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THE ORANI TRADE PARAMETERS

PAPERS AND PROCEEDINGS OF A WORKSHOP HELD AT THE INDUSTRIES ASSISTANCE COMMISSION IN APRIL 1983

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FOREWORD

On 14 April 1983, researchers from Government and Universities gathered in Canberra to present papers and outline their views on the trade parameters (import substitution and export demand elasticities) incorporated in the ORANI Model.

The Workshop was hosted by the Industries Assistance Commission. Eight papers were presented and all are reprinted in this volume, together with a summary of the discussion. Some of the papers have been published in revised form and we have included comments on one of the papers provided by Workshop participants.

I am grateful to those people who presented papers and to the Workshop participants who contributed to the debate on the ORANI trade parameters.

Any comments or inquiries in relation to this working paper should be directed in the first instance to:

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OVERVIEW

SESSION 1

Overview of the Estimates of the Elasticity of Substitution Between Imported and Domestically Produced Goods used in the ORANI Model
Chris Alaouze (University of Melbourne)

Dr Alaouze explained that he had not been able to find any comparable work for other countries with the exception of some data for the US. His paper therefore concentrated on the Alaouze, Marsden, Zeitsch paper (1977) which had focussed on 46 4-digit ASIC groups.

He outlined the structure of his paper:

- a summary of the elasticity values;
- an overview of the results in terms of their econometric support; and
- a review of a recent American paper (if time permits).

Dr Alaouze defined an import substitution elasticity as the percentage change in the ratio of imported to domestic production divided by the percentage change in the ratio of relative prices.

This formula was restated in equation 2.1

$$\sigma_i = \frac{\partial \ln(x_{2i}/x_{1i})}{\partial \ln(P_{1i}/P_{2i})} \qquad (2.1)$$

This could then be used to derive equation 2.2 which was the basic log form used in the estimations.

$$\ln(x_{2i}/(x_{1i}) = a + \sigma_i \ln(P_{1i}/P_{2i}) \qquad (2.2)$$

There were two ways this definition could be viewed:

- as a component in an optimisation process with foundations in micro theory (viz Morrisset) and thus an imposition of some restrictive assumptions about preferences; or
- as a functional form supported by the belief that the elasticity was constant over the range of data used.

No matter how equation 2.2 is viewed it was necessary to modify it for estimation by taking account of:

- lags; and
- non-price inducements.

The ordering of the lags in imports was fixed at one and a half quarters by assumption. The domestic price was defined as an anticipated domestic price (the domestic good ordering lag was fixed at half a quarter).

A lot of effort had been put into the assembly of the data and this had paid off in terms of comparative econometrics.

There was no real income term in the equations - the income elasticities of imported and domestic goods were assumed to be identical. The coverage of quantity indexes was similar. There was, however, some difficulty in assessing the effects of quantitative restrictions.

Dr Alaouze then referred to the three relevant cases for the elasticity values, ie when Gi = 1, Gi 1 and Gi 1 (see the overview paper by Alaouze for an explanation).

The estimation procedure was performed using two models:

- a rapid adjustment model; and

- a partial adjustment model.

Dr Alaouze then drew attention to the results contained in Table 1 of his paper.

He summarised the results as follows:

- there were 28 good results out of the 46 ASIC groups;

- these 28 showed no definite autocorrelation although some were indeterminate;

- the partial adjustment model gave good estimates for some (three period adjustment/approximately one year); and

- the rapid adjustment estimates were used for the remainder.

He also drew attention to the summary of results in Table 2 of his paper before finishing.

ORANI Export Demand Price Elasticities - Some Thoughts on Methodology
John Freebairn (La Trobe University)

Professor Freebairn began with the question, 'Do the elasticities matter?', ie are any of our policy analyses sensitive to changes in the parameter values.

He suggested that there were two ways of approaching this question:

- a simple supply and demand or partial approach; and

- a formal sensitivity analysis such as that suggested by Dr Pagan.

Professor Freebairn maintained that because ORANI is a linear model it was possible to go a long way with sensitivity analysis. He suggested that it may be possible to go further and look at covariances. He drew attention to the sensitivity analysis of Dixon, Parmenter and Rimmer and the work of Cronin.

Professor Freebairn maintained that because ORANI is a linear model it was possible to go a long way with sensitivity analysis. He suggested that it may be possible to go further and look at covariances. He drew attention to the sensitivity analysis of Dixon, Parmenter and Rimmer and the work of Cronin.

In summarising these efforts, Professor Freebairn said that Dixon et al. argued that elasticities did not matter greatly whereas Cronin thought they did; particularly for industries such as Motor vehicles and Textiles, Clothing and Footwear. Collectively this research gave an indeterminate response to the question.

Professor Freebairn then foreshadowed a secondary question, 'Suppose it does make a difference - what then?'.

He outlined two alternative approaches:

- direct econometric estimation; and

- the synthetic approach.

Professor Freebairn then characterised both methods. He maintained that even a simple text book approach to direct econometric estimation would generate a very complex model. He suggested that there would be heterogeneity problems and the intrusion of political preferences into market behaviour. There would be inevitable specification errors and the direction of the resultant bias would be unclear. In summary, the results obtained would be difficult to defend.

The second method, the synthetic approach - a combination of both priors and sample information - would have temporal and uncertainty problems.

Summing up, Professor Freebairn thought that the current estimates could be improved with:

- an adjustment story;

- the use of mixed estimators; and

- inclusion of cross price terms.

The inclusion of cross price terms into the ORANI model posed no theoretical problems but there were severe practical limitations. Existing ORANI values were overestimates and only the surface had so far been touched.

Questions on the overview papers

Mr Cronin mentioned two areas of concern:

- one had to accept fairly wide confidence intervals for some commodities - of the order of two degrees of magnitude; and

- although the long term elasticity values he advocated were smaller than the existing numbers in the IMPACT file for many commodities (typically -3 to -5 rather than -10 to - 20) they were still pretty large numbers.

SESSION 2

Gains from Trade and Import Substitution and Export Demand Elasticities in Long Run ORANI

Nico Klijn (Industries Assistance Commission)

Mr Klijn began by explaining that he was concentrating on the long run. He said that long run ORANI had been used on a number of occasions and that usually the short run elasticities were used. Some sensititivity analysis had been reported for short run ORANI. He referred to the paper by Dixon, Parmenter and Rimmer. In their short run analysis the sensitivity was found to be very low for the particular closure used.

He said that in his paper he had looked at the work of Harry Johnson and Dixon where the consumption and production costs of protection were analysed.

Dixon's work suggested that the consumption costs (and by analogy the production costs) would rise to a maximum and then fall asymptotically to zero as the import substitution elasticities rise from zero to high levels. There are a series of these curves, one for each initial free trade budget share.

However, if initial protected budget shares are used the gains from trade rise at an accelerating rate, reach a point of inflection then asymptote to a high value as the import substitution elasticities rise. It is important therefore to know where you are on this curve for the typical values of import substitution used in ORANI applications (generally between 1 and 3).

On the export side the story was fundamentally different. The gains from trade are not positive until a certain export demand elasticity is reached. They then rise with higher absolute values of the export demand elasticity.

Quantitative analysis using a long run version of MO78 had confirmed that the gains from trade were sensitive to both sets of parameters.

Mr Klijn then moved away from sensitivity analysis to a consistency problem between the long run ORANI supply elasticities for Australia and the foreign supply elasticities used in the calculation of export demand elasticities. He pointed out that foreign supply elasticities used were no higher than 3. However, Australian supply elasticities were infinite for mining and manufacturing and were at least 4.8 for agriculture. He invited suggestions for solution of this apparent inconsistency and suggested that for mining the existence of fixed factors might solve the inconsistency.

Questions

Mr Cronin referred to the Conference on the Agricultural Sector and Economy-wide Modelling held at Melbourne University in December 1982. There appeared to be some consensus among agricultural economists that the implicit long run aggregate supply elasticity for agriculture in the ORANI model was unrealistically large and that a realistic order of magnitude was about one.

Professor Dixon referred to a paper by Allan Lloyd which was presented in Melbourne recently which was critical of the ORANI parameter set.

Dr Alaouze asked where the sigma curve flattened out. He was referred to the Klijn paper.

SESSION 3

Sensitivity Analysis for ORANI-Type Models
Adrian Pagan (Australian National University)

Dr Pagan began by observing that if the poultry export demand elasticities are correct the Benjamin Offices should be turned into a chook farm.

He observed that there were two approaches to sensitivity analyses:

- the Cronin approach which involves putting in your own best estimates; and
- the Dixon et al. approach where selective sensitivity tests are applied.

He concluded that both approaches were inadequate:

- the Cronin method involved too much variation at once; and
- the Dixon method involved variation of all parameters at once.

Dr Pagan suggested a solution : the presentation of the partial derivatives with respect to the individual coefficients. He had applied this method to the results obtained from M078.

Dr Pagan expressed the view that economists do not feel comfortable with derivatives. He made three points:

- the derivatives are simulation specific;
- they are not difficult to compute; and
- they are not strictly valid for large changes (though they are close).

Dr Pagan commented on the current set of elasticities. There were two sources of uncertainty:

- the correct specification of the model is unknown; and
- there may be errors in the equations.

Dr Pagan criticised the sensitivity analysis attempted by Dixon et al., saying that many of the parameters were not accurate to within 10 per cent. This would not be a problem if the original coefficients had t values of 20 which was a very rare ocurrence.

This posed the question of the relevant range. Dr Pagan drew attention to his back of the envelope analysis which reproduced the ORANI results. Using this analysis Dr Pagan suggested that a 50 per cent change in the coefficients was quite plausible - a change sufficient to give large variations in the results.

Dr Pagan then described the changes he had made to M078 to facilitate sensitivity analysis. He said M078 was not good for this purpose because it used COBB-DOUGLAS production functions which meant the elasticities changed and that factor substitution was restrictive. He had therefore used CES production functions and a linear expenditure system.

A comparison of M078 with the revised model M078LS is presented in Dr Pagan's paper.

He said the principal determinants of the results can be identified using the partial derivatives. The procedure allows some interesting possibilities. For instance, one could set up changes in a small number of parameters which could exactly reverse the result you were interested in.

There were three lessons that flowed from his analysis:

- the elasticities require a great deal of thought;
- the partial derivative approach is useful; and
- the factor substitution elasticities are very important.

SESSION 4

The Effects of Tariff Cuts Upon the Export Sector in Some Long Term Applications of ORANI

Michael Cronin (Bureau of Industry Economics)

Mr Cronin observed that the IAC had used the ORANI model in about six reports. Two different approaches to long run closure were used: denoted as versions A and B. In the post-1984 Passenger Motor Vehicles Inquiry, version A was used in the draft report and version B in the final report.

Version A assumed absorption fixed and the balance of trade exogenous. The simulation of reduced protection showed an increase in GDP of 0.3 per cent. This was treated by the Commissioners as a welfare indicator. Two comments should be made about this result. First, it was very sensitive to parameter values: with more realistic parameter values this model would have shown a reduction in GDP. Second, the simulated increase in GDP resulted from the creation of a trade surplus, with no implications for welfare and had nothing to do with allocative efficiency. Version A of ORANI is a mercantilist model.

Version B had absorption endogenous and the balance of trade fixed. The simulation showed an increase in GDP of 0.2 per cent. Once again this increase would be exaggerated by the parameter values used. More importantly the simulated increase was caused by a costless expansion of the capital base. GDP could not then be a welfare indicator since most of the increment would in reality flow to depreciation and transfers overseas rather than to net national income. Furthermore, this version also has nothing to do with allocative efficiency. Version B of ORANI can be called a cargo cult model since it implies that a ritualistic tariff cut leads supernaturally to a free gift of capital to Australia.

Mr Cronin anticipated that version C of ORANI - the new long run closure currently being developed by the IAC - would produce results similar to those in the supplement to his main paper. This used a simplistic five-sector model of the Australian economy to assess the effect of a ten per cent tariff cut on all dutiable imports. Using his preferred parameter values Mr Cronin estimated an increase of 0.01 per cent in national welfare was estimated. It was also shown that the welfare effect increased monotonically with the numerical values of each of three parameters: the import substitution elasticity, the export transformation elasticity and the export demand elasticity.

Questions

Mr Klijn asked if the consumption variable was a welfare indicator.
Mr Cronin replied that it was such under the restrictive assumptions of his model which excluded investment and inter-temporal transfer of consumption.

Dr Pagan pointed out that although the Cronin supplementary paper presented a useful sensitivity analysis it could have been summarised more succinctly by setting out the partial derivatives of the endogenous variable responses with respect to each parameter. Mr Cronin agreed.

Dr Pagan asked why the unconstrained capital stock in version B was incompatible with the 'proper' closure of ORANI. Mr Cronin replied that without an appropriate constraint the optimisation problem was falsified and no normative inference could be drawn.

Mr Parmenter added the criticisms of the existing long run closures for ORANI were not new. The IMPACT group itself had pointed out these problems in the 'San Diego' working paper.

Mr Cronin replied that since the IAC used these versions of ORANI operationally to support policy recommendations, it was important to remind the Commission that they were wrong. The IAC should suspend long run applications until these problems had been overcome.

Mr Klijn told the workshop participants that the draft report on Certain Iron and Steel Products did not use a long run closure. Mr Cronin replied that this was a sound decision.

Dr Schweinberger said that the problem of foreign factor owners has been addressed in the literature. He added that investment is an inter-temporal issue.

Mr Cronin agreed that such policy issues were best addressed with a dynamic growth model. A specification of such a model had been put forward in a BIE seminar paper, but had not yet been implemented.

Dr Alaouze said that it is inadvisable to hold the exchange rate fixed in the analysis of tariff cuts.

Mr Parmenter replied that the real exchange rate is endogenous in ORANI simulations even if the nominal rate is fixed.

Mr Cronin pointed out that although the implicit real exchange rate would shift in both long term and short term ORANI simulations, it did not move in such a way a to clear the market for foreign exchange.

Dr Schweinberger added that the tendency in ORANI simulations for tariff cuts to show an increase in the trade surplus was contrary to the theory literature, citing Swan and Salter.

SESSION 5

Aggregation of Trade Parameters in the ORANI Model

John Sutton (Industries Assistance Commission)

Dr Sutton began by explaining the motivation for the paper. Aggregation was often necessary to reduce turnaround time and to reduce computing costs particularly where multiple solutions were required. Four principle reasons for aggregation were advanced:

- to accommodate development work such as the addition of extra equations;
- sensitivity analysis;
- training; and
- to accommodate disaggregations.

Aggregation raised the need for a default formula for the trade parameters. Such a formula would have a wider application than the ORANI model.

Four aggregation criteria were noted:

- the industries to be aggregated should be of little interest in the simulation;
- the aggregated industries have common features;
- the aggregated industries do not have links with the target industries; and
- the aggregated industries do not involve non-homogeneous groupings of export and non-export industries nor endogenous investment and non-endogenous investment industries.

The relevant equations featuring the import substitution elasticities are referred to in Dr Sutton's paper with the aggregation formula suggested being equation (7). The important feature of this formula is that the weights do not sum to one. As the aggregation increases the value of sigma falls.

Questions

Mr Klijn noted that the sum of the individual results should equal the aggregate.

Mr Cronin pointed out that the choice of aggregation in ORANI simulations should depend on the particular problem in hand. If devaluation was being examined import classes subject to dissimilar tariffs could be aggregated without violating the Hicks-Leontief condition. When examining across-the-board tariff cuts, only items of similar tariff levels should be aggregated.

Mr Cronin added that the same aggregation conditions should be met in econometric work. He suggested that it had been breached in the IMPACT research on import substitution elasticities. When items of unlike tariff levels or histories were aggregated, the response of the aggregate to exchange rate changes and to tariff cuts would differ and the estimated parameters would not be stable.

Dr Alaouze replied that it would be necessary to carry out the estimations at tariff item level to overcome Mr Cronin's criticisms. Such an approach was not practical as it took two years and three people to do the 28 estimations on which the current sigmas are based. Mr Lawson added that there had been no work done since.

Mr Cronin replied that it was important since large biases may be involved.

SESSION 6

Export Demand Elasticities for Australian Livestock Products
Joe Dewbre and Garry Smith (Bureau of Agricultural Economics)

Mr Dewbre presented the following summary of export demand elasticities.

Wool		- .6 to - .8
Beef	US	-1.0 to 0.0
	Japan	0.0
	Other	-1.3
Mutton		-2.4

All except US Beef were OLS estimates and were statistically sound. The estimates for US Beef had been obtained from another source. They had been estimated from annual data and were characterised by all the biases mentioned earlier by Professor Freebairn. Mr Dewbre added that he was not as willing as Professor Freebairn to accept the superiority of the synthetic estimates, his major reservation being that close examination of the product tended to reduce the elasticity and this would diminish the inferential estimates that could be derived from world estimates. For example in the beef market there was every indication that Australian beef does not compete with the aggregate.

In conclusion Mr Dewbre argued that the empirical estimates were lower than inferential estimates but had problems of statistical formulation, time and price transmission.

Mr Parmenter asked Mr Dewbre to comment on the proposition that Australia is exporting too much wool.

Mr Dewbre replied that might be a valid inference if his estimate applied in the longer term. His estimates were based on annual data without adjustment lags and were more likely to reflect short term than long term responses.

Mr Parmenter added that if the estimates were policy relevant then the changes which are considered are trivial.

Mr Dewbre said that there would be institutional constraints affecting any attempt to take advantage of demand elasticities less than -1.0 except in the long run and that the long run elasticities may be different.

Mr Cronin asked if the short run version of ORANI was or was not intended to model the short run. If it was, then it should incorporate short run values of trade elasticities.

Mr Parmenter said that he didn't believe in values less than -1.0 because of the surprising policy implications. Professor Freebairn argued that he did not think short run values of export demand elasticities were relevant to export strategies, so these surprising policy implications did not exist.

Mr Klijn said that the institutional barriers could possibly be overstated. It did not need direct government involvement to respond to low short term elasticities - for instance, the Australian Wool Corporation could organise it. Mr Cronin added that it does this through its buffer stock scheme.

Mr Parmenter asked why exporters were not observed exploiting these low elasticities.

Mr Cronin offered the explanation that they would be interested in maximising long run profits.

Mr Dewbre defended his approach saying that he was not supporting a set of numbers but was identifying problems.

Mr Parmenter said that a feasible set of numbers was needed.

Professor Freebairn suggested that a system of structural equations were necessary to come to grips with the problem of product differentation.

Dr Pagan asked Mr Dewbre about the nature of the lag structure he had used.

Mr Dewbre replied that no lags had been used.

Dr Pagan said that in his experience with Japanese demand there may be a lag in excess of one year.

Mr Dewbre asked what this omission would mean to the estimates. Mr Pagan replied that it would result in an overestimate of the short run elasticities.

Dr Alaouze said that because the estimates were based on an OLS estimator they were certain to be biased. He added that they were not even 2SLS - that they were not really estimates at all.

Dr Alaouze commented that the estimates are not really demand elasticities but a combination of demand and supply and some other things. Demand for these products could be thought of as a derived demand since demand for wool, for instance, is a demand derived from the demand for clothing. The demand for clothing is price elastic.

Mr Dewbre said that it was in the same ball park and that studies that have incorporated this give elasticities between -.2 and -.8, with an average of -.35. These studies include substitution.

Dr Alaouze maintained they were too low.

OVERVIEW OF THE ESTIMATES OF THE ELASTICITY OF SUBSTITUTION BETWEEN IMPORTED AND DOMESTICALLY PRODUCED GOODS USED IN THE ORANI MODEL

Chris M. Alaouze

(University of Melbourne)

1. INTRODUCTION

This paper presents an overview of the estimates of the elasticity of substitution (ES) between imported and domestically produced goods classified at the four digit Australian Standard Industry Classification (ASIC) level reported in the study of Alaouze, Marsden and Zeitsch (1977), (AMZ). The data used in the AMZ study are quarterly and span the period September 1968 to June 1975. This period is ideal for import demand estimation as it includes large movements in import prices, domestic prices and industrial activity. The 46 four digit ASIC groups which were investigated in the AMZ study represented approximately 35 per cent of Australian merchandise imports in 1973-74.

This paper has four remaining sections. The following section includes a summary of the major assumptions and some aspects of the statistical models used in estimating the ES. In Section 3, relevant values of the ES are interpreted while an overview of the estimates reported in the AMZ study is presented in Section 4. The final section contains some concluding remarks.

2. EMPIRICAL SPECIFICATION AND ASSUMPTIONS

The ES between an imported good and its domestic substitute can be written as:

$$\sigma_i = \frac{\partial \ \ell n \ (x_{2i}/x_{1i})}{\partial \ \ell n \ (P_{1i}/P_{2i})} \qquad (2.1)$$

where : σ_i is the ES between imported and domestically produced goods of type i;

x_{2i} is the quantity of imports of good i used;

x_{1i} is the quantity of domestically produced good i used;

P_{2i} is the price of imports of good i; and

P_{1i} is the price of the domestically produced good i.

If it is assumed that utility and production functions possess the usual concavity properties which rule out corner solutions, the ES (σ_i) as defined in equation 2.1 is necessarily positive.

In attempting to estimate the ES from available data it is natural to consider the following functional form as the basis of an econometric specification:

$$\ell n \left[x_{2i}/x_{1i}\right] = a + \sigma_i \; \ell n \left[P_{1i}/P_{2i}\right] \qquad (2.2)$$

Equation 2.2 has a long history in import demand estimation (see AMZ for references). Morrissett (1953) showed that the ES defined in equation 2.1 will only reflect the substitutability of one good for another along an isoquant or an indifference curve if certain restrictions, which include that the income elasticity of demand for each good is equal, hold.

The empirical work reported in the AMZ paper is based on the assumption that the income elasticity of demand of the imported good is equal to the income elasticity of demand of the domestically produced good. It was assumed that this would be a reasonable working approximation because the 4 digit ASIC level is highly disaggregated and the coverage of the import and domestic indexes at this level of aggregation is very similar.

The specification 2.2 was modified to take into account the effect of ordering lags, pressure of demand, seasonality and various types of import restrictions on the import-domestic good quantity ratio.

2.1 Ordering Lags

It was assumed that the import ordering lag was 1 1/2 quarters and that the domestic good ordering lag was 1/2 a quarter. It was also assumed that the price of the import measured at t was the price quoted at time of ordering (t-3/2), and that the price of the domestic good measured in period t was the price quoted in period t-1/2. The decision to import was assumed to be based on an estimate of the domestic price quoted at t-1/2 (as viewed from the import ordering period, t-3/2) and the expected orders of the domestic good in period t-1/2 (as viewed from t-3/2). The construction of the various expectational series is discussed in the AMZ paper.

