FEDERAL: A Two-region Multisectoral Fiscal Model of the Australian Economy

by

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This thesis contains no material which has been accepted for the award of any other degree of diploma in any university, and, to the best of my knowledge and belief, contains no copy or paraphrase of material previously published or written by another person except when due reference is made in the text of the thesis.

J. K. Madden

ABSTRACT

This thesis is concerned with the construction and testing of a two-region computable general equilibrium (CGE) model. The model, entitled FEDERAL, is designed to allow detailed analysis of regional and national economic shocks within a federal economic system. Although containing some Australian institutional features, FEDERAL's theory could easily be adapted to another market-oriented economy which has a federal system.

The first chapter of the thesis outlines previous work in CGE regional modelling while Chapter 2 develops FEDERAL's theoretical structure, using the well-known ORANI model - as described in Dixon, Parmenter, Sutton and Vincent (1982) - as its starting point. The principal new features of FEDERAL are:

- it is a multi-regional model
- it contains extensive modelling of two tiers of government finance (i.e. Commonwealth and State)
- it contains detailed modelling of regional income.

The multi-regional form of FEDERAL adds a new layer of complexity as compared with ORANI. This is particularly the case with the modelling of margin industries (trade, transport and insurance). FEDERAL carries this detailed area of ORANI into full multi-regional complexity by modelling the provision of margin services supplied on the flow of each individual commodity in intraregional, interregional and international trade by each region of margin supply.

The modelling of two tiers of government introduces a vast array of Commonwealth and state taxes and subsidies affecting the decisions of economic agents in each region. FEDERAL also models in

detail current and capital expenditure by governments, transfers to persons, intergovernmental transfers and, via a set of receipts and outlays accounts, the three governments' borrowing requirements.

A feature of the modelling of regional disposable income is the track kept of foreign and interregional ownership of capital in each regional industry.

The third chapter outlines FEDERAL's data-base while Chapter 4 looks at the construction of the data-base for the 9-industry implemented version - the two regions being Tasmania, the state of interest, and mainland Australia. Techniques are devised to individually estimate each of the required 115 input-output data matrices.

Chapter 5 discusses testing the model's homogeneity properties and analyses the results of some illustrative simulations examining the effects of national (tariff) and regional (payroll tax) shocks. The results of these simulations are used to draw out key features of the model's structure.

The final chapter provides a brief overview and considers future research - both in terms of model applications and possible areas of improvement in the model's structure.

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I originally set out an approach to this thesis topic at the Macroeconometrics Modelling Workshop, a section of the Conference of Economists at the University of New South Wales, in May 1985. I subsequently gave a number of workshops on my thesis to the Workshop in Computer General Equilibrium Modelling at the University of Melbourne. These workshops covered the model's equation structure (September 1986), the model's data base (December 1987) and trial simulations (April 1989). I gave seminars on theoretical aspects of my model at the University of Tasmania in September 1987 (Labour Market Workshop) and October 1987 (Economics Department Seminar). I also put forward simulation results at the Econometrics Conference at the University of New England in July 1989. I would like to thank all participants at those seminars who gave helpful comments, in particular, Peter Higgs, Mark Horridge, Tony Meagher, Brian Parmenter and Alan Powell.

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CHAPTER 1

Relationship of FEDERAL to Existing Models

1.1 Introduction

This thesis is concerned with the construction and testing of a two-region computable general equilibrium (CGE) model of the Australian economy. The model, entitled FEDERAL, is designed to allow detailed analysis of regional and national economic shocks within the context of Australia's federal economic system. The key features of FEDERAL are outlined in section 1.3 of this chapter.

The model's theoretical structure, described in Chapter 2, does not rely on any particular choice for the model's two regions. Indeed there is nothing intrinsic in the model's theoretical structure limiting the choice of regions to two. However, subscript and superscript numbering and the method of calculating the model's coefficients and parameters, described in Chapter 3, allow only for two regions.

The two regions in the first version of FEDERAL (i.e. the version constructed for this thesis) are Tasmania, the region (or state) of interest, and the Australian mainland. The method of constructing the two-region input-output data-base for the model is described in Chapter 4. The implemented version of the model is known as FEDERAL (TASMAIN).[1]

In Chapter 5 we describe a number of illustrative applications to show FEDERAL's capabilities of simulating national and regional shocks and to demonstrate our understanding of the model's major mechanisms.

Chapter 6 reviews the value of the model in terms of how well it captures regional economic mechanisms and its capabilities for the analysis of regional shocks. A range of possible simulations to be undertaken in the future is discussed. A number of remaining model and data limitations are also considered, along with possible suggestions for removing some of these.

In the remainder of this chapter we consider the existing regional CGE models for Australia and their deficiencies, and discuss how the FEDERAL model has been designed to overcome these limitations.[2]

1.2. Regional General Equilibrium Models

There are three basic types of regional computable general equilibrium models. They are:

(i) Regional disaggregation attachment to models of the national economy ("top-down" models in the terminology of Klein and Glickman (1977));

(ii) Multi-regional model of the national economy ("bottom-up" models);

(iii) Stand-alone models of a sub-national region.

We deal with each of these in turn.

1.2.1 Top-Down Models

The top-down approach involves the sequential running of a model at the super-regional (usually national) level to obtain economy-wide results and then feeding these results into a second model which decomposes the national results into a set of regional results. The first publicly available regional general equilibrium model in Australia, ORANI-ORES, was of this sort (see Dixon, Parmenter and Sutton (1978)).

