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INCORPORATING REGIONAL DIMENSIONS IN ECONOMY-WIDE MODELS : A PRELIMINARY REPORT ON A TASMANIAN VERSION OF ORANI*

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1. INTRODUCTION

ORANI is a large, multisectoral model of the Australian economy[1], designed primarily as a tool for policy analysis within agencies of the Australian Federal Government.[2] Numerous applications of the model to policy-relevant questions have been published. Regional results have been produced using a minimum of regional data, by strictly "tops-down" allocations of the economy-wide results to sub-national (usually State) levels.[3] An alternative approach to regional modelling is the "bottoms-up" approach which explicitly models economic activity at the regional level, links the regions in a multi-regional framework, and derives economy-wide results as explicit aggregations of regional results. Liew (1981) has adapted this latter approach and constructed a multisectoral, multi-regional model of Australia, using techniques similar to those employed in the economy-wide ORANI model. Although theoretically appealing, the "bottoms-up" method is very costly in terms of data, requiring detailed information about the individual regional economies and about inter-regional flows.

In this paper we report on the development of more detailed regional modelling with ORANI, using a hybrid of the tops-down and bottoms-up approaches. A crucial characteristic of ORANI is that, although the structure of the model in levels is non linear, it is

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1. See Dixon, Parmenter, Sutton and Vincent (1982), hereafter referred to as DPSV.

2. The model was developed as part of the Federal Government's inter-agency, IMPACT Project, see Powell (1977).

3. See Dixon, Parmenter and Sutton (1978), IAC (1977), Dixon, Powell and Parmenter (1979).

solved in a linear, percentage change form.[4] The model is therefore readily amenable to piecemeal modifications. Our current regional developments entail such modifications. These take the form of incorporating in the economy-wide model, industries which are defined on the basis of their State locations as well as their input-output classifications. If all the industries and final demand categories in the model were disaggregated in this way, the result would be a complete multi-regional model. Our current development is much more modest - we have just separated out the Tasmanian components of some industries which are important in the Tasmanian economy. The aim is to develop a model specifically designed for the analysis of the effects on the Tasmanian economy of policy-relevant changes, emphasizing the inter-action of the Tasmanian with the national economy.

The paper is organized as follows. In section 2 we review the experience we have had to date with regional modelling. In particular we compare the tops-down regional disaggregation methods which have been employed for ORANI, with the bottoms-up methods used by Liew. Our preliminary Tasmanian version of ORANI is described in more detail in section 3. Section 4 contains concluding remarks.

2. A REVIEW OF ORANI-BASED REGIONAL MODELLING[5]

2.1 Tops-down regional disaggregation of ORANI results

Results from ORANI give considerable detail about the impact of economic disturbances on different industrial sectors in the economy. For many policy purposes, details of the regional impact may also be required. The methods which have been developed in order to meet this need with ORANI have three convenient, but limiting, properties. Firstly, they operate sequentially without feedback from the regional computations to the economy-wide model. Secondly, the regional results can be shown to be consistent with the economy-wide results in the sense that the latter can be obtained by suitable re-aggregations of the former. Thirdly, regional results are produced using a minimum of regional data.

The simplest of the regional disaggregations methods that have been used with ORANI assumes that the regional shares in the economy-wide outputs of all industries are unaffected by the economic disturbance being examined. This implies that if the economy-wide model projects that the disturbance will increase the economy-wide output of some industry by 10 per cent, then the output of that industry will increase by 10 per cent in each of the regions. The IAC (1977) used this assumption to disaggregate ORANI results to the State level. Under the constant-regional-shares assumption, the

4. The solution method is based on that originally proposed for economic models by Johansen (1960). It is described in detail in DPSV, chapter 5.

5. This section draws heavily on material prepared by Liew as part of his Ph.D. project (Liew, 1981).

differential impacts across regions of a disturbance just reflect differences in the industrial structures of the regions.

The standard method for disaggregating ORANI results to the State level (see DPSV, chapter 6) is a modification of the method first proposed by Leontief, Morgan, Polenske, Simpson and Tower (1965), hereafter referred to as LMPST. Industries identified in the economy-wide model are first divided into two distinct groups ("national" and "local") on the basis of whether or not their outputs are traded between regions. National industries are industries which produce goods such as clothing, steel, etc., which are mobile between regions. Local industries produce commodities (mainly services) which, for technological or institutional reasons, are not subject to inter-regional trade. Because the main population centers in the Australian States are located at great distances from the State borders, the national-local dichotomy is very sharp for a State disaggregation of industrial activity in the Australian economy. State results from the ORANI-LMPST disaggregation model are derived in three stages. First the economy-wide model, ORANI, is run to calculate economy-wide projections, including projections for output levels of both the national and local industries. Next, the projected outputs of those industries classified as national are allocated to the States by some exogenous assumption. The obvious option is to assume constant State shares in the output of each national industry. Finally, State output levels for the local industries are computed via State commodity-balance equations for their outputs, i.e., equations which set the supply of local commodities in each State equal to the demand for local commodities in the State.

The three stages can be represented more formally as follows.[6]

First, results are obtained from ORANI for[7]

(i) x_n, x_ℓ (the percentage changes at the economy-wide level in the outputs of national ($n \in N$) and local ($\ell \in L$) industries caused by the economic disturbance which is under investigation),

(ii) y_n, y_ℓ (the percentage changes at the economy-wide level in investment by national ($n \in N$) and local ($\ell \in L$) industries),

(iii) w_j, b_j (the percentage changes in the wage rates and employment rates of industry j - national or local - $j \in J$),

6. The description given here is a slightly simplified version of that given in DPSV, chapter 6. In particular we ignore complications introduced by the provision in ORANI for multi-product industries, and by the explicit modelling of trade and transport margins.

7. In our notation N identifies the set of national industries, L the set of local industries and J the set of all industries.

(iv) $x_{\ell}^{(3)}$ (the percentage changes in economy-wide household consumption of local ($\ell \epsilon L$) goods),

(v) $x_{\ell}^{(5)}$ (the percentage changes in the economy-wide 'other final demands', (mainly demands by the government) for local ($\ell \epsilon L$) good ℓ), and

(vi) v (the percentage change in the economy-wide aggregate labour income).