2.2 Pressure of Demand

2.2.1 Positive pressure of demand effects

It is widely recognised that during periods of excess domestic demand, import demand increases independently of prices and domestic activity. The usual explanation provided for this phenomenon is that under conditions of excess demand, producers have difficulty in meeting their orders at ruling prices. However, recognising the short-term nature of this increased demand, producers are reluctant to increase prices, and prefer to ration their output by increasing their delivery lags, with the direct effect of increasing queue lengths. Thus the user pays two prices for the good: the quoted price and the imputed cost of queueing. In an attempt to minimise total cost, the customer may turn to imports. When this occurs, import demand is no longer fully explained by nominal prices and activity. This shall be called the 'positive' pressure of demand effect.

2.2.2 Negative pressure of demand effects

It has also been suggested that when domestic output is less than normal, import demand is retarded because domestic producers offer rebates, prompt delivery and other non-price inducements which tend to reduce import demand. This shall be referred to as the 'negative' pressure of demand effect.

In the AMZ study, proxy variables constructed from survey data were used to correct for pressure of demand effects on the import to domestic good ratio.

2.3 Dummy Variables

Dummy variables reflecting import restrictions and seasonal factors were included in the estimating equations whenever appropriate. For specific details, the interested reader should consult the AMZ paper.

Finally it should be noted that the small country assumption is applied (the world price is not affected by Australian import demand); that is, the import price was assumed to be exogenous. Under this assumption, all the explanatory variables which enter the estimating equations are pre-determined and therefore OLS is an appropriate estimation procedure.

3. INTERPRETATION OF THE ES

Equation 2.2 may be transformed to:

$$\frac{x_{2i}}{x_{1i}} = c \left(\frac{P_{1i}}{P_{2i}}\right)^{\sigma_i} \qquad (3.1)$$

Multiplying both sides of equation 3.1 by P_{2i}/P_{1i} yields:

$$\frac{P_{2i}\, x_{2i}}{P_{1i}\, x_{1i}} = c \left(\frac{P_{1i}}{P_{2i}}\right)^{\sigma_i - 1} \qquad (3.2)$$

From equation 3.2 there are three relevant cases:

- the ratio of market shares remains constant (in value terms) as the ratio of prices changes;

  $\sigma_i = 1$

- the market share of the imported good rises relative to that of the domestic good (in value terms) as the ratio of domestic to import prices increases; and

  $\sigma_i > 1$

- the market share of the imported good falls relative to that of the domestic good (in value terms) as the ratio of domestic to import prices increases.

  $\sigma_i < 1$

4. OVERVIEW OF THE ES ESTIMATES

Two basic econometric models were estimated: a rapid adjustment model and a partial adjustment model. The rapid adjustment model assumes that the quantity ratio (in equation 2.2) adjusts immediately to changes in the price ratio, whereas the partial adjustment model assumes that there is a partial adjustment to a target import-domestic quantity ratio in each period. The partial adjustment model allows us to compute the elasticity of substitution for various response periods. It should be noted that the partial adjustment specification contains a lagged dependent variable, and hence if the disturbances are autocorrelated the parameter estimates are inconsistent.

The ES estimates for the ASIC groups for which fairly satisfactory empirical results were obtained are presented in Table 1. For convenience, the ES estimates in Table 1 are summarised in frequency distribution form in Table 2. In discussing the results the 3 period ES estimate from the partial adjustment model shall be taken as the estimate of the ES for a particular ASIC when this estimate is available, otherwise the ES estimate from the rapid adjustment model will be used as the estimate for that ASIC. Because it is assumed that the ordering lag for imports is 1 1/2 quarters, the ES estimates from the partial adjustment model will reflect roughly the yearly response.

Broadly speaking, for those commodities which are not intermediate inputs (16), the majority of the ES estimates (10) lie between 1 and 2, with a minority (1) less than 1 and a larger number (5) greater than 2.

The ES estimates for intermediate inputs (12) are evenly divided with half less than 1 and the remaining 6 between 1 and 2.

Looking at the empirical results in the aggregate, of 28 ASIC groups, 7 have an ES less than 1, and 2 have an ES greater than 1 so that the general impression one obtains is that the response of value shares to changes in the price ratio of imported and domestically produced goods is typically elastic.

TABLE 1 : ELASTICITY OF SUBSTITUTION ESTIMATES

ASIC Industry			Elasticity of Substitution Estimate		
			Rapid adjustment	Partial adjustment	
				3 period	period
1 FOOD PRODUCTS					
ASIC	2132	Vegetable products	.99	1.28	1.28
	2140	Margarine, oil and fats	1.24	-	-
	2192	Beer	2.26	2.42	2.42
2 MISCELLANEOUS DURABLES					
ASIC	2331	Textile floor coverings	-	1.38	1.67
	2522	Mattresses	-	1.97	2.23
	3211	Motor vehicles	4.37	-	-
	3322	Refrigerators and household appliances	2.17	1.24	2.95
	3323	Waterheaters	1.51	-	-
3 CLOTHING					
ASIC	2411	Hosiery	0.74	-	-
	2412	Cardigans and pullovers	1.72	-	-
	2433	Men's trousers and shorts	3.12	2.62	3.79
	2424	Men's and boys' suits and coats, waterproof clothing	-	1.58	2.57
	2425	Underwear, nightwear, shirts and infant clothing	2.07	-	-
	2426	Foundation garments	-	1.04	1.76
4 MISCELLANEOUS GOODS					
ASIC	2711	Chemical fertilizers	1.423	-	-
	2725	Soap and detergent	1.263	-	-
5 INTERMEDIATE INPUTS (LOW ELASTICITY)					
ASIC	2317	Worsted yarn and broadwoven fabric	0.35	-	-
	2611	Pulp, paper and paperboard	0.65	0.77	0.80
	2831	Cement	0.75	-	-
	3212	Truck and bus bodies	0.85	-	-
	3324	Electric and telephone, cable, wire and strip	0.79	-	-
	3431	Flexible plastic sheeting	0.98	-	-
6 INTERMEDIATE INPUTS (HIGH ELASTICITY)					
ASIC	2315	Man-made fibre and broadwoven fabric	2.38	2.14	2.58
	2318	Woollen yarns	-	1.36	1.78
	2713	Synthetic resins and rubber	1.71	-	-
	2914	Steel pipes and tubes	1.51	-	-
	2927	Rolled and extruded alluminium	1.1	1.4	1.47
	3432	Rigid plastic sheeting	1.47	-	-

TABLE 2 : FREQUENCY DISTRIBUTION OF ES ESTIMATES

ASIC Group	ES Range			
	$\sigma < 1$	$1 < \sigma < 2$	$\sigma > 2$	Total
Not intermediate inputs	1	10	5	16
Intermediate inputs	6	6	0	12
All ASIC groups	7	16	5	28

5. CONCLUDING REMARKS

This overview will be concluded with an overall evaluation of the results of the four digit ASIC study. Data were available for 46 ASIC groups, but for nine of these, exports accounted for more than 10 per cent of domestic output (a series of domestic output was used because no domestic use data were available), and while the ES models were estimated for these nine ASIC groups their results were not included in the discussion.

Of the remaining 37 ASIC groups, five yielded negative estimates of the ES. In the AMZ paper, explanations for the negative ES were given for four of these ASIC groups, but the negative ES of ASIC 2316 (Cotton and broadwoven fabrics) was deemed inexplicable. Upon closer inspection, it is shown in Table 7.3 of the AMZ paper that ASIC 2316 exported 3 per cent of domestic output in 1968-69 and 7 per cent in 1974-75. In view of the fact that domestic output data were used in lieu of domestic use data, this secular rise in exports could explain the negative ES.

This leaves a total of 32 ASIC groups. For 28 of these, no significant autocorrelation was detected in the residuals, and, in the majority of cases, the estimated ES was significantly different from zero.

Significant first order autocorrelation was detected in 3 cases: ASIC 2314 (Man-made fibre and yarn), ASIC 2821 (Clay bricks and refractories) and ASIC 2835 (Asbestos and cement products). In one case, ASIC 3325 (Batteries) significant first order autocorrelation was detected in the rapid adjustment model, and Durbin's h-statistic could not be computed.

This is not a bad record and must lend some confidence to the functional form and the underlying modelling methodology. There is obviously scope for further work with those ASIC groups for which significant autocorrelation was detected.

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ORANI EXPORT DEMAND PRICE ELASTICITIES: SOME THOUGHTS ON METHODOLOGY

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1. INTRODUCTION

Exports represent an important market for Australian output. In 1980-81 about 14.4 per cent of GDP was from exports of goods. The main sectoral contributions to exports were agriculture 46 per cent, mining 28 per cent and manufactures 26 per cent. In the case of many of the agricultural and mining industries, exports account for more than half the sales and in several cases more than eighty per cent of sales. For several manufacturing industries, including basic iron and steel and other base metal products, exports represent over ten per cent of total industry sales.

2. MODEL CONTEXT

The demand function facing Australian exports in the ORANI model is represented by a price dependent function;

$$P^e_i = f^e_i - \gamma_i X_i$$

where P^e_i is the percentage change in the foreign currency received per unit of export of good i,

X_i is the percentage change in quantity of product i exported,

f^e_i is the percentage change in an index representing net changes in non-own price factors shifting the excess demand for exports, and

γ_i is the price flexibility term or inverse of the own price export demand elasticity.

For most but not all applications, the price and export quantity variables, P and X, are determined endogenously, the shift variable, f^e, is an exogenous variable used for evaluating changes in world trade conditions, and the price flexibility parameter, γ, is a part of the given parameter file.

3. EXPORT DEMAND IN ORANI STUDIES

In many but not necessarily all ORANI analyses, specific values of the price parameter of the export demand function γ in (1) can have important direct and indirect effects on the results obtained. At the direct industry level the greater the export demand elasticity (and the smaller γ) the greater will be the change in industry exports, output and employment for a given change affecting industry production costs and shifts in the f^e variable. These effects will be greater the more elastic the industry supply as happens with longer-run studies. The direct export industry effects apply symmetrically for expansion and contraction scenarios. Indirect effects include the interindustry links to output using and input supplying industries, balance of payments effects, and price and wage effects. Balance of payments effects depend on whether the exchange rate is set exogenously by or is an endogenous variable. If the latter is the case, the more elastic the export demand functions, the greater will be the effect of export industry expansion (contraction) on a required revaluation (devaluation) for balance of payments equality. Prices received by export industries have direct and indirect effects on the consumer price index (CPI) which, in turn, can affect wage rates according to the indexation scenario. Changes in wages and intermediate input prices affect costs faced by other industries. In general, the more inelastic the export demand functions the greater will be the price and cost effects for a given expansion and contraction of export industries. The key issue then is whether these types of qualitative effects are of sufficient quantitative importance to influence the results obtained from ORANI simulations.

In a recent study, 'The Sensitivity of ORANI Projections of the Short-run Effects of Increases in Protection to Variations in the Values Adopted for Export Demand Elasticities' (Dixon, Parmenter and Rimmer, 1982) it was concluded that the main qualitative results are not rejected by wide variations of the elasticities and '...if we are satisfied that export demand elasticities, are, on average, greater than two, then the exact values we choose for them between two and infinity, do not have critical implications for ORANI results'. Clearly, these results for one context cannot be generalised to hold for all contexts. They do however warn us that before spending money and effort in refining parameter estimates it is necessary to establish that different plausible values would have a significant effect on the results. Such an assessment can be guided both by theory and by empirical sensitivity analysis with the ORANI model.

As further background, Table 1 provides a summary of three sets of export demand elasticity estimates that have been prepared for ORANI simulations. Since the simulations are for the short-run context in which industry capital stocks are fixed - a period of a one to two years - the elasticity estimates refer to a one to two year period of adjustment. Only for wool, prepared fibres, and in the case of Cronin's (1979) estimate for food products nec, are the export demand elasticities set at less than two. It should be noted that the estimates in Table 1 are surrounded by considerable uncertainty and quite wide confidence intervals over and above underlying conceptual differences of opinion.

In the following sections, alternative ways of estimating export price elasticities are investigated.

4. DIRECT ECONOMETRIC APPROACH

The use of regression techniques and time series data is an intuitively appealing method of obtaining values for the export price elasticities. In this section the underlying structural model will be discussed, some implications drawn from the model, and some of the practical problems with the approach outlined.

The essence of the story can be obtained from a simple model; initially assuming a competitive world, no transport costs, no government interventions, and no time effects. Some of the effects of relaxing these assumptions will be discussed later. The demand for the exports of a commodity from one country is obtained as the sum of the excess demand functions of all other countries:

$$DE = \sum_i ED_i = \sum_i D_i(P, P_{oi}, Y_i) - \sum S_i(P, P_{ai}, W_i)$$

$$= f(P, P_{o1}, \ldots, P_{on}, Y_1, \ldots, Y_n, P_{a1}, \ldots, P_{an}, W_1, \ldots, W_n)$$

where DE is demand for Australian exports;

ED_i is the excess demand for country i (i=1,2,...,n);

$D_i(\cdot)$ is the demand function of country i;

$S_i(\cdot)$ is the ith country's supply function;

P is the world price (by assumption the same for all countries);

P_{oi} is a vector of substitute and competitive product prices in each country's demand function;

Y_i is an index of demand shift factors (such as income);

P_{ai} is a vector of alternative product prices and input costs affecting supply decisions in each country; and

W_i is an index of supply shift factors such as weather.

Even under our simplifying assumptions the export demand function in (2) is seen to contain a large number of variables in addition to that of the export price P. At a minimum a correctly specified model would include the prices of products considered as important demand alternatives, production alternatives and production costs - a list that could be quite large at a level of disaggregation desired by ORANI - as well as demand and supply shifters in the important importing and export competing countries. Failure to include these other exploratory variables constitutes a specification error which results in biased parameter estimates in the cases where excluded and included variables are correlated.

The simplistic procedure of using estimates for the export demand elasticity from an OLS regression of export quantity on price almost certainly is biased. Orcutt (1950), Harberger (1953) and others argue that the estimate will be biased downwards, essentially because the excluded demand shift variables (Y_i of (2)) are positively correlated with the included price, because of a simultaneous equation bias, and because of identification problems. But the exclusion of cross price terms and supply shift variables has an opposite effect (Magee, 1975). Binkley's (1981) theoretical work emphasises the difficulty in determining the net direction of bias.

A further problem with the simple regression approach is the aggregate treatment of the supply and demand curve shift variable. The frequently quoted Houthakker and Magee study (1969) for example, uses an index of the rest of world income as the only shift factor and further assumes, albeit implicitly, identical parameters for countries as diverse as the USA, USSR and Bangladesh. It is likely that the aggregation problems become of more concern when finer levels of commodity disaggregation are under study.

In reality we need to relax some of the assumptions of our initial illustrative model represented in equation (2). First, time lags are important, both on the demand and the supply side. Since most of Australia's exports are intermediate goods rather than final consumer goods their demand is a derived demand and further production stages are involved. Here production and investment decisions involve lags due to recognition, decision, delivery, replacement and production factors and they may extend over several years, for example, the choice of form of energy use as it affects coal demand. The customer market idea discussed by Okun (1981) and others effectively smooths out the effect of short-term price disturbances. Similar lags are found on the supply side with the addition of biological constraints. Agricultural supply studies find small responses to prices within a year, and in the case of meat the short-run effect may be perverse, with long-run effects taking several years. The long lead times within mining developments, including infrastructure, are well known. The Junz and Rhomberg (1974) study which was directed primarily at manufactures concluded that '...following price changes, fifty per cent of the ultimate full effect of changes in quantities of goods traded takes place in the first three years following the price change, and about ninety per cent in the first five years'. In the ORANI short-run context of one to two years, it seems that using the long-run export demand elasticity estimate is too strong an assumption. In a general context, it is clear that careful attention to time dynamics as they affect both demand and supply response components of the export demand function in (2) is imperative.

Transport costs are of considerable importance for most of Australia's exports. Conlon (1982), using data for the third quarter of 1974, estimated average transport costs for all exports to be 13.6 per cent of the fob price. Rates for specific commodities include wool 3.3 per cent, cereals 21.2 per cent, meat 6.2 per cent, basic iron and steel 13 per cent, aluminium 12 per cent and petroleum and coal products 50.1 per cent. The relative importance of transport costs effectively reduces the export price elasticity below that obtained using a simple model ignoring transport costs. It does this directly when the transport cost is a fixed mark-up, and indirectly when transport costs reduce the world market areas in which Australia is a viable competitor.

The simplifying assumption of a competition model also abstracts from reality. While the evidence is weak and contentious, it has been argued in a number of articles that market power is exercised by some participants in the world market. In the case of wheat, for example, the principal exporters have been modelled as duopolists (McCalla, 1966) and oligopolists (Alaouze, Watson and Sturgess, 1978) and on the other hand the principal importers have been modelled as monopsonists (Carter and Schmitz, 1979). In the case of coal and iron ore Smith (1977) has suggested that Australia and Japan are involved in a bilateral monopoly bargaining game. The results of most monopoly/oligopoly models regarding price and quantity responses differ from those of a competitive model.

Of particular importance in the world market is the pervasive role of government interventions via tariff and non-tariff forms of assistance. An important effect of these policies is to partly insulate domestic prices from world prices with the effect that changes in our export prices are reflected in part only in changes in prices of the commodity in other countries. In effect, changes in our prices have less effect on demand and supply in other countries than is assumed in the competitive model (see, for example, Bale and Lutz (1979) for a theoretical analysis). These issues are explored further in the next section. In the context of time series regression analysis, the important point is that the forms and levels of assistance vary over time. Thus, an effective econometric study would require the inclusion of trade and national policy variables in the excess demand function (2).

Recognition of product heterogeneity has important implications for the export demand curve. Recall that the simple model assumed homogeneity. Product heterogeneity can arise not only from intrinsic physical differences but also from a host of other considerations. Factors such as reliability of supply, political and economic preferences for a diversified pattern of supply sources and familiarity and ease of communication result in importers regarding imports of a similar physical good from one country as an imperfect substitute for that obtained from another country. Empirical support for this hypothesis includes the work of Armington (1969) and Artus and Rhomberg (1973) at a fairly aggregate level, and at a more disaggregated level the work of Grennes, Johnson and Thursby (1977) for wheat and Goddard (1983) for beef. An important effect of the product heterogeneity is to reduce the export demand elasticity, with the reduction being greater the lower the elasticity of substitution perceived by importers for the Australian product relative to that of competing exporters. In the context of an econometric model it means that there is not one price for the product, but a separate price for the product supplied by each country. Hence, a properly specified model would require inclusion of all of these prices.

The recognition of some of the realities of world trade would further complicate equation (2). Specific reference would have to be given to the effects of time, transport costs to different markets, government trade intervention policies, and the single world price would have to be replaced by prices of the product offered by all principal exporters. Although all this is conceptually possible, there are numerous hurdles to overcome before a workable empirical model can be estimated.

In general, there are few if any econometric studies of the export demand for Australian agricultural commodities at the level of disaggregation required by the ORANI model which are free from significant specification errors and are complete in the sense argued above.

5. SYNTHETIC APPROACH

An alternative method for estimating the export demand price elasticity, one which is less demanding of data, underlies the estimates which are reported in Table 1 and currently used in ORANI analyses. This method may be denoted as the synthetic approach. Returning again to our simple competitive model, the own-price export demand elasticity, e, is given by:

$$e = \frac{dX}{dP}\,\frac{P}{X} = \sum_j \frac{dD_j(\cdot)}{d\;P}\,\frac{P}{D_j}\,\frac{D_j}{X} - \frac{dS_j(\cdot)}{dP_i}\,\frac{P}{S_j}\,\frac{S_j}{X}$$

$$= \sum_j e^d_j \frac{D_j}{X} - \sum_j e^s_j \frac{S_j}{X} \qquad (3)$$

where e^d_j is the elasticity of demand for the product in country j (j = 1,2,...n);

e^s_j is the elasticity of supply;

D_j is quantity demand in country j;

S_j is quantity supply in country j; and

X ($= \Sigma D_j - \Sigma S_j$) are Australian exports.

Equation (3) has been generalised by Cronin (1979) and by Bredahl, Meyers and Collins (1979) to allow for partial responses of prices in other countries, P_j, to changes in our price, P, as:

$$e = \sum_j e^d_j \; \theta_j \; \frac{D_j}{X} \; \sum_j e^s_j \; \phi_j \frac{S_j}{X}$$

where $\theta_j = \frac{dP_j}{dP} \frac{P}{P_j}$ is the elasticity of price transmission between the price faced by buyers in country j and our export price; and

$\phi_j = \frac{dP_j}{dP} \frac{P}{P_j}$ is the elasticity of price transmission between the price faced by producers in country j and our export price.

In the perfectly competitive model case $\theta j = \phi j = 1$ for all j. In the other extreme case some of the θj and ϕj are zero because of prohibitive transport costs or government policies which effectively isolate domestic prices from our export price. Values between zero and unity are feasible. In effect, the lower any θ_j or ϕ_j, the lower will be the export demand elasticity (for an empirical example with reference to US export demand for wheat, corn and soyabeans see Bredahl, Meyers and Collins (1979)).

In practice, there is considerable debate and uncertainty about the precise values which should be given to the price transmission elasticities. As one option they may be estimated from a regression of different country prices on our export price. This procedure has been used by Zwart and Meikle (1979) and by Abbott (1979) in studies of the world wheat market. They discovered that many elasticities fell in the zero-unity band rather than at either extreme. Potential difficulties with this approach arise from changes in government policies over the sample period and, in the case of large importing and exporting countries, the possibility of simultaneous equation bias.

A second approach is to explicitly use information about government policies and how they work. For example, the Common Agricultural Policy (CAP) of the European Economic Community (EEC) virtually insulates EEC prices from world prices. Price schemes for grains and dairy products in Australia and Canada essentially insulate consumer prices, and producer prices are given by a blend of the fixed consumer price and the world price. Much policy information is available for agricultural products and some is available for minerals and manufactures from government reports, marketing board reports, international agencies, and journal articles. There will be some areas for legitimate debate. For example, some (including Bredahl, Meyers and Collins, 1979, and Zwart and Meikle, 1979) argue that the price transmission elasticities for the centrally planned economies are zero. Others (including Freebairn, Rausser and de Gorter, 1982) argue that their excess demand price elasticity is unity with the value of foreign exchange rather than physical quantity being predetermined or that planners engage in arbitrage, between say, wheat and rice in the case of China and meat and coarse grains for feed animals in the case of the USSR. In principle the empirical econometric approach and the prior information can be combined in a formal way using a Bayesian estimator or the Theil and Goldberger mixed estimator.

Similar procedures can be used to take account of transport costs. One option is to use $1/(1+t)$ as the price transmission elasticity where t is the transport cost as a proportion of the export price.

Equation (4) can be generalised to allow for the time pattern of response and for cross price as well as direct price effects (Freebairn, Rausser and de Gorter, 1982). They calculate direct and cross price elasticities for the export demand functions for US wheat, corn and soyabeans for one quarter (only demand response is non-zero), for one year (demand response and one year or short-term supply response) and the long run.