The economy-wide model ORANI is very well-known and we do not describe it here. For a brief description, see Higgs, Parmenter and Rimmer (1988), while a complete description of both ORANI and the ORES module is contained in Dixon, Parmenter, Sutton and Vincent (1982) - hereafter referred to as DPSV. ORES (ORANI Regional Equation System) is based on the method devised by Leontief, Morgan, Polenske, Simpson and Tower (1965) for disaggregating results from a national input-output model into regional results. Central to the method is a division of industries into two groups: national industries and local industries. National industries produce only national commodities, those which can be traded between regions (e.g. textiles, oil, metal products). Local industries produce only local commodities, that is commodities which are non-traded both internationally and interregionally (e.g. retail trade, building, water and sewerage, ready-mixed concrete). Major assumptions of ORES are that: regional shares in aggregate output of national industries remain constant; regional output of local industries are determined via regional market-clearing constraints for local commodities.[3]

These assumptions imply a very limited demand for regional data. Sales information is only required for local commodities and then only for intra-regional sales. Provided it is assumed that the same industry in each region possesses the same input-output technology and final demanders display no regional variation in commodity-usage patterns, the required information is available from the ORANI input-output data-base together with regional shares in: output by industry, commodity output, aggregate household consumption and exports and government expenditure by commodity.

As well as its small data demands, ORES has the advantage of being simple, possessing attractive aggregation properties (regional results are consistent with national results) and incorporating two factors likely to be very important in the determination of the regional distribution of the effects of national economic shocks. These factors are: (i) differences between regions in the industry composition of regional output, and (ii) intra-regional multiplier effects.

ORES, then, has many attractive features. On the other hand it is subject to several important limitations which need to be considered. The first limitation arises from the dichotomy between local and national industries. Though very advantageous in reducing regional data requirements, this dichotomy is sufficiently unrealistic to have some distorting effects on regional results. In regard to the local industries, the geographical nature of Australia does, indeed, result in a significant number of industries supplying the vast bulk of their output, though not normally all, to demanders within their own region, as the model assumes. This is a direct result of the fact that, in general, Australia's principal population centres are a long way from state boundaries - states being the regions in the working version of ORES.

On the other hand the assumption made in regard to the national industries that the regional output of an industry producing a national commodity is dependent only on that industry's output economy-wide is a major deficiency. The consequent independence of the regional (national) industry's output from any regional pattern of demand for its output provides a definite problem with the assumption for national industries. As Dixon, Parmenter and Sutton (1978, p. 50) point out, "The truth must be that the sales of industry i in region r depend to varying extents on shifts in the demands for good i in the different regions. For example, shifts in demand in region r or in regions physically close to region r are probably more influential in determining the sales from region r than demand shifts in distant regions." Furthermore we would expect any difference between regions in the share of fixed factors in the inputs of a national industry to result in changes in regional output shares for that industry following a shock to the system.

Another major problem with ORES, as pointed out by Dixon, Parmenter and Sutton (1978), is that there is no constraint on the mobility of capital across regions in the short run. In general, we would expect fixed capital in the form of plant and buildings to be immobile between regions, particularly in the short run. Changes in the rental price of capital for a particular industry would consequently vary across regions. However ORES does not allow for any variation in factor prices between regions. Rather the model assumes that labour-output ratios change by exactly the same percentage in each region and thus by implication so do capital-output ratios. Given no under-utilization of capital in a region, differences across regions in percentage changes in output of a particular (local) industry can only be accommodated by an implied movement between regions of the industry-specific capital stock. In the case of the industry, Ownership of Dwellings, for instance, regional differences in output changes would imply a movement of houses between the regions.

These problems do not necessarily prevent ORES from useful and quite satisfactory results for many simulations. In practice, the problem of inter-regionally mobile capital is serious only for the few local industries which are highly capital intensive (and then only in the short-run). Furthermore the distortions in regional employment results which arise from the deficiencies in the ORES model are likely to be partly offset due to a tendency of ORES to overestimate short-run output responses for local industries (see DPSV, pp. 266-267). A comparison of results from a miniature ORANI-ORES model with those from a miniature bottom-up model (not containing the ORES limitations just noted), undertaken by Parmenter, Pearson and Jagielski (1985) for a hypothetical data base, suggested that the ORANI-ORES results probably paint broadly the same picture as a bottom-up model would do, at least for certain shocks at the national level. As we shall see, results for the tariff experiment with FEDERAL give qualified support to that view.

However a problem with ORES of probably greater importance to regional analysts is that the module was designed purely to distribute regionally the effects of national economic shocks and is not well suited to examining the impact of economic shocks which occur at the regional level. Indeed, it was for some time generally thought that ORES was not useful at all for analysing shocks originating at the regional level. However, Madden, Challen and Hagger (1983a) introduced the device of adding shift variables to ORES to allow a regional shock to be formed by decomposing it, in a prior calculation, into a shock at the national level and shocks to the regional share shift variables.[4] This approach was used to analyse the effects of (i) a resources boom geographically located in particular states (Madden, Challen and Hagger (1983a)); (ii) an implementation of the Grants Commission's proposals for changes in state tax-sharing relativities (Madden, Challen and Hagger (1983b));

and (iii) a recession in the Tasmanian tourism industry (Hagger, Madden and Challen (1984)). The range of shocks which can be introduced by this method is, however, very limited and basically consists of shocks to various types of final demand by commodity.

1.2.2 Bottom-up Models

The limitations of ORANI-ORES discussed in the last section can be overcome through the use of a bottom-up approach, involving the explicit modelling of economic activity in the regions under analysis. With such an approach, the decisions of each economic agent (e.g. producers, consumers, investors etc.) in relation to output, purchases etc. in each region, are modelled conjointly, which means that such decisions are made simultaneously in a fully interdependent system. Information about the effects on national aggregates is obtained simply as an aggregation of the results for the separate regions.

A multi-regional model of the Australian economy was constructed by Liew (1981). The model, MRSMAE (a Multi-regional Multisectoral Model of the Australian Economy) is no longer in use. However, MRSMAE made an important contribution in "demonstrating the feasibility of building a regional model for Australia using the 'bottom-up' approach" (Liew (1981) p. 193). We now examine its key features, before considering some of its draw-backs.