In the second stage, economy-wide outputs of national goods are allocated to States according, for example, to the constant-State-shares assumption.

$$X_n^r = X_n D_n^r \quad \text{for all } n \epsilon N, \qquad r=1,\ldots,m, \tag{2.1}$$

where X_n^r is the output of industry n in State r, D_n^r is the base-period proportion of aggregate output of industry n which is produced in State r.

In percentage change form the above equation becomes[8]

$$x_n^r = x_n \quad \text{for all } n \epsilon N, \qquad r=1,\ldots,m. \tag{2.2}$$

In the third stage the condition that State outputs of local goods equal State demands is imposed,[9] i.e.,

$$X_i^r = \sum_{n \epsilon N} A_{in}^{(1)} X_n^r + \sum_{\ell \epsilon L} A_{i\ell}^{(1)} X_\ell^r + \sum_{n \epsilon N} A_{in}^{(2)} Y_n^r + \sum_{\ell \epsilon L} A_{i\ell}^{(2)} Y_\ell^r + X_i^{(3)r} + X_i^{(5)r}, \tag{2.3}$$

$$\text{for all } i \epsilon L, \qquad r=1,\ldots,m,$$

where Y_j^r is the investment by industry j in State r, $X_i^{(3)r}$ is the household consumption of good i in State r, $X_i^{(5)r}$ is the other final demand for local good i in State r, $A_{ij}^{(1)}$ is the intermediate input of good i required per unit of good j, and

8. Lower case symbols are used to represent percentage changes in the variables (in levels) represented by the corresponding upper case symbols.

9. Note that in equation (2.3) it is also assumed that technology is constant across the States, hence the absence of "r" superscripts from the A coefficients. This assumption reflects data limitations only.

$A_{ij}^{(2)}$ is the input of good i required per unit of investment for industry j. In percentage change form, equation (2.3) becomes,

$$x_i^r = \sum_{n \in N} \beta_{in}^{(1)r} x_n^r + \sum_{\ell \in L} \beta_{i\ell}^{(1)r} x_\ell^r + \sum_{n \in N} \beta_{in}^{(2)r} y_n^r + \sum_{\ell \in L} \beta_{i\ell}^{(2)r} y_\ell^r + \beta_i^{(3)r} x_i^{(3)r} + \beta_i^{(5)r} x_i^{(5)r}, \qquad (2.4)$$

$$\text{for all } i \in L, \qquad r = 1, \ldots m,$$

where the β coefficients are the shares of the various demands in the total demand for local good i in State r. Equation (2.4) can be solved for the percentage changes in State outputs of local industries (the x_ℓ^r's) once y_n^r, y_ℓ^r, $x_i^{(3)r}$ and $x_i^{(5)r}$ are explained in terms of ORANI economy-wide variables or in terms of the x_ℓ^r's themselves.

Investment by industry at the economy-wide level is allocated to the States according to the equations:

$$Y_n^r = Y_n D_n^r, \qquad \text{for all } n \in N, \quad r = 1, \ldots, m, \qquad (2.5)$$

and

$$Y_\ell^r = (Y_\ell / X_\ell) X_\ell^r, \qquad \text{for all } \ell \in L, \quad r = 1, \ldots, m, \qquad (2.6)$$

where Y_j is the economy-wide investment of industry j. The percentage change forms of equations (2.5) and (2.6) are

$$y_n^r = y_n, \qquad \text{for all } n \in N, \quad r = 1, \ldots, m, \qquad (2.7)$$

$$y_\ell^r = y_\ell - x_\ell + x_\ell^r, \qquad \text{for all } \ell \in L, \quad r = 1, \ldots, m. \qquad (2.8)$$

Household consumption of local goods at the State level is explained by labour income in each State. It is assumed that

$$X_\ell^{(3)r} = f_\ell^{(3)r}\left(X_\ell^{(3)}, V^r/V\right) \text{for all } \ell \in L, r = 1, \ldots, m, \qquad (2.9)$$

where $X_\ell^{(3)}$ and V are economy-wide variables already defined and V^r is total labour income in State r. The corresponding percentage change equation is

$$x_{\ell}^{(3)r} = \alpha_{\ell}^{r} x_{\ell}^{(3)} + \gamma_{\ell}^{r}(v^{r} - v) \;, \quad \text{for all } \ell\varepsilon L, \; r=1,\ldots,m, \qquad (2.10)$$

where α_{ℓ}^{r} is the elasticity of the consumption in State r of local good ℓ with respect to the aggregate consumption of good ℓ, and γ_{ℓ}^{r} is the elasticity of the consumption in State r of local good ℓ with respect to the share of State r in the total labour income of the economy.[10] Equation (2.10) does not tie down $x_{\ell}^{(3)r}$ until State labour incomes are explained. This can be done by writing

$$V^{r} = \sum_{j\varepsilon J} W_{j} B_{j}^{r} \;, \qquad r=1,\ldots,m, \qquad (2.11)$$

where W_j is the wage of a unit of labour paid by industry j, and B_j^r is the employment of labour by industry j in State r. In percentage change form, (2.11) becomes

$$v^{r} = \sum_{j\varepsilon J} (w_{j} + b_{j}^{r}) S_{j}^{r} \;, \qquad r=1,\ldots,m, \qquad (2.12)$$

where S_j^r is the share of industry j in the total labour income of State r. Equation (2.12) is still not sufficient to explain the $x_{\ell}^{(3)r}$'s without equations for percentage changes in State employment levels by industry (the b_j^r's). The equations used in the ORANI-LMPST disaggregation are

$$b_{j}^{r} - x_{j}^{r} = b_{j} - x_{j} \;, \quad \text{for all } j\varepsilon J, \qquad r=1,\ldots,m. \qquad (2.13)$$

In other words, it is assumed that the percentage change in employment per unit of output in industry j in each State is the same as the percentage change in employment per unit of output in industry j for the whole economy.[11]

The last set of equations required to close (2.4) explain

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10. In implementing the disaggregation procedure α_{ℓ}^{r} is assumed equal to 1 for all ℓ and r, and γ_{ℓ}^{r} is user-specified.