Three comments concerning the elasticity estimates now used in the ORANI model should be noted. First, there is a need to make more explicit statements about the allowance for the time pattern of response of export demand to Australian price changes. The effect of time lags in the adjustment of expectations and of production systems affecting the demand for and supply of products in the principal importing and exporting countries should be made conformable with the time period of the ORANI analysis. It appears that it is necessary to more fully understand the influence of contracts and the possibility of endogenous policy functions and their time path of effects on the price transmission elasticities as well as the time paths of demand and supply elasticities.

Second, for some types of problems it seems desirable to extend the empirical analysis to include cross price effects. In the case of a currency change, for example, the prices of all commodities are affected. This is a trivial extension in the modelling sense since x and p in (1) will become vectors and f^e and γ will become matrices with non-zero terms in the off-diagonals of the γ matrix. Ignoring the cross price effects tends to overestimate the effects of currency changes on demand. This arises because the cross price terms are opposite in sign to the own price terms. Of course the data demands are increased, however the increased availability of estimates of systems of demand and supply equations for related commodities makes the suggestion a feasible one.

Third, the choice of values of the price transmission elasticities can be considered in a more systematic way, drawing on both sample and other information. Researchers should not feel bound to specify only zero or unity, but also should consider in-between values based on actual regressions and on assessment of government policies, transport costs, and real and perceived differences in product quality. In addition, the elasticities can be given a time dimension.

6. CONCLUDING COMMENTS

While the export demand equations are an important component of the ORANI model and hence warrant periodic scrutiny, the decision to devote more time and effort to refining the estimates should be made only after it is established that reasonable alternative values could significantly affect results. The degree to which this occurs will vary with the objectives of the analysis. From a general knowledge view however, it is useful to obtain more refined estimates of export demand functions.

A useful estimate of the export demand function should have as a backdrop a structural analysis. This will highlight the key determining variables and provide a benchmark for assessing simplifying approximations. Because of inadequate data however, it is doubtful that econometric estimates of unconstrained general structural models will meet with much success.

If interest lies mainly with the direct and cross price terms then the synthetic approach offers a feasible strategy. The procedure can be generalised to incorporate time lags, cross price effects, government policies, transport costs, and to a lesser and more ad hoc extent, product heterogeneity both real and perceived. Both sample and other information can be combined in deriving the estimates. There will remain uncertainty about the true population values and this should be recognised explicitly.

Finally, it is likely that further improvement in understanding and estimating the demand for Australian exports is possible and may well be a cost effective exercise..

TABLE 1 : EXPORT DEMAND ELASTICITIES SUGGESTED FOR USE IN SHORT RUN ORANI SIMULATIONS

Commodity		Standard ORANI value	Cronin's long run estimate	Fallon's estimate
ORANI number	Description			
A1	Wool	1.3	1.6	1.3
A3	Wheat	12.5	12.5	12.5
A4	Barley	20.0	12.5	12.5[c]
A5	Other cereal grains	20.0	12.5	12.5[c]
12	Iron	20.0	5.0	10.0
13	Other metallic minerals	20.0	4.0	8.0
14	Coal	20.0	5.0	20.0
18	Meat products	16.7	4.0	10.0
22	Flour and cereal products	20.0	20.0[c]	20.0[c]
25	Food products nec[a]	20.0	0.0	20.0
30	Prepared fibres[b]	2.6	1.6	2.6
63	Basic iron and steel	20.0	20.0	20.0
64	Other basic metals	2.0	20.0	10.0
	Other	∞	∞[c]	∞[c]

a Includes sugar and dairy.
b Mostly scoured wool.
c Values assigned by Dixon, Parmenter and Rimmer (1982) in lieu of no specific information by Cronin and Fallon.

SOURCE: Derived from Table 3.1 of Dixon, Parmenter and Rimmer (1982).

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GAINS FROM TRADE AND IMPORT SUBSTITUTION AND EXPORT DEMAND ELASTICITIES IN LONG RUN ORANI

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1. INTRODUCTION

This paper deals with the sensitivity of the gains from trade in long run versions of the ORANI model to import substitution and export demand elasticities. Previous investigations of the sensitivity of ORANI results to these elasticity values by Dixon, Parmenter and Rimmer (1982) were based on short run ORANI simulations and do not carry over to long run model applications.

Participants at this Workshop will be familiar with the ORANI model of the Australian economy. A long run version of this model was used by the Industries Assistance Commission in its reports on 'Passenger Motor Vehicles and Components - Post 1984 Assistance Arrangements', 'Phosphatic and Nitrogenous Fertilizers', 'Approaches to General Reductions in Protection', and 'Certain Iron and Steel Products, and Certain Alloy Steel Products'. This long run version differed from the short run version by having exogenously given rates of return and endogenously determined capital stocks. This treatment is based on an assumption that Australia in the long run is a 'small' country with free access to the world capital market. The treatment implies that in the long run all factors of production are free to switch between industries, except of course land which is 'climatic zone' specific in ORANI.

In the fertilizers reference the long run effects of assistance generally on the costs of production of agriculture were analysed. In 'Approaches to General Reductions in Protection', the long run gains from various trade liberalisation options were suggested by reporting the simulated increases in Gross Domestic Product.[1]

Generally in these applications, the same values of import substitution and export demand elasticities were used as in short run applications. However for the motor vehicle and components study, the short run value for the import substitution elasticity of five was replaced by a long run value of seven and additional simulations were performed with export demand elasticities generally doubled in value. For the report on fertilizers, additional simulations were performed with all agricultural export goods having export demand elasticities uniformly equal to minus sixty.

In this paper it is argued that the long run gains from trade in ORANI are very sensitive to the values of import substitution and export demand elasticities. For example, the values of these elasticities chosen by Dixon, Parmenter and Rimmer (1981) in their long run Miniature ORANI (MO) model have been shown to result in negative gains from the removal of protection.

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1 Other long run simulations have been reported by Dixon, Harrower and Powell (1977); Vincent and Ryland (1980); Vincent, Dixon, Parmenter and Sams (1980) and Dolan, Powell and Sams (1981).

2. ESTIMATES OF EXPORT DEMAND AND IMPORT SUBSTITUTION ELASTICITIES IN THE LONG RUN

The values of the export demand elasticities used in the ORANI model are based on Freebairn (1978). Freebairn observed that apart from wool, sheepmeats, dairy products, beef to quota markets, sugar, bauxite and alumina 'little would be lost by assuming an infinitely elastic export demand'. Fallon (1982) updated Freebairn's estimates for long run elasticities and used derived demand relationships between export demand elasticities for raw materials and their processed products using a formula developed by Hicks (1932).

Import substitution elasticities for ORANI are based on Alaouze, Marsden and Zeitsch (1977) and Alaouze (1977). They have recently been revised by Mannion and Fallon (1981).

3. IMPORT SUBSTITUTION ELASTICITIES AND THE GAINS FROM TRADE (COSTS OF PROTECTION) IN LONG RUN ORANI

The degree of substitutability between imported and locally produced goods is, for any given set of tariff distortions, a major determinant of the magnitude of the cost of protection.

In the long run, imported and locally produced goods must be close to perfect substitutes, with local cost advantages or disadvantages and tariffs determining whether goods are produced locally or overseas.

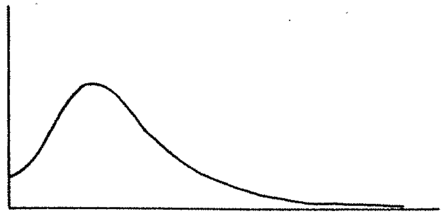
The relationship between the consumption cost of tariff distortions and the degree of substitutability between goods has been analysed by Johnson (1965). The consumption cost of protection is the protection induced reduction in the consumer's attainable utility level from the level prevailing in the free trade situation. This reduction in utility results from the distortion in prices even though income adjusts to include tariff revenue and implied production subsidies. Johnson used a constant-elasticity of substitution (CES) utility function, exhibiting homogeneity of degree one, to tabulate the consumption cost (expressed as a fraction of free trade income) of a tariff on one of two goods as a function of the elasticity of substitution and free trade budget shares.

Dixon (1978) looked at the consumption cost in a three good case, where two of the goods are perfect complements, ie they are consumed in fixed proportions, and where one of these goods has two substitutes. By formulating a CES substitution relationship for these two versions Dixon was able to use some of Johnson's analysis. He also tabulated the consumption cost of protection (a gain when tariffs are removed) as a function of the elasticity of substitution and free trade budget shares. His tabulation showed that with increasing elasticity of substitution, for any given free trade budget share, the consumption cost increases from zero (no substitution), to reach a minimum and to fall for high values of this elasticity. Dixon mentioned a limiting case of perfect substitutes in the following terms; 'a tariff which discriminates against blue kerosene in favour of pink kerosene will carry no welfare loss'. He concluded that 'the consumption gain could be large for a country with high tariffs which are non-uniform across groups of close substitutes'.

ORANI[1] contains a similar 2-level utility function treatment. However at the first level, goods are not complements but are subject to a Klein-Rubin utility function which yields a linear expenditure system of demand functions.[2] At the second level substitution between imported and locally produced goods is specified with a CES relationship.

The relationship between the elasticity of substitution and the consumption cost in ORANI, according to the Dixon approach, ie starting from a given set of <u>free trade</u> budget shares, is depicted in Diagram 1.

DIAGRAM 1



1 See Dixon (1980) and IAC Passenger Motor Vehicles and Components - Post 1984 Assistance Arrangements (1981) p. 329, for the long run assumptions.
2 Although the linear expenditure system is not used in ORANI, the estimation of parameters for ORANI's constant elasticity demand system was based on it.

The only difference from Dixon's analysis is that Dixon used complementarity in consumption at the first level of the utility function, whereas ORANI used the Klein-Rubin function which gives some degree of substitution at the first level. This difference is reflected in Diagram 1 by a positive rather than zero consumption cost for an elasticity of substitution at the second level equal to zero.

Diagram 1 shows that on the basis of the Dixon analysis the long run version of ORANI would yield zero consumption cost under perfect substitution between imported and local goods.

Moreover, since an analogous specification of the second level of the production function is used for the demand for intermediate inputs in the long run version of ORANI, and supply functions for non-rural import-competing and export industries are horizontal, the production cost of protection would also be zero under perfect substitution between imported and local goods.

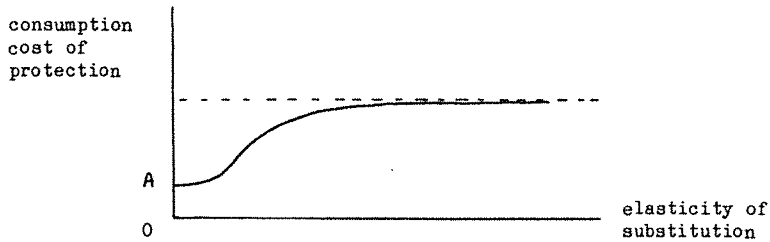
Therefore the Dixon analysis would lead to the conclusion that the total costs of protection in the long run version of ORANI would be zero under perfect substitution between imported and local goods, provided at least one of the non-rural export industries can expand without driving down its export price, ie provided there are no terms of trade effects. All textbooks on international economics discuss under assumptions of perfect substitution between imported and local goods the positive cost of protection when not all goods are complements. Hence, there must be something wrong with the applicability of the analysis outlined above.

The solution to this problem of course, is that protection has no consumption cost when the price of an imported perfect substitute is raised by protection, if initially under free trade both goods were used. Demand would just switch to the now relatively cheaper local good. Absolute prices would be unaffected as would consumer demand. There would only be a switch in production from some export industries to import-competing industries. These effects would occur for any positive tariffs independent of their level, ie long run protection levels would be arbitrary.

However, when imported and local goods are perfect substitutes, there is a possible alternative interpretation, ie that protection has raised the price of an (under free trade cheaper) imported good to the local unit cost of production. This means that imported and locally produced goods can both be consumed at the same price in the protected situation.

Diagram 2 gives the consumption cost in ORANI, for a given set of budget shares in the initial protected situation, as a function of the elasticity of substitution between imported and local goods.

DIAGRAM 2



Analogous observations can be made about the production cost due to the similarity in ORANI of the second level of the production function and the second level of the utility function.

Therefore, the consumption plus production costs of protection would show a similar relationship with the elasticity of substitution as in Diagram 2. Ignoring terms of trade effects this would constitute the welfare costs in the ORANI model.

The interesting question now is to what extent has use of low import substitution elasticities (generally in the range of one to three, with the highest value of 7.5) limited the long run welfare gains from trade liberalisation that long run ORANI could have shown.

This question can be answered by actually computing model results for large import substitution elasticities with a fully consistent equilibrium version of the long run ORANI model.[1] However, on qualitative grounds it is clear that welfare gains from trade liberalisation would be negligible under the standard ORANI import substitution elasticities.

1 For a consistent long run equilibrium specification of ORANI, see Klijn and Tillack (1982, 1983).

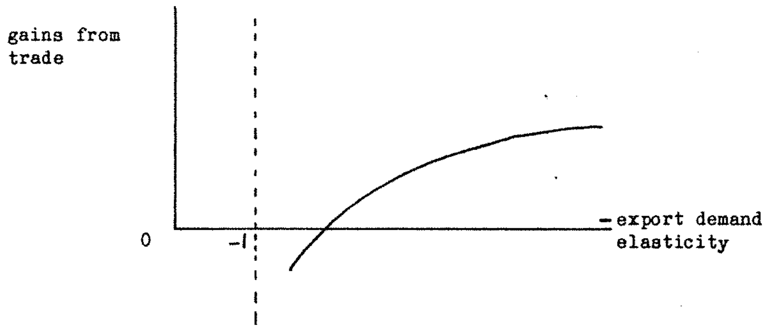
4. EXPORT DEMAND ELASTICITIES AND THE GAINS FROM TRADE IN LONG RUN ORANI

Dixon, Parmenter and Rimmer (1982) concluded that if 'export demand elasticities are, on average, greater than two then the exact values that we choose for them between two and infinity, do not have critical implications for ORANI results'. However, their analysis was performed with the short run ORANI model and their conclusion cannot relate to long run ORANI versions.

Monopoly power in export markets, as indicated by finite export demand elasticities, has given rise to the literature on the optimum tariff as a substitute for the imposition of an export tax designed to exploit monopoly power. For example, if export demand elasticities were, in absolute terms, uniformly equal to two, then the optimal tariffs would be at a uniform 50 per cent ad valorem rate. The average Australian tariff rate is approximately 25 per cent. Hence across the board proportional tariff reductions would then be likely to lead to terms of trade losses exceeding the gains from reductions in distortions in relative prices.

The relationship between the gains from trade, or the cost of protection, and the absolute value of the export demand elasticity has been depicted in Diagram 3, below.

DIAGRAM 3



5. AN EXAMPLE OF NEGATIVE GAINS FROM TRADE: MINIATURE ORANI

Miniature ORANI (MO) is a small model used to illustrate the working of the larger, more complicated ORANI model. Dixon, Parmenter and Rimmer (1981) provide a long run closure and implementation of MO. In this long run version of MO they have used import substitution elasticities that are uniformly equal to unity and export demand elasticities for the two goods equal to -2 and -20 respectively. Initial tariffs for the two import goods were 11.1 and 41.7 per cent respectively. In a long run application, using the closure described by Klijn and Tillack (1982) these tariffs were removed. Removal of assistance resulted in welfare losses, with the welfare indicator, real national income, falling by .57 per cent. It is interesting to note that in that application optimal intervention did increase real national income by 9.25 per cent. The methods used to obtain these results are described in Klijn and Tillack (1983).

6. SUPPLY ELASTICITIES IN LONG RUN ORANI AND FOREIGN SUPPLY ELASTICITIES: A CONSISTENCY PROBLEM

As outlined in the introduction, long run assumptions imply that only land remains as a fixed factor in the ORANI model. This results in horizontal supply functions for all goods outside agriculture, while within agriculture supply elasticities become large. Thompson (1982) lists the following long run supply elasticities for Australian agriculture implied by the ORANI model, parameters and data base:

pastoral zone	9.5
wheat-sheep zone	4.8
high rainfall zone	14.7
northern beef	13.9
milk cattle and pigs	11.5
other farming, export	6.6
other farming, import-competing	6.5
poultry	∞

These elasticities were based on long run elasticities of substitution between any pair of primary factors for each agricultural zone or industry all equal to 1.28 (IAC, March 1982).

However, in order to arrive at estimates for export demand elasticities, wildly different long run foreign supply elasticities are postulated.

Foreign supply elasticities assumed by Freebairn for agriculture range only up to two for agricultural products, except for wheat and other grain where the top of the range is unspecified but 'large'. Fallon assumed a highest foreign supply elasticity for any of Australia's export goods of three. Suggestions on how this consistency problem might be overcome would be appreciated.[1]

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1 During the discussion several speakers argued that the long run supply elasticities reported above for agriculture were unrealistically high, and that lower long run substitution elasticities between primary factors should have been chosen for agriculture. No solution was provided for the inconsistency in mining and manufacturing between infinite domestic and small foreign long run supply elasticities.

7. CONCLUSION

It has been shown above that the values of the long run import substitution elasticities in ORANI influence the gains from trade. The higher the import substitution elasticities the larger the gains from a removal of protection, provided world prices are given.

Contrary to the conclusion for short run applications, the values of export demand elasticities do significantly affect the results for long run applications, and the sign of the gains from trade will depend on the values used.

Finally, the Australian and overseas supply elasticities used in different building blocks of the Long Run ORANI model diverge significantly raising doubts about the appropriateness of the values of the export demand elasticities and about the supply specification.

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SENSITIVITY ANALYSIS FOR ORANI-TYPE MODELS

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I would like to thank Peter Dixon and
Brian Parmenter for their comments on earlier notes.
The final version is much improved by their suggestions.

1. INTRODUCTION

As computable general equilibrium (CGE) models have made the transition from the ivory tower to the places in which policy options are canvassed, there has been a growing disquiet about the way in which these models are calibrated. This arises partly because the methods adopted are not those associated with the standard short run econometric models, but also because many users have a feeling that there exist within the formulations parameters of extreme importance, and yet little information with which that feeling of disquiet could be assuaged! A good example of this would be Alan Lloyd's (1982) critique of the implied agricultural supply elasticities within ORANI.

Those charged with the development of CGE's have responded by engaging in sensitivity analysis. For the ORANI model, the best known experiment of this kind is that undertaken by Dixon, Parmenter and Rimmer (1982a), who, after shocking the trade elasticities separately in ORANI by (10 per cent) compared the basic tariff-cut results with those obtained under the new parameter settings. Generally, they concluded that the sensitivity was not very marked. Their critics, eg Cronin (1982), responded by constructing miniature models and engaging in sensitivity analysis with different <u>combinations</u> of possible parameter values.

Although both of these approaches can be helpful in certain contexts, it seems to me that both have deficiencies. The first because the user of CGE's may wish to look at other combinations of parameter values than those detailed. The second because it generates too much information; even in a three parameter problem with eight possible settings there are an enormous number of results that would need to be presented to yield a comprehensive picture. If only a subset is given then the problem remains, as it is unlikely to be possible to satisfy all with this restricted choice. Thus Cronin's 'best estimates' may well be that, but there is always the sneaking suspicion that even odds on favourites can lose!

What is needed therefore is a way of summarising how sensitive CGE model solutions are to variations in the parameters embodied in them. It seems almost obvious that, to a first approximation, the partial derivatives of the solutions with respect to the parameters provide what is needed. Computation and tabulation of these, with the CGE calibrated at 'best bets', enables users to perform any sensitivity analyses they desire. Accordingly, section 2 of this paper derives expressions for the requisite partial derivatives for models of the Johansen class, while section 3 applies these formulae to a small model in Dixon et al. (1982b) that was constructed to understand the nature of ORANI. A more complete account of the material of this paper, along with some extensions, is available in Pagan and Shannon (1983).

2. THE FORMULAE

Members of the Johansen class of models can be represented as

$$Ay + Bx = 0 \quad , \qquad (1)$$

where y is the rate of change of endogenous variables and x the rate of change of exogenous variables (the exception in ORANI being the balance of trade which is in actual rather than proportional change form). The solution to (1) is

$$y = -A^{-1}Bx \quad . \qquad (2)$$

What we wish to examine is the sensitivity of the solution vector y to variation in the coefficients contained in A and B; these parameters being (α_{ij}) and (β_{ij}). Differentiating y with respect to α_{ij} and β_{ij} will provide formulae for <u>local</u> sensitivity analysis.

$$\frac{\partial y}{\partial \alpha_{ij}} = A^{-1} \frac{\partial A}{\partial \alpha_{ij}} A^{-1} B x = -A^{-1} \frac{\partial A}{\partial \alpha_{ij}} y \qquad (3)$$

$$\frac{\partial y}{\partial \beta_{ij}} = -A^{-1} \frac{\partial B}{\partial \beta_{ij}} x \qquad (4)$$

$$\therefore \frac{\partial y_k}{\partial \alpha_{ij}} = -\alpha^{ki} y_j \qquad (5)$$

$$\frac{\partial y_k}{\partial \beta_{ij}} = -\alpha^{ki} x_j \qquad (6)$$

where α^{ki} is the (k,i)th element in A^{-1}.

Provided y_k is non-zero it is useful to convert (5) and (6) to sensitivity elasticities;

$$S(y_k, \alpha_{ij}) = -(\alpha^{ki} y_j \cdot \alpha_{ij} \mid y_k) \qquad (7)$$

$$S(y_k, \beta_{ij}) = -(\alpha^{ki} x_j \cdot \alpha_{ij} \quad y_k) \qquad (8)$$

Equations (7) and (8) can then be used to determine which coefficients of a model are important for particular results. The structure of these formulae reveals a number of important points. First, the elasticities depend only upon information available for any particular simulation, ie only the elements of A^{-1} and the solutions y, and computational costs to generate equations (7) and (8) are therefore very low. Second, the elasticities will vary with the experiment through the dependence of $\partial y_k / \partial \alpha_{ij}$

upon y_j, and the output solutions differ between simulations. Thus it is never possible to conclude that a particular coefficient is always a crucial one: it can only be asserted to be pivotal for a specified policy change or set of changes.

Once the elasticities in equations (7) and (8) are available they may be used in several interesting ways. First, the relative size of each elasticity provides a primary guide to those parameters which have the greatest import for the model solution. Second, it is possible to find the effect of variations in combinations of parameters from appropriate linear combinations of the elasticities, eg if there are two parameters θ_1 and θ_2 with sensitivity elasticities S_1 and S_2, a 1 per cent increase in θ_1 and a 1 per cent decrease in θ_2 has overall impact S_1-S_2. Finally, it is sometimes important to know what combinations would generate 'extreme' results. Thus, if the percentage change in the solution $S_1k_1 + S_2k_2$ to a k_1 per cent change in θ_1 and k_2 per cent change in θ_2 were constrained to be zero, it follows that k_1 and k_2 must be in the ratio $k_1 = -(S_2k_2 / S_1)$. The feasibility of such combinations may then allow an assessment to be made of the likelihood of encountering 'extreme' solutions.