In describing MRSMAE, Liew (1984, pp. 129-130) points out three key features. "We have," Liew says,

"(i) treated commodities of the same kind coming from different regions as imperfect substitutes and have modelled inter-regional commodity flows,

(ii) explicit regional specific factor supply constraints, thus allowing factor prices to vary across regions, and

(iii) allowed government policies and other exogenous factors originating at the regional level to affect national aggregates such as aggregate employment."

Liew constructed his model by reformulating the theoretical structure of ORANI to incorporate these features.[5] Although Liew builds the structure of MRSMAE from scratch, his reformulation can be seen as essentially amounting to a number of relatively straightforward additions to the model.

Firstly, he added to all production variables a state dimension (states being the regions in MRSMAE). Secondly, all demands for domestic commodities were treated as having a state dimension, with the economy-wide variable also being retained where required. Primary factor demands were also given a state dimension as were all prices which were to be allowed to vary across states.

It was, of course, necessary to model the new variables. This was substantially accomplished by the second step which involved extending the multi-level form in which producer and consumer problems are solved in ORANI. Thus, having chosen an effective input level of a particular domestic good, the producer then chooses how much of the good to source from each state in accordance with the substitution possibilities described by a CES function. Similarly consumers and foreigners treat domestically-sourced goods drawn from the various state sources as imperfect substitutes. Consumers (foreigners) choose a level of effective consumption (Australian exports) of a particular commodity and then minimize their cost of purchases over the various states subject to a CES relationship between consumption (exports) from those states.

Liew's final step was to introduce market clearing equations for the regionally specified commodities and those primary factors which were deemed to be immobile between states. Neither labour nor land was regarded as industry-specific and thus the prices of these factors do not include an industry dimension. However both of these factors were deemed to be immobile between states and thus separate price variables are required for each state.

The above outline relates only to Liew's major modelling steps. Examples of the more detailed steps are the addition of extra equations to create economy-wide price variables from the corresponding sets of regional price variables and equations to determine other aggregate variables. Furthermore Liew introduced a number of new features into his model. Particularly worthy of mention is the splitting of capital into machines and buildings. Machines are deemed mobile inter-state but not between industries, while the reverse applies to buildings which are mobile inter-industry but not inter-state.

As a regional model, MRSMAE is clearly superior to ORANI-ORES in the sense that none of the deficiencies in theoretical structure attributed to ORANI-ORES in section 1.2.1 are present in MRSMAE. However, some serious practical problems precluded MRSMAE from being implemented as a fully operational model. Unfortunately MRSMAE requires vast quantities of regional data. A fully integrated multi-state input-output table for Australia's six states is required. This involves not only input-output tables for all six states formed on a consistent basis, but also information on all interstate commodity flows broken down by state and sector of origin and destination. In addition the set of elasticities required is expanded enormously from the ORANI set. For instance, additional substitution elasticities between alternative state sources for material inputs are required for each industry in each state. In regard to the additional input-output data required, the existing tables for Australia's six states are incompatible, both as regards industry classification, elements of construction methodology and the data-base year. Furthermore there is almost a complete absence of the required interstate commodity flows. As a result Liew (1981, Chapter 3) was forced to use very mechanical methods in the construction of his input-output data base. He employed a gravity method developed by Leontief and Strout (1963), together with the assumption of no variation between each industry's technology across states. The absence of data which would have allowed for diversity in regional technology is likely to have seriously weakened MRSMAE's ability to provide results superior to those provided by ORANI-ORES. Furthermore, Liew was forced by lack of data and resources to simply infer values for the elasticities on the basis of the ORANI parameter file.

1.2.3 A Hybrid Approach

As we saw in the last section, while MRSMAE overcame the problems inherent in ORANI-ORES it introduced a new set of problems, largely associated with data limitations. In 1981 the IMPACT team developed the idea of a hybrid model to try to obtain the best features of both models while avoiding the worst. They constructed a prototype, ORANI-TAS, in order to demonstrate this idea using the Tasmanian economy as an example (see Higgs, Parmenter, Rimmer and Liew (1981)).[6]

ORANI-TAS is a hybrid model in the sense that it contains some of the "bottom-up" modelling features of MRSMAE but still contains some of the "top-down" features of ORANI-ORES. The essential idea behind ORANI-TAS is that, in contrast to MRSMAE, only some sectors of the model are given a regional dimension. This is done by explicitly modelling some elements of the Tasmanian economy within the framework of the economy-wide ORANI model. Certain industries and commodities are redefined as being region specific. These industries and commodities are split into a Tasmanian and Mainland component by a readjustment of the ORANI data base. No change to the structure of the ORANI equations is required. This regionalizing of certain industries introduces the "bottom-up" features of ORANI-TAS. The "top-down" features come from the fact that ORES must still be run as a subsequent step in order to obtain regional results for those industries which have not been disaggregated regionally in ORANI-TAS.

One important consequence of the development of ORANI-TAS was an increase in the range of shocks which could be introduced at the regional level. For instance, shocks were imposed to the labour costs of explicitly-modelled Tasmanian industries (Challen, Hagger and Madden (1983)) and to their technological structure (Madden and Challen (1983)). However, the number of explicitly-modelled regional industries was small in the proto-type ORANI-TAS model, and this formed a constraint on these type of shocks. This problem could be partly alleviated by regionalizing all national industries. However, there would seem little point in regionalizing the local industries. If all industries were split into Tasmanian and mainland there would exist a significant degree of geographical modelling of commodity demands in ORANI-TAS. However this would only cover intermediate demands and a significant proportion of "local" commodities sales goes to final demand which would not be modelled on a regional basis.[7] It would seem that ORES which contains a regional balance constraint for local industries and which incorporates a link between regional household consumption and regional income, provides a better way of modelling the local industries and thus ORES should be retained as a regional disaggregation package for ORANI-TAS to provide results for these industries.

Thus, ORANI-TAS(-ORES) still contains those limitations surrounding the modelling of local industries contained in ORES. In particular, substantial limitations still exist in the ability to use ORANI-TAS for analysing regional shocks. A completely regionalized model, containing inter alia regional aggregate variables and regional macro indices, would allow for a much fuller range of regional shocks and provide a considerably more comprehensive set of regional results.

