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MODELLING THE EFFECTS OF ECONOMY-WIDE SHOCKS ON A STATE ECONOMY IN A FEDERAL SYSTEM — A hybrid of the top-down and bottom-up approaches to regional modelling

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Peter J. Higgs, B.R. Parmenter and Russell J. Rimmer*

I. INTRODUCTION

In the Australian system of government, issues of economic policy are often the subject of negotiation between State and Federal governments. Moreover, State governments regularly intervene at public hearings of bodies such as the Conciliation and Arbitration Commission (a wage fixing tribunal) and the Industries Assistance Commission (which advises the Federal Government on tariff protection policy). This system has created a strong demand for information about the effects at the State level of national economic policy. Researchers associated with the IMPACT Project[1] have developed economic models capable of meeting this demand. Dixon, Parmenter and Sutton (1978) and Dixon, Parmenter, Sutton and Vincent (1982, chapters 6 and 7) (hereafter DPSV), have reported State-level results generated from the Project's economy-wide model (ORANI) by a tops-down regional disaggregation method similar to that pioneered by Leontief, Morgan, Polenske, Simpson and Tower (1965) (hereafter LMPST). The ORANI-LMPST method accounts for differences in the industrial structures of the States and allows the introduction of State income-consumption multipliers, but it explains the intranational geographical allocation of activity within an industry only for cases in which the geographical pattern of demand is the crucial factor, i.e., for industries producing commodities which are not traded between the States. Liew (1981) has experimented with the more ambitious approach of modelling sectoral activity explicitly at the State level, with economy-wide results generated as explicit aggregations of the State-level results. This multisectoral, multiregional method is very demanding in terms of both data and computing.[2]

In this paper, we describe a method which produces projections for a single State. It avoids the practical problems of complete multiregional, multisectoral modelling but is more reliable than ORANI-LMPST because it incorporates more State-specific data. The formal structure of the ORANI-LMPST procedure is retained but the standard version of ORANI is replaced with a version which distinguishes in the economy-wide framework a number of geographically defined industries. Such a State-specific version of the model could be built for any State. We have implemented the method with Tasmanian data.[3]

The rest of the paper is organized as follows. An outline of the theoretical structure of the proposed method is given in section II. First we sketch the ORANI-LMPST procedure. Then we describe the Tasmanian version of ORANI (called ORANI-TAS) and indicate how its use can be expected to improve Tasmanian projections generated via LMPST. The data requirements of ORANI-TAS are discussed in section III. Results of a simulation of the short-run effects of an across-the-board tariff change are presented in section IV. Section V contains concluding remarks and suggestions for further developments of the IMPACT regional modelling methods.

II. THE THEORETICAL STRUCTURE OF THE MODELLING METHOD

II.1 The structure of the ORANI-LMPST procedure

ORANI is a model of the Australian economy in the tradition pioneered by Johansen (1960)[4]. It is sectorally, but not regionally disaggregated. Economic activity is modelled via the conventional optimizing assumptions of neoclassical microeconomics. Thus domestic producers and investors are assumed to choose their produced and primary inputs to minimize costs subject to technological constraints. Output mixes are chosen to maximize revenue subject to production possibility constraints. Households maximize utility subject to a budget constraint. Imports are treated as imperfect substitutes for domestic commodities of the same commodity class. Exports of the economy's major export commodities are endogenous. All economic agents are assumed to be price takers, and domestic prices are set equal to unit costs so that no activity earns pure profits. Macroeconomic magnitudes (aggregate employment, the balance of trade, various price indexes, etc.) are computed as explicit aggregations of microeconomic variables. The model has been implemented using Australian data which distinguish 113 industries, 115 commodity categories and 9 occupational categories of labour.

The key assumption of the LMPST method which is used to disaggregate economy-wide results from ORANI to a State basis is that the industries which are distinguished in the economy-wide model can be allocated to two non-overlapping groups : "national" industries the products of which can be traded freely between regions, and "local" industries producing goods which are not subject to inter-regional trade.

For the "local" industries, regional demand is crucial in determining regional output. For "national" industries, the geographical pattern of production is assumed to be independent of the geographical pattern of demand. This dichotomy is very powerful in reducing the data requirements of the regional disaggregation. Because of the geographical distribution of population within the Australian States, it is particularly appropriate for State analysis of the Australian economy.[5]

An ORANI-LMPST solution for the effects on State r of an economy-wide economic disturbance entails a 3-stage computation (DPSV, chapter 6). First, ORANI is solved for the economy-wide results, i.e., for projections of the percentage effects on its endogenous variables of the shock under investigation. The ORANI solution can be represented as

$$z^{ew} = Ay^{ew} , \qquad (1)$$

where z^{ew} and y^{ew} are vectors of the model's endogenous and exogenous variables. In levels of the variables, ORANI is a non-linear model, mainly because of the opportunities allowed for economic agents to modify their behavior in response to relative prices. Following Johansen (1960) it is solved as a linear system in the percentage changes of the variables (DPSV, chapter 5). The matrix A in equation (1) hence contains the elasticities of the endogenous with respect to the exogenous variables. The user of ORANI has a great deal of flexibility in partitioning the variables into exogenous and endogenous sets, but the endogenous variables will usually include economy-wide output and employment in each of the model's industries.

The second stage of the 3-stage computation is the allocation to the State level of the economy-wide output changes for the "national" industries. The model's theory does not explain the geographical distribution of output in these industries. An obvious rule to use for this allocation is that for each "national" industry the shares of the States in total output remain constant at base-period values.[6] This implies

$$z^r_N = z^{ew}_N, \qquad (2)$$

where z^{ew}_N is a subvector of z^{ew} containing projected percentage changes in the economy-wide output levels of "national" industries and z^r_N is a vector containing projections of output changes for these industries in State r. State projections of the output changes for the "national" industries are required both as an element in the aggregate impact of the shock on the State economy and because intermediate demands by "national" industries contribute to aggregate demand for the output of the State's "local" industries.