Two qualifications need to be entered. The first of these concerns the fact that the formulae may not apply for large changes. Experience with a number of models suggests that the local approximation is quite a good one, even for changes in parameters of the order of 100 per cent. For example, in one experiment the predicted change to a 50 per cent decrease in a parameter was 38 per cent whereas the actual value turned out to be 34 per cent. In Pagan and Shannon (1983) a method of improving the accuracy of such elasticities for large changes is described. Essentially it projects the first derivatives from the second derivative information, and the resulting elasticity can be thought of as evaluated over an arc rather than at a point. Nevertheless, since the principal motivation for the current proposal is to provide some idea of the order of magnitude rather than exact solutions, the elasticities in equations (7) and (8) may well suffice for most situations.

The second objection concerns the provision of a sensitivity ranking through the absolute value of the S-elasticities. Implicitly this presumes that equal changes in parameters are equi-probable, but this is not generally the case. To appreciate why let β be an unknown parameter, $\hat{\beta}$ its estimated value and $\beta^* = \hat{\beta} \pm k\,s$ be constrained to be k standard deviation (s) from $\hat{\beta}$. Then

$$\beta^* = \hat{\beta}\,[1 \pm \frac{ks}{\hat{\beta}}] = \hat{\beta}[1 \pm k/t] \qquad (9)$$

where t is the t-statistic $\hat{\beta}/s$,

$$\therefore \frac{\beta^*}{\hat{\beta}} = 1 \pm k/t \qquad (10)$$

and the change in $\hat{\beta}$ is k/t, ie for any given k and t the possible variation in the parameter values can be determined. Thus if k=2, ie assuming $\hat{\beta}$ is normally distributed the 95 per cent confidence intervals are to contain β^* we obtain,

t=2 : change = 100%

t=4 ; change = 50% ,

so that, unless t-values are very high for the estimated elasticities, quite large changes would need to be considered in any sensitivity analysis. In particular the 10 per cent changes considered by Dixon, Parmenter and Rimmer (1982a) for the import substitution elasticities seem very low; they profess considerable confidence in them because they are estimated but it is clear that, with k=2, the t-statistics on the parameter estimates would need to be around 20 to justify such a stance. Perhaps this was so, but there is currently no information available on that question, as the standard deviations provided in Alaouze et al. (1977) are for the short run import substitution elasticities rather than the long run versions used in ORANI.

3. APPLICATION

3.1 Genesis

In order to obtain some idea of how sensitive ORANI might be to particular parameters embodied in it, some experiments were conducted with a 'miniature' representation of it. Initially the M078 model in Dixon et al. (1982b) (DPSV) was selected for this role. But that model is not a good one for sensitivity studies highlighting trade elasticities, as the cross elasticity between imports and domestic goods cannot be varied independently of other price elasticities if restrictions of symmetry, homogeneity and additivity are to hold. A similar problem exists when attempting to change the own price elasticities. For these reasons it seemed worthwhile modifying M078 to facilitate sensitivity analysis.

Within ORANI imported and domestic goods are combined via a CES function with substitution elasticity σ_i into a composite good. A Klein-Rubin utility function is then maximised with respect to the composite goods, yielding the LES in these composite goods. Demand functions for the individual goods are then obtained by substitution.

Let X_1 and X_2 be the composite goods, η_{ij} the composite good price elasticities, ε_i the composite good expenditure elasticities and P_i the composite good prices. From DPSV equations (14.28) - (14.32),

$$\eta_{ij} = -S_j^* \varepsilon_i \qquad (i \neq j)$$

$$\eta_{ii} = -\varepsilon_i - \sum_{k \neq i} \eta_{ik}$$

$$S_j^* = P_j \theta_j / \Sigma_k P_k X_k$$

where θ_j is the minimum (or subsistence) level for X_j. If ε_i are given, imposing symmetry on η_{ij} implies that S_1* and S_2* are in fixed proportion. Accordingly there is only a single free parameter (say S_2*) or, equivalently, η_{ij}, as η_{ij} is in fixed ratio to S_2*.

Once estimates of ε_1 ε_2 and S_2* are available it is possible to generate η_{ij} (i=1,2; j=1,2). Combined with values for σ_1 and σ_2 (the substitution elasticities between domestic and imported goods 1 and 2 respectively) the demand functions for all goods can be generated from equations (14.21) of DPSV. S_2* was obtained by noting that international evidence suggests that S_1* + S_2* should be around .5 for developed countries. ε_1 and ε_2 were set at .7 and 1.7 respectively (MO78 has both at unity) as there were some goods in ORANI with expenditure elasticities below unity (DPSV Table 29.2). The import substitution parameters were σ_1= 1.0,σ_2=2.0, again because DPSV Table 29.2 gives many as 2.0 but the remainder average around unity.

Generating commodity demand equations in this way yields a model identical to MO78 except in the estimated commodity demand elasticities.

Because these were obtained with the LES demand system (L) and import substitution (S) we refer to it as the MO78LS model. As the demand equations are found by specifying η_{12}, σ_1 and σ_2, sensitivity is

performed with respect to these coefficients. Of course this is possible because the ε_1 are fixed.

Table 1 comparing MO78 with MO78LS for the tariff experiment in DPSV (Chapter 2) reveals a reasonable correspondence, the most striking difference appearing in the effects on the demand for imported commodity 2. MO78LS has a much sharper contraction in imports of this commodity than MO78, no doubt due to the import substitution elasticity of 2 for good 2 in MO78LS versus that of unity in MO78 (in fact, using the sensitivity elasticity of imported good 2 to changes in σ_2 of .88 in MO78LS, a 50 per cent change in σ_2 from 2.0 to 1.0 is predicted to change the imported good response from -.874 to -.434, which is very close to the actual MO78 response). However, given the elasticities used in ORANI we prefer to keep σ_2 at 2.0.

TABLE 1 : COMPARISON OF MO78 AND MO78LS, TARIFF EXPERIMENT (per cent)

Var	MO78	MO78LS	Var	MO78	MO78LS
1	-.021	.039	21	-.309	-.304
2	.362	.438	22	-.850	-.827
3	.123	.172	23	-.666	-.652
4	-.418	-.874	24	0.0	0.0
5	.518	.532	25	-.027	.010
6	.383	.399	26	.356	.409
7	0.0	0.00	27	.525	.558
8	.459	.477	28	-.016	.035
9	1.00	1.00	29	.206	.262
10	.383	.399	30	0.0	0.0
11	0.0	0.0	31	.518	.532
12	-.766	-.798	32	-.148	-.120
13	-.444	-.435	33	.723	.794
14	.164	.209	34	.459	.477
15	-.464	-.455	35	-.230	-.195
16	-.389	-.377	36	-.151	-.289
17	.105	.147	37	-.364	-.379
18	.180	.225	38	-.041	-.015
19	-.479	-.471	39	.518	.533
20	-.396	-.398			

NOTE: Tariff experiment Table 7.1 DPSV. The 13 exogenous variables are listed in Table 6.1 DPSV p. 34.

3.2 Use

Sensitivity elasticities are presented in Table 2 for a number of coefficients in MO78LS: $-\eta_{12}$, σ_1, σ_2, the reciprocal of the export elasticity for the first commodity (e_1) (the second commodity is hardly exported) and capital-labour substitution elasticities (σ^1, σ^2). Note that MO78 has $\sigma^1 = \sigma^2 = 1.0$ but the equations for factor demands - DPSV equations (5.33) - can be written to allow for non-unit substitution elasticities by following DPSV equations (12.64).

The key features of the sensitivity results are described below.

1. Industry results are sensitive to the import substitution parameter σ_2 but hardly at all to σ_1. It would require very large changes in σ_1 but not σ_2 to reverse any of the aggregate employment responses. A 10 per cent variation in both σ_1 and σ_2 would change the aggregate employment response by 4.0 per cent. In contrast, from Dixon et al. (1982a), a 10 per cent decrease in all the σ_2 of the ORANI model changes the aggregate employment response by 5.5 per cent. Of course the tariff experiments are not the same - that in ORANI being a 25 per cent across the board tariff increase - but it appears that the MO78LS model under-predicts ORANI sensitivity in this area.

2. The export elasticity is a very important parameter but, as it is set at 2.0 in MO78, there is not a lot of scope for reductions in it.

3. The factor substitution elasticity in the exporting sector (σ^1) is very important for the aggregate employment results, while that of the 'non-traded' sector (σ^2) is not. From this it emerges that the employment increases in MO78 (and presumably ORANI) coming from tariff reductions are very much dependent upon the exporting sector exhibiting a strong employment increase, and a crucial element in that is the size of σ^1. In many ways it is this parameter rather than the trade elasticities which should be the focus of debate, as data did not enable a fine discrimination on the value of this coefficient - see DPSV section 29.2, especially f.n. 30 which suggests that σ^1 for agricultural industries might be less than .2, in contrast to the .5 used in ORANI. There have been other criticisms of the implied supply response for agriculture within ORANI (Lloyd, 1982) and the sensitivity analysis of MO78LS indicates that this may be well placed.

4. Even though individual coefficient elasticities may not be high, combinations may yield dramatic results eg a 50 per cent reduction in σ^1_1, a 20 per cent increase in e_1 and a 100 per cent increase in σ_2 (giving $\sigma^1{}_1 = .5$ $|e_1| = 1.67$, $\sigma_2 = 4$) would almost completely eliminate the decline in employment as a result of the tariff increase. With the possible exception of e_1, none of these values could be considered implausible. Certainly, all would be well within the permissible range of variation if estimated from data.

5. Utility function parameters (η_{12}) are not very crucial to any outcome.

TABLE 2 : COEFFICIENT SENSITIVITY ELASTICITIES FOR THE MO78LS MODEL, TARIFF INCREASE SIMULATION

Variable		Change Bas. Sim	η_{12}	σ_1	σ_2	ε_1	σ^1	σ^2
z_1	output indy 1	(-)	.03	.01	0.03	-.45	.55	-.03
z_2	2	(+)	.16	-0.00	0.70	0.18	.22	.26
$y_{(11)1}$	indy 1 commod	(-)	.04	.01	0.05	-.48	.47	-.04
$y_{(21)1}$	outputs	(-)	.01	.01	-.02	-.35	.80	.03
$y_{(11)2}$	indy 2 commod	(+)	.16	-.02	0.84	.72	.78	.53
$y_{(21)2}$	outputs	(+)	.16	-0.00	0.68	0.08	.12	.21
$x_{(31)1}$	employ by indy	(-)	.03	.01	0.03	-.45	.55	-.03
$x_{(31)2}$		(+)	.16	-.00	0.70	0.17	.22	.06
agg. emp.		(-)	-.05	.02	-.42	-.87	.77	-.22
agg. imports		(-)	-.10	-.04	0.66	-.44	-.15	.05
agg. exports		(-)	-.00	-.01	0.06	-1.65	.36	-.06
C.P.I.		(+)	.04	-0.00	0.06	.13	.13	-.07

η_{12} = cross elasticity between composite good 1 and 2 in consumption;
σ_1 = elasticity of substitution between domestic and imported good 1;
σ_2 = elasticity of substitution between domestic and imported good 2;
ε_1 = reciprocal of export elasticity, good 1;
σ^1 = elasticity of substitution between capital and labour, first industry; and
σ^2 = elasticity of substitution between capital and labour, second industry.

4. CONCLUSION

This paper has argued that the provision of the partial derivatives of the solutions of CGE models with respect to parameters gives a succinct presentation of the information that users of such models would need to perform their own sensitivity analysis. For models of the Johansen class, the cost of computing these derivatives is small, as the elements constituting them should be available from the solution process. Of course, extending the idea to something like ORANI, which has an enormous number of parameters, requires a shift in emphasis from individual coefficients to groups. Determining a meaningful classification is therefore the principal challenge in applying the idea developed here more generally.

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SENSITIVITY ANALYSIS FOR ORANI-TYPE MODELS : A COMMENT

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The sensitivity analysis proposed by Dr Pagan is local sensitivity analysis as indicated in his paper. Local sensitivity analysis refers to sensitivity with respect to changes in parameter values within a local neighbourhood of a chosen set of parameter values, ie it is valid for small changes in parameter values. If it is nevertheless used globally, by extrapolating from infinitesimal changes, it may not correctly indicate magnitude or direction of change.

The paper does not explicitly deal with local sensitivity analysis with respect to parameters which are subject to constraints. Constrained parameter changes arise, for example, from consumer demand theory.

Local sensitivity analysis when parameters are subject to constraints and all parameters are allowed to vary, is straightforward. For instance, consider the linear model

$$y = Bx, \tag{1}$$

where y and x are vectors of endogenous and exogenous variables expressed in terms of percentage changes from an observation of the levels of these variables, and B is a matrix of coefficients evaluated at this observation.

The policy responses are given by

$$\frac{\partial y}{\partial x} = B. \tag{2}$$

Local sensitivity of the policy responses with respect to an unconstrained parameter z is given by

$$\frac{\partial B}{\partial z} . \tag{3}$$

Local sensitivity of the policy responses with respect to constrained parameters, z_i, is given by

$$dB = \sum_i \frac{B}{\partial z_i} dz_i, \tag{4}$$

and

$$0 = \sum_i \frac{\partial g}{\partial z_i} dz_i , \tag{5}$$

where

$$g(z) = 0 \tag{6}$$

represents a (vector) function of constraints on parameters z_i.

For example, local sensitivity with respect to consumer demand elasticities is given by

$$dB = \sum_i \frac{\partial B}{\partial \varepsilon_i} d\varepsilon_i + \sum_i \sum_j \frac{\partial B}{\partial \eta_{ij}} d\eta_{ij}, \qquad (7)$$

where variations in expenditure elasticities, ε, and price elasticities, η, satisfy the constraints of:

- homogeneity $\quad d\,\varepsilon_i + \sum_j d\eta_{ij} = 0, \qquad (8)$
- symmetry $\quad w_i d\eta_{ij} + w_i w_j d\,\varepsilon_i = w_j d\eta_{ji} + w_j w_i d\,\varepsilon_j, \qquad (9)$
- additivity $\quad \sum_i w_i d\,\varepsilon_i = 0, \qquad (10)$

where w_i are budget shares.

Note that although the constraints (5) restrict the feasible set of parameter changes they leave the investigator with a number of degrees of freedom in the choice of parameters subject to sensitivity analysis.

The demand analysis in the paper postulates given and fixed expenditure elasticities. Hence in the sensitivity analysis variation of some price elasticity is implicitly postulated only to affect other price elasticities and to leave expenditure elasticities unchanged. Nowhere in the paper is any reason put forward for this postulate.

The paper does not give enough information to allow the reader to check fully for consistency among the data, theory and results. Nevertheless, from the information given it is clear that the data are inconsistent. This is because the demand parameters are based on a postulated symmetry of uncompensated cross price elasticities, while standard demand theory only derives the symmetry of income compensated effects of price changes. Consequently, the conclusion that S_1* and S_2* are in fixed proportion is false. With inconsistent data and parameters the results cannot be consistent.

1. The inconsistency revealed in this example applies to the original version of the paper. The paper icluded in this volume has subsequently been corrected for this inconsistency.

THE EFFECTS OF TARIFF CUTS UPON THE EXPORT SECTOR IN SOME LONG TERM APPLICATIONS OF ORANI

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1. INTRODUCTION

In several inquiries during recent years the IAC has employed the ORANI model to analyse the effects of proposed changes in industry protection. Clearly, the IAC needs a multi-sectoral model of the economy to illustrate its arguments that reduced protection to import-competing industries would lead (in the long term) to expansion in other sectors of the economy and in economic aggregates, such as employment, income and consumption.

This paper will concentrate on the sensitivity of ORANI simulations carried out by the IAC to the modelling of the export sector. Two recent applications will be used as case studies. Version A is that used in the draft report on Passenger Motor Vehicles and Components (IAC, 1981a). Version B is that used in the final report on Passenger Motor Vehicles and Components (IAC, 1981b) and subsequently in the report on General Reductions in Protection (IAC, 1982).

Both versions share the basic features of ORANI industry modelling:

- economic activities are classified into 109 industries/ commodities;
- consumption demand for each commodity is described by an LES demand system;
- intermediate demand for each commodity is described by a set of fixed (Leontief) input-output coefficients;
- export demands for an exportable subset of commodities are related to prices by a set of constant elasticities;
- the shares of imported and local goods for an importable subset of commodities are related to relative prices by a set of CES import substitution functions;
- production in each industry is related to inputs of factors (land, capital, labour) by a set of CES production functions; and
- the markets for all goods are cleared under perfect competition, and factors employed in each industry are fully utilised under profit maximisation.

The IAC applications had two further features in common:

- the model was approximately solved using a linearised solution algorithm; and
- the rate of return to capital was held fixed and capital was assumed to be in infinitely elastic supply.

The further assumptions in Version A were:

- the real average wage rate and relativities were fixed and labour was in infinitely elastic supply; and
- real domestic absorption was fixed and the balance of payments was unconstrained.

The alternative assumptions in Version B were:

- aggregate employment was fixed and the real average wage rate was endogenous; and

- the balance of trade was fixed and domestic absorption was equated to gross domestic product.

2. THE IMPORT-COMPETING SECTOR

In passing it should be noted that IAC applications of ORANI have seriously underestimated the long term increases in imports and contractions in import-competing outputs which are likely to result from protection reductions. In the case of motor car protection the sources of error are described and quantified by Cronin (1982). In general these understatements arise from:

- approximation bias. The linearised solution algorithm was used in assessing the effects of large protection reductions;

- parameter bias. The one-year import substitution elasticities of Dixon et al. (1977) were used in estimating long term effects; and

- aggregation bias. Under the ORANI industry classification both non-competing imports (ie non-dutiable goods) and semi-processed imports (ie inputs into the Australian industry are assumed to be substitutes for the final output of the Australian industry to which they are formally classified).

The last point is best illustrated with a simplified example. One quarter of imports classified to (say) cotton textiles are dutiable at 40 per cent, while the other three-quarters are non-dutiable and non-competing. ORANI then treats cotton textiles as a single good subject to an average tariff of 10 per cent, implying that a 10 per cent tariff cut would have the same impact upon the competitiveness and output of the Australian industry as a one per cent revaluation. If the import category were disaggregated, however, then a 10 per cent tariff cut would be roughly equivalent to a three per cent revaluation. Obviously, when tariff cuts are examined using the ORANI structure the Hicks-Leontief condition for aggregation is strongly violated. The impact could be understated up to a factor of three, depending on the sources of variation in the data base used for parameter estimation.

3. THE ORANI MODELLING OF THE EXPORT SECTOR

The ORANI model (as described by Dixon et al., 1977) determines the level of exports for each of eleven major commodities. The level of exports for all other commodities is set exogenously.

In terms of the linearised approximation used by the IAC and the IAC assumption that labour and capital costs and the labour and capital components of materials costs are indexed to the domestic price level, exports of a commodity would be determined by the following relationships:

. an export demand equation;

$$\tilde{x} = \eta_x \quad (\tilde{p} + \tilde{e}) \tag{3.1}$$

where $\tilde{x}$ is the proportionate change in exports,
η_x is the price elasticity of export demand,
$\tilde{p}$ is the proportionate change in the commodity price,
$\tilde{e}$ is the proportionate change in the exchange rate.

. a domestic demand equation;

$$\tilde{d} = \eta_d \quad (\tilde{p} - \tilde{\pi}) \tag{3.2}$$

where $\tilde{d}$ is the proportionate change in domestic consumption,
η_d is price elasticity of domestic demand.
$\tilde{\pi}$ is the proportionate change in a price index for all substitute commodities.

. a commodity supply equation;

$$\tilde{q} = \varepsilon \quad (\tilde{p} - \tilde{c}) \tag{3.3}$$

where $\tilde{q}$ is the proportionate change in output,
ε is the price elasticity of supply,
$\tilde{c}$ is the proportionate change in an index of input costs.

. and a commodity balance equation;

$$\tilde{q} = S_x \tilde{x} + S_d \tilde{d} \tag{3.4}$$

where S_x is the share of output going to exports,
S_d is the share of output going to domestic consumption.

These four simultaneous equations can be solved to give the proportionate change in exports of a commodity as:

$$\tilde{x} = \eta_x \frac{\varepsilon\tilde{c} - S_d\eta_d\tilde{\pi} + S_x\eta_x\tilde{e}}{\varepsilon - S_d\eta_d - S_x\eta_x} + \eta_x \tilde{e} \tag{3.5}$$

If we assume, as does the IAC, that the exchange rate is fixed ($\tilde{e} = 0$), then:

$$\tilde{x} = \eta_x \frac{\varepsilon\tilde{e} - S_d\eta_d\tilde{\pi}}{\varepsilon - S_d\eta_d - S_x\eta_x} \qquad (3.6)$$

3.1 An Approximate Replication of the Export Sector in Version A of ORANI

Using the ORANI model the IAC estimated (IAC, 1981a, see Table 9.1 on page 139) that aggregate Australian exports would expand in the long term by 5.7 per cent as a result of its proposed reduction in protection to passenger motor vehicles.

The mechanism behind this effect is discussed on page 274:

> 'With the prices of all foreign products assumed fixed ... falling domestic prices mean that Australian exports become (relatively) cheaper overseas and therefore expand.'

Passenger cars themselves are not a significant cost component in export industries, and the predicted cost reduction in export industries stems almost entirely from the estimated reduction of 0.9 per cent in the consumer price index, which is also reported in Table 9.1.

The cost-push effects (both direct and indirect) of lower passenger car prices would reduce the consumer price index by only 0.23 per cent (given the IAC estimates of the effects upon producer and import prices of motor cars). The IAC assumption that wages and capital charges are fully indexed to the consumer price index sets up a virtuous spiral in which price reductions generate wage rate reductions, which generate further price reductions, and so on (see the last paragraph on page 273). Effectively, any initial cost-push effect upon the domestic price level is multiplied by a factor of four as a result of this assumption.

It is important to realise that the assumption of full indexation is purely arbitrary, and does not rest on an analysis of the macro-economic relationships which influence the domestic price level. Without endorsing that assumption, I will examine the consequences of a hypothetical fall of 0.9 per cent in the consumer price index and in labour and capital costs in the export sector.

A simple approximation to the ORANI solution can be obtained by applying equation (3.6) to two composite commodities - 'rural products' (wool, cereals. meat, sugar, etc.) and 'minerals' (coal, iron ore, non-ferrous metal ores, and non-ferrous basic metals). We will assume that for both commodity groups the change in the consumption price deflator ($\tilde{\pi}$) and the change in the input cost deflator ($\tilde{c}$) are equal to -0.9 per cent (the IAC estimate of the effect upon the domestic price level).