1.2.4 Single-Region Models

Stand-alone models (usually input-output) have been the most common type of inter-industry model used to analyse sub-national economies. For small open economies which are unlikely to have a significant impact on other regions in their nation a single-region model would seem to offer considerable savings in model construction without significant limitations compared to a multi-regional model. An example of a single-region CGE model is that by Norrie and Percy (1983) for the Canadian prairie economy.

During the time the FEDERAL model was being constructed, the Institute of Applied Economics and Social Research was constructing a single-region model of the Northern Territory, ORANI-NT (see Parmenter and Meagher (1987)). The Northern Territory is only about a third the size of the Tasmanian economy and much less diversified. Feedback from the Northern Territory to the rest of the economy is likely to be minimal and thus there is good justification for the construction of a single-region model.

Tasmania is also a very small economy and would therefore seem a possible candidate for a single-region model. However, the case for the other states being modelled as single regions is less convincing, particularly for the larger states of New South Wales and Victoria where feedback effects are likely to be quite significant.

FEDERAL was built as a general regional model which could be used to analyse any state, once an appropriate FEDERAL data base had been constructed for that state. There was clearly therefore a need that it be multiregional. Furthermore, although the present implemented version, FEDERAL (TASMAIN), focusses on Tasmania, the smallest Australian state with less than three per cent of Australian GDP, there are definite advantages in it being a multiregional model. For instance, the effort in simulating the Tasmanian effects of national shocks is considerably eased. With a single-region model it would be necessary to first run an ORANI experiment to obtain economy-wide results which could be used to set values exogenously for the Tasmanian model. Multiregional FEDERAL (TASMAIN) presents a much cleaner approach.

This advantage would not have been sufficient to justify the effort of multiregional modelling if the intention had been to design a specifically Tasmanian model. This, however, was not the case. FEDERAL (TASMAIN) is a prototype for versions focussing on the larger states where the full advantages of multiregional modelling can be reaped.

1.3. FEDERAL

Like the hybrid model, FEDERAL seeks to gain the advantages of "bottom-up" modelling without the data problems associated with MRSMAE. The approach to achieving this was the specification of two regions rather than six. Madden (1985) demonstrated that provided an ASIC-based state input-output table, with vectors of interstate imports and exports, was available, the methods used to create the required input-output data for regionalized industries in ORANI-TAS could be used to disaggregate the ORANI input-output data base into a two-region input-output data base. Although it will become clear in Chapter 4 that this is a non-trivial task, the end result is a multi-regional data base that does contain region-specific technologies and sales patterns.

In addition to these data-base advantages FEDERAL contains the following key new features:

- it carries ORANI into its full multi-regional complexity
- it contains extensive modelling of two tiers of government
- it contains detailed modelling of regional income.

Liew's model was developed from the first version of ORANI and did not allow for multi-product industries or technological change. Although these features are not incorporated in the implemented nine-industry version of FEDERAL, they are incorporated into FEDERAL's theoretical structure as described in Chapter 2. Furthermore, in implementing MRSMAE, Liew in order to reduce computation burdens simplified the ORANI modelling of margins and sales taxes. The demand for margins was treated the same as the demand for any other good (DPSV (1982, p. 106) outline the theoretical problems of this approach) and the percentage changes in purchasers' prices were equated with the percentage changes in the corresponding basic prices. FEDERAL, on the other hand, carries the detailed modelling of margins and sales taxes in ORANI into their full multi-regional complexity. It separately models the provision of margin services supplied on the flow of each individual commodity in intraregional, interregional and international trade by each region of margin supply. Furthermore, MRSMAE omits ORANI's investment theory while FEDERAL again carries this aspect of ORANI into its multi-regional form.

The modelling of two tiers of government in FEDERAL introduces a further degree of complexity in the modelling of sales taxes. State governments levy "sales" taxes on commodities purchased in their regions, in addition to sales taxes imposed by the Commonwealth government. Industry costs are affected by state and Commonwealth governments imposition of production taxes and state governments imposition of payroll taxes. Consumption and investment decisions are affected by state land taxes, while Commonwealth PAYE taxes affect consumption and can affect wage costs; and other income taxes affect both consumption and investment decisions. Following the example of the NAGA model (see Meagher and Parmenter (1985)), FEDERAL models government accounts; in this case the outlays and receipts of three separate governments - the Commonwealth government and two state governments. A full list of all receipts modelled can be obtained from Table 5.17, while Commonwealth government outlays cover both current and capital expenditure, unemployment benefits, grants to the states, transfers to persons and other outlays. Outlays by state governments cover current and capital expenditure, transfers to persons and other outlays.

In MRSMAE, consumption is linked only to regional labour income and an exogenous term for transfers to the region. By contrast, consumption in FEDERAL is linked to all regional disposable income including all net-factor incomes, transfer payments and endogenously-determined unemployment benefits. In modelling after-tax non-wage income of a region, track is kept of foreign and interregional ownership of capital and land in each regional industry.

On the other hand, FEDERAL does not break capital into industry-specific machines and region-specific buildings like MRSMAE, since, without knowledge of the substitutability of machines for buildings, there seemed to be little to be gained from this approach (see Liew (1981, p. 160)).

In summary, FEDERAL overcomes the data limitations of MRSMAE in relation to an interregional input-output data base. Data limitations remain in respect of various elasticities, but in this respect FEDERAL has the advantage over the tops-down approach in making all its regional elasticities explicit. FEDERAL is also a much more complex multi-regional model than MRSMAE in that it carries all of ORANI's theory into its full multi-regional form, and it contains extensive regional modelling of public finance and disposable income.