In stage 3 of the ORANI-LMPST package a State commodity-balance equation is used to solve for the outputs of the State's "local" industries required to satisfy intermediate and final demands in the State. This can be represented by

$$z^r_L = (I-B^r_L)^{-1} \quad (B^r_N \, z^r_N + d^r_L), \qquad (3)$$

where z^r_L is a vector of percentage changes in the outputs of "local" industries in State r and $d^r{}_L$ is a vector combining those elements of final demand for the output of "local" industries in State r which are independent of the output changes of the State's industries. The matrices $B^r{}_L$ and $B^r{}_N$ are built up from the shares of "local" industry outputs accounted for by uses explainable as functions of the State outputs of "local" and "national" industries.[7] The State final demand vector ($d^r{}_L$) is itself computed from the results of the ORANI computation.

Together, equations (2) and (3) give projections of percentage output changes for all industries in State r. These projections can be used to calculate implied percentage changes in gross State product and aggregate State employment (see DPSV, subsection 45.3).

II.2 A prototype State version of ORANI : ORANI-TAS

ORANI-TAS is a Tasmanian version of ORANI which can replace the standard version of ORANI at stage one of the ORANI-LMPST procedure to produce projections of the effects of economy-wide shocks on the Tasmanian economy which are more reliable than the projections given by the standard ORANI-LMPST package. In the standard version of ORANI most of the industrial categories are defined according to conventional input-output criteria, that is, on the basis of the type of commodity which the industry produces. Exceptions are in the agricultural sector, where industries have been defined on a climate-related, geographical basis and modelled as producing mixes of conventionally defined agricultural commodities (DPSV, subsection 28.2.1). Each agricultural commodity is treated as a homogeneous product even if it is produced in more than one geographical zone[8]. The prototype version of ORANI-TAS requires no modifications to the standard ORANI theory, it just exploits further the scope for recognizing geographically defined industries in the data base. Tasmanian data are used to identify some Tasmanian industries which might have characteristics (cost structures, for example) different from those of the corresponding industries in the rest of the economy. In contrast to the assumption used for agriculture in ORANI, the commodities produced by a Tasmanian industry in ORANI-TAS and the products of the equivalent industry in the rest of the economy are treated as different commodities with individual sales patterns. This idea of modelling commodities of the same type, but from different (intranational) sources, as distinct commodities is a straightforward extension of ORANI's treatment (following Armington, 1969, 1970) of imported and domestically produced commodities.[9] For computing convenience we have assumed that only household users can substitute directly between the two domestic sources of any commodity.[10] Industrial and government users must draw their supplies in fixed proportions.

ORANI-TAS can be used to produce projections of the effects of shocks on all industries at the economy-wide level, and separate projections of the Tasmanian and mainland effects in the selection of industries for which Tasmanian data have been introduced. Clearly, the distinction of separate Tasmanian and mainland components of an industry in the model will be worthwhile only when those aspects of the standard ORANI theory which determine the relative responses of industries to shocks can be expected to throw some light on geographical differences in output changes in the industry. Differences in technology are one important factor. These determine the relative changes in industries' price/cost ratios caused by price and wage changes in the economy, and industries' relative responses to such changes. Differences in sales patterns among domestic users, and more crucially between domestic and overseas sales, are another cause of inter-industry variation in ORANI projections. If the intranational location of demand is an important factor in locating output changes (i.e., if inter-regional trade is restricted), then geographical definitions for industries will not be useful since the geographical demand pattern is not modelled in the economy-wide model, i.e., at stage one of the ORANI-LMPST (or ORANI-TAS-LMPST) procedure. It is however modelled at stage three of the procedure and used to determine the geographical pattern of output for "local" industries (cf. equation (3)). Thus it is clear that the

Tasmanian industries selected for explicit treatment in ORANI-TAS must all be industries which are classified as "national" in the ORANI-TAS-LMPST package. Otherwise the package would contain competing explanations of the Tasmanian output level for some industries; one at stage one of the package in ORANI-TAS itself, and another at stage three in the modified LMPST solution.

II.3 Tasmanian projections from ORANI-TAS-LMPST

When the LMPST method is used in conjunction with an economy-wide model like ORANI which, with the exception of agriculture, does not include geographically defined industries, the necessity of making (at stage two) essentially exogenous State allocations of the output projections for the "national" industries is a major weakness. This allocation is, however, not a problem for "national" industries which are already defined on a State basis in the economy-wide model, such as the Tasmanian industries distinguished in ORANI-TAS. Changes in the geographical pattern of output in the relevant industries are already incapsulated in the $z^{ew}{}_{N}$, projected by ORANI-TAS. Equation (2) is then quite appropriate - all it does is transfer into the modified LMPST solution (equation (3)) the Tasmanian output change determined in ORANI-TAS.[11] ORANI-TAS-LMPST will produce reliable projections for Tasmania which are superior to those from ORANI-LMPST to the extent that the main Tasmanian "national" industries are distinguished in ORANI-TAS, and to the extent that the model's theory is capable of explaining State differences in output responses within those "national" industries.