11. Note that this assumption is defensible only if changes in factor prices are assumed to be constant across States. We would expect this to be the case in the long run.

other final demands. These equations are

$$X_{\ell}^{(5)r} = X_{\ell}^{(5)} Q_{\ell}^{r}, \qquad \ell \varepsilon L, \qquad r=1,\ldots,m, \qquad (2.14)$$

where Q_{ℓ}^{r} is the share of other final demands for local good ℓ which is purchased from State r, and $X_{\ell}^{(5)}$ is the economy-wide other final demands for local good ℓ. In percentage-change form, (2.14) is

$$x_{\ell}^{(5)r} = x_{\ell}^{(5)} + q_{\ell}^{r}, \qquad \text{for} \quad \ell \varepsilon L, \qquad r=1,\ldots,m. \qquad (2.15)$$

The q_{ℓ}^{r}'s are normally set exogenously to zero.

As well as accounting for differences in the industrial compositions of the State economies, the ORANI-LMPST disaggregation also captures intra-regional multiplier effects on the demand for local goods. Data requirements are minimized by the imposition of the local-national dichotomy which, combined with the exogenous State allocation of the national-industry outputs, obviates the need for inter-regional flow data, and by the assumption that technology is not State-specific.

2.2 Liew's bottoms-up multi-regional, multi-sectoral model of the Australian economy (MRSMAE).

Rather than modelling economic activity at the economy-wide level and allocating the economy-wide results to the States, MRSMAE follows the "bottoms-up" approach in which economic agents (producers, consumers, etc.) in each State are separately identified and their decisions with regard to output, investment, commodity and factor demands, etc., are explicitly modelled at the State level, accounting for inter-State as well as inter-industry flows. Commodities of the same input-output category but from different States are treated as separate commodities which are regarded by users as imperfect substitutes. Factor supplies can be modelled as State-specific, industry-specific or mobile between States and industries. If economy-wide results from MRSMAE are required, they are obtained by aggregation (across States) of the projections for State-specific variables.

The structure of MRSMAE is a system of simultaneous equations representing:

(i) the demand by producers in each State for inputs of commodities from each State and from overseas;

(ii) the demand by producers in each State for labour of each of nine skill groups, for buildings, for machines and for agricultural land;

(iii) the demand by investors in each State for inputs of commodities from each State and from overseas to capital formation;

(iv) the demand by households in each State for commodities from each State and from overseas;

(v) the demand by foreigners for exports of commodities from each State;

(vi) other (mainly government) demands for commodities from each State and from overseas (these demands are entirely exogenous);

(vii) the linking of the prices of outputs, units of investment, exports and imports to the costs of current production, investment, exporting and importing;

(viii) market clearing conditions for commodities of each type and source, and for primary factors;

(ix) indexing facilities which allow some factor prices (wage-rates, for example) to be indexed to the domestic price level;

(x) the definition of miscellaneous aggregate variables such as economy-wide and State price indexes, gross-state and gross-national products, aggregate State and aggregate economy-wide employment levels, etc.

Producers' demands for commodities and primary factors (equation types (i) and (ii)) are derived from the assumption that producers minimize production costs subject to the production technology illustrated by Figure 2.1. From the figure it can be seen that imperfect substitution possibilities are assumed to exist between material inputs of the same commodity class but from different (domestic or overseas) sources; between labour of different skill groups in forming aggregate labour inputs; and between aggregate labour inputs, aggregate capital inputs and inputs of agricultural land. No substitution is allowed between material inputs of different commodity categories; between machines and buildings in forming aggregate capital inputs; or between material inputs, aggregate primary-factor inputs and other costs. Where substitution possibilities exist, a CES specification is adopted. Similarly, investors (equation type (iii)) are assumed to be cost minimizers and to face technological constraints similar to those faced by producers except that they use only material inputs. The use of primary factors in capital formation is accounted for via the use of materials, especially construction.

Households in each State are assumed to maximize utility subject to an aggregate-consumption constraint. Aggregate consumption in each State is related to income accruing in the State. In determining the composition of the consumption bundle, all goods, both imported