Chapter 2

The Structure of the FEDERAL Model

2.1. Introduction

This chapter develops the theoretical structure of FEDERAL. As noted in section 1.3 of the previous chapter, our starting point for FEDERAL is the ORANI model. Just as our model builds on ORANI, so too our explanation builds on DPSV. Our intention here is to aid readers already familiar with ORANI and also to keep our explanation as succinct as possible.

FEDERAL's equations can be broken into two groups. Firstly, there are those which deal with the theory of production, household consumption, exports and investment, plus the treatment of prices, market-clearing equations and certain macro indices and aggregates. FEDERAL's underlying theory for these equations differs little from ORANI except for alterations necessary to add a regional dimension and various tax terms. The second group of equations are concerned with explaining state and Commonwealth government finances and certain regional aggregates. These equations are based on various accounting relationships or indexing formulae.

Because of these features our task of explaining the FEDERAL equation structure can be greatly simplified. The derivation of the first group of equations in FEDERAL closely parallels the ORANI derivation. Full documentation of the derivation of the ORANI system of equations from normal neoclassical assumptions about the behaviour of economic agents is available from Chapter 3 of DPSV. Although the FEDERAL equations differ from the ORANI equations in that they contain a regional dimension with associated differences in underlying technology, etc. and some other additional features, the form of the equations is basically the same in both models and, as indicated, the same standard techniques are used in the derivation of the FEDERAL equations as were used with ORANI. The second group of equations by their very nature can be introduced in their percentage change form since the derivations from the levels form is straightforward. Consequently we provide little in the way of derivations in this thesis, but rather we examine the FEDERAL equations in their linearized form, considering the main assumptions underlying them and discussing the economic sense of each equation.

The linearized form of the FEDERAL equations is shown in Table 2.1 at the end of this chapter. FEDERAL, like ORANI, is a non-linear model in terms of the levels of the variables. The linear system is obtained by a process of logarithmic differentiation and is expressed in percentage rates of change of the variables.

The format of Table 2.1 has been arranged to correspond with that of Table 23.1 of DPSV. The notational conventions of DPSV have also been employed as much as possible. However as FEDERAL identifies considerably more variables and parameters than ORANI the range of symbols is necessarily greater and, due to the added regional dimension, the notational system is more involved.

It is particularly important to remember that, where variables are concerned, upper case letters are used to refer to the level of the variables. Table 2.1 contains only three such variables, the other upper case letters in the equations being coefficients. All the other variables in the linearized system are percentage changes and are represented by lower case letters. Thus in equation (2.1) z_j^r represents the percentage change in variable Z_j^r, i.e. $z_j^r = (dZ_j^r/Z_j^r)100$.

2.2. The FEDERAL Equation System

2.2.1 Current Production

2.2.1.1 Input Demands

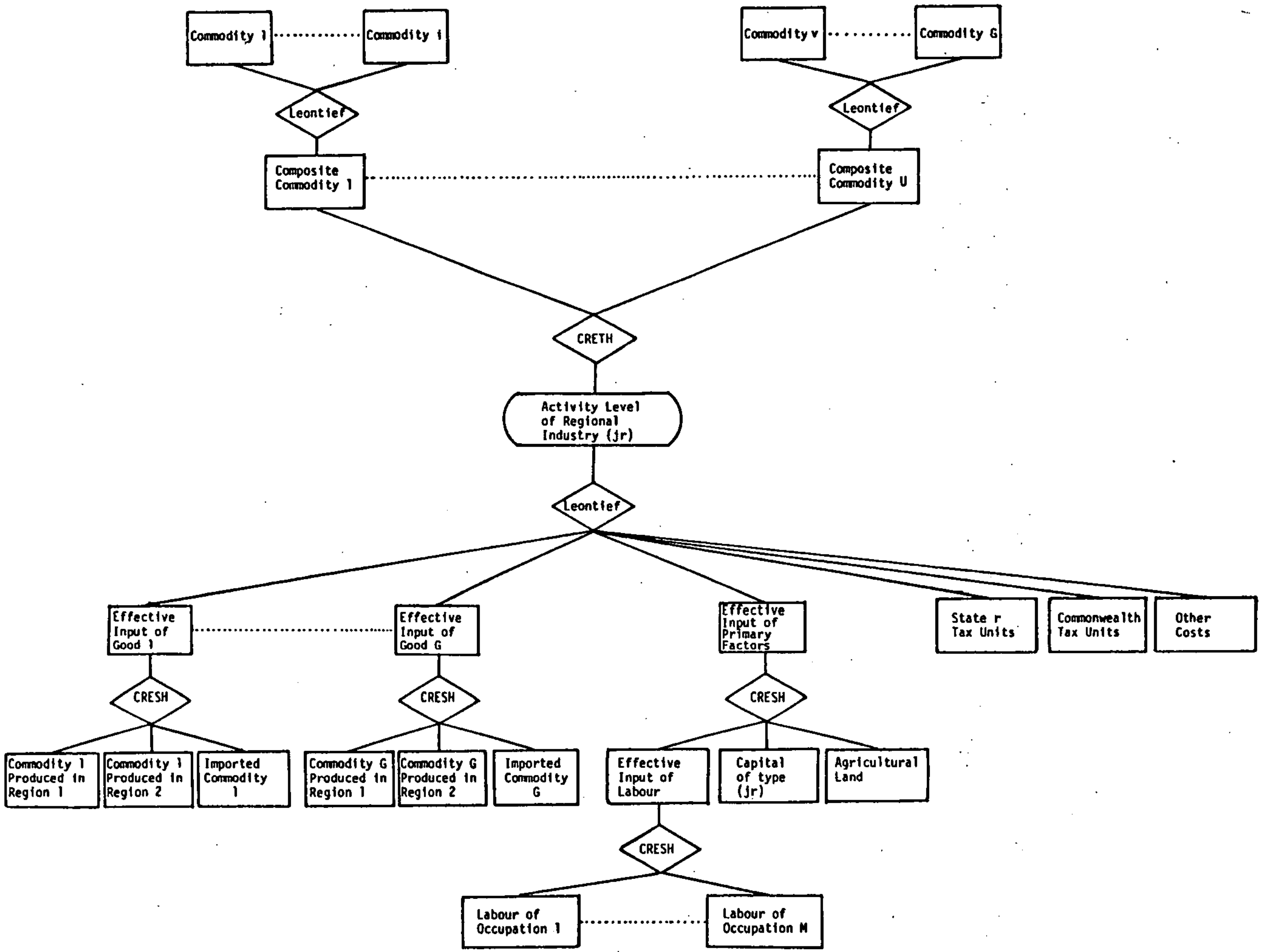
Equations (2.1) to (2.10) of Table 2.1 deal with current production of commodities. Those equations follow the form of equations (12.23) to (12.84) of ORANI with the difference in specification due to certain differences in production technology flowing from the added regional dimension.