III. DATA REQUIREMENTS

The data used for the standard version of ORANI and for the LMPST disaggregation method are fully described in DPSV (chapter 4 and section 40). In this section we outline the mobilization of the Tasmanian data for ORANI-TAS.[12]

III.1 Input-output data

The core of the data base for any version of ORANI is an extended set of input-output accounts, the general format of which is illustrated in Figure 1. Flows of imported commodities are shown in separate matrices from the flows of the equivalent domestically produced commodities. As well, the usage of commodities (e.g., trade and transport services) as margins services to facilitate commodity flows between domestic producers (or importers) and users is shown separately from the direct usage. Apart from these extensions, Figure 1 has a form similar to that of a conventional input-output table. The columns show industries' cost structures or the commodity composition of final demand. The rows show the usage patterns of commodities or primary factors. Matrix $\tilde{Y}$ is a make matrix showing the product mixes of domestic industries.[13]

The input-output data base for ORANI-TAS is a straightforward modification of the standard ORANI data. First, the Tasmanian industries which are required to be shown explicitly in the model were chosen. Secondly, the data describing the economy-wide industries into which the selected Tasmanian industries are aggregated in the standard

			Final Demands				
		Domestic industries (current production)	Domestic industries (capital formation)	Household cons'n	Exports	Other	
		$\longleftarrow h \longrightarrow$	$\longleftarrow h \longrightarrow$	$\longleftarrow 1 \longrightarrow$	$\longleftarrow 1 \longrightarrow$	$\longleftarrow 1 \longrightarrow$	
Domestic commodities	g	$\tilde{A}$	$\tilde{B}$	$\tilde{C}$	$\tilde{D}$	$\tilde{E}$	Row sums = total direct usage of domestic commodities
Imports	g	$\tilde{F}$	$\tilde{G}$	$\tilde{H}$	$\underline{\underline{0}}$	$\tilde{J}$	- Duty - $\tilde{Z}$ Rows sums = total imports (c.i.f.)
Margin type 1: on domestic flows	g	$\tilde{K}_1$	$\tilde{L}_1$	$\tilde{M}_1$	$\tilde{N}_1$	$\tilde{O}_1$	Row sums = total margin (type 1) on sales of each domestic commodity
Margin type 1: on imports flows	g	$\tilde{P}_1$	$\tilde{Q}_1$	$\tilde{R}_1$	$\underline{\underline{0}}$	$\tilde{T}_1$	Row sums = total margin (type 1) on sales of each imported commodity
Continues through margin types 2 to g							
Margin type g+1 (tax): on domestic flows	g	$\tilde{K}_{g+1}$	$\tilde{L}_{g+1}$	$\tilde{M}_{g+1}$	$\tilde{N}_{g+1}$	$\tilde{O}_{g+1}$	Row sums = total tax on sales of each domestic commodity
Margin type g+1 (tax): on imports flows	g	$\tilde{P}_{g+1}$	$\tilde{Q}_{g+1}$	$\tilde{R}_{g+1}$	$\underline{\underline{0}}$	$\tilde{T}_{g+1}$	Row sums = total tax on sales of each imported commodity
Primary inputs: Labor	M	$\tilde{U}$	$\underline{\underline{0}}$	$\underline{\underline{0}}$	$\underline{\underline{0}}$	$\underline{\underline{0}}$	
Primary inputs: Capital	1	$\tilde{V}$					
Primary inputs: Land	1	$\tilde{W}$					
Other costs	1	$\tilde{X}$					
		Column sums = outputs of domestic industries at basic values	Column sums = investment expenditure by each industry	Column sums = total household expenditure	Column sums = total exports	Column sums = total "other" final demand	

Domestic commodities	g: $\tilde{Y}$ (Product-mix matrix)	Row sums = domestic output by commodity
	Column sums (of $\tilde{Y}$) = output by industry	

FIGURE 1: Input-Output Data Base for ORANI[(a)]

(a) For the standard version of ORANI, and for ORANI-TAS, the dimensions of the data matrices are : g(the number of commodities) = 115, h (the number of industries) = 113, M (the number of occupations) = 9.
Source - Reproduced from DPSV Figure 25.1.

data base were split into the mainland and Tasmanian components. Finally, in order not to alter the overall dimensions of the data, aggregations of industries in the tertiary sector were made so that the numbers of industries and commodities distinguished in ORANI-TAS are the same as the numbers distinguished in the standard version of ORANI.[14]

In principle, we could use Tasmanian input-output data to separate all "national" industries in ORANI into their Tasmanian and mainland components. However, the payoff from disaggregation will be lower the more similar is the Tasmanian industry to its mainland equivalent, and the smaller is the industry as a share of the Tasmanian economy. In the first case, there will be nothing in the economy-wide model to cause the Tasmanian industry to react differently from the economy-wide industry to an economy-wide shock.[15] We will do just as well, therefore, by assuming that Tasmania retains a constant share in the industry's economy-wide output (cf. equation (2)). In the second case, the impact of an economic disturbance on the Tasmanian economy as a whole depends very little on the response of the particular Tasmanian industry.

Table 1 contains a list of the 6 Tasmanian industries which are distinguished in ORANI-TAS. Each was chosen because it differs sharply from the mainland equivalent either in its degree of export orientation (sales pattern) or in its labour intensity (technology). The relevant Tasmania-mainland comparisons are shown in the table, and also the shares of the industries in the aggregate value added of Tasmanian "national" industries. Together the six industries account for about 36 per cent of this aggregate value added.

TABLE 1 : TASMANIAN INDUSTRIES DISTINGUISHED IN ORANI-TAS AND THE CRITERIA USED FOR THEIR SELECTION[a]

Tasmanian Industries Distinguished in ORANI-TAS	Share in the Aggregate Value Added of Tasmanian "National" Industries	Share of Exports in Value of Total Output		Share of Labour in Total Primary-Factor Costs	
		Tasmanian Industry	Equivalent Mainland Industry	Tasmanian Industry	Equivalent Mainland Industry
Other farming export	0.02	0.60	0.11	0.66	0.42
Fishing	0.01	0.27	0.52	0.59	0.52
Metallic minerals[b]	0.12	0.07	Iron 0.65 Other metallic minerals 0.37	0.49	Iron 0.13 Other metallic minerals 0.48
Milk products	0.01	0.23	0.11	0.70	0.62
Pulp, paper	0.09	0.05	0.01	0.59	0.91
Basic metal products[c]	0.11	0.33	Basic iron and steel 0.13 Other basic metals 0.29	0.50	Basic iron and steel 0.63 Other basic metals 0.53

a) Data used refer to 1968/69 and were derived from the standard ORANI data base (DPSV, chapter 4) and Edwards (1977).

b) Under our classifications the Tasmanian Metallic minerals industry contains both Iron and Other metallic minerals.

c) Under our classifications the Tasmanian Basic metal products industry contains both Basic Iron and Steel and Other basic metals.