For <u>rural products</u> the export share (S_x) is approximately 0.5 and the domestic consumption share (S_d) is therefore also 0.5. The domestic demand elasticity for rural products in aggregate cannot be readily derived from the ORANI specification; it must be small and in this exercise it is set at -0.3.

The export demand elasticities used in ORANI are reported (Dixon and Powell, 1979, page 45) as:

wool	- 1.3
cereals	- 12.5
meat	- 16.7
sugar etc.	- 20.0.

These values imply an average export demand elasticity for rural products of about -12.

The elasticity of supply for rural products implicit in the IAC calculations follows from the assumption (page 271) that infinitely elastic supplies of labour and capital are available to agriculture and that the only fixed factor is land. Under these conditions, the ORANI production function implies that the price elasticity of supply is:

$$\varepsilon = \frac{\theta(S_w + S_k)}{(1 - S_m)\, S_\ell} \qquad (3.7)$$

where θ is the elasticity of substitution between land and other factors of production,
S_ℓ is the share of land rent in gross revenue,
S_m, S_w, S_k are the shares of materials, wages and capital returns in gross revenue.

In ORANI ' θ ' is set at 0.5 (Dixon et al., 1977, page 161). The cost shares are approximately S_ℓ = 0.15, S_m = 0.55, $S_w + S_k$ = 0.30[1]. The implicit supply elasticity is therefore about 2.2.

$$\varepsilon = \frac{0.5\,(0.30)}{(0.45)\;(0.15)} = 2.22$$

Using these parameter values in equation 3.6 an increase of three per cent in rural product exports is estimated as an approximation to the IAC estimate.

$$\hat{x} = -12\;\frac{2.2(-0.9\%) - 0.5(-0.3)\;(-0.9\%)}{2.2 - 0.5(-0.3) - 0.5(-12)}$$
$$= +3.0\%.$$

For <u>mineral exports</u> the mechanism by which the IAC reached its estimates is straight forward. The export demand elasticity used in ORANI for all minerals is -20 (Dixon and Powell. 1979, page 45). The IAC has <u>assumed</u> that the supply elasticity for all minerals is infinity:

1 S_m should include the costs of processing farm outputs into exportable rural products (eg meat processing in order to calculate an elasticity with respect to fob prices rather than to 'basic value' prices.

'The supply curve for (non-agricultural) industries is horizontal in the long term - changes in output can occur at unchanged prices' (page 271 of the Draft Report).

The export share (S_x) for minerals is about 0.67, the domestic consumption share (S_d) is about 0.33, and we will set the domestic demand elasticity (η_d) at -0.3.

Inserting these parameter values in equation 3.6 shows that the IAC would have estimated an increase in mineral exports of 18 per cent.

$$\tilde{x} = -20 \frac{\infty(-0.9\%) - 0.33(-0.3)(-0.9\%)}{\infty - 0.33(-0.3) - 0.67(-20)}$$
$$= +18\%.$$

Combining the estimated effects upon rural exports and mineral exports leads to an estimate that total exports would increase by 6.8 per cent as a result of the proposed reduction in motor vehicle protection. The estimated changes in exports are summarised in Table 1.

TABLE 1 ESTIMATED CHANGE IN EXPORTS RESULTING FROM REDUCTION IN MOTOR VEHICLE PROTECTION PROPOSED BY IAC

Exported commodity	Share of total exports (%)	Estimated change (%)
Rural products	44	+3.0
Minerals	31	+18.0
Other	25	0.0
All exports	100	+6.8

The estimated increase in exports is slightly larger than that reported by the IAC (5.7 per cent) - the IAC have probably used 1968-69 export data which would understate the relative importance of mineral exports. The preceding estimate is based on the values used by the IAC for supply elasticities and for export demand elasticities. It is critically dependent on these parameter values. which will be discussed in the following sections.

3.2 An Approximate Replication of the Export Sector in Version B of ORANI

When Version B of ORANI was applied to evaluate the same shock (the reduction in motor car protection initially proposed by the IAC) it was estimated that aggregate Australian exports would expand by 3.4 per cent (IAC, 1981b, see Table A12.2 on page 334). In this version the effect on costs in the export sector is more complicated, since the real wage rate is endogenous. In the simulation of lower motor car protection the nominal wage rate fell by 0.6 per cent and the consumer price index by 0.8 per cent; as an approximation we will examine the effects of a -0.7 per cent change in the input cost deflator ($\tilde{c}$) and a -0.8 per cent change in the consumption price deflator ($\tilde{\pi}$).

For rural products the IAC used the same export demand elasticities as in Version A for most commodities, but adopted a lower value of -10 for meat (IAC, 1981b, page 326). The implied aggregate export demand elasticity for rural products would be roughly -10.

In Version B the elasticities of substitution between primary factors were set at 1.28 for all industries. The implicit supply elasticity for aggregate rural output was therefore about 5.7 (applying equation 3.7).

If these parameter values are inserted into equation 3.6 the expansion in rural product exports would be estimated as approximately 3.8 per cent.

$$\tilde{x} = -10 \frac{5.7\ (-0.7\%) - 0.5\ (-0.3)(-0.8\%)}{5.7 - 0.5\ (-0.3) - 0.5\ (-10)} = -3.8\%.$$

For mineral exports the export demand elasticities in Version B (IAC, 1981b, see page 326) were set as follows:

iron ore	- 10
other metal ores	- 8
coal	- 20
iron and steel	- 20
other basic metals	- 10.

The implied aggregate export demand elasticity for mineral products was about -13.

As before, all factor inputs in mining were assumed to be variable, so that the supply elasticity for minerals was infinite.

Inserting these parameter values into equation 3.6 shows that the IAC would estimate an increase in mineral exports of about 9 per cent.

$$\tilde{X} = -13 \frac{\infty\ (-0.7\%) - 0.33\ (-0.3)\ (-0.8\%)}{\infty\ -0.33\ (-0.3) - 0.67\ (-13)} = +9.1\%.$$

Combining the estimated effects upon rural exports and mineral exports leads to an estimate that total exports would increase by 4.4 per cent as a result of the proposed reduction in motor car protection. For the same reason as before this is slightly larger than the increase reported by the IAC.

3.3 Supply Elasticities in the Export Sector

The agricultural supply parameters in ORANI are not based on empirical research; they result simply from the factor substitution elasticity imposed across the board on all industries. The available empirical evidence suggests that the long term aggregate supply elasticity for the farm sector is relatively low.

Vincent (1977) and Ryland and Vincent (1978) estimated partial substitution elasticities between land and variable factor inputs in agriculture at about 0.07. Inserting that value into equation (3.7) yields an agricultural supply elasticity of about 0.3. However, neither of these models appears to incorporate lag structures. so this result represents neither a short term nor a long term supply elasticity, but something in between.

Pandey et al. (1981) calculated a long term aggregate supply elasticity for Australian agriculture of 1.1. Tweeten and Quance (1969) estimated a long term aggregate supply elasticity for US agriculture of 0.8. A translog cost function for US agriculture estimated by Binswanger (1974) suggests that the aggregate supply elasticity might be as large as 2, if land is regarded as the only restraint operating in the long term.

I would regard the most plausible mean value for the long term agricultural supply elasticity as approximately one.

The mineral supply elasticity was arbitrarily assumed by the IAC to be infinite. This is somewhat extreme. Long run mineral supply functions should be upward sloping since output expansion requires the exploitation of marginal resources at higher extraction costs, lower yields and/or higher transport costs. In the context of depletion theory an upward shock in demand which is expected to persist will lead to expectations of a faster rate of growth in future extraction costs and of earlier recourse to any 'backstop technology'. Consequently, the entire price trajectory will be lifted, increasing rents on current production.

I do not know of any empirical estimates of the elasticity of Australian mineral supply. A large number of overseas studies on a variety of metal ores reports long term supply elasticities within a range of 0.2 up to 2. A recent study of the US coal industry by Modiano and Shapiro (1980) offers a relevant analogy to Australian coal supply, since US coal reserves are very large with a fairly shallow gradient in extraction costs. A comparative static approximation to their dynamic model suggests a long term supply elasticity of about 5.

I will adopt 5 as a hypothetical value for the Australian aggregate supply elasticity, since there are no precedents in the empirical literature for higher values.

3.4 Export Demand Elasticities

Various attempts at direct econometric estimation of demand equations for Australian primary exports have been unconvincing, although the point estimates of the elasticities are invariably fairly low. For instance, Butler and Saad (1974) estimated a long run demand elasticity of about -2 for foodstuff exports. Throsby and Rutledge (1979) tentatively reported long run demand elasticities of -2 for processed food exports and of -0.7 for agricultural non-food exports; they concluded that the statistical weakness of these results was such that 'they cannot be regarded as providing serious support for hypothesis of low demand elasticities for the products in question'.

Given the problems associated with direct estimation of export demand elasticities there is little doubt that a more productive approach is to derive values for export demand elasticities from empirical estimates of consumption demand elasticities and production supply elasticities. A wide variety of empirical studies can be exploited to assess these underlying parameter values, and a well established piece of derived demand theory can be used to construct from such materials estimates of the elasticities of export demand for the major Australian export commodities.

This approach was adopted by Horner in his seminal paper of 1952. This paper very carefully analysed many relevant issues and calculated elasticities of export demand facing three Australian export commodities. The long run values of these parameters were found to be rather low : -2.15 for wool, -5.20 for wheat and -3.18 for butter.

Although the derived demand formulation used by Horner for Australian exports and subsequently applied by Tweeten (1967) in the USA, was adequately explained, other researchers have frequently used incomplete formulations leading to seriously biased conclusions. A restatement of the general expression for deriving the elasticity of export demand is therefore put forward here.

The quantity demanded (X_a) of one country's exports of a commodity is identically equal to the sum of the quantities demanded (C^i) in every other country less the sum of the quantities supplied (S_j) in every other country. Then. differentiating with respect to the single country's export price (P_a) will define the elasticity of export demand.

$$\eta_{xa} = (\partial X_a/\partial P_a)\ (P_a/X_a)$$

$$\eta_{xa} = \sum_i\Sigma(\partial C_i/\partial P_a)\ P_a/X_a - \sum_j\ (\partial S_j/\partial P_a)\ P_a/X_a$$

$$= \sum_i \frac{\partial C_i}{\partial P_i} \cdot \frac{P_i}{C_i} \cdot \frac{\partial P_i}{\partial P_a} \cdot \frac{P_a}{P_i} \cdot \frac{C_i}{X_a} - \sum_j \frac{\partial S_j}{\partial P_j} \cdot \frac{P_j}{S_j} \cdot \frac{\partial P_j}{\partial P_a} \cdot \frac{P_a}{P_j} \cdot \frac{S_j}{X_a}$$

where P_i is the consumer price in country 'i' and P_j is the price in country 'j'. Thus,

$$\eta_{xa} = \sum_i \eta_{ii}\ \phi_{ia}\ C_i/X_a - \sum_j \varepsilon_{jj}\ \theta_{ja}\ S_j/X_a$$

where
η_{ii} is the own price elasticity of demand in country i,
ε_{jj} is the own price elasticity of supply in country j,
ϕ_{ia} is the elasticity of the consumer price in 'i' to the export price in 'a',
θ_{ja} is the elasticity of the producer price in 'j' to the export price in 'a'.

The preceding expression can be applied at whatever level of aggregation is appropriate. Subscripts 'i' and 'j' could be used to indicate disaggregation not only among countries but if relevant, among regions, user industries, market segments. etc. - provided that demand (supply) in each segment is independent of demand (supply) in every other segment.

In the case of a perfectly homogeneous commodity (no product differentiation) sold in a perfectly free international market (no government intervention) and incurring negligible transport costs. then all $\phi_{ia} = 1$ and all $\theta_{ia} = 1$. If in addition demand elasticities are identical for all markets and supply elasticities are identical for all sources, then equation (4) simplifies to:

$$\eta_{xa} = \eta C/X_a - \epsilon S/X_a$$

This latter expression has been applied by Johnson (1977) to export demand and by Scobie and Johnson (1979) in the case of Australian export demand. It has been pointed by Bredahl et al. (1979) and Cronin (1971) that this approach is likely to lead to very large overstatements of the export demand elasticities for many commodities. since the 'price transmission elasticities' (ϕ_{ia} and θ_{ia}) should not lightly be ignored (ie set equal to unity). Several reasons for price transmission elasticities being substantially smaller than unity in the real world are discussed below. An econometric assessment of this issue has been attempted for wheat and feed grains by Abbott (1979). He concluded that 'these results suggest that domestic prices and net imports are unrelated to border prices in many countries'.

3.4.1 Retail margins

For some commodities, such as meat or dairy products, available information on consumption demand elasticities relates to retail prices rather than to import or wholesale prices. The costs of distribution will be mainly independent of the import price, so that the elasticity of import price (P_m) to retail price would be approximately:

$$\phi_{r.m.} = P_m/(P_m + M)$$

where M is the distribution margin.

For example, if margins represent about 50 per cent of the price at retail then $\phi_{r.m.} \approx 0.5$.

Tweeten (1967) used an econometric approach to estimate that the long run elasticity of farm-gate prices to retail food prices in the USA was about 0.4. He found that the corresponding short run elasticity was larger; this might reflect the tendency of distributors to use fixed percentage mark-ups in the short term. while in the longer run competitive pressures relate margins to distribution costs.

3.4.2 Heterogenous commodities

In a calculation of the export demand elasticity for Australian wool one should take account of (inter alia) the weak substitution between (finer) Australian wools and (coarser) New Zealand (NZ) wools, ie the elasticity of NZ to Australian wool prices. This is likely to be less than unity.

3.4.3 Transport costs

For most agricultural commodities and for non-ferrous metals, international freight costs add between 15 and 30 per cent to Australian export prices. Similar relationships exist for low value-high bulk commodities, such as coal and iron ore; the low unit values are matched by lower average freight charges reflecting the use of modern bulk carriers and the concentration of exports upon Japan and other relatively near markets.

Like retail margins freight costs will usually be independent of the commodity price, so that the elasticity of the overseas import price to the Australian export price (P_a) would be:

$$\phi_{ma} = P_a/(P_a+F)$$

where F is the unit freight cost.

For example, if freight charges represent 20 per cent of the import price, then $\phi_{ma} \approx 0.8$.

3.4.4 Transport barriers

Horner pointed our that freight costs are sometimes large enough to isolate certain regional markets from effective price arbitrage with Australia's export market. For some commodities data on world production and consumption include significant elements of subsistence activity in developing countries. Since arbitrage between, say, nomadic cattle herding in the Ethiopian highlands and the market for internationally traded beef in which Australia participates is likely to be non-existent, the relevant price transmission elasticity (θ_{ia}) should be treated as zero.

A parallel example occurs where Australia's export market (eg for coking coal or iron ore) is effectively limited by freight costs to the Pacific region, and arbitrage between that regional market and the larger 'Atlantic' market is fairly weak. Smith (1977) discusses this situation in some detail. The implication for the price transmission elasticities between 'Atlantic' prices and Australian export prices is that they are likely to be low for small price changes, but large for price changes sufficient to overcome the transport gradients (in either direction).

3.4.5 Deficiency payments

National agricultural policies frequently seek to achieve production (or farm income) targets for a commodity. If the instruments used are deficiency payments (or the price guarantees of the former UK farm policy), then the nexus between that country's farm-gate price and the international commodity market is cut. It would appear that (except when the guarantee lies below the current world price), $\theta_{ia} \approx 0$.

3.4.6 Import quotas

More commonly today the major consuming countries seek to pass the costs of agricultural support onto consumers by using import quotas and/or variable import levies. Such instruments tend to insulate local consumer prices as well as local producer prices from the international commodity market. In such cases, as long as the quotas are not under-utilised, it would be right to assume that $\theta_{ia} \approx 0$ and $\phi_{ia} \approx 0$.

Where a country has clearly adopted a policy of insulating its local market from outside influences - as most Organisation for Economic Cooperation and Development (OECD) countries have for most temperate-zone foodstuffs - the long run price transmission elasticity will be negligible, even though import quotas may be temporarily liberalised or suspended in response to demand fluctuations or production shortfalls. Collectively, outside suppliers cannot expect to achieve a sustained increase in shipments to such markets by way of price reductions.

3.4.7 State trading

In centrally planned economies (CPEs) commodity imports are governed by state trading monopolies. In the short run these organisations meet volume targets for foodstuff and raw material imports, which depend upon production plans for user industries, production plans for local substitutes, and temporary production shortfalls (see Neuberger and Lara, 1977). Import plans are not set in terms of a foreign exchange allocation for each commodity, which would make import volumes respond inversely to price fluctuations. Instead fluctuations in commodity prices (to the extent they are not mutually compensating) lead to changes in reserves, in net borrowing, or in across-the-board cutbacks. In the short run, commodity production and consumption in a CPE are effectively insulated from world commodity prices and, as Bredahl et al.(1979) have concluded, the relevant price transmission elasticities should be set at zero.

The proposition that in the longer term a CPE import plan for a particular commodity will be significantly influenced by any moderate changes in the world price of that commodity is not generally convincing. A Balance of Payments constraint must operate in the longer run, requiring the planning agencies to respond to any sustained change in the terms of trade between aggregate imports and aggregate exports. However, this does not necessitate reducing imports of a commodity whose price has increased if to do so would conflict with other policy objectives. Imports of some other good could be reduced, or exports could be expanded. The major CPEs have a broad enough industrial base to be able to insulate particular activities from outside influences as effectively as do the European Economic Community (EEC) and Japan.

In this light the effective long run response of domestic output and consumption of a particular commodity to changes in the external price is likely to be negligible. Some support for this view is provided by Abbott (1974) who estimated elasticities of consumption with respect to the import price for wheat and feed grains in the Soviet Union. The most likely values were zero for both commodities, and (with 84 per cent confidence) the maximum values were -0.04 for wheat and -0.02 for feed grains. In applying equation (4) to countries where the price mechanism does not control resource allocation, it does not matter whether this conclusion is represented by setting $\phi_{ia} = \theta_{ia} \approx 0$, or by setting $\eta_{ii} = \varepsilon_{ii} \approx 0$.

3.4.8 Reported values of export demand elasticities

Demand elasticities calculated from a carefully derived demand analysis of individual commodity markets are usually smaller than those used by the IAC. Appendixes B and C report two examples, for beef and coal respectively. In my view the most plausible average values for long term export demand elasticities are something like -4, for both rural products and minerals.

This view might be compared with econometric estimates for the long term demand elasticity facing aggregate Australian exports:

RBA (Jonson et al., 1980)	-0.12
OECD (Samuelson, 1973)	-0.128
Hickman and Lou (1973)	-0.75.

Of course, it is often argued that such econometric estimates understate the true elasticity. Consequently Stoeckel (1978) argued that -4 would be a more plausible value, and Jonson et al. suggested -2.

4. IMPLICATIONS FOR MACRO-AGGREGATES

4.1 Version A of ORANI

What happens if we recalculate the export effects of the IAC motor car proposals using the parameter values proposed in the previous sections? The estimated increase in rural exports is just over one per cent, instead of the 3 per cent in Version A.

$$\tilde{x} = -4 \; \frac{1(-0.9\%) - 0.5\;(-0.3)(-0.9\%)}{1 - 0.5\;(-0.3) - 0.5(-4)} = +1.3\%$$

The estimated increase in mineral exports is about 2.5 per cent, instead of the 18 per cent of Version A.

$$\tilde{x} = -4 \; \frac{5(-0.9\%) - 0.33\;(-0.3)(-0.9\%)}{5 - 0.33\;(-0.3) - 0.67\;(-4)} = +2.4\% \; .$$

When the IAC evaluated the effects of its original proposals for motor car protection, it concluded that they would lead to a significant improvement in the balance of trade. This result was central to its conclusions on aggregate employment since, 'with aggregate domestic absorption fixed, this surplus implies an increase in real gross domestic product' (IAC, 1981a, p. 275). The increase in GDP estimated with Version A of ORANI was 0.3 per cent and the IAC added that 'increased consumption and investment could be expected to flow from the increased GDP ... When allowance is made for the multiplier effects of the initial increase in consumption the eventual long term results could be of the order of an additional half a per cent for real GDP' (IAC, 1981a, p. 145).

This numerical result stemmed from the modelling of the motor car sector and of the export sector employed in Version A. The former has been analysed by Cronin (1982) and the latter has been examined in the present paper. If one recalculates the balance of trade impact using more plausible parameter values, it appears to deteriorate in response to reduced motor car protection. There is nothing surprising in this outcome.

TABLE 2 : ESTIMATED LONG TERM EFFECTS IN VERSION A

		Estimated change using			
	1979-80	IAC parameters		Alternative parameters	
	($b)	(per cent)	($b)	(per cent)	($b)
IMPORTS:					
Motor cars	0.4	+38.9(a)	+0.16	+218(c)	+0.87
Motor components	0.3	+66.3(a)	+0.20	+ 10(c)	+0.03
All other	16.7	na	na		
Total	17.4	+ 4.0	+0.70		+0.90
EXPORTS:					
Rural products	8.1	3.0(b)	+0.24	+ 1.3(d)	+0.11
Minerals	5.7	+18.0(b)	+1.03	+ 2.4(d)	+0.14
All other	4.8	0	0		
Total	18.6		+1.27		+0.25
Balance of trade			+0.57		-0.65

Note: na not available.

SOURCES: a IAC, 1981a, p. 139.
b This paper, Section 3.1.
c Cronin (1982).
d This paper, see Section 3.1.

If one maintained the IAC assumptions of fixed absorption. a fixed real wage and a fixed nominal exchange rate, the trade deficit would translate into a reduction in real GDP of about half a per cent. Allowing for the IAC's multiplier effects would this ultimately reduce real output by one per cent? Obviously not. because these assumptions are untenable in a long -term model.

Version A of ORANI suffers not only from suspect parameter values. but also from bad economic theory. Protection reductions had favourable effects only when it appeared that they increased exports more than they increased imports. In other words the theory was mercantilist.

4.2 Version B of ORANI

When the IAC subsequently re-evaluated the original proposals for motor car protection using Version B of ORANI it concluded that they would lead to an increase in real GDP of 0.2 per cent. In this version, balance of trade and employment constraints were imposed and the real wage rate and the real exchange rate were endogenous. Once again there were two problems - a parameter problem and a theory problem.

The parameter problem is illustrated in Table 3. On my preferred parameter values the domestic price changes estimated by the IAC lead to a balance of trade deficit. To clear this deficit the rents to the factors assumed fixed in Australia (land and labour) would have to fall. Consequently the increase in real GDP could not be as large as that estimated by the IAC.