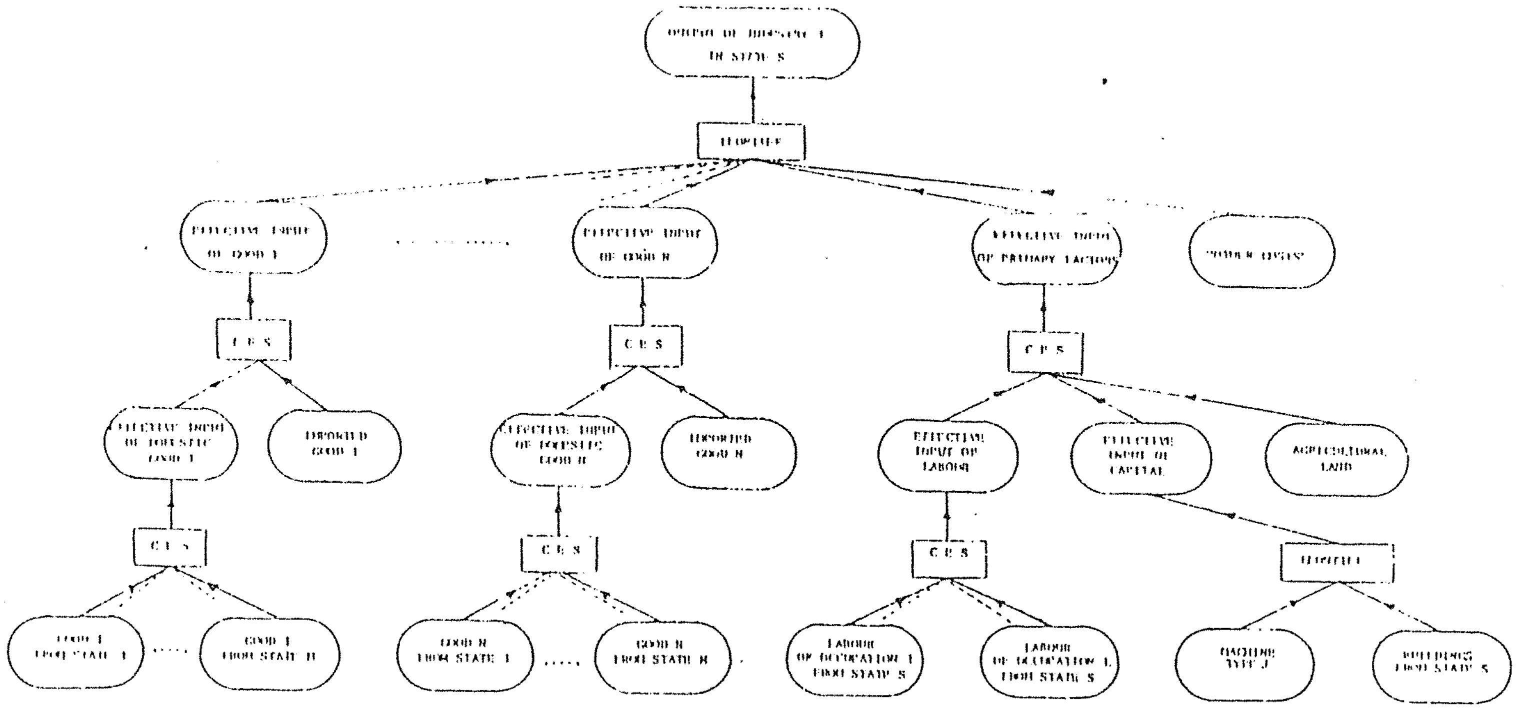

FIGURE 2.1 PRODUCTION TECHNOLOGY IN [illegible] FOR CURRENT GOODS IN INDUSTRY J IN STATE S.

and locally produced, are imperfect substitutes. Households, therefore, can substitute not only between alternative sources of the same type of commodity (Victorian, NSW and imported textiles, for example) but also between different commodity types (textiles and automobiles, for example).

Foreigners' demands for Australian exports in MRSMAE are assumed to be less than perfectly elastic. Like domestic users, foreigners regard supplies of the same commodity type from different State sources as imperfect substitutes.

In the levels of its variables, MRSMAE (like ORANI) is a nonlinear system. The solution method employed is that pioneered by Johansen (1960) (also adopted for ORANI) in which the equations are converted to their linear percentage-change form. The percentage-change form of the model can then be represented as

$$Az = 0 \tag{2.16}$$

where z is a $h \times 1$ vector of percentage-change variables and A is a $k \times h$ matrix of coefficients from the linear equations. For MRSMAE, the number of variables exceeds the number of equations (i.e., $h>k$). $h-k$ of the variables must be set exogenously. The values for the k endogenous variables are obtained via

$$z_1 = -A_1^{-1} A^2 z_2 \tag{2.17}$$

where z_1 is the $k \times 1$ vector of endogenous variables, z_2 is the $(h-k) \times 1$ vector of exogenous variables, and A_1 and A_2 are corresponding $k \times k$ and $k \times (h-k)$ submatrices of A. The coefficients of the matrix A for MRSMAE consist primarily of sales and cost shares computed from input-output data, and of various substitution parameters. Since inter-regional commodity flows are explicitly modelled, a multi-regional input-output data base was required. With the scanty regional data available, Liew (1981) used the method developed by Leontief and Strout (1963) together with the assumption of constant technology across the States to develop such a data base for Australia.

2.3 A comparison of the ORANI-LMPST disaggregation and MRSMAE

The main differences between the regional models discussed in the previous two subsections can be classified under three headings (i) the treatment of supply constraints, (ii) the modelling of demand factors, and (iii) the range of issues which are amenable to analysis.

(i) Supply constraints

The ORANI-LMPST disaggregation produces State-level results without modelling State-specific factors for any industry. Industry-output projections are generated at the economy-wide level from ORANI, accounting for a variety of economy-wide supply and demand factors, including industry-specific supply constraints (e.g., industry-specific land and capital supplied). The State location of "national-industry" outputs is entirely exogenous, whilst State outputs for the "local" industries are determined by demand factors alone, via State input-output computations. The latter implicitly employ the assumption that factor-price changes are constant across States (see p.6, footnote 11), i.e., that primary factors are mobile between States.

A central characteristic of MRSMAE, on the other hand, is that the State outputs of the model's industries are determined simultaneously, by supply and demand factors all of which are explicitly specified at the State level. These can include State-specific, as well as industry-specific, supply constraints. In generating the results discussed later in this subsection, supplies of agricultural land were assumed to be industry- and State-specific, buildings were State-specific but mobile between industries, and both labour and machines were in excess supply.

(ii) Demand factors

Using the ORANI-LMPST method, no information is required about the regional structure of demand for the products of national industries because the location pattern of output changes for these industries is assumed to be independent of changes in the regional pattern of demand. For the outputs of local industries, only intra-State demand is allowed. MRSMAE contains a detailed modelling of the State pattern of demand for the outputs of all industries, founded on the assumption that users of commodities in each State regard supplies of any commodity from each State as imperfect substitutes. In fact, the amount of inter-State demand included in the data base for MRSMAE for the products of those industries classified as local in ORANI-LMPST is very small.

(iii) Range of analysis possible

The ORANI-LMPST disaggregation facility was designed only to give projections of the effects at the State level of disturbances originating at the economy-wide level. Events at the State level have no feedback to the economy-wide results using this method. It is therefore not possible to simulate the effects on the economy of disturbances originating at the State level. Limited scope for introducing State-specific aspects of exogenous changes under investigation does exist via the exogenous State allocation of output changes for the national industries. In generating the State results discussed later in this subsection, we in fact assumed that State's shares in the outputs of national industries were fixed. We could equally well have introduced exogenous changes in these shares.

MRSMAE, in contrast, is applicable to the analysis of disturbances arising at the State, as well as the economy-wide, level. Most of the model's variables have explicit State dimensions, and these State variables can be set exogenously, allowing the introduction of State-specific shocks. The interactive nature of the multi-regional model allows projections of the effects of such shocks on all States and on the economy as a whole.