The main data source used in splitting the Tasmanian industries listed in Table 1 from their economy-wide aggregates is an input-output table of the Tasmanian economy compiled by Edwards (1977). This provided detailed data, at the forty-five sector level, on the flows of Tasmanian commodities to Tasmanian industries and to Tasmanian final demand. It also gave the aggregate imports from interstate and from overseas allocated directly to Tasmanian users, and the aggregate flows of each Tasmanian commodity to the mainland. It did not provide a detailed disaggregation of these interstate flows. It was necessary to use other information to :

(i) expand the relevant rows and columns of Edwards' input-output table to ORANI's dimensions of 115 commodities by 113 industries;

(ii) disaggregate by commodity type imports from the mainland to the Tasmanian users;

(iii) allocate the sales of the Tasmanian commodities to the mainland users;

(iv) disaggregate by commodity type the overseas imports to Tasmanian users; and

(v) separate margin flows from direct flows of commodities. (These are aggregated in Edwards' tables which employ the basic value convention).

When implementing steps (i) to (v) above we made judgements based on information from various publications of the Tasmanian office of the Australian Bureau of Statistics, from the 1977/78 Tasmanian input-output tables (see Edwards <u>et al.</u> (1981)), and from ORANI's economy-wide data base.[16]

III. 2 Parameters

Versions of ORANI require a number of econometrically estimated parameters (substitution parameters, etc. : see DPSV, sections 26 and 29). At this stage no new work has been done on estimating values for these for the Tasmanian industries distinguished in ORANI-TAS. In conducting the simulations reported in section IV, we used for the split Tasmanian and mainland industries the same parameter values as are used for the equivalent economy-wide industries in the standard ORANI data base (see DPSV, section 29).

IV. RESULTS: THE EFFECTS ON THE AUSTRALIAN AND TASMANIAN ECONOMIES OF A 25 PER CENT ACROSS-THE-BOARD INCREASE IN ALL TARIFF RATES

In this section we present some results from an ORANI-TAS-LMPST simulation of the short-run effects on Tasmania and on Australia as a whole of a general increase in the levels of protection against imports enjoyed by domestic industries. Real wage levels and the levels of aggregate real domestic consumption, investment and government spending are assumed not to be affected by the increase.[17] A detailed analysis of the economy-wide and State results of the general tariff increase, under the same assumptions but derived using the standard ORANI-LMPST package, is provided in DPSV, chapter 7. Here we concentrate on the differences between those results and the results generated via ORANI-TAS; that is we attempt to show how adding Tasmanian detail to the model changes our estimate of the relative Tasmanian and economy-wide effects of the economy-wide shock.

IV.1 A comparison between the economy-wide macroeconomic results from ORANI and ORANI-TAS

Table 2 lists the macroeconomic effects in ORANI and ORANI-TAS of the tariff increase. The most striking feature of the table is the similarity between its two columns. Both ORANI and ORANI-TAS project that the tariff increase will raise the domestic price level, reduce exports as well as imports, and cause slight reductions in the balance of trade surplus and aggregate employment. The key to understanding the general - equilibrium analysis of protection in the Australia economy is the recognition of the adverse effects on exports.[18] It is reassuring that the magnitudes of these effects in ORANI and ORANI-TAS

TABLE 2. THE EFFECTS ON MACROECONOMIC VARIABLES IN ORANI AND ORANI-TAS OF A 25 PER CENT ACROSS-THE-BOARD TARIFF INCREASE[a]

Variable	ORANI [b]	ORANI-TAS [b]
Index of Consumer Prices	2.23	2.19
Aggregate Exports (foreign currency value)	-2.55	-2.56
Aggregate Imports (foreign currency value)	-1.60	-1.62
Balance of Trade	-0.03	-0.03
Aggregate Employment	-0.20	-0.20

NOTES

a) All projections are percentage changes with the exception of the balance of trade which has the units "billions of 1968/69 Australian dollars".

b) The closure of the model used, indexation assumptions and value for the user-specified regional consumption parameter adopted to obtain the ORANI and ORANI-TAS projections presented in Tables 2, 3 and 4 are given in the Appendix.

are so similar. We would not expect significant differences in economy-wide projections to be caused by disaggregation of the Tasmanian and mainland components of industries in a way which leaves unaffected the overall size of input-output flows in the model's data base and the average values of its parameters. This is especially so since Tasmania accounts for only a small share (about 2.5 per cent) of Australian GDP.

The minor differences between the columns of Table 2 are explained by the fact that in ORANI-TAS the economy is treated as slightly more export oriented than in the standard version of ORANI. Our practice is to treat as endogenously determined, exports of all commodities for which export sales account for more than 20 per cent of total sales. Export demand elasticities for most of these "export" commodities are assumed to be fairly high (see DPSV, subsection 29.6) so that the domestic prices of the commodities can be regarded as determined by approximately exogenous world prices. In ORANI-TAS both Other Farming Export (Tasmania) and Milk Products (Tasmania) meet the criterion (see Table 1) although the economy-wide categories in which they are aggregated in the standard ORANI data base do not.[19] Thus in ORANI-TAS a slightly higher share of total exports are subject to a cost-price squeeze on account of the tariff increase and the fall in aggregate exports is slightly higher. Similarly a slightly greater proportion of the CPI weights correspond to commodities whose domestic prices are held down by world-market conditions. The rise in the CPI projected to follow from the tariff increase is slightly less and domestic import-competing industries replace a slightly greater amount of imports.