The FEDERAL current production technology can be described by means of Figure 2.1. The production functions displayed there can best be broken into two halves. The top half of the diagram describes the technology for producing a range of commodity outputs from a particular activity level. The bottom half describes the input technology for producing an activity level. The activity level should be seen as a production possibility frontier, with an increased level of inputs leading to an expanded production possibilities set. Readers wishing to compare the ORANI technology for current production with that of FEDERAL can consult a similar diagram for ORANI in Figure 2.1 of Higgs (1986).

The input demand functions for current production by industry j in a particular region r, described in equations (2.1) to (2.6), are derived by assuming producers choose their inputs for a particular activity level so as to minimize costs subject to the production functions described in the lower half of Figure 2.1. Since input prices are assumed to be exogenous to any particular producer's activity level we find that input demands are a function

Figure 2.1

Current Production Technology in FEDERAL



of activity levels and, where substitution possibilities exist, relative prices. The actual form of each input demand equation flows from the assumed production technology which we now examine in a little more detail.

It can be seen that there are three levels of production functions. At the top level we find that effective inputs of produced commodities (e.g. fuel, steel, chemicals), effective inputs of primary factors, Commonwealth and State production taxes and certain "other cost" items are all required in fixed proportions. The term <u>effective</u> input of a particular type refers simply to any combination of sub-types of that input which provide a given level of productive capacity from the input. Thus we see nested into the top-level Leontief production function a number of second level non-linear functions which allow substitutability between sub-types of inputs within the broader input types. Thus the produced inputs of a given commodity i from the three geographical sources (region 1, region 2 and foreign) follow a CRESH function. Similarly effective units of primary factors are a CRESH combination of effective units of labour, regional-industry-specific capital and agricultural land. For labour we find a third level of technology with ten separate occupational classes of labour inputs also being governed by a CRESH function.

We are now able to look at each of the current-production input-demand equations in turn. Equation (2.1) describes the demand for produced inputs, $x_{(is)j}^{(1)r}$. Although Table 2.2 provides a description of all the variables in the system (and Table 3.2 all the coefficients and parameters), it is useful to explain the variable subscripts and superscripts of $x_{(is)j}^{(1)r}$ here. The (1) indicates that the demand is by a producer of current output. The r superscript tells us in which region the producer is located. The subscript i indicates which of the g commodities is being demanded and s tells us from which source (s = 1, 2 for commodities from the two domestic regions and s = 3 for an imported commodity). Finally the j indicates the industrial class to which the producer belongs.

Equation (2.1) has a quite straightforward economic interpretation which (like DPSV do for their corresponding equation) we give in detail. First consider the case where there is no technical change. This has the effect of assigning the value zero to all the "a" terms. Then, if the expression in the first set of brackets is also zero (i.e. regional industry (jr) faces no change in the relative prices of good i between the three alternative sources), a one per cent rise in Z_j^r results in a one percent rise in each of the $X_{(is)j}^{(1)r}$, $i = 1,\ldots,g$, $s = 1,2,3$. This result is a consequence of the constant returns to scale production functions employed in the underlying theory. Now consider the effect of a change in relative prices. $\sigma_{(is)j}^{(1)r}$ is a CRESH parameter reflecting the degree of substitutability between good i from source s and good i from the other two sources. The parameter restrictions on $\sigma_{(is)j}^{(1)r}$ ensure it is also a strictly positive number. Now, if for regional industry (jr) the price of good i from, say, source 1 rises relative to the average price of good i from the other two sources,[1] the expression in brackets in the appropriate equation explaining $x_{(i1)j}^{(1)r}$ will be strictly positive. Thus $X_{(i1)j}^{(1)r}$ will rise (fall) less (more) rapidly than Z_j^r. This will induce regional industry (jr) to substitute good i from at least one of the other two sources in place of region 1 sourced i. The degree of substitution away from source 1 depends on the value of its CRESH parameter for that good's sales to (jr).

The effect of changes in the technical change terms can best be seen by examining the case where there is no alteration in relative input prices (i.e. the expression in the first set of brackets is zero) and in (jr)'s activity levels (i.e. $z_j^r = 0$). Suppose Hicks-neutral technical change at the rate of 1 per cent is imposed by setting $a_j^{(1)r} = -1$, then (2.1) implies that regional industry (jr)'s demands for all 3g intermediate inputs will decline by one per cent.

Now suppose that a one per cent i-augmenting technical change is introduced by setting $a_{ij}^{(1)r} = -1$, then (jr)'s demands for intermediate inputs of good i from all three sources will decline by one per cent. Finally, consider the case where (is)-augmenting technical change is imposed. For instance, an (i1)-augmenting technical change could be imposed at the rate of one per cent by setting $a_{(i1)j}^{(1)r} = -1$. We see that jr's demand for good i from source 1 will change by $-(1 - \sigma_{(i1)j}^{(1)r}(1 - S_{(i1)j}^{*(1)r}))$. Recalling that $\sigma_{(i1)j}^{(1)r} > 0$ any fall in (jr)'s demand for input (i1) must be less than one per cent. That is, the (i1)-augmenting technical change causes some substitution of input (i1) for the other two input sources and it is possible that the substitution could be so strong as to cause the demand for input (i1) to actually rise. Input demands from the other two sources must fall by $\sigma_{(is)j}^{(1)r} S_{(i1)j}^{*(1)r}$ per cent $(s \neq 1)$.