In each of dimensions (i) - (iii) above the specification of MRSMAE appears theoretically superior to that of ORANI-LMPST. MRSMAE provides a more general treatment of regional factors and is able to address a wider range of regional policy issues. These advantages however are not costless. Adding the State dimension to a multi-sectoral model of the Australian economy expands the size of the model alarmingly. For example, if n industrial sector are to be distinguished, n^2 intermediate commodity flows must be explained in the economy-wide model. For a multi-regional model identifying the 6 Australian States, the number of interemdiate flows is $36n^2$. In order for the multi-regional version to remain manageable, some sacrifice is usually required, as compared to the economy-wide model, in the degree of detail with which inter-industry relationships are modelled. MRSMAE, for example, distinguishes only 30 industrial sectors whereas ORANI-LMPST has more than 100. In addition ORANI allows for multi-product industries, contains a detailed modelling of the relationship between producers' and purchasers' prices, and allocates investment across investing industries endogenously. None of these features is included in MRSMAE.

A related problem with the multi-regional model is its heavy demand for regional data, especially data on inter-regional commodity flows. No consistent set of data from primary sources on inter-regional flows is available for the Australian economy. As explained in subsection 2.2, Liew had to resort to gravity methods to generate the required data.

Finally in this subsection we compare some results from MRSMAE and ORANI-LMPST. Table 2.1 contains results from the two models showing the projected effects of a 25 per cent across-the-board tariff increase on gross products and aggregate employment in each State and for Australia as a whole. The simulations from which these results are taken are described in detail in Liew (1981, chapter 5) (for the case of MRSMAE) and DPSV, chapter 7 (for the case of ORANI-LMPST). The assumptions concerning the economic environment for the economy as a whole are broadly similar. In both cases capital constraints were imposed, although for the MRSMAE simulations these are region- (but not industry-) specific, whereas in ORANI they are industry-specific. Labour markets were assumed slack and real wages fixed in both sets of simulations. Another assumption common to all the simulations is that changes in State consumption shares fully reflect changes in State shares in labour income.[12] For ORANI aggregate domestic absorption was held fixed. In the MRSMAE simulation the consumption portion of aggregate absorption will have changed in proportion to the economy's aggregate gross product. As can be seen from the table, only a small change in GNP is projected, hence only a small change in aggregate absorption is experienced.[13]

12. The parameters γ_ℓ^r in equation (2.10) were all set equal to 1.

13. This should not be taken to imply that the costs of protection are small. See Dixon (1978).

TABLE 2.1 PROJECTED PERCENTAGE EFFECTS OF A 25 PER CENT, ACROSS-THE-BOARD TARIFF INCREASE ON GROSS STATE PRODUCTS AND INDICIES OF AGGREGATE EMPLOYMENT FROM MRSMAE AND ORANI-LMPST.

State	Projections from MRSMAE[a]		Projections from ORANI-LMPST[b]	
	Gross Product	Index of Aggregate Employment	Gross Product	Index of Aggregate Employment
New South Wales[c]	-0.06	-0.09	-0.11	-0.18
Victoria	0.00	0.27	0.41	0.38
Queensland	-0.10	-0.48	-0.90	-1.06
South Australia[d]	-0.03	0.06	-0.06	-0.13
Western Australia	-0.13	-0.72	-0.66	-0.84
Tasmania	-0.07	-0.31	-0.53	-0.65
Australia	-0.05	-0.08	-0.12	-0.19

(a) Extracted from Liew (1981), Table 8.7.

(b) Extracted from DPSV, Table 45.7.

(c) Includes the Australian Capital Territory.

(d) Includes the Northern Territory.

Both sets of projections suggest that, due to the severity of the cost-price squeeze on the export sector, the tariff increase will cause a small fall in aggregate employment and gross product. The rankings of the State results are very similar in both models. Both project output and employment gains for Victoria (the State with the heaviest concentration of import-competing industries) and losses in all other States, especially Queensland and Western Australia (both of which rely heavily on export activities). In all projections the performance of New South Wales is close to that of the economy as a whole. This is because the economy of New South Wales constitutes a large share of the national economy and is very diversified.

The major difference between the two sets of projections in Table 2.1 is that there is considerably less diversity across States in the gross-state-product results from MRSMAE than in those from ORANI-LMPST. This is explained by the existence of State-specific factor constraints in MRSMAE. The implicit aggregate State supply curves are therefore less elastic in MRSMAE than in ORANI-LMPST. The greater richness available from MRSMAE in explaining output results for individual industries at the State level is not revealed by the aggregate variables presented in the table.

3. A PRELIMINARY TASMANIAN VERSION OF ORANI

3.1 A hybrid bottoms-up, tops-down strategy

In subsection 2.3 we noted that both strands of ORANI-based regional modelling developed to date have some unsatisfactory characteristics. The added complication of the regional dimension in Liew's MRSMAE force some compromises with respect to the range of inter-industry phenomena which could be accommodated. Primary data are not available to support a complete multi-regional model for Australia, even at the 6-State level of regional disaggregation. On the other hand, the ORANI-LMPST package accounts for only a limited range of regional forces, in particular it has nothing to say about the regional location of output changes for those industries classified as national. At the same time it was shown that, for one important issue (namely the effects of across-the-board tariff changes), the broad features of the State results were not fundamentally changed by using the full multi-regional approach (MRSMAE) rather than the theoretically less satisfactory tops-down regional disaggregation (ORANI-LMPST). In this section we will describe how we are taking advantage of the scope for making piecemeal modifications in ORANI[14] to introduce more region-specific characteristics into the model. At the same time the formal tops-down structure of the ORANI-LMPST procedures is retained to complete and summarize State projections.

The key to the inclusion of regional detail in ORANI is the recognition that there is nothing in the model's theoretical design

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14. See P.2 above. The point is discussed in more detail in DPSV, subsections 1.8, 8.2 and 36.2.

which dictates that its industries must be defined only by conventional input-output classifications - regional criteria are equally acceptable. The first development of this kind with ORANI was the respecification of the model's agricultural sector. The product based input-output definitions of agricultural industries were replaced by definitions based on the Bureau of Agricultural Economics geographical zone categories. In the new definitions, the pastoral-zone, the wheat-sheep zone, the high-rainfall zone, and northern beef production are identified as agricultural industries.[15] The development described in this section employs available Tasmanian input-output data[16] to distinguish some separate Tasmanian industries in ORANI, each with their own State-specific sales patterns, cost structures, etc. The aim is to produce a version of ORANI specifically designed for use in policy analysis for the Tasmanian economy. This version emphasizes the interaction of the Tasmanian with the national economy and is especially useful for the analysis of the impact of economy-wide disturbances on the State.