IV.2 Output results for the industries regionlized in ORANI-TAS

Table 3 permits us to compare -

(i) the ORANI-TAS output projections for the Tasmanian components of the regionalized industries with the projections for the mainland components, and

(ii) the ORANI-TAS output projections for the regionalized industries with the ORANI projections for the corresponding industries.

As well as the ORANI and ORANI-TAS projections for the relevant industries, the table also includes the results of a back-of-the-envelope (BOTE) explanation of the ORANI-TAS projections for the regionalized export industries. The BOTE explanation follows closely the explanation of the export-industry results given in DPSV, subsection 45.2.1. It uses the following short-run supply function which is implied by the CES primary-factor nests of the production functions used in the models:

$$z_j = \frac{\sigma(1-S_{Kj})}{S_{Kj}} \left[p_{0j} \frac{1}{S_{Vj}} - p_{Ij} \left(\frac{1}{S_{Vj}} - 1 \right) - w \right] , \qquad (4)$$

where z_j, p_{0j}, p_{Ij} and w are percentage changes, in turn, in the output of industry j, the basic price of its output, the average price of its intermediate inputs and the nominal wage rate; σ is the elasticity of

TABLE 3 : OUTPUT PROJECTIONS[a] FROM ORANI AND ORANI-TAS FOR INDUSTRIES REGIONALIZED IN ORANI-TAS: 25 PERCENT ACROSS-THE-BOARD TARIFF INCREASE

ORANI Industry	ORANI Projection	ORANI-TAS Industry	ORANI-TAS Projection	BOTE[b] Explanation Of ORANI-TAS Export Industry Projections: BOTE Estimate (via eq. (7))[c]	Cost Shares[d] S_{Kj}	S_{vj}
Other farming export	-1.42	Other farming export (T)[e]	-4.94	-4.63[f]	.34	.46
		Other farming export (M)	-1.39	n.a.		
Fishing	-2.54	Fishing (T)	-2.00	-2.04	.41	.77
		Fishing (M)	-2.53	-2.33	.48	.51
Iron	-0.28	Metallic minerals (T)	-2.13	-1.85	.51	.57
Other metallic minerals	-1.85	Iron (M)	-0.27	-0.23	.87	.72
		Other metallic minerals (M)	-1.74	-1.69	.52	.60
Milk products	0.01	Milk products (T)	-4.11	-23.23	.30	.11
		Milk products (M)	0.02	n.a.		
Pulp, paper	0.31	Pulp, paper (T)	0.27	n.a.	.41	.39
		Pulp, paper (M)	0.31	n.a.	.09	.27
Basic iron and steel	-2.18	Basic metals (T)	-2.04	-4.21	.50	.26
Other basic metals	-2.25	Basic iron and steel (M)	-2.16	-5.32	.37	.35
		Other basic metals (M)	-2.25	-5.88	.47	.21

(a) All projections are percentage changes.
(b) Back-of-the-envelope.
(c) The value for σ in equation (7) is 0.5 for all commodities.
(d) S_{Kj} and S_{Vj} are, respectively the share of fixed factors in total primary costs and the share of value added in total costs of industry j.
(e) (T) indicates Tasmania. (M) indicates Mainland.
(f) n.a. = not applicable. These are "non-export" industries in ORANI-TAS.

substitution between labour and fixed factors of production; and S_{Kj} and S_{Vj} are the shares of fixed factors in total primary costs in industry j and of primary factors in total costs. Nominal wage rates are indexed to the CPI in our simulation. In using (4) to explain our Export-industry results we assume that the average price of intermediate inputs moves in line with the CPI, that is, for each export industry j, we assume

$$p_{Ij} = w = cpi = 2.19 \quad , \tag{5}$$

where cpi is the percentage change in the CPI in the ORANI-TAS simulation and its value (2.19) is taken from Table 2. Finally, for export commodities a good approximation to the ORANI-TAS projections is to assume that selling prices are fixed, i.e.,

$$p_{0j} = 0. \tag{6}$$

This is because elasticities of demand on foreign markets for these commodities are assumed to be high.

Using (5) and (6), (4) reduces to

$$z_j = \frac{\sigma(1-S_{Kj})}{S_{Kj}\, S_{Vj}} \cdot 2.19 \quad . \tag{7}$$

As can be seen from Table 4, equation (7) is a good explanation of the ORANI-TAS output projections for six out of the ten regionalized export industries. For industries whose selling prices are more or less fixed on world markets, ORANI projections of short-run responses to domestic cost shocks depend primarily on primary-factor cost shares which, given the production functions assumed in the model, determine industries' supply elasticities. In general, the more capital intensive is an industry the less willing is it to vary its output in the short-run.

For the Tasmanian Milk products and Basic metals industries and for the mainland Basic iron and steel and Other basic metals industries, equation (7) does not provide a good explanation. The problem is that for these industries the assumption that the average price of intermediate inputs moves in line with the CPI is not appropriate. Each buys its major intermediate input from another export or export-related industry whose selling price on the domestic market is assumed to be held down by an (approximately) fixed world price. Thus (5) is an overstatement of the rise in the prices of purchased inputs for these four industries and, as can be seen from Table 3, (7) overstates the severity of the effect of the cost-price squeeze on their outputs. Note however that within the basic metals group, (7) still explains the ORANI-TAS ranking of the output responses of the three regionalized industries.

We have not included in Table 3 BOTE explanations of the output responses of the regionalised non-export industries. For these, (7) would not be sufficient because the domestic output price (p_{0j}) could not be set exogenously. For industries without the alternative of selling their outputs on world markets, output price is determined by the interaction of domestic supply and demand. In principle we could add a domestic demand equation and use the two-equation BOTE system to explain simultaneously the ORANI-TAS projections for output and domestic prices. However, for domestically oriented industries output prices move closely with input costs; that is, the difference computed in the term in square brackets on the RHS of (4) is usually very small. To fix this difference with sufficient accuracy requires us to use detail from large sections of the model's data files - approximations like (5) are inadequate. In these circumstances BOTE calculations cease to be useful in explaining the magnitudes of the model's projections. As can be seen from Table 3, introducing in ORANI-TAS regional detail about the non-export industries (Other farming export (M); Milk products (M); Pulp, paper (T) and Pulp, paper (M)) does not alter their sensitivity to the tariff shock from what was projected in ORANI.