TABLE 3 : ESTIMATED LONG TERM EFFECTS IN VERSION B

	1979-80	Estimated change using			
		IAC parameters		Alternative parameters	
	($b)	(per cent)	($b)	(per cent)	($b)
IMPORTS:					
Motor cars	0.4	+51.6(a)	+0.21	+218(c)	+0.87
Motor components	0.3	na	na	+ 10(c)	+0.03
All other	16.7	na	na		
Total	17.4	+ 3.4(a)	+0.59		+0.90
EXPORTS:					
Rural products	8.1	3.8(b)	+0.31	+ 1.0(d)	+0.08
Minerals	5.7	+9.1(b)	+0.44	+ 1.8(d)	+0.10
All other	4.8	0	0		
Total	18.6		+0.75		+0.18
Balance of trade			+0.16		-0.72

Notes: na not available.

The IAC constrained the change in the trade balance to zero; this discrepancy reflects my use of 1979-80 trade data as commodity weightings.

SOURCES:
- a IAC, 1981b, p. 334, column X.
- b This paper, Section 3.2.
- c Cronin (1982).
- d Calculated from parameter values proposed in Sections 3.3 and 3.4.

The theory problem arises because the IAC did not define appropriate general equilibrium conditions in Version B of ORANI. The usual assumption in neo-classical trade theory is that factor endowments are fixed and factor markets cleared. Quantitative models embodying this theory have been developed by Boadway and Tredennick (1978) for Canada, by de Melo (1978) for Colombia, and by Stoeckel (1978) for Australia.

The IAC did not adopt this assumption in the case of capital inputs but instead allowed the capital base to expand. Where did the additional capital come from? If it came from overseas how much of the additional factor income accrues to foreigners? If it came from domestic sources, how much consumption would have to be foregone and what increase in the real rate of return would be required?

There is no objection to departing from traditional neo-classical trade theory and treating financial capital as a tradable commodity. But if one does so, the service cost of imported capital should be treated as an outgoing in the balance of payments. The trade constraint in the IAC model should be replaced with a current payments constraint, so that gross domestic absorption is equated to gross national product rather than to gross domestic product. Depreciation and overseas transfers should be deducted to calculate net national income, since gross domestic product has lost any meaning as an approximate welfare indicator.

As it stands Version B of ORANI is based on the theory that tariff reductions will mysteriously lead to the injection of a free gift of capital into the Australian economy. It is essentially a cargo cult model.

I believe that in Version B the 0.2 per cent increase in real GDP (resulting from reduced protection to motor cars) was associated with an expansion in the capital base of something like 0.7 per cent. Since capital income makes up nearly one-third of GDP, it seems likely that capital expansion rather than improved allocative efficiency, made up nearly all of the reported GDP increase.

5. CONCLUSION

So far, the IAC has not produced a convincing quantitative estimation of the effects of reductions in protection upon economic welfare or on any macro-economic aggregate. Let us consider some major ingredients which I think are required in such quantitative analysis:

- a reasonable long run micro-economic specification of industry behaviour. I have not criticised the micro-economic theory in ORANI because it is a useful and respectable starting point. Of course, it would be better still if it incorporated size economies, inter-material substitution and a more appropriate industry classification;

- a reasonable empirical backing for the parameter values in the industry modelling. In my view this is lacking, and not just in the export sector; and

- a respectable general equilibrium specification of the relationships between macro-economic aggregates. ORANI by itself is not a general equilibrium model and the IAC has not yet incorporated ORANI within a satisfactory general equilibrium setting. The most obvious course of action is to apply the assumptions of neo-classical trade theory to a quantitative model. This may not be the only respectable trade theory, but I always thought that the IAC liked it.

APPENDIX A : ELASTICITIES OF SUPPLY FOR MINERAL PRODUCTION

The long run response of the output of a mineral commodity to its own price needs to be considered within the framework of the economies of depletion of non-renewable resources. Possible approaches to the depletion-price problem are analysed by Heal (1976), Hanson (1980) and Pindyck (1981), among many others.

A representative model would include:

- a demand specification, say,

$$q_t = q_o \; e^{\gamma t} \; p_t^{\eta} \tag{1}$$

where q_t is the quantity demanded and p_t is the commodity price;

- a definition of expected economic reserves,

$$R_t = R_o - \int_o^t q_\tau \; d\tau \tag{2}$$

A specification that extraction/transport costs increase with the depletion of reserves, say,

$$b_t = a \; e^{-\beta R_t} \tag{3}$$

where b_t is the real unit cost of extraction and transport;

- an assumption of a backstop technology which would provide unlimited supplies of the commodity at some real unit cost greater than the present extraction cost when presently exploitable reserves are depleted,

$b_t < a$ for $t < F$, so that

$$R_F = 0 \text{ and } p_F = a. \tag{4}$$

Note that the backstop technology might be either a very large reserve of the same generic material which is relatively difficult to access (eg coal from Eastern Siberia), or an alternative material requiring more costly processing (eg aluminium from clay, or oil from coal).

For $o < t < F$, the competitive supply price is given by

$$P_t = ae^{r(t-F)} + \int_t^F re^{\,r(t-\tau)} \; b\tau \; d\tau \tag{5}$$

where r is a real discount rate (Hanson, 1980).

Note that the discount rate should in principal take account of producers' uncertainty concerning the duration of property rights and future taxation liabilities.

Such a system can be solved to determine the equilibrium trajectories of price and output. It is not directly consistent with the concept of long run static price elasticities of supply and demand which underlies the analysis elsewhere in this paper. However, there are implications for these elasticities. An upward shock in demand which is expected to persist, and therefore generate an increase in long run output, will lead to expectations of a faster rate of growth in future extraction costs and will bring forward the expected recourse to the backstop technology. Consequently the price impact of such a demand shock will incorporate effects from the future extraction cost schedule.

This effect can be incorporated in a more tractable specification if it is assumed that any one time producers expect an approximately constant rate of extraction, and view long run demand shifts as a series of steplike shocks. This would imply that:

$$\hat{q}_t = q, \ \hat{R}_t = R_o - qt, \ \hat{F} = R_o/q,$$

$$\hat{b}_t = ae^{-\beta(R_o - qt)} \text{ and}$$

$$\begin{aligned} po &= ae^{-rR_o/q} + \int_0^{R_o/q} re^{-r\tau} \ ae^{-\beta(R_o - q\tau)} d\tau \\ &= ae^{-rR_o/q} + rae^{-\beta R_o} \int_0^{R_o/q} e^{(\beta q - r)\tau} d\tau \\ &= ae^{-rR_o/q} + \frac{rae^{-\beta R_o}}{\beta q - r} \left(e^{\beta R_o - rR_o/q} - 1\right) \\ &= ae^{-rR_o/q} + \frac{ra}{\beta q - r} \left(e^{-rR_o/q} - e^{-\beta R_o}\right) \\ &= \frac{a\beta q}{\beta q - r} e^{-rR_o/q} - \frac{ra}{\beta q - r} e^{-\beta R_o} \end{aligned} \tag{6}$$

$$(\beta q - r)p = a\beta q e^{-rR/q} - rae^{-\beta R}$$

$$\begin{aligned} \beta p + (\beta q - r)\frac{\partial p}{\partial q} &= a\beta e^{-rR/q} + \frac{rR}{q^2} a\beta q e^{-rR/q} \\ &= \frac{q + rR}{q^2} \left(a\beta q e^{-rR/q}\right) \\ &= \frac{q + rR}{q^2} \left((\beta q - r)p + rae^{-\beta R}\right) \end{aligned}$$

$$\beta q + (\beta q - r)\frac{\partial p}{\partial q}\frac{q}{p} = \frac{1 + rF}{p}\left\{(\beta q - r)p + rb\right\}$$

$$\begin{aligned} \frac{\partial p}{\partial q}\frac{q}{p} &= \frac{(1 + rF)\ (\beta q - r + rb/q) - \beta q}{\beta q - r} \\ &= \frac{(1 + rF)\ (b/p - 1) + qF}{q/r - 1} \end{aligned}$$

Thus the approximate long run supply elasticity

$$\varepsilon_s = \frac{\partial q}{\partial p} \cdot \frac{p}{q} = \frac{\beta q/r - 1}{(1 + rF)\ (b/p - 1) + \beta qF} \tag{7}$$

Two special cases might be considered.

(i) Constant unit extraction costs

$$\text{i e } \beta = 0$$

$$\text{then } p_t = b_t = a$$

$$\text{and } \varepsilon_s \rightarrow \infty$$

(ii) Myopia by owners of mineral assets
If owners of assets took no account of the implications for depletion of sustained output increases, then effectively

$$r \rightarrow \infty$$

$$p_t \rightarrow b_t$$

$$\text{and } \quad \varepsilon_s \rightarrow \frac{1}{\beta q} \tag{8}$$

An Example

The US coal industry is generally regarded as having potential access to very large reserves with a fairly shallow gradient in extraction costs. The same features are frequently mentioned in relation to major Australian mineral deposits (eg black coal, iron ore, bauxite) in support of the view that long run supply elasticities are virtually infinite.

The geological features influencing extraction costs in the US coal industry have been analysed by Zimmerman (1977). Subsequently these results were further developed by Modiano and Shapiro (1980) to allow for freight cost differentials and to produce a schedule for delivered cost in thermal equivalent ex Chicago.

Modiano and Shapiro estimate a monotonic increase in marginal extraction costs from 0.73 ($ per million Btu) in 1979 at an output of 18×10^{15} Btu until cumulative depletion reaches 236×10^{15} Btu. At that point they assume that infinite reserves become available at a unit extraction cost of 1.40. (This is a fairly arbitrary backstop assumption; no doubt when these reserves are exploited, marginal extraction costs will be found to continue rising.)

This data base suggests the following parameter values for equations (6) and (7):

$$b_o = 0.73, \ a = 1.40, \ F = 14, \ \beta q = 0.046$$

If we assume a real discount rate of 0.05, then equations (6) and (7) give:

$$P_o = 1.19$$

and $\varepsilon_s = 5.7$

If we assume a real discount rate of 0.10, then equations (6) and (7) give:

$$P_o = 1.07$$

and $\varepsilon_s = 4.4$

In comparison, it can be seen that if the depletion effects were ignored we would expect:

$$P_o = b_o = 0.73$$

and $\varepsilon_s = \frac{1}{\beta q} = 22$

Clearly the estimated value of the static long run supply elasticity is very much lower if one takes account of depletion effects. The approximate method suggested here is a crude way of converting a dynamic problem to a static problem, but it should usually be significantly better than adopting a virtually infinite long run supply elasticity by assumption.

APPENDIX B : THE ELASTICITY OF DEMAND FOR BEEF EXPORTS

In recent years Australian beef exports have represented nearly 3 per cent of the world market and about 25 per cent of world trade.

TABLE B.1 : WORLD MARKET FOR BEEF

		Demand			Supply		
		%	η_i (LT)	ϕ_{iA}	%	$\sqrt{\varepsilon_i}$ (LT)	θ_{iA}
Australian exports	(A)				3		
Competing suppliers[a]	(C)				8	0.7	1
North America	(U)	31		0	28		0
W. Europe and Japan	(E)	19		0	18		0
Soviet Bloc	(S)	25		0	23		0
Open markets	(O)	10	−0.4	1	5	0.5	1
Rest[b]	(R)	15		0	15		0

a Production in New Zealand, Argentina and Uruguay.
b Includes subsistence production in Africa and Asia.

The world market for beef is dominated by widespread Government intervention in all the major consuming countries, which are themselves the major producers of the commodity. The common policy objective in these countries is to maintain a given level of production (or of self-sufficiency). This inevitably requires insulating their domestic producers from external price movements. In practice the policy instruments chosen - quotas in the USA, Canada and Japan; minimum import prices and quotas in the EEC; state trading in the Soviet Bloc - also insulate consumer prices from external price movements.

Among the residual suppliers to the world market (New Zealand, Argentina and Uruguay), Australia has a dominating position with about 50 per cent of their joint exports. One might expect Australia's influence on price levels in the rump of the world market to be quite substantial. The discussion which follows is based on the premises that:

- Australia competes for market share with the other Southern Hemisphere exporters, and that their supply is therefore responsive to Australian price (this is not strictly true under present arrangements); and

- consumer markets totalling up to 10 per cent of world consumption are without quantitative restrictions, and respond to price movements in the residual market (this probably overstates the flexibility in world consumption).

The derived demand elasticity for Australian beef is defined as:

$$\eta_{XA} = \sum_i \eta_i \phi_{iA} \; C_i/X_A - \sum_j \varepsilon_j \; \theta_A \; S_j/X_A$$

$$= -0.4(10/3) - 0.7(8/3) - 0.5(5/3)$$

$$= -4 \text{ (LT)}$$

In this calculation it was assumed that although total beef import levels in North America and Japan were controlled by (effectively) quotas, Australia and other exporting countries competed for market share within the quota. This is not the case under current arrangements since the importing countries set country-specific quotas (the USA explicitly and Japan implicitly).

If there were free competition among Australian meat exporters, prices would be equated across the export markets. The demand elasticity for exports to quota markets would be zero and the Australian export demand elasticity would be:

$$\eta_X = S_R \; \eta_{XR}$$

where S_R is the share of non-quota markets in Australian exports, and η_{XR} is the elasticity of demand for Australian beef in non-quota markets. 'S_R' was about 35 per cent in 1978 (although it is likely to become smaller since the expansion of the US quota). Freebairn and Gruen (1977) estimated, very tentatively, that $\eta_{XR} = -1.3$. This would yield a very low Australian export demand elasticity of about -0.5.

However, the Meat Board's Export Diversification Scheme means the behaviour of Australian meat exporters is analogous to that of a price discriminating cartel without supply control. Under the scheme exporters earn entitlements to ship to (higher-price) quota markets in proportion to their shipments to (lower-price) non-quota markets. The fact that the scheme applied to sheepmeat as well as to beef is a minor complication and is ignored.

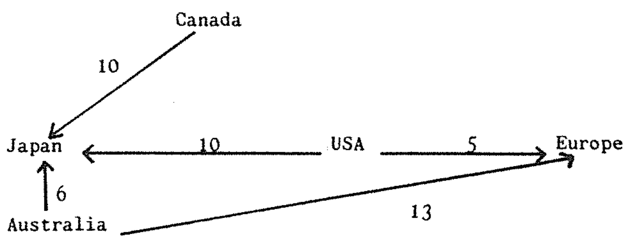
APPENDIX C : THE ELASTICITY OF DEMAND FOR COAL EXPORTS

In 1977 Australian coal exports represented about 1.5 per cent of the world market and about 18 per cent of world trade. Australian exports are specialised in two respects: about 95 per cent of coal exports are coking coal and about 80 per cent of coking coal exports are shipped to Japan with another 10 per cent going to other Pacific markets (in 1977). This concentration upon the Pacific market is simply a reflection of the importance of freight cost differentials for a low-value-bulk commodity.

The relevant freight costs are described in Figure C1.1 below.

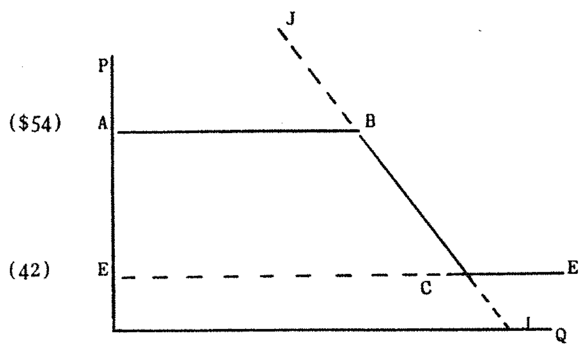
FIGURE C1.1 : COAL FREIGHT COSTS IN 1976

($US per metric tonne)



The implications of such freight differentials are described by Ben Smith (1977). Briefly, bilateral bargaining between Australia and Japan should take place between an upper price bound representing the given 'Atlantic' price of coking coal plus freight to Japan, less the Japan-from-Australia freight costs and a lower bound representing the 'Atlantic' price less the 'Atlantic'-from-Australia freight cost. From Figure C1.2 it would seem that there would be a $12 gap between these bounds in 1976.

FIGURE C1.2 : DEMAND FOR AUSTRALIAN COAL



Australia would face the demand curve ABCE in the diagram where JJ represents Japanese aggregate demand for coking coal, EE represents 'Atlantic' demand, and ABC represents Japanese demand for Australian coking coal. The European cif price for typical Australian quality coking coal was about $55 in 1976 and it seems clear that contract prices to Japan (averaging about $46) lay within the gap.

For large price changes (10-20 per cent or more) the (LT) export demand elasticity could become very large. For smaller price changes, that elasticity would be dominated by the Japanese production-Australia demand schedule. This can be evaluated from the following data base.

TABLE C1.1 : SUPPLY OF COKING COAL TO JAPAN IN 1978

		(per cent)	ϵ_i	θ_{iA}	η_J
Australia	(A)	36			
Canada	(C)	16	55	1	
U.S.A.	(U)	11	-	0	
Other imports	(R)	11	5	1	
Japanese production	(J)	26	-	0	
Total supply		100			-0.3

Japanese coking coal production is declining, is said to be high cost and is almost certainly inelastic to the Australian price. Imports from Canada represent almost the entire output of the British Columbia coalfield, which faces heavy rail freight costs on any shipments eastwards; the (LT) supply elasticity for this field is likely to be small (no doubt '5' is an over-estimate). A very large price increase could, of course, prompt the development of new coalfields in Canada or elsewhere.

The continued imports of coking coal from the USA are surprising in view of the differential transport costs already described. Imports from the USA consist of low-ash coals. On new steel-making technology these can be substituted by high-ash Australian and Canadian coal. The continued imports of low-ash coal probably reflect incomplete adoption of the new technology rather than competition on price with Australian coal.

The elasticity of Japanese demand for Australian coal can be defined as:

$$\eta_{JA} = \eta_J \quad \phi_{JA}(C_J/X_A) - \epsilon_J \quad \theta_{JA}(S_J/X_A) - \epsilon_u \quad \theta_{uA} \quad (X_u/X_A)$$

$$-\epsilon_C \quad \theta_{CA}(X_C/X_A) - \epsilon_R \quad \theta_{RA}(X_R/X_A)$$

$$= -0.3(100/36) - 0 - 0 - 5.0(16/36) - 5.0(11/36)$$

$$= -4.2(LT)$$

This value is intended to represent a long term demand elasticity subject to the absence of a massive (real) price change capable of offsetting the freight differentials or of stimulating the development of infra-structure for new coal fields, and to the existence of competition among Japanese buyers. Smith (1977) analysed the possible consequences of cartelisation among Japanese buyers on the one hand, and among Australian sellers on the other. This would tend to steepen the effective demand curve facing Australia.

In 'normal' circumstances one would expect the short term export demand elasticity to be very low. Virtually all the market is tied up under long term contracts and it would normally be difficult to vary supplies from competing producers in the short run. In periods of recession with widespread over-capacity and under-delivery on contracts this may not be the case.

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PARAMETER VALUES AND EFFECTS OF PROTECTION IN A SIMPLE NEO-CLASSICAL TRADE MODEL

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To the best of my knowledge no quantitative analysis of the effects of protection as suggested by neo-classical trade theory has yet been implemented using a large model of the Australian economy. No doubt such analysis will be undertaken in the near future. In the meantime it may be useful to examine the sensitivity of the effects of protection to parameter values in the context of a stylised five-sector model of the economy.

Some qualifications should be made in advance. First, no neo-classical trade model, however complex, can tell the full story about the 'costs of protection'. This version of trade theory is comparatively static and is restricted by the assumptions of universal diminishing returns, perfect competition, a fixed resource base and full utilisation of resources. It does not handle growth dynamics, scale economies, unemployment, etc.

Second, the small stylised model put forward here does not deal with input-output relationships among industries, nor with the dispersion of the actual Australian tariff. It may well be that that tariff dispersion generates larger effects upon economic welfare than does the average tariff.

Third, the solutions put forward here relate to small changes in protection.

Variables

m_c, p_{mc}	quantity and duty paid price of competing imports
m_n, p_{mn}	quantity and price of non-competing imports
p_{wc}, p_{wn}	world prices of competing and non-competing imports
q, p_q	quantity and price of domestic goods
q_c, p_{qc}	quantity and price of import-competing output
q_n, p_{qn}	quantity and price of non-tradable outputs
t	nominal rate of protection for competing imports
c	aggregate consumption
x, p_x	quantity and price of exports.

Parameters

s_q, s_x	shares of domestic goods and exports in total output
s_{qc}, s_{qn}	import-competing and non-tradable shares of domestic goods output
s_{mc}, s_{mn}	competing and non-competing shares of total imports
z_i	share of good i in final consumption

θ	elasticity of transformation between domestic goods and exports
σ	elasticity of substitution between import-competing domestic goods and competing imports
η	elasticity of demand for exports

Specification

Transformation between production for the domestic market and for exports is described by

$$\tilde{q} - \tilde{x} = \theta\ (\tilde{p}_q - \tilde{p}_x) \tag{1}$$

Substitution between competing imports and import-competing output is described by

$$\tilde{q}_c - \tilde{m}_c = \sigma\ (\tilde{p}_{mc} - \tilde{p}_{qc}) \tag{2}$$

Demand for exports is defined by

$$\tilde{x} = \eta\ \tilde{p}_x \tag{3}$$

Production is constrained by a fixed resource base

$$s_q\ \tilde{q} + s_x\ \tilde{x} = 0 \tag{4}$$

$$s_{qc}\ \tilde{q}_c + s_{qn}\ \tilde{q}_n = \tilde{q} \tag{5}$$

Resources are perfectly mobile between non-tradable and import-competing production

$$\tilde{p}_{qc} = \tilde{p}_{qn} = \tilde{p}_q \tag{6}$$

The small country assumption holds for imports

$$\tilde{p}_{mc} = t/(1+t)\ \tilde{t} + \tilde{\tilde{p}}_{wc} \tag{7}$$

$$\tilde{p}_{mn} = \tilde{\tilde{p}}_{wn} \tag{8}$$

There is a balance of trade constraint

$$s_{mc}\ (\tilde{m}_c + \tilde{p}_{wc}) + s_{mn}\ (\tilde{m}_n + \tilde{p}_{wn}) = \tilde{x} + \tilde{p}_x \tag{9}$$

Aggregate consumption is defined as

$$\tilde{c} = z_{qn}\ \tilde{q}_n + x_{mn}\ \tilde{m}_n + z_{qc}\ \tilde{q}_c + z_{mc}\ \tilde{m}_c \tag{10}$$

Demand for non-tradables and non-competing imports is Leontief to aggregate consumption

$$\tilde{q}_n = \tilde{m}_n = \tilde{c} \tag{11}$$

This specification might tend to overstate the neo-classical costs of protection since equation (6) assumes infinite transformability between non-tradable and import-competing outputs. This might approximate reality only in the extreme long term in which resources might be fully mobile between the services and manufacturing sectors. On the other hand it is slightly restrictive in assuming zero price competition between non-tradables and imports.

Application to a Tariff Change

Treating world prices as constant and the tariff as a policy variable leads to an analytical solution for all the remaining variables.