In terms of the ORANI-LMPST procedure described in subsection 2.1, we have cut into stage one of the package and modified the economy-wide model by separating out some selected Tasmanian "national" industries from the respective economy-wide industries. For example, instead of having an economy-wide industry called Other Farming Export we have split this industry into two sub-industries, Other Farming Export Mainland and Other Farming Export Tasmania. What happens to Other Farming Export Tasmania in response to some economic shock now depends on the Tasmania-specific sales pattern and technological characteristics of the Tasmanian component of Other Farming Export. Stages two and three of the ORANI-LMPST package can then be computed as before, except that for the new Tasmanian national industries, the allocation of output changes to the State ceases to be arbitrary.[17] For example, the change for Other Farming Export Tasmania is allocated entirely to Tasmania and that for Other Farming Export Mainland entirely to the mainland States. Previously the response of the Other Farming Export industry in Tasmania would have been determined in ORANI-LMPST with no allowance for the differences between sales patterns, technological characteristics, etc., of the Tasmanian and mainland components. Yet, such differences can be quite large (as will be shown in section 3.2) and may be expected to cause differences in the responses of the

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15. See Dixon, Parmenter, Powell and Vincent (1979). The regional implications of this development and its potential for future extension were discussed in Dixon, Parmenter and Vincent (1978).

16. See Edwards (1977) and Edwards et al.(1981). An important feature of these data from the point of view of multi-regional modelling is that they employ ASIC-based industry classifications, and definitions which are broadly compatible with those used by the Australian Bureau of Statistics in the preparation of its national input-output accounts. In our study, Edwards' 1968/9 data were used to disaggregate ORANI data based on the ABS tables for the same year (see ABS, 1977).

17. In subsection 2.1 we argued that stage 3 of our procedure can, for geographical reasons, be expected to produce reliable State results for the local industries.

Tasmanian and mainland industries to economic disturbances. Results from our Tasmanian version of ORANI will indicate the likely extent of these differences.

3.2 Criteria for the separation of Tasmanian national industries

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.[18] We will do just as well, therefore, by assuming that Tasmania retains a constant share in the industry's economy-wide output (cf. equation (2.2)). 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.

For the purposes of this preliminary Tasmanian version of ORANI, time and computing constraints have forced us to minimize the changes made to the structure of the model. In particular, the range of region-specific phenomena accounted for in the preliminary model is limited because

(i) no attempt has been made to accommodate region-specific primary factor supplies except to the extent that industry-specific factors are included for regionally defined industries;