Equations (2.2) to (2.4) deal with the inputs of State and Commonwealth production taxes and "other costs" (basically working capital) for current production. Since these inputs are assumed to be required in fixed proportion to activity we find that, for no change in technology, the percentage change in the demand for an input of this type is equal to the percentage change in the regional industry's activity level. Note that for equations (2.2) and (2.3), covering production taxes, there are no technological change terms since it is assumed that one tax ticket is always required for one unit of output. Note that in the case of the state government tax term, $x_{g+2,j}^{(1)r}$, only one regional superscript appears. This implies that state government production taxes can only be applied to regional industries located in the same region as the state government.

Equations (2.5) to (2.7) concern regional industries primary factor input demands for current production. Equation (2.5) determines the change in regional industry (jr)'s demand for the three basic types of primary factors, effective labour, fixed capital and land. In the absence of technical and relative price changes the percentage change in demand for these factors will be the same as the percentage change in activity levels. Changes in relative factor prices and technological coefficients will affect the demands for each primary factor in an analogous way to the determination of the demand for produced inputs from each of the three alternative souces via equation (2.1).

We recall from Figure 2.1 that an effective unit of labour is a CRESH combination of M types of occupations. Equation (2.6) determines the demand for labour by occupational class. We see that if there is no change in relative wage costs per unit of labour between labour types the demand for labour of each occupation changes in proportion to the total demand for labour. However, if regional industry (jr) was faced with wage costs per unit of labour which had (say) fallen for a particular occupational type q relative to the average wage costs for all labour types, equation (2.6) indicates that it would increase labour type q's share in its total labour inputs to a degree determined by the relative price movement and the CRESH parameter $\sigma^{(1)r}_{(g+1,1,q)j}$.

Equation (2.7) determines the regional industry wage rate for an effective unit of labour. In order to explain this equation we briefly consider some steps in its derivation. During the process of deriving equation (2.6) we find that the value of effective inputs of labour purchased by industry (jr) equals the sum of the values of labour inputs of each individual skill class purchased by (jr). That is,

$$P^{(1)r}_{(g+1,1)j}X^{(1)r}_{(g+1,1)j} = \sum_{q=1}^{M} P^{(1)r}_{(g+1,1,q)j}X^{(1)r}_{(g+1,1,q)j}$$

or in percentage change form

$$p^{(1)r}_{(g+1,1)j} = \sum_{q=1}^{M} p^{(1)r}_{(g+1,1,q)j}S^{(1)r}_{(g+1,1,q)j}$$

$$+ \sum_{q=1}^{M} x^{(1)r}_{(g+1,1,q)j}S^{(1)r}_{(g+1,1,q)j}$$

$$- x^{(1)r}_{(g+1,1)j}$$

In the absence of specific-skill-augmenting technical change the last two terms on the RHS of this equation - the percentage change in effective units of labour used by regional industry (jr) and the weighted average of the percentage changes in labour by skill group - cancel. In this case we therefore have $p^{(1)r}_{(g+1,1)j}$ equal to a weighted average of the percentage changes in the costs to regional industry (jr) of labour units for the M different skill groups. In the presence of specific-skill-augmenting technical change the last two terms on the RHS of the above equation differ by the weighted average of the percentage changes in the skill-augmenting technical change terms. Performing the appropriate substitution gives us equation (2.7).

2.2.1.2 Output Supplies

Equations (2.8) to (2.10) deal with the supply of commodities by each of the regional industries. Producers choose a particular mix of commodities so as to maximize their revenue from a particular activity level subject to the production technology described in the top section of Figure 2.1. We see that each regional industry produces a number of composite commodities which are combined according to a CRETH function. Composite commodities are then decomposed into commodities according to a Leontief function. The distinction between commodities and composite commodities was introduced into ORANI to overcome data problems and we maintain the distinction in FEDERAL to allow for the possibility that similar data problems might need to be overcome.

Equation (2.8) determines the percentage change in regional industry (jr)'s supply of composite commodities. In the absence of technological and relative price changes it will be equal to the percentage change in the regional industry's activity level. If the price of composite commodity u rises relative to a weighted average of the prices of all composite commodities produced by the regional industry the expression in brackets will be positive.[2] Since the coefficient, $\sigma^{(0)r}_{(u*)j}$, must always be positive to satisfy the CRETH parameters (i.e. a convex transformation function), the percentage change in the supply of composite commodity u will rise (fall) more (less) rapidly than (jr)'s activity level.

The first of the technical change terms on the RHS of (2.8) allows for a uniform change in the output of all composite commodities from (jr) for any given activity level of that regional industry. It is thus evident that the $a_j^{(0)r}$ term duplicates the role of the $a_j^{(1)r}$ term discussed under equation (2.1). The $a_{(u*)j}^{(0)r}$ terms allow for the possibility of composite-commodity-u-augmenting technical change.

Equation (2.9) determines the supply of commodities and follows directly from the Leontief relationship between commodities and composite commodities which constrains the revenue maximization problem. The supply of a commodity will move in proportion to the supply of the composite commodity to which it belongs unless technical change altering the commodity mix of the composite commodity occurs.

The percentage change in composite commodity prices appearing in equation (2.8) are determined in equation (2.10). $p_{(u*)j}^{(0)r}$ is a weighted share of the percentage change in the basic prices of the commodities which make up composite commodity u. Basic prices are the prices received by the producer and are explained in section 2.2.7. Each commodity has only one basic price which is common to each regional industry which might produce it and each user. The weight $S_{(ir)j}^{(0)}$ is the share of commodity i in the composite commodity u produced by regional industry (jr).[3] The technical change variables appear on the RHS of (2.10) for an analogous reason to that put forward above for the presence of technical change variables in equation (2.7).