If we define

$$1/F = 1 - \frac{\eta}{\theta s_q} - \frac{\eta\ s_x}{\sigma\ s_q\ s_{qc}} - \frac{1+\eta}{\sigma\ s_{mc}} + \left(\frac{1}{s_{mc}} - \frac{1}{s_{qc}}\right)\frac{1+t+\eta t}{\sigma+\sigma/s_x} \tag{12}$$

Then,

$$\tilde{c} = \frac{Ft}{1+t}\ \frac{1+t+\eta t}{t+1/s_x}\ \tilde{t} \tag{13}$$

$$\tilde{x} = \frac{F\eta t}{1+t}\ \tilde{t} \tag{14}$$

It can be seen that

$$\frac{dc}{dt} = \frac{cF}{1+t}\ \frac{1+t+\eta t}{t+1/s_x}$$

$$= 0 \text{ when } t = -1/(1+\eta)$$

That is, consumption (or aggregate welfare) is maximised by the 'optimal tariff'. This is the usual textbook formula, but it may be noted that under this specification it is optimal to set the tariff on the competing subset of imports at $-1/(1+\eta)$. The average tariff on all imports is irrelevant; any tariff on the non-competing subset would have no efficiency implications since the latter was defined as totally non-substitutable.

The Structural Coefficients

The model has been approximately parameterised on the basis of National Accounts and import statistics for 1977-78 as follows:

$s_x = 0.167, \quad s_q = 0.833$

$s_{qc} = 0.20, \quad s_{qn} = 0.80$

$s_{mc} = 0.30, \quad s_{mn} = 0.70$

$t = 0.30$

In calculating these coefficients:

- import-competing output was defined as gross product in manufacturing less primary processing of rural and mining products;
- non-competing imports were defined as all imports subject to zero or minimum rates of duty; and
- the nominal rate on competing imports is the import-weighted average tariff adjusted to take account of average freight costs and of the 'tariff equivalents' of import quotas as estimated by the IAC.

Numerical solutions can be calculated by defining the endogenous variables in terms of the remaining parameters.

$$1/F = 1 - 1.20\ \eta/\theta - 4.41\ \eta/\sigma - 3.64/\sigma \qquad (15)$$

$$\tilde{c} = (0.0476 + 0.0110\eta)\ F\ \tilde{t} \qquad (16)$$

$$\tilde{x} = 0.231\ \eta\ F\ \tilde{t} \qquad (17)$$

$$\tilde{m}_c = (0.658 + 0.743\eta)\ F\ \tilde{t} \qquad (18)$$

$$\tilde{q}_c = (-0.190 - 0.275\eta)\ F\ \tilde{t} \qquad (19)$$

Sensitivity to the Economic Parameters

The three remaining parameters are the elasticity of export demand (η). the elasticity of export transformation (θ) and the elasticity of import substitution (σ). The effects of a ten per cent cut in our hypothetical uniform tariff (on competing imports) are evaluated for alternative settings of these parameter values. The effects of the tariff cut are outlined in Table 1.

TABLE 1 : EFFECTS OF A TEN PER CENT TARIFF CUT

Setting	A	B	C	D	E	F	G	H
θ	3	∞	3	3	1	∞	3	3
σ	5	2	2	∞	5	5	5	5
η	-5	-12	-5	-5	-5	-5	-2	∞
Variable	(percentage change)							
Consumption	+.01	+.03	+.006	+.02	+.007	+.02	-.09	+.08
Exports	+1.7	+1.1	+0.9	+3.9	+1.1	+2.5	+1.6	+1.8
Competing imports	+4.5	+3.2	+2.5	+10.0	+2.9	+6.5	+2.9	+5.8
Import-competing output	-1.8	-1.2	-1.0	-4.0	-1.1	-2.5	-1.3	-2.1
Real exchange rate	-1.3	-1.0	-0.6	-2.3	-1.5	-0.5	-1.5	-0.7

The values of these parameters appropriate to either a long run or a short run solution are uncertain. Column A represents my views on the middle of the plausible range for long run analysis. Column B approximates to the values used by the IAC in its long term applications of ORANI. Columns C and D show the effects of varying the elasticity of import substitution between a low and a high value. Columns E and F show the effects of varying the elasticity of export transformation between a low and a high value. (The elasticity of aggregate export supply is equal to this parameter multiplied by (1 - the share of exports in GDP).) Columns G and H show the effects of varying the elasticity of export demand from a low to a high value.

What can be said about the sensitivity of the simulated impact of a tariff cut? First, the direction of the effect upon aggregate welfare depends in this model only upon the magnitude of the export demand elasticity (in relation to the initial tariff level). Second, the size of the impact upon any variable increases monotonically with each of the three elasticities.

It might be noted that if all three elasticities are assumed to be infinite then the equilibrium becomes unstable. Any reduction in the tariff leads to a corner solution in which the import-competing sector is wholly replaced by imports. Setting only the import substitution elasticity at infinity is not sufficient to yield this result since the direct effect of the tariff cut is compensated by a change in the real exchange rate. defined here as the ratio of the domestic price level to the world price of imports.

AGGREGATION OF TRADE PARAMETERS IN THE ORANI MODEL

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1. INTRODUCTION

The ORANI78 Large Charge (078LC)[1] programs are written for arbitrary numbers of industries, commodities and occupations, up to the limits imposed by the core size of the computer.[2] Hence changing the numbers of industries etc. requires changes only to the input-output data files, and to the values of parameters, but not to the solution programs. This paper describes default procedures for aggregating the trade parameters.

The only information required for aggregation of trade parameters is specification of the aggregation mappings for commodities and industries, the original ORANI input-output data and trade parameters, and the aggregated ORANI input-output data. The main advantage of aggregation is the reduction in computing time and hence in turnaround time and cost. This is particularly advantageous for program development, for exploratory work and for training purposes.

This paper is based on relevant sections of a previous paper (Sutton, 1981) which deals with aggregation of commodities, industries and occupations for the entire ORANI78 model. The reasons for using aggregation are discussed in greater detail in Section 2. Section 3 describes the selection and specification of the aggregation mappings, including restrictions on these mappings. Section 4 contains some general remarks on aggregation of parameters while Sections 5 and 6 contain derivations of aggregation formulae for import substitution elasticities and export demand elasticities respectively.

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1. This document is written in terms of the revised version of ORANI78 Large Change which I have proposed as the new standard ORANI computer system (Sutton, 3 December 1980). Don't be deterred by the mention of 'large change'. This system is designed to be used for the usual single step calculations. It can also be used for large change calculation if necessary.
2. Increasing some of these numbers would require re-dimensioning of arrays, but the important point is that these numbers always occur in the Fortran code, eg in DO loops, as variables rather than specific values.

2. WHY AGGREGATE

Optimal usage of the ORANI model requires utilisation of all reliable and relevant information. This includes maximising the numbers of industries and commodities, provided that data are available. However there are many applications where aggregations of commodities, industries and occupations are desirable in order to reduce computing turnaround times and also to minimise computing costs.

At present the cost of an ORANI solution using the full model is approximately $200 during the day, and there is the possibility that even then the computation will not be completed by the end of the day due to slower turnaround for jobs with large computing times and large core storage requirements. For these reasons most ORANI solutions are computed overnight. This is inconvenient if results are needed urgently and is particularly frustrating if any errors are made in submitting the job. Aggregation can significantly reduce the computing times and core storage requirements and thus enable a sequence of ORANI solutions to be computed during the day.

Many of the algebraic operations in ORANI solutions are matrix multiplications and matrix inversions, for which the numbers of arithmetic operations are proportional to n^3 where n is the dimension of the matrix. Hence reducing the numbers of commodities and industries can reduce the computing costs dramatically. As an example, for the preliminary version of 078LC, reducing the number of commodities from 115 to 31 and the size of the A matrix from 273 to 96 reduced the CPU time from 145 seconds to 10.4 seconds.

Some of the situations for which aggregation of the ORANI data files is desirable are:

- development, revision and testing of computer programs. For example, aggregation has already saved much time in development and testing of the preliminary version of 078LC. It would also be useful for development of the ORANI-MACRO interface and for long-run macro-closure of ORANI, especially if investigating several alternative closures;

- preliminary sensitivity analysis. It is expected that detailed studies on an aggregate version of the model will indicate which combinations of changes to the parameters and input-output tables warrant examination with the full model;

- training courses and learning to use the ORANI programs. Aggregation has two advantages. First, it reduces to a more manageable size the process of interpreting results in terms of the database. Second it reduces the frustration and inconvenience associated with the inevitable mistakes, long computer turnaround times, and the flushing of files which is more likely to occur when several groups simultaneously generate large files. It also reduces costs dramatically. These comments apply to both the initial learning process and to experienced users trying new ways of using the model. The aggregated version of ORANI77 has already been used successfully for training purposes in Canberra;

- when disaggregation increases the numbers of commodities and industries beyond those allowed by array dimensions and core storage limitations. Rather than modify the programs to accommodate the increased dimensions, an easy solution is to aggregate some commodities and industries which are of little relevance to the particular study; and

- studies which require a sequence of ORANI solutions such as non-linear solutions or any attempt to achieve dynamics by linking solutions together. Suitable aggregation will have little effect on the values of macroeconomic aggregates or other variables of interest (providing the aggregation is chosen carefully) and the large times and costs involved in multiple solutions of the model will be greatly reduced.

ORANI results should always be eyeballed to confirm that they are consistent with the theory. Users become familiar with a standard set of input-output tables and parameters and this speeds the eyeballing process. For this reason it is desirable to establish a small number of standard aggregations and restrict most aggregation experiments to these.

Finally, it should be pointed out that conclusions and criticisms based on aggregated data files could be spurious, particularly if supplementary non-standard data have been used. Strange results should be followed up by simulations using standard data files at approximately the 109 industry level.

3. SELECTION OF AN AGGREGATION

(Which commodities, industries and occupations to aggregate.)

Ideally aggregation should reduce the size of the computation but in such a way that the results for variables of primary interest, such as the macroeconomic aggregates, and the results for particular industries are essentially the same as would be obtained from simulations using the full model. It is impossible to obtain exactly the same results in principle, because this would be equivalent to computing the correct result even when some of the information had been lost (by aggregation). This could occur only if the equations of the model could be partitioned into non-interacting sectors, such that aggregation of one sector had no effect on other sectors. Loss of information would be restricted to that sector alone, and the information lost would not be of interest. Such partitioning does not occur in general equilibrium analysis where the emphasis is on interaction between different parts of the economy.

The aim is to select an aggregation which minimises the size of the computations while at the same time minimises the distortions to the results of interest. The choice of aggregation will depend on the nature of the interconnections between the commodities and industries revealed by inspection of the input-output data. It would be usual to aggregate commodities/industries which have similar parameters/cost shares/sales shares. Of course if a small industry is combined with a much larger one then the values of the parameters etc. for the smaller one will have little influence on the values for the composite industry.

There are several restrictions on which commodities and industries can be combined. These restrictions are imposed by the theoretical structure of the ORANI model and the corresponding characteristics of the data files. They are caused by the special role of the markup commodities/industries, and of joint production for a subset of the commodities and industries. In joint production each industry may produce more than one commodity and each commodity may be produced by more than one industry. For commodities and industries outside joint production there is a one-one correspondence between commodity and industry. The obligatory restrictions are:

- except for joint production, the same aggregation should be used for both commodities and industries;
- if margin and non-margin commodities/industries are aggregated, then the combination must be in the margin set. The ORANI input-output file contains separate matrices for each of the margins. The computer programs allow margins to be added only to other margins. It is recommended, but not compulsory, that non-margins not be added to margins; and
- if joint production and non-joint production commodities/industries are aggregated, then the resultant combination must be in the joint production set. It is recommended, but not compulsory, to combine joint production only with joint production. There are additional restrictions on joint production aggregation which are imposed by the details of the CRETH specification.

In addition, there are several recommended (non-obligatory) restrictions;

- non-competing imports should not be combined with other commodities;
- ORANI 'export' commodities should not in general be combined with non-export commodities. It would be reasonable to relax this restriction to aggregate a small industry of one type with larger industries of the other type. Due to the large differences in behaviour between exports and non-exports in the ORANI model, it is suggested that in gross aggregations the agricultural, mining and manufacturing sectors each be split into at least one export and one non-export component; and
- industries with exogenous investment should not, in general, be combined with industries which have private investment.

4. SOME GENERAL REMARKS ON THE AGGREGATION OF PARAMETERS

New parameters are required whenever commodities and industries are aggregated. One option is to re-estimate parameters for the appropriate new commodities and industries. This paper is concerned entirely with an alternative method of computing aggregate parameters by mechanical operations on the existing parameters according to formulae derived from the structural equations of the model. These formulae will be coded into the aggregation program and used as the default procedures for aggregating parameters. A cautionary note should be added. It appears that for some parameters the appropriate aggregation formula depends on the particular simulation or application.[1] Nevertheless it is suggested that the formulae presented here are a great improvement on those used for aggregation in ORANI 77 in that they have some theoretical basis.

It should be added that if commodities, industries and occupations are to be <u>disaggregated</u>, then the new parameters should be constrained to satisfy relationships to the existing parameters according to the formulae given.

Each parameter appears in only one structural equation and each parameter aggregation formula can then be derived by algebraic operations on the appropriate equation. Two important principles underlie the derivations, as follows:

- since physical quantities of different goods (such as litres of beer and kilograms of tobacco) cannot be added together but corresponding dollar value flows can, the equations are manipulated to produce expressions for changes in dollar value flows; and

- it is assumed that the prices and/or quantities for the individual components which constitute an aggregation group experience the same percentage changes, and that the aggregate experiences the same change. Once the decision to combine a set of commodities (such as beer, other alcoholic drinks and tobacco) has been made it is assumed that they behave as one commodity. The individual components/commodities are thereafter indistinguishable. This means that if there is any subsequent interest in the changes for individual components, it is not possible to introduce different changes for different components. If the user is not happy with this for particular commodities, then those commodities should not be included in the aggregation in the first place.

Aggregation results will now be derived for each parameter. Throughout the derivations G will be used to denote the set of commodities i, iG, which are to be combined. Similarly, H will denote the set of industries j, jH. In the interests of simplifying the algebraic notation the subscripts G and H will be omitted from the variables and parameters in most of the formulae. It will be obvious that each expression is relevant only to the parameter aggregation over G or H.

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1 See for example the discussion by Parmenter (1977) of the problem of computing tariff rates from rates for component commodites.

It can be shown algebraically that application of each of the parameter aggregation formulae in two or more successive steps yields the same value as applying the formulae directly. This will be referred to as the additivity property. For example, consider the aggregation of industries 1 and 2 to form industry A, and the aggregation of industries 3 and 4 to form industry B, and the combination of industries A and B to form industry Z. Given parameters λ_1, λ_2, λ_3 and λ_4 the aggregation formulae can be used form λ_A and λ_B and then reapplied to λ_A and λ_B to give λ_Z. This value of λ_Z will be identical with that obtained by applying the formulae directly to λ_1, λ_2, λ_3 and λ_4.

5. AGGREGATION OF IMPORT SUBSTITUTION ELASTICITIES $\sigma_i^{(k)}$

The model uses three sets of elasticities for substitution between domestic and foreign sources of supply. In the current implementation it is assumed that $\sigma_{ij}^{(1)} = \sigma_{ij}^{(2)} = \sigma_i^{(3)} = \sigma_i$, $i=1,\ldots,g;j=1,\ldots,h$. (Dixon et al., 1982, section 29.1). This restriction was imposed due to the unavailability of data, but it can also be defended partially on the grounds that nearly every good (at the 109 commodity level) is used primarily for only one of intermediate usage, investment and household consumption. The parameter file contains provision for 3 vectors $\sigma_i^{(1)}$, $\sigma_i^{(2)}$ and $\sigma_i^{(3)}$ and the standard parameter file is assembled with $\sigma_i^{(1)} = \sigma_i^{(2)} = \sigma_i^{(3)}$.

Omitting the technological change terms, the relevant equations[1] are

$$x_{(is)j}^{(1)} = z_j - \sigma_{ij}^{(1)} \left[p_{(is)j}^{(1)} - \sum_{s=1}^{2} S_{(is)j}^{(1)} p_{(is)j}^{(1)} \right] \qquad (12.23)$$

$$x_{(is)j}^{(2)} = y_j - \sigma_{ij}^{(2)} \left[p_{(is)j}^{(2)} - \sum_{s=1}^{2} S_{(is)j}^{(2)} p_{(is)j}^{(2)} \right] \qquad (13.4)$$

$$x_{(is)}^{(3)} = x_i^{(3)} - \sigma_i^{(3)} \left[p_{(is)}^{(3)} - \sum_{s=1}^{2} S_{(is)}^{(3)} p_{(is)}^{(3)} \right] \qquad (14.21)$$

where $i=1..g$, $j=1..h$, $s=1,2$.

For simplicity of exposition consider a pair of equations

$$x_{i1} = z - \sigma_i \left[p_{i1} - \sum_{s=1}^{2} S_{is} p_{is} \right]$$

and $$x_{i2} = z - \sigma_i \left[p_{i2} - \sum_{s=1}^{2} S_{is} p_{is} \right]$$

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1 Equation numbers of this form correspond to those in Dixon et al. (1982).

which describes the inputs of domestically produced goods (1) of type i and imported goods (2) of type i into one industry. Since the shares satisfy $S_{i1} + S_{i2} = 1$, these equations can also be written as

$$x_{i1} = z - \sigma_i S_{i2} \left(p_{i1} - p_{i2}\right) \quad (1a)$$

$$x_{i2} = z - \sigma_i S_{i1} \left(p_{i2} - p_{i1}\right) \quad (1b)$$

The corresponding equations in the aggregated system will be

$$x_1 = z - \sigma S_2 \left(p_1 - p_2\right) \quad (2a)$$

$$X_2 = z - \sigma S_1 \left(p_2 - p_1\right) \quad (2b)$$

The aim is to determine a value for σ in terms of the σ_i and any necessary input-output data. The method is described below.

Let the dollar value of inputs into the industry be denoted as D_i for domestic and M_i for imports so that $D_i = P_{i1}X_{i1}$ and $M_i = P_{i2}X_{i2}$.

Then, for the composite commodity, $D = \sum_{i \epsilon G} D_i$ (3)

and $M = \sum_{i \epsilon G} M_i$ (4)

where G is the set of commodities which are aggregated.

In differential form equation (3) becomes

$$d = \Sigma \frac{D_i}{D} d_i$$

or since $D = P_1 X_1$,

$$p_1 + x_1 = \sum \frac{Di}{D} \left[p_{i1} + x_{i1}\right]$$

Using equations (1a) and (2a) to replace x_{i1} and x_1 gives

$$p_1 + z - \sigma S_2 \left[p_1 - p_2\right] = \Sigma \frac{D_i}{D} \left[p_{i1} + z - \sigma_i S_{i2} \left[p_{i1} - p_{i2}\right]\right] \qquad (5)$$

To proceed further it is now necessary to make the rather heroic assumptions that $p_{i1} = p_1$ and $p_{i2} = p_2$. This means that the prices of the commodities making up the composite good experience equal percentage changes as does the price of the composite good.

It also implies that $p_{i1} - p_{i2} = p_1 - p_2$. Then, since $\Sigma D_i = D$, equation (5) reduces to

$$\sigma S_2 = \sum_{i \varepsilon G} \frac{D_i}{D} \sigma_i S_{i2} \qquad (6)$$

Using $S_2 = \dfrac{M}{M + D}$, $\quad \sigma = \dfrac{\sum_{i \varepsilon G} \sigma_i \dfrac{D_i}{D} \dfrac{M_i}{D_i + M_i}}{\dfrac{M}{D + M}}$

$$\sigma = \frac{\sum_{i \varepsilon G} \sigma_i \dfrac{D_i M_i}{D_i + M_i}}{\dfrac{DM}{D + M}} \qquad (7)$$

Starting from equation (4) and using equation (1b) will yield the same result. Equation (6) is equivalent to equation (A2.9) in Parmenter (1977).

Equation (7) demonstrates that the σ's should not be combined simply on the basis of either import shares or domestic production shares but rather on the basis of a combination of the two. The formula reveals a pleasing symmetry between domestic flows and import flows and is particularly interesting in that if it is written as $\sigma = \Sigma W_i \sigma_i$, then in general the weights do not sum to 1. Thus, even if the σ_i are equal, σ for the composite commodity can take a different value. However the W_i will sum to 1 if the import shares, S_{i2}, are all equal.

Consider a simple example for 3 goods, each with the same σ, say 2.4.

Good	D_i	M_i	$M_i + D_i$	$\frac{M_i D_i}{M_i+D_i}$	W_i	$W_i \sigma_i$
Good 1	\$100	0	100	0	0	0
Good 2	80	20	100	16	0.33	0.8
Good 3	60	40	100	24	0.50	1.2
	240	60	300	$\frac{MD}{M+D} = 48$		2.0

Hence σ for the composite good is 2.0 whereas σ for each of the individual goods was 2.4.

The expression for combining σ's should be applied separately to each industry in intermediate usage (each j in equation (12.23)), to each industry in investment and to household consumption. Hence it follows in the ORANI tradition of generating numerous elasticities from very little data.

For practical purposes the parameter file is designed to accommodate just one set of σ_i for each of the 3 broad types of usage. It is thus necessary to sum over all industries for each of intermediate usage and investment when forming M's and D's. The question arises as to whether there should be separate sets of σ's for each of intermediate usage, investment and household consumption, or whether the same set should be employed for all three types of usage. In the latter case the M's and D's would be formed by summing over all three types of usage. This choice may depend on the level of aggregation. For example, when a large number of commodities are combined there is less likelihood that the composite commodity will be used primarily for just one end-use. Hence in this case there are grounds for using different sets of σ_i's. It would be convenient if the computer program could compute σ's either way, according to the setting of a switch, and if it produced some diagnostic outputs for import shares, sales shares and W_i weights which would assist in making such a decision.

The method of summing M's and D's over different industries has yet to be defined. It is not allowed for in the pure theory of parameter aggregation. If the fiction that each commodity has just one end-use is believed, then the M's, D's and (M + D)'s can each be formed simply by summing over industries j. In the case of just one set of σ's for all types of usage the summation is over all three types of usage. This seems a reasonable procedure for practical purposes. The σ_i will be determined mainly by the dominant users and other users will be forced to accept this value.

Referring to equations (12.23), (13.4) and (14.21), users' decisions concerning changes in quantities of imports and domestically produced goods depend on purchasers' prices. It will be appreciated that the M's and D's in the aggregation formula refer to values at purchasers' prices. For the purpose of the derivation it was convenient to omit the superscripts which indicated that shares and prices were at purchasers' prices.

6. AGGREGATION OF RECIPROCAL EXPORT DEMAND ELASTICITIES γ_i

Although it is usual to use export demand elasticities, the present analysis will be in terms of γ_i, which is the reciprocal of the export demand elasticity. This is the parameter which has been used throughout the ORANI literature.