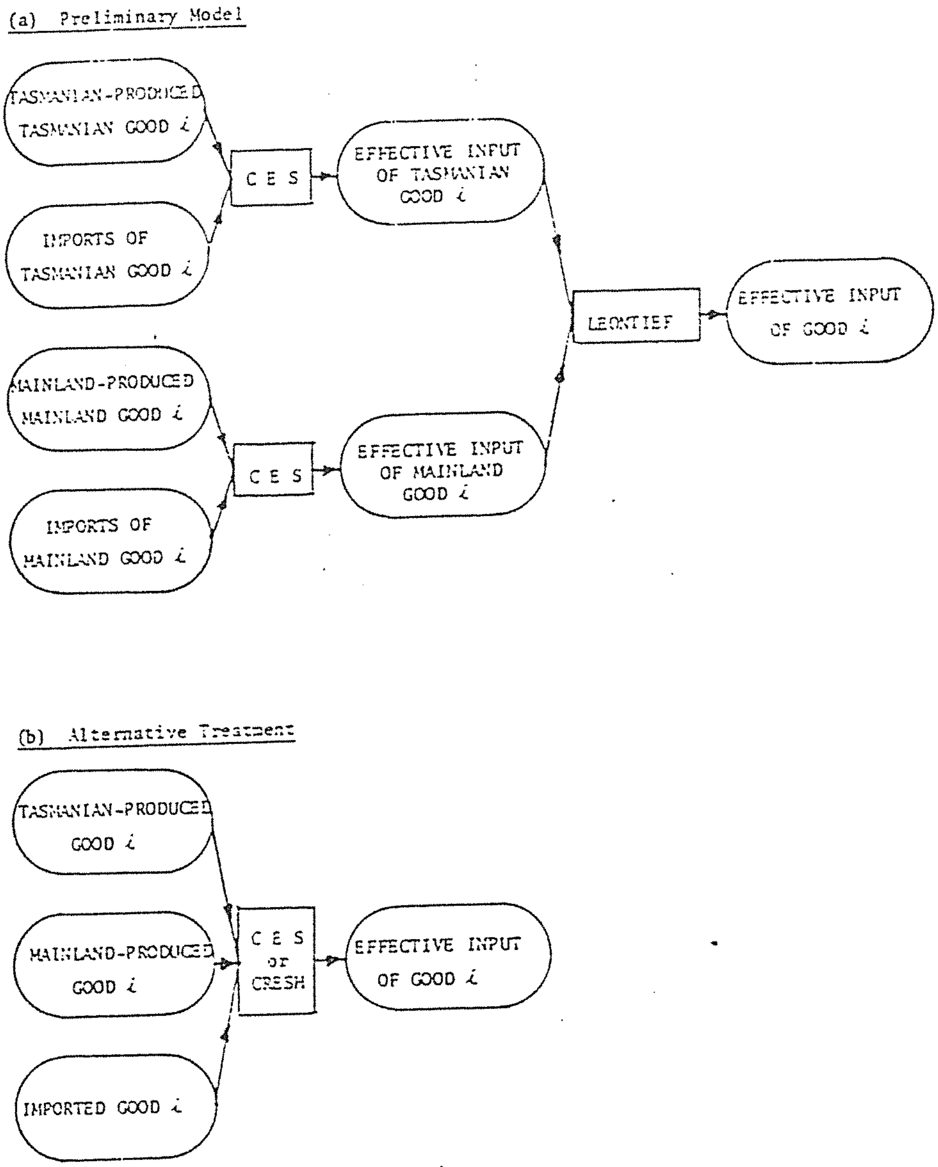
and

(ii) except for households, users of good i (say) are not allowed to substitute directly between supplies from Tasmanian and mainland sources. The structure of industry j's demand for the outputs of the regionally defined industries which is dictated by the existing ORANI theory is illustrated in Figure 3.1, part (a). Both Tasmanian-produced good i and mainland-produced good i compete with imports of good i (according to separate CES substitution possibilities), but not with each other. We have split the imports of good i in the ORANI data base into imports competing with Tasmanian-produced and mainland-produced good i so as to give each user the same import share in his effective usage of Tasmanian good i as he has in his effective usage of mainland good i.[19] Note that, notwithstanding

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

19. The two substitution elasticities have also been set equal.

FIGURE 3.1 POSSIBLE DEMAND STRUCTURES FOR INDUSTRY j IN A TASMANIAN VERSION OF ORANI



the absence of direct substitution possibilities, the share of Tasmanian production relative to that of mainland production in a user's effective usage of good i will change if their relative prices change. The reason is that the extent to which imports displace Tasmanian production will differ from the extent to which they displace mainland production. A preferable specification, similar to that used in MRSMAE, is illustrated in part (b) of Figure 3.1. Here, inputs of good i from all three sources are allowed to be substituted directly for each other. Such a treatment could be incorporated in future versions of the Tasmanian model.

Given these limitations, differences in the responses of regionally defined industries in ORANI will be caused primarily by differences in sales patterns, especially export shares, and by differences in labour shares in total primary costs. After examining these factors, we chose 6 industries[20] for which to make the Tasmania-mainland disaggregations in the preliminary model. These are listed in Table 3.1 together with the relevant export and labour shares. In total these 6 industries account for about 35 per cent of total value added in Tasmanian national industries.

3.3 Data requirements

The input-output data-base for ORANI is illustrated in Figure 3.2. The data requirements of the version of ORANI used for this paper are simplified by the fact that only 8 commodities are used as margins services in the data base, and because only the totals down the columns of the pairs of matrices $(\tilde{K}_i, \tilde{P}_i)$ and $(\tilde{L}_i, \tilde{Q}_i)$ for the non-zero mark-up commodities are required, not the full matrices. For each of the 6 regionally disaggregated industries in the Tasmanian version, we need a disaggregation of all the required elements in the relevant columns of $\tilde{A}$, $\tilde{F}$, $\tilde{K}_1$, $\tilde{P}_1, \ldots \tilde{K}_{g+1}, \tilde{P}_{g+1}, \tilde{U}, \tilde{V}, \tilde{W}, \tilde{X}$ and $\tilde{B}$, $\tilde{G}$, $\tilde{L}_1$, $\tilde{Q}_1, \ldots, \tilde{L}_{g+1}, \tilde{Q}_{g+1}$. We also require disaggregations of the relevant rows (i.e., those corresponding to the outputs of the split industries[21]) of $\tilde{A}$, $\tilde{B}$, $\tilde{C}$, $\tilde{D}$ and $\tilde{E}$. The corresponding rows of the matrices ($\tilde{F}$, $\tilde{G}$, $\tilde{H}$, and $\tilde{J}$) are split so as to maintain the constant input shares described in subsection 3.2, part (ii). The rows of $\tilde{Z}$ were split in proportion to the splits in the row totals of the four imports matrices. The rows and columns of $\tilde{Y}$ were also disaggregated.

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20. A further reason for limiting the number of industries chosen was that, for computing simplicity, we did not wish to change the dimensions of the model. For each new industry distinguished, we made an offsetting aggregation elsewhere in the data base, mainly in the public-sector industries.

21. Note that all the split industries in the preliminary model are single-product industries.

TABLE 3.1. EXPORT AND LABOUR SHARES OF INDUSTRIES CHOSEN FOR TASMANIA-MAINLAND DISAGGREGATIONS

INDUSTRY	SHARE OF EXPORTS IN VALUE OF TOTAL OUTPUT		COST SHARE OF LABOUR IN TOTAL PRIMARY FACTORS	
	TASMANIA	MAINLAND	TASMANIA	MAINLAND
Other farming export	0.60	0.11	0.63	0.37
Fishing	0.27	0.52	0.58	0.46
Metallic minerals[(a)]	0.07	Iron 0.63 Other metallic minerals 0.38	0.42	Iron 0.10 Other metallic minerals 0.41
Milk products	0.23	0.11	0.59	0.53
Pulp, paper	0.05	0.01	0.49	0.70
Basic metal products[(b)]	0.33	Basic iron and steel 0.13 Other basic metals 0.29	0.41	Basic iron and steel 0.54 Other basic metals 0.34

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

(b) Under our classifications the Tasmanian Basic metal products industry contains both Basic iron and steel and Other basic metals.

Figure 3.2 : Input-Output Data Base for ORANI[a]

		Domestic industries (current production)	Final Demands: Domestic industries (capital formation)	Final Demands: Household cons'n.	Final Demands: Exports	Final Demands: Other		
		←h→	←h→	←1→	←1→	←1→		
Domestic commodities	g	$\bar{A}$	$\bar{B}$	$\bar{C}$	$\bar{D}$	$\bar{E}$	Row sums = total direct usage of domestic commodities	
Imports	g	$\bar{F}$	$\bar{G}$	$\bar{H}$	$\underline{0}$	$\bar{J}$	- Duty - $\bar{Z}$	Rows sums = total imports (c.i.f.)
Margin type 1: on domestic flows	g	$\bar{K}_1$	$\bar{L}_1$	$\bar{M}_1$	$\bar{N}_1$	$\bar{O}_1$	Row sums = total margin (type 1) on sales of each domestic commodity	
Margin type 1: on imports flows	g	$\bar{P}_1$	$\bar{Q}_1$	$\bar{R}_1$	$\underline{0}$	$\bar{T}_1$	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	$\bar{K}_{g+1}$	$\bar{L}_{g+1}$	$\bar{M}_{g+1}$	$\bar{N}_{g+1}$	$\bar{O}_{g+1}$	Row sums = total tax on sales of each domestic commodity	
Margin type g+1 (tax): on imports flows	g	$\bar{P}_{g+1}$	$\bar{Q}_{g+1}$	$\bar{R}_{g+1}$	$\underline{0}$	$\bar{T}_{g+1}$	Row sums = total tax on sales of each imported commodity	
Primary inputs: Labor	M	$\bar{U}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	$\underline{0}$		
Primary inputs: Capital	1	$\bar{V}$						
Primary inputs: Land	1	$\bar{W}$						
Other costs	1	$\bar{X}$						
		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	$\bar{Y}$ (Product-mix matrix)	Row sums = domestic output by commodity
		Column sums (of $\bar{Y}$) = output by industry	