IV.3. Statewide and economy-wide results

A summary of our projections of the effects of the 25 percent across-the-board tariff increase on output and employment in Tasmania and in Australia as a whole is given in Table 4. The Tasmanian results in the first two columns of the table are derived from the LMPST package used in conjunction with the standard version of ORANI. The corresponding results derived from ORANI-TAS and LMPST are given in the second two columns. Both sets of computations suggest that the adverse effects on Tasmania of the tariff increase would be more severe than the effects on the national economy.[19] For the six regionalised "national" industries ORANI-TAS allows a divergence between output performance in Tasmania and economy-wide. On average ORANI-TAS projects that these industries would do worse in Tasmania than did the corresponding economy-wide industries in ORANI (see Table 3). This accounts for 0.11 of the 0.86 percentage points difference between the two Tasmanian gross product projections in Table 4. The remaining 0.75 percentage points are accounted for by reduced output in Tasmanian "local" industries attributable to negative multiplier effects in the deteriorating State economy.

TABLE 4. PROJECTIONS FROM ORANI AND ORANI-TAS OF THE EFFECTS OF A 25 PER CENT ACROSS-THE-BOARD TARIFF INCREASE ON TASMANIAN AND AUSTRALIAN GROSS PRODUCTS AND EMPLOYMENT LEVELS[a)]

	ORANI-LMPST		ORANI-TAS-LMPST	
	Gross Product	Index of Aggregate Employment	Gross Product	Index of Aggregate Employment
Tasmania	-0.54	-0.66	-1.40	-1.59
Australia	-0.12	-0.20	-0.11	-0.20

a) All projections are percentage changes.

V. CONCLUSION

The work reported in this paper reflects a pragmatic approach to policy-oriented economic research. We have shown that by making some piecemeal changes to its data base, a well-established economy-wide multisectoral model (ORANI) can be reoriented to throw light on the implications of economy-wide shocks for an individual State within the Australian federation. In addressing this question, modelling aspects of the interaction of the State with the rest of the economy as a whole is important but the interaction of the State with other individual States is less crucial. The regional projections reported here continue to take advantage of the observation that, for geographical reasons, the LMPST simplifications based on the dichotomy between "local" and "national" industries is particularly useful for regional economic analysis in Australia. The ORANI-TAS-LMPST system can be viewed as a hybrid of the bottoms-up and tops-down methods of obtaining regional projections of economic shocks. ORANI-TAS provides a limited bottoms-up analysis of the effects of the shocks on selected Tasmanian "national" industries. The implications of the shocks for "local" industries in the State and for the State economy as a whole are then traced out via the tops-down, LMPST extension.

The results reported in section IV indicate that even limited incorporation of State-specific data into the economy-wide model can have significant effects on the State projections produced by our modelling system. This suggests that further refinement of our pragmatic approach might be worth pursuing. An obvious candidate is the modification of the ORANI theoretical structure to allow a greater range of State-specific elements in the demand specification of ORANI-TAS. At present the structure can accomodate polar cases in which supplies of a given commodity from alternative intranational sources to producers and investors are treated as perfect substitutes or as non-substitutable. (We chose the latter for computing convenience.) An improvement would be to extend the "Armington" approach to cover the intranational as well as international sources of supply, that is, to treat Tasmanian and mainland supplies of a given commodity as <u>imperfect</u> substitutes, accomodating the polar cases by assigning values of infinity or zero respectively to the relevant elasticities of substitution.

ENDNOTES

* Work on this paper commenced whilst all of the authors were full-time researchers at the IMPACT project. We wish to thank Alan Powell and Peter Dixon for comments on an earlier draft, and George Edwards, Martin Wallace and Warren Jones for assistance with data.

1. IMPACT is an economic research project sponsored by agencies of the Australian Federal Government in cooperation with the University of Melbourne and La Trobe University. See Powell (1977).

2. The main data problem is the need for detailed information on inter-State commodity flows which is not available for Australia. To cover the gap Liew used a gravity method to generate data. The inclusion of the 6-State dimension in Liew's model forced him to make many compromises in the amount of sectoral detail which he was able to include.

3. Tasmania is the sole offshore island in the Australian Federation.

4. For a complete description of ORANI see DPSV (1982).

5. The bulk of Australia's population is concentrated in metropolitan centres located hundreds of miles from the State boundaries. In implementing the modified LMPST method, it proved possible to classify industries accounting for 53 percent of the economy's total employment and value added as "local".

6. Other rules could be used so long as they imply State output changes appropriately weighted averages of which give back the original economy-wide change. Cf. DPSV, section 42.

7. For details see DPSV, section 39. In implementing the equivalent of equation (3) some elements of final demand (e.g. demand for investment goods and, via a labour-income consumption link, household demand) were expressed as functions of z_N^r and z_L^r. Cf. DPSV, equations (39.29) and (39.30).

8. For example, wheat users are assumed not to distinguish between Victorian wheat and Queensland wheat. This simplifying assumption is not ideal for all agricultural commodities.

9. A similar idea underlies the demand specification of the multisectoral, multiregional model of Liew (1981). In Liew's model supplies of a given commodity from the six Australian states are imperfect substitutes for all users.

10. **Some indirect substitution is allowed if both the Tasmanian and mainland production compete with overseas imports. Then if the price of the Tasmanian products increases relative to the mainland price, imports will replace the Tasmanian source to a greater extent than the mainland source.**

11. In other words, it is quite appropriate to assume that the share of Tasmania in the total output of a Tasmanian industry distinguished in ORANI-TAS remains fixed at its base-period value - the share must always be one.