2.2.2 Input Demands for Capital Formation

In FEDERAL we explicitly model three types of investment activity by each of the 2h regional industries. Regional industries can undertake private investment, state government investment and Commonwealth investment.[4] Thus we recognize the possibility of difference in the pattern of input requirements for capital formation not only across regional industries but also, for any regional industry, across these three classes of investors.

The distinction between classes of investors may be of fairly limited importance, since it is unlikely that, for any regional industry, the pattern of input requirements for capital formation would vary significantly across classes. Furthermore there is little in the way of currently available data to support the distinction. Thus the payoff for the inclusion of the large number of extra equations is likely to be very small or non-existent. However the cost of introducing the generalization is also small. Nevertheless, as noted in section 4.3.2.3, if data does become available for different patterns of capital formation by the three classes of investors, it will be necessary to alter the model's structure to distinguish between three classes of capital input into current production. Internal conflict within the model is avoided at present by allowing each industry to vary input technology across investor classes only in regards to sales tax payments.

An alternative approach would be to maintain equation (2.11) but replace equations (2.12) to (2.15) with a single equation which calculates y_j^r, redefined to cover regional industry capital formation by all investors, as the weighted sum of private

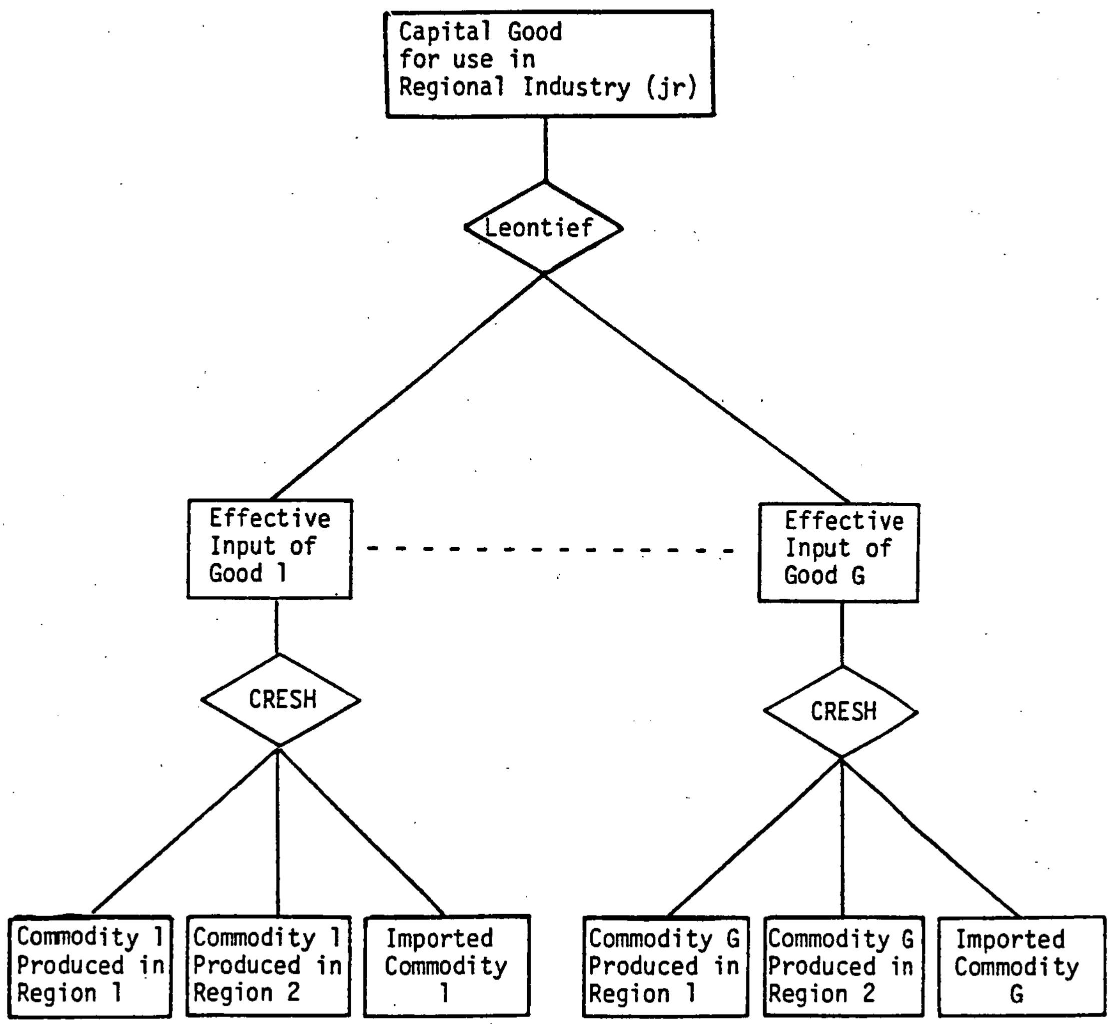
y_j^r, $y_j^{(5)r}$ and $y_j^{(6)}$. We would then drop equations (2.36) and (2.37) and assume $\pi_j^r = \pi_j^{(5)r} = \pi_j^{(6)}$. Equations (2.45) and (2.47) would also be redundant. The second terms of equations (2.97) and (2.111) could be replaced by one which was a weighted sum of the percentage industry changes in industry expenditures on capital investment by Commonwealth and state government investors respectively. This specification would still allow us to employ different theories for the allocation of investment across regional industries according to the class of investor, in the way outlined in section 2.2.8.

It will also be noted that in the case of investment by the Commonwealth government we do not explicitly model the distribution of investment across regions. This is in line with our original concept of FEDERAL which had the Commonwealth government not regionally located but able to alter the pattern of its demand for commodities across regions. However in our capital accumulation equation (see section 2.2.8) we must assume no change in the regional distribution of Commonwealth investment across regional industries. We intend to remove this restriction in the next version of FEDERAL by explicitly modelling