(a) Reproduced from DPSV, Figure 25.1.

The required row and column-splits were made using information from Edwards' 1968/9 Tasmanian input output tables (see Edwards, 1977). In addition, numerous discretionary judgements were required on the part of the authors. The reasons for this include the following:

(i) Edwards' tables distinguish only 45 industrial sectors compared to 112 in ORANI;

(ii) interstate and overseas imports allocated to users in Edwards' tables are not distinguished by commodity category;

(iii) interstate exports are not allocated to users in Edwards' data;

(iv) interstate imports in the Edwards' data may include some overseas imports routed via the mainland and are valued cif, i.e., inclusive of trade and transport margins required in transferring them from the mainland;

(v) no data were available on the occupational structure of Tasmanian industries;

(vi) no data were available on the commodity structure of capital formation in Tasmanian industries.

In making these judgments we used information from various publications of the Tasmanian office of the ABS, from the 1977/8 input-output tables prepared by Edwards et al. (see Edwards et al., 1981), and from ORANI's economy-wide data base.[22]

4. CONCLUDING REMARKS

In this paper we have reported on recent progress in the development of a preliminary Tasmanian version of ORANI which we anticipate will be of use to economists requiring analysis of Tasmanian economic-policy issues, especially analysis of the effects of economy-wide disturbances on the Tasmanian economy. We have taken the view that, for this purpose, what is required is some detailed modelling of the structure of important sectors in the Tasmanian economy and of the interaction of Tasmanian industries with the mainland economy. Modelling the interaction of Tasmania with other Australian States individually (i.e., a full multi-regional framework) would seem to be of lesser importance.

In subsection 3.2, we identified a number of limitations in the theoretical structure underlying our preliminary model. ORANI is sufficiently flexible to be readily amenable to the modifications required to overcome these limitations in future versions of the

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22. For further details see Higgs, Parmenter, Rimmer and Liew (1981).

Tasmanian model. Additional detail about the Tasmanian economy could also be included. The strategy which we have employed is, of course, equally suitable for the development of versions of ORANI for any of the other Australian States. The main problem is data generation.

At this stage, computation of the preliminary Tasmanian model has not been completed. A section containing results of simulations with the model will be added to this paper as soon as they are completed.

REFERENCES

Australian Bureau of Statistics (1977), Australian National Accounts, Input-Output Tables 1968/69, Australian Government Publishing Service, Canberra.

Dixon, P.B., (1978), "Economies of Scale, Commodity Disaggregation and the Costs of Protection", Australian Economic Papers, 17, June, 63-80.

Dixon, P.B., B.R. Parmenter, A.A. Powell and D. Vincent (1979), "The Agricultural Sector of ORANI 78 : Theory, Data and Application", IMPACT Preliminary Working Paper, No.OP-25 mimeo, 78 pp.

Dixon, P.B., B.R. Parmenter, and J. Sutton (1978), "Spatial Disaggregation of ORANI Results : A Preliminary Analysis of the Impact of Protection at the State Level", Economic Analysis and Policy, 8, March, 35-86.

Dixon, P.B., B.R. Parmenter, J. Sutton and D. Vincent (1982), ORANI : A Multi-Sectoral Model of the Australian Economy, North-Holland Publishing Company, Amsterdam, forthcoming.

Dixon, P.B., B.R. Parmenter and D. Vincent (1978), "Regional Developments in the ORANI Model", Paper presented at the Third Meeting of the Australian and New Zealand Regional Science Association, Monash University, December.

Dixon, P.B., A.A.Powell and B.R.Parmenter (1979), Structural Adaptation in an Ailing Macroeconomy, Melbourne University Press, Melbourne.

Edwards, G.C. (1977), "An Input-Output Model of the Tasmanian Economy" in Mandeville, T.D. (ed), Proceedings of the Input-Output Workshop, Second Meeting of the Australian and New Zealand Section of the Regional Science Association.

Edwards, G.C., et al. (1981), "A 1977-78 Based Input-Output Model of the Tasmanian Economy", Centre for Regional Economic Analysis, University of Tasmania.

Higgs, P.J., B.R. Parmenter, R. Rimmer and L. Liew (1981) "The Data Base for the Preliminary Tasmanian Version of ORANI", IMPACT Research Memorandum, ORANI Module, November.

Industries Assistance Commission (1977), Structural Change and Economic Interdependence, Australian Government Publishing Service, Canberra, July.

Johansen, L. (1960), A Multi-Sectoral Study of Economic Growth, North-Holland Publishing Company, Amsterdam (2nd edition 1974).

Leontief, W., A. Morgan, K. Polenske, D. Simpson and E. Tower (1965) "The Economic Consequences - Industrial and Regional - of an Arms Cut", Review of Economics and Statistics, XLVII, August, 217-241.

Leontief, W. and A. Strout (1963), "Multi-regional Input-Output Analysis", in Barna T. (ed.), Structural Interdependence and Economic Development, McMillan, p.119-150.

Liew, L.H. (1981), A Multi-Regional, Multi-Sectoral General Equilibrium Model of the Australian Economy, unpublished Ph.D. thesis, Monash University, Melbourne.

Powell, A.A. (1977), The Impact Project : An Overview : First Progress Report of the IMPACT Project, Vol.I, Australian Government Publishing Service, Canberra.