12. A complete description of the data is available from the authors on request.

13. The input-output data input required by the ORANI computing system is a somewhat simplified version of that represented in Figure 1. Only 8 of the 115 domestic commodities are used as margins services and for these, only the column sums of each pair of matrices $(\tilde{K}_i, \tilde{P}_i)$ and $(\tilde{L}_i, \tilde{Q}_i)$ are required, not the full matrices.

14. This final step is for computing convenience only. In order to make room for the 6 new Tasmanian industries we aggregated the Electricity industry with the Gas industry, and created an Aggregate Government Sector industry containing Water and sewerage, Public administration, Defence, Health, Education and libraries, and Welfare services.

15. Of course, even in this case, disaggregation would allow the imposition of shocks specific to the Tasmanian (or the mainland) industry.

16. Further details are available from the authors.

17. Details are provided in the Appendix. For a discussion of the standard short-run macroeconomic assumptions made in ORANI simulations see Dixon, Parmenter and Powell (1982).

18. For a complete analysis of the ORANI results see DPSV, Chapter 7.

19. By making the Tasmanian disaggregations we have treated the production of directly exported fruit separately from the production of sugar cane although both these activities are aggregated in a single industry (Other farming export) in the standard data base. Similarly we have recognized that the Tasmanian dairy industry is more heavily oriented towards exportable milk products than is the mainland industry which concentrates largely on the production of whole milk for the domestic market.

20. When ORANI-LMPST is used to project the effects of the tariff increase on each of the six Australian States, Tasmania ranks third (after Queensland and Western Australia) in the ranking of States according to the severity of the impact of tariff increase. See DPSV, Table 45.7.

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APPENDIX: TECHNICAL DETAILS OF THE SIMULATIONS

This appendix contains: (i) a list of the exogenous variables in the ORANI and ORANI-TAS simulations together with the values assigned to them; (ii) a list of the endogenous export commodities and the reciprocals of their export demand elasticities; (iii) the indexation assumptions adopted in the simulations; (iv) a list of the commodities selected as "local"; (v) documentation of the elasticities files used and (vi) the value assigned to the γ parameter, which relates regional consumption levels to the regional allocation of labour income.

List of exogenous variables

Table A.1 contains a list of the exogenous variables in the ORANI and ORANI-TAS simulations. The values assigned to these variables were all zero except for the ad valorem tariff rates, t(i,20), which were all equal to 25. Note that the 1968/69 Australian input-output tables form the core of both the ORANI and ORANI-TAS data bases (see DPSV, chapter 4) and that base period tariff rates used for the ORANI simulations can be found in DPSV Table 45.4 and for ORANI-TAS in Higgs *et al*. (1981) Table 5.1.

List of endogenous export commodities

Table A.2 contains a list of the commodities for which export demands are determined endogenously in ORANI and ORANI-TAS, and the reciprocals of their export demand elasticities.

TABLE A.1: THE EXOGENOUS VARIABLES IN THE ORANI AND ORANI-TAS SIMULATIONS

Variable	Subscript Range	Number	Description
$p^{m}_{(i2)}$	i=1,...,g.	g	C.i.f. foreign currency import prices
t(i2,0),v(i2,0)	i=1,...,g.	2g	Tariff terms
t(is,jk),v(is,jk)	i=1,...,g, s,k=1,2, j=1,...,h.	8g	Ad valorem and specific sales-tax terms
t(is,3),v(is,3)	i=1,...,g, s=1,2.	4g	
v(i1,4)	$i \in G$. (a)	g	Selection of specific export-tax terms and complementary selection of export volumes
$x^{(4)}_{(i1)}$	$i \notin G$.		
t(i1,4)	i=1,...,g.	g	Ad valorem export tax terms
a's (excluding a(j))	subscript ranges can be read from Table 23.2 in DPSV	$4g^2h + 5g^2 + 7gh + Mh + 8h + 3g + \sum_{j=1}^{h} N(j)$	Technological change and changes in household preferences
$k_j(0)$	j=1,...,h.	h	Current capital stocks
c_R		1	Real household aggregate expenditure
i_R		1	Aggregate real private investment
n_j	j=1,...,h	h	Use of agricultural land in each industry
$f^{(1)}_{(g+1,1)}$		1	Wage shift variables
$f^{(1)}_{(g+1,1,m)}$	m=1,...,M.	M	
$f^{(1)}_{(g+1,1)j}$	j=1,...,h.	h	
$f^{(1)}_{(g+1,1,m)j}$	m=1,...,M, j=1,...,h.	Mh	

continued......

Table A.1 continued

Variable	Subscript range	Number	Description
$f^{(5)}_{(is)}$	i=1,...,g, s=1,2.	2g	"Other" demand shift terms
$f^{(2)}_{j}$	$j \notin J.$[(b)]	h-J*	Exogenous investment
$f^{e}_{(i1)}$	i=1,...,g.	g	Shifts in foreign export demands
$f^{(1)}_{g+2,j}$	j=1,...,h.	h	Shifts in the price of "other cost" tickets
q		1	Number of households
ϕ		1	The exchange rate, \$A per \$US, say

$$\text{Total} = 4g^2h + 5g^2 + 15gh + 2Mh + 13h + 15g + M + \sum_{j=1}^{h} N(j) + 5-J^{*} \quad \text{(c)}$$

(a) G is the set of commodities for which export demands are determined endogenously. The sets G, together with the reciprocals of the export demand elasticities for the ORANI and ORANI-TAS simulations are listed in Table A.2.