Thus

$$p^e_{(i1)} = -\gamma_i x^4_{(i1)} + f^e_{(i1)} \qquad (i=1,...g,) \qquad (15.2)$$

where $p^e_{(i1)}$ = fob foreign currency export price;

$x^{(4)}_{(i1)}$ = export demands;

$f^e_{(i1)}$ = shifts in foreign export demands.

The variables are in percentage change form. Values of γ_i are important only for the ORANI 'export' commodities.[1]

Written in levels, $E_i = p^e_{(i1)} X^{(4)}_{(i1)}$, where E_i is the foreign currency dollar value of exports for good i. Thus in percentage change form:

$$e_i = p^e_{(i1)} + x^{(4)}_{(i1)} \qquad (8)$$

Consider aggregation over the group of commodities defined by the commodity set G, Gi. Let E be the total value of exports for this set G. Then

$$E = \sum_{i \varepsilon G} E_i \qquad \text{or} \qquad e = \sum_{i \varepsilon G} W_i e_i \qquad (9)$$

where the W_i are foreign currency dollar value export shares defined by

$$W_i = \frac{E_i}{E}$$

Adding $x^{(4)}_{(i1)}$ to both sides of equation (9) gives

$$e_i = p^e_{(i1)} + x^{(4)}_{(i1)} = (1 - \gamma_i) x^{(4)}_{(i1)} + f^e_{(i1)} \qquad (10)$$

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1 See the discussion in Dixon et al. (1982) following equations (19.14) and (18.15). The variable $p^e(i1)$ is of relevance only for 'export' commodities.

A similar equation can be defined for the composite commodity

$$e = p^{e} + x^{(4)} = (i - \gamma)\, x^{(4)} + f^{e} \tag{11}$$

where the non-subscripted variables refer to the aggregated quantities. Substituting these expressions for e and e_i into equation (9) gives

$$(1 - \gamma)\, x^{(4)} + f^{e} = \sum_{i \varepsilon G} W_i\, (1 - \gamma_i)\, x^{(4)}_{(i1)} + \sum_{i \varepsilon G} W_i f^{e}\, (i1) \tag{12}$$

Equation 12 is exact. It contains no assumptions or approximations. However it does contain γ, $x^{(4)}$ and $f^{(e)}$ which were introduced in equation (11) and are not yet defined.

In order to derive simple results it will be assumed that:

- the shifts in export demands $f^{e}_{(i1)}$ are equal for all commodities in the set G, and equal to f^{e}. (If the $f^{e}_{(i1)}$ are not equal or approximately equal, then the aggregation may not be valid.) Hence f^{e} equals

  $\sum_{i \varepsilon G} W_i f^{e}\, (i1)$ so that equation (12) simplifies to

  $$(1 - \gamma)\, x^{(4)} = \sum_{i \varepsilon G} W_i\, (1 - \gamma_i)\, x^{(4)}_{(i1)} \tag{13}$$

- the percentage changes in the quantities of exports $x^{(4)}_{(i1)}$ are the same for all commodities in set G, and equal to $x^{(4)}$. Hence equation (13) simplifies to

  $$1 - \gamma = \sum_{i \varepsilon G} (1 - \gamma_i) \quad \text{or} \quad \gamma = \sum_{i \varepsilon G} W_i \gamma_i \tag{14}$$

where $W_i = \dfrac{Ei}{E} = \dfrac{P^{e}_{(i1)}\, x^{(4)}_{(i1)}}{\sum_{i \varepsilon G} P^{e}_{(i1)}\, x^{(4)}_{(i1)}}$

dollar value share within set G of exports accounted for by goods of type i,

$\sum_{i \varepsilon G} W_i = 1.$

Refering to ORANI equation (18.12), the product $P^{e}_{(i1)}\phi$, where ϕ is the exchange rate, is equal to the basic value price plus margins and export taxes associated with delivering the export goods fob. Since ϕ is a scalar, W_i can be written as

$$W_i = \frac{p^e_{(i1)} \phi \, x^{(4)}_{(i1)}}{\sum_{i \in G} p^e_{(i1)} \phi \, x^{(4)}_{(i1)}}$$

where $p^e_{(i1)} \phi \, x^{(4)}_{(i1)}$ is the sum of basic value, margin and commodity tax dollar value flows for exports of goods i, all of which are available in the ORANI input-output database.

What happens if the aggregation combines ORANI export commodities with ORANI non-export commodities? The quantity of exports $x^{(4)}_{(i1)}$ will be endogenous for the export commodities and exogenous for the non-export commodities. Hence the assumption of $x^{(4)} = x^{(4)}_{(i1)}$ is invalid. This illustrates the undesirability of combining export and non-export commodities.

John Fallon of the IAC has pointed out that the assumption that $x^{(4)}_{(i1)} = x^{(4)}$ is a special case. He has suggested that the aggregation formula $\frac{I}{\gamma} = \sum_{1} \frac{Wi}{\gamma i}$ is more appropriate. This formula can be derived from a different set of assumptions, namely that the shifts in foreign export demands $f^e_{(i1)}$ are all zero and that the world export prices all experience the same percentage change, so that $p^e_{(i1)} = p^e$. Starting from equation (9), $e = \sum_{i \in G} W_i e_i$

$$p^e + x^{(4)} = \sum_{i \in G} W_i \, (p^e_{(i1)} + x^{(4)}_{(i1)}).$$

Then because $f^e_{(i1)} = 0$, equation (15.2) becomes $x^{(4)}_{(i1)} = -\frac{p^e_{(i1)}}{\gamma_i}$

$$\text{Hence} \quad p^e - \frac{p^e}{\gamma} = \sum_{i \in G} W_i \, (p^e_{(i1)} - \frac{p^e_{(i1)}}{\gamma_i}$$

$$p^e(1 - \frac{1}{\gamma}) = \sum_{i \in G} W_i \, p^e_{(i1)} \, (1 - \frac{1}{\gamma_i})$$

If $p^e_{(i1)} = p^e$, then $1 - \frac{1}{\gamma} = \sum_{i \in G} W_i \, (1 - \frac{1}{\gamma_i})$

$$\text{or} \quad \frac{1}{\gamma} = \sum_{i \in G} \frac{W_i}{\gamma_i} \qquad (15)$$

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EXPORT DEMAND ELASTICITIES FOR AUSTRALIAN LIVESTOCK PRODUCTS

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1. INTRODUCTION

The purpose of this paper is to present and discuss some empirical estimates of the export demand elasticities for three livestock commodities - wool, mutton and beef. With the exception of that for US beef, all the estimates were obtained from single equation OLS regression of annual data on export quantities, domestic Australian prices and some shift variables. The US estimate was calculated using parameters from two equations - one representing US demand for total imports and the other representing Australia's share of those imports. The estimates are listed in Table 1.

The equations all belong to the EMABA (Econometric Model of Broadacre Agriculture) model which is partially documented in Dewbre, Shaw and Corra (1983).

Without exception the elasticity results in Table 1 are smaller (in the case of beef very much smaller) than those reported in previous analyses and comparable estimates used in the ORANI model. There are several explanations for this apparent discrepancy. First, the limitation of the statistical technique (single equation OLS) has been shown to result in downward bias of empirical estimates of trade elasticities. (The basic statistical argument was put by Orcutt (1950) together with supporting non-statistical arguments. Magee (1970) presents an alternative view.) Second, most other reported export demand elasticity estimates have been obtained by inference from assumptions about 'rest of world' long run demand and supply elasticities. Those reported in Table 1 obviously relate to a response period of only one year. Third, inferential estimates have usually taken incomplete account of imperfections in price transmission between trading countries. Cronin (1979) discusses this problem concisely. Finally, most previous conclusions about magnitudes of export demand elasticities have been based upon assumptions of homogeneity of products in trade - an assumption which has been challenged in recent literature related to modelling agricultural trade flows (Grennes, Johnson and Thursby (1978) and in several related articles).

This last issue will be emphasised in the discussion of individual commodity export demand elasticities which follows. In particular, the implications of relaxing homogeneity assumptions for the usual calculations of export demand elasticities, market shares and price elasticities of supply and demand are explored.

2. WOOL

Few studies have reported directly estimated elasticities of export demand for Australian wool. As is the case with most agricultural commodities, such elasticities are calculated from reported estimates of 'rest of world' wool consumption demand and supply elasticities.

Almost all of the reported estimates of price elasticities of consumption demand for wool fall in the relatively narrow range of -0.2 to -0.5. Reported supply elasticity estimates (long run) fall within a slightly greater range 0.2 to 0.8. An extensive review of previous estimates of wool supply and demand elasticities is provided by Freebairn (1978). The estimates reported in the Freebairn paper place the Australian wool supply elasticity at the lower end of this range (0.2).

Under the assumption that wool price changes are transmitted perfectly between countries which buy or sell wool, the elasticity of demand for Australian wool can be expressed as:

$$E_{A,w} = (\eta_w - (1-M_A)\epsilon_w)\frac{1}{M_A}$$

where,

$E_{A,w}$ = export demand elasticity for Australian wool;
M_A = share of total rest of world wool consumption supplied by Australia;
η_w = rest of world consumption demand elasticity; and
ϵ_w = rest of world supply elasticity.

The analysis commences with the usual homogeneous product assumptions. Australia supplies roughly 25 per cent of total rest of world wool consumption, ie $M_A = .25$. Under the presumption that the aggregate category of wool consumption represents a combination of wool types which are substitutes for one another, the demand and supply elasticities for this aggregate are probably at the lower ends of the ranges reported for particular wool categories, ie $\eta_w = -.2$, $\epsilon_w = .2$. The calculated elasticity of wool demand under these assumptions is thus:

$$E_{A,w} = (-.2 - (1-.25)\ .2)\frac{1}{.25}$$

$$= -1.4.$$

This figure is consistent with the lower range of estimates reported by Freebairn and with those used in ORANI.

Clearly however, Australian wool, which is used almost exclusively in apparel end uses, should be distinguished in the first instance from wool types which do not substitute in this market. Australian wool accounts for roughly 40 per cent of total rest of world apparel wool consumption, ie $M_A = .4$. Eliminating wool types which do not effectively compete with apparel wools in consumption should leave consumption demand elasticities unaffected (assuming that own-price elasticities of demand for apparel and non-apparel wools are roughly equal). However it seems likely that supply substitution possibilities are increased somewhat when we restrict our attention to less aggregate categories (ie producers can more easily shift between apparel and non-apparel wool production in response to those same price changes). If we choose therefore the mid-point of the reported range of supply elasticities, the expression for the export elasticity of apparel wool demand becomes:

$$E_{A,w} = (-.2 - (1-.4)\ .5)\frac{1}{.4} = -1.25$$

But all apparel wools are not the same. Australian apparel wool is used mainly in end products requiring finer wool types produced mainly from Merino sheep. Australia produces roughly 80 per cent of total Merino wool consumed in the rest of the world, ie $M_A = .8$. In this case it cannot be safely assumed that consumption demand elasticities remain unaffected by the exclusion of non-merino apparel wools from the aggregate as these wool types do in fact substitute in some end uses for Merino wool types. In this example, the value of the consumption demand elasticity should be chosen from the middle of the reported range ($-\eta_v = -.35$) and for reasons cited previously the supply elasticity should be higher ($-\varepsilon_w = .7$). Recalculating the export demand elasticity:

$$E_A = (-.35 - (1-.8)\ .7)\ \frac{1}{.8} = -.65$$

This estimate is consistent with results reported in Table 1.

One more case is examined. The differentiated product models of Armington (1969) and Johnson et al. (1979) are based on the assumption that products are differentiated by country of origin. For wool this is not an implausible assumption. Australian wool typically commands a substantial price premium over competing wools from other countries - it is distinguished technically because of higher yields and better product description and in non-technical ways (a principal argument used for differentiated product models) by, inter alia, marketing support provided by the Australian Wool Corporation. In the latter extreme case the market share of Australia is obviously 1.0. Consumption demand elasticity however is surely higher than in any of the previous cases as substituting wool types have again been eliminated from the aggregate. If the highest of the reported range of elasticities is chosen as the estimate (probably still an under-estimate) the expression for the export demand elasticity becomes:

$$E_A = (-.5\ (1-1)\ \varepsilon_w)\ 1 = -.5$$

ie the export demand elasticity is equal to the rest of world consumption demand elasticity.

3. BEEF

The export market for Australian beef is affected by import policy intervention to a much greater extent than for other export commodities. Both of Australia's major individual country markets - the US and Japan - regulate imports with quotas and other importing countries exert some form of policy control on the beef trade. For purposes of assessing export demand elasticities, researchers have usually categorised Australian beef export markets into two groups - those which are assumed to be totally unresponsive to price - the quota markets - and those which, despite some intervention, exhibit a degree of responsiveness to price.

3.1 Non-Quota Markets

Several inferential estimates of the aggregate export demand elasticity for beef in this latter market category have been reported. All have been very high, ranging from lows of around -10 to highs of around -100 (Fallon, 1982). Two direct estimates of this elasticity have been reported - Reeves, Longmire and Reynolds (1980) report an estimate based on regression of a price dependent export demand equation of approximately -11.0, while Freebairn and Gruen (1977) report an estimate of -1.25, virtually the same as was obtained in the present analysis.

No analytical effort has been expended to date on trying to reconcile the disparity in these estimates of the 'other markets' export demand elasticity. The statistical analyses supporting direct estimates have been adhoc and cursory in every case. Furthermore little progress is likely to be made without disaggregating by country and by category of beef exports.

3.2 Quota Markets

In this paper, the precedent set by previous researchers in assuming that quantities of beef exported to Japan are unresponsive to price has been continued. However there is a break with tradition in the treatment of the US market. Most previous researchers, eg Freebairn and Gruen (1977) and Reeves, Longmire and Reynolds (1980). have argued that since beef imports by the US have been determined either directly by the quota or under the threat of quota imposition, it could be safely assumed that import demand was insensitive to price variation. The price elasticity of US import demand for Australian beef estimated in this paper has employed data for periods during which the quota was technically off. It is argued that the influence of the 'threat of quota imposition' during those periods simply operates to modify the degree of price responsiveness, but not to eliminate it altogether. What this means is that the US export demand for imports function is discontinuous. Shifts in supply or demand which occur in a range outside quota restraints cause price changes according to some non-zero elasticity. However supply or demand variations which occur within the range where quotas are binding yield no variation in price, ie a zero elasticity.

An additional aspect of US price responsiveness is based on the same product differentiation arguments sketched previously in relation to wool. The estimate of the US export demand elasticity reported in Table 1 is based on the assumption that the beef product which Australia ships to the US is differentiated, not merely from the aggregate total US beef market, but also from the particular domestic US product - processing beef - with which it competes directly. This assumption stems from the fact that the products are technically distinguishable. Imported beef is a frozen product while the domestic product is virtually all purchased in fresh form. Further, imported beef is a much leaner product - 80-90 per cent chemical lean - in contrast to a 50 per cent chemical lean domestic product (Harrison and Teasdale, 1983). Existing marketing arrangements, in part the consequence of the operation of the quota, have also resulted in an implicit non-technical differentiation of Australian beef. Finally, beef supplied from hoof and mouth disease free areas is distinguished from beef supplied by countries where that disease exists.

Whatever its merits the differentiated product assumption yields estimates of the beef export demand elasticity which are much lower than would otherwise be obtained. For example, the inferential estimate of the US export demand elasticity based on the same data set as that used to calculate the Table 1 value, but on the assumption that US cow beef and imported beef are perfect substitutes. is -4.5.

4. MUTTON

While the value of the export demand elasticity for mutton reported in Table 1 (-2.5) is the highest of the estimates reported in the table, it is still much lower than inferential estimates (ranging from -4 to -20) reported elsewhere (Freebairn, 1979). (Most other reported estimates relate to total sheep meat but since the overwhelming share of total Australian sheep meat exports are mutton, the comparability should not be affected much.) No other direct estimates of this elasticity have been reported. The estimates in the table suffer from the same inadequacies of statistical technique as the 'other markets' beef estimate. However most Australian mutton exports are shipped to a single country - Japan - and thus the deficiencies could be more easily remedied here than in the case of 'other markets' beef

5. SUMMARY

The directly estimated livestock product export demand elasticities which are reported here are much lower than those based on inference from rest-of-world supply and demand elasticities. While inadequacies of statistical technique and the time frame of reference explain some of the disparity, a much stronger argument can be put in terms of the differentiated product nature of Australian export commodities. Additional research work is necessary to disaggregate and analyse export data by country and by product sub-groupings.

TABLE 1 : EXPORT DEMAND ELASTICITIES FOR AUSTRALIAN LIVESTOCK COMMODITIES

Commodity		Elasticity
Wool		-0.6 to -0.8
Beef		
	US	-1.0 <u>or</u> 0
	Japan	0
	Other markets	-1.3
Mutton		-2.4

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DISCUSSION

Discussion - Dr Robert Dixon (Melbourne University)

Dr Dixon commenced his discussion with the observation that the Workshop had not achieved a great deal and asked, 'Where do we go from here?' He observed that the ORANI parameters allow for too much or too fast a response. The Workshop had begun by considering the question: 'Does it matter - can we narrow down the number of areas where parameter values should be refined?'

The paper by Dr Pagan was very important here giving a sensible and creative approach. The work by Dixon et al. is no substitute for this type of approach.

There was often no independence between elasticities.

There was a clear need to explain individual discrepancies. There had been various assertions throughout the day concerning:

- aggregation;
- heterogeneity;
- data sets; and
- estimation/technique/specification bias.

Problems and creative possibilities arise in the area of appropriate databases and the cost effectiveness of research efforts.

Questions also arise about the derivation of key coefficients. ORANI provides a good method of derivation but how often should estimates of the key coefficients be revised?

In the area of estimation techniques Dr Dixon expressed surprise that there wasn't more emphasis on the problems of time series estimation. Estimates are invariably sensitive to model specification and in the end the researcher has to be very brave to support the numbers.

Dr Dixon listed several problems with the ORANI model which hadn't been discussed:

- the model assumes symmetrical responses;
- the short run and long run are ill-defined; and
- fixed elasticities independent of the state of the economy may be misleading.

In particular the short and long run assumed by these estimating elasticities may not correspond to the short run and long run of ORANI users.

Discussion - Dr Albert Schweinberger (Australian National University)

Dr Schweinberger observed that there are still people who believe in true elasticities. In fact an elasticity only acquires a meaning in a formal model and every model is subject to certain assumptions. There will always be debate unless one clearly identifies the assumptions.

The long run and short run debate is identical to the 'J' curve problem in Balance of Payments analysis - the short term response is well known to be very different from the long term response.

Dr Schweinberger said that it was not jingoistic to distinguish between national and aggregate (world) welfare.

The problem of adjustment costs was worthy of special attention. Participants were referred to an important article by Leamer in the Journal of International Economics (1980, 10, pp. 21-36). This article took a neoclassical viewpoint which should be attractive to the IAC.

Dr Schweinberger said that he found the Freebairn approach interesting for a number of reasons:

- income variables were left in;
- agents in other countries are quantity constrained in their labour markets; and
- there was no distinction between nominal and effective demands.

On the elasticities themselves, Dr Schweinberger drew attention to the duality approach. For example, if you wish to estimate an elasticity of substitution in demand you would:

- derive two Roy's identities; and
- get a well specified demand function.

In commenting on the existing elasticities Dr Schweinberger said it appeared that homothetic preferences were assumed yet there were non-zero income elasticities and the proposition was refuted by the data. He expressed an interest in homothetic preferences in the context of expanding aggregate demand in Australia.

Dr Schweinberger concluded by noting the contrast between the residual (synthetic) approach and the modelling approach, the latter involving the derivation of a supply curve for the exported (not exportable) good.

Open discussion

Mr Parmenter responded to Dr Schweinberger's comment on homothetic preferences. He said that the system was commodity based and the same demand elasticity was assumed for domestically produced and imported cars.

Dr Alaouze maintained that broad movements are observed and that there were two ways of looking at them:

- as production or consumption; or
- just as a functional form.

Dr Alaouze said that he was unsure about the possibility of testing the income elasticity assumptions. Dr Schweinberger added that he had serious reservations.

Dr Pagan said surely the focus was on relative price changes.

Mr Merchan asked about the possibility of applying more sophisticated estimation procedures.

Dr Alaouze said he would welcome such work. He had some mild criticism of the IAC for not releasing the relevant data on import substitution. He questioned however, the value of adding a real income term or additional variables because it would not be possible to identify what would be picked up.

Mr Cronin asked Dr Alaouze why the domestic price was independent of the import price in his econometric analysis, but not so in ORANI simulations.

Dr Pagan said the Alaouze Marsden Zeitsch paper was quite good at the time it was done. They had gone to a lot of trouble in some aspects but didn't model income effects. He agreed partly with this assumption at the level of aggregation at which the analysis was attempted.

Mrs Walker said that Richardson had found the assumptions were quite reasonable at a low level of aggregation.

Dr Alaouze said that he was not convinced that an income term would pick up anything meaningful.

Dr Schweinberger said that this was totally at variance with the state of the art in demand analysis.

Mr Cronin said that the sigmas were firmer than other numbers in the ORANI parameter file, since they were partly based on econometric estimation. However, there were a number of problems, not the least being subsequent doubts about the reliability of the import price indexes used in the analysis. Mr Cronin speculated that the data base had not been released because it was too 'shonky'. Mrs Walker agreed that this may be the case.

Mr Cronin listed a number of shortcomings which he claimed cast doubt on the sigma estimates:

- the prime series were subject to compositional bias because of quality changes over the period;
- superior import price estimates now available on an annual basis were at odds with the quarterly data used in the analysis;
- the simultaneity problem, (domestic prices not independent of import prices);

- the aggregation of competing and non-competing imports;

- the aggregation of goods such as motor vehicles and components, the former being substitutes and the latter complements to local production; and

- the highly restrictive lag structure (order times were not the only issue, lead times can be much longer).

Mrs Walker said that she had re-estimated four of the Alaouze Marsden Zeitsch equations with different lag structures and found that the different structures did not significantly affect the results.

Mr Cronin asked whether adaptive expectations were significant. A tariff cut is a long run signal whereas an exchange rate change is treated by economic agents as a stochastic event. He added that some of these problems could not be tackled across-the-board. Industry-specific research, taking account of the characteristics of particular product markets, would be preferable. Such research was probably inhibited in the IAC by the tendency to use the ORANI model instead.

Mr Tillack asked whether Dr Pagan's treatment of individual coefficients as separate parameters was strictly valid.

Dr Sutton asked why it would be useful to estimate elasticities with different equations than those contained in the ORANI model.

Mr Cronin replied that it was not conducive to good empirical research to let the prior restrictive structure of the model dictate the econometrics.

Dr Pagan suggested that when the IAC performs an application it should be addressed to different scenarios such as those presented at the Economic Summit.

Mr Cronin further suggested that the ORANI mining story be exposed to the scrutiny of the mining industry, since no mining industry economist had made an input to this Workshop.