.01	15	11	73	33.05	66
12	57	28.04	56	12	27	23.01	3
13	106	91.01	27	13	7	2.00	40
14	4	1.04	16	14	46	27.01	49
15	108	93.01	43	15	91	52.01	11
16	8	3.00	30	16	4	1.04	14
17	93	54.01	17	17	93	54.01	17
18	90	51.01	20	18	5	1.05	2
19	92	53.01	22	19	67	32.03	74
20	3	1.03	6	20	90	51.01	18
21	2	1.02	10	21	88	48.02	8
22	1	1.01	9	22	92	53.01	19
23	107	92.01	58	23	89	48.03	9
24	103	81.01	42	24	14	16.00	7
25	13	14.00	29	25	86	46.01	32
26	9	4.00	1	26	10	11.01	35
27	11	11.02	8	27	106	91.01	13
28	12	12.00	2	28	94	55.01	10
29	105	83.01	40	29	13	14.00	25
30	101	71.01	50	30	8	3.00	16
31	83	37.01	37	31	56	28.03	53
32	86	46.01	25	32	44	26.04	46
33	20	21.06	54	33	19	21.05	52
34	87	48.01	34	34	87	48.01	34
35	10	11.01	26	35	99	61.05	39
36	82	36.02	63	36	53	27.08	48
37	104	82.01	52	37	83	37.01	31
38	81	36.01	38	38	81	36.01	38
39	99	61.05	35	39	58	28.05	51
40	7	2.00	13	40	105	83.01	29
41	98	61.04	55	41	97	61.03	43
42	100	61.06	47	42	103	81.01	24
43	97	61.03	41	43	108	93.01	15
44	96	61.02	48	44	6	1.06	88
45	95	61.01	53	45	84	41.01	4
46	44	26.04	32	46	102	72.01	5
47	15	21.01	5	47	100	61.06	42
48	53	27.08	36	48	96	61.02	44
49	46	27.01	14	49	109	99.01	1