(b) J is the set of industries for which investment is endogenous. The set $\{j \notin J\}$, for which investment is exogenous, consists of industries 17, 84, 85, 86, 103, 104, 105, 106, 107, 108, 112 and 113 in ORANI, and 20, 90, 107, 108, 112 and 113 in ORANI-TAS. Note that the ORANI and ORANI-TAS $\{j \notin J\}$ sets are equivalent even though the industry numbers do not match. The different pattern of industry numbers is due to the splitting and aggregating of industries in ORANI-TAS. For a key to the ORANI industry numbers refer to DPSV Table 45.4 and for the ORANI-TAS numbers refer to Higgs, Parmenter, Rimmer and Liew (1981) Table 3.3.

(c) For the ORANI and ORANI-TAS simulations reported;

g (the number of commodities)	=	115,
h (the number of industries)	=	113,
M (the number of occupations)	=	9, and
J* (the number of industries for which investment is endogenous)	=	101 in ORANI and 107 in ORANI-TAS.

Therefore in the ORANI simulations the total number of exogenous variables was 6,244,004 and in the ORANI-TAS simulations it was 6,243,998.

TABLE A.2: COMMODITIES FOR WHICH EXPORT DEMANDS ARE DETERMINED ENDOGENOUSLY IN ORANI AND ORANI-TAS AND THE RECIPROCALS OF THEIR EXPORT DEMAND ELASTICITIES

ORANI			ORANI-TAS		
Commodity Number	Commodity	Reciprocal of the Export Demand Elasticity	Commodity Number	Commodity	Reciprocal of the Export Demand Elasticity
A1	Wool	0.77	A1	Wool	0.77
A3	Wheat	0.08	A3	Wheat	0.08
A4	Barley	0.05	A4	Barley	0.05
A5	Other cereal grains	0.05	A5	Other cereal grains	0.05
11	Fishing	0.05	A8	Other farming export (Tasmania)	0.05
12	Iron	0.05	12	Fishing (Tasmania)	0.05
13	Other metallic minerals	0.05	13	Fishing (Mainland)	0.05
14	Coal	0.05	14	Metallic minerals (Tasmania)	0.05
18	Meat products	0.06	15	Iron (Mainland)	0.05
25	Food products n.e.c.	0.05	16	Other metallic minerals (Mainland)	0.05
30	Prepared fibres	0.38	17	Coal	0.05
63	Basic iron and steel	0.05	21	Meat products	0.06
64	Other basic metals	0.05	22	Milk products (Tasmania)	0.05
			29	Food products n.e.c.	0.05
			34	Prepared fibres	0.38
			68	Basic metal products (Tasmania)	0.05
			69	Basic iron and steel (Mainland)	0.05
			70	Other basic metals (Mainland)	0.05

Indexation assumptions

The values adopted for the user-specified indexation parameters in ORANI and ORANI-TAS were:

$h^{(5)}_{(is)}$, $h^{(1)}_{g+2,j}$, $h^{(1)}_{(g+1,1,m)j}$, $^{(f)}$ $h^{(2)}_{\ell}$, $h_2(i2,0)$, $h_1(i1,4)$, $h_3(i1,4)$,

$h_1(is,jk)$, $h_3(is,jk)$, $h_1(is,3)$ and $h_3(is,3)$

all equal to 1, and

$h_1(i2,0)$, $h_3(is,0)$, $h_2(i1,4)$, $h_2(is,j^k)$ and $h_2(is,3)$

all equal to 0;

(for $i = 1,\ldots,g$; $s = 1,2$; $j = 1,\ldots,h$; $k = 1,2$;
$m = 1,\ldots,M$; and $\ell \notin J$).

For a description of these parameters see DPSV Table 27.1. Note that the most important indexation assumption adopted was that wages were fully indexed to the consumer price index.

List of "local" commodities

Table A.3 contains a list of the commodities selected as "local" in the ORANI and ORANI-TAS regional simulations.

TABLE A.3: COMMODITIES SELECTED AS "LOCAL" IN ORANI AND ORANI-TAS REGIONAL SIMULATIONS

ORANI		ORANI-TAS	
Commodity Number	Commodity	Commodity Number	Commodity
12	Services to agriculture	12	Services to agriculture
25	Bread, cakes	29	Bread, cakes
28	Soft drinks, cordials	32	Soft drinks, cordials
29	Beer and malt	33	Beer and malt
62	Ready-mixed concrete	67	Ready-mixed concrete
86	Electricity	92	Electricity and gas
87	Gas	93	Residential building
88	Water, sewerage	94	Building n.e.c.
90	Building, n.e.c.	95	Wholesale trade
91	Wholesale trade	96	Retail trade
92	Retail trade	97	Motor vehicle repair
93	Motor vehicle repair	98	Other repairs
94	Other repairs	103	Communication
99	Communication	104	Banking
100	Banking	105	Finance & life ins.
101	Finance & life ins.	106	Other insurance
102	Other insurance	107	Investment, real estate
103	Investment, real estate	108	Other business services
104	Other business services	109	Ownership of dwellings
105	Ownership of dwellings	110	Aggregate government sector
108	Health	111	Entertainment
109	Education, libraries	112	Restaurants, hotels
110	Welfare services	113	Personal services
111	Entertainment	114	Business expenses
112	Restaurants, hotels		
113	Personal services		
114	Business expenses		

Elasticities files used

The elasticities files used for the ORANI simulations were the same as those documented in DPSV section 29, except that the elasticities of substitution between domestic and foreign sources of supply for the "local" commodities listed in Table A.3 were set to zero. This preserves the property that the sum of the State results will exactly equal the national results.[1] The elasticities' files used for the ORANI-TAS simulations are documented in Higgs et al. (1981). Again the elasticities of substitution between domestic and foreign sources of supply for the "local" commodities were set to zero.

Value of the γ parameter

In both the ORANI and ORANI-TAS simulations we elected to set the γ parameter to 1.0. This means that changes in regional consumption levels fully reflect changes in the regional allocation of income.

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1. For further discussion see DPSV section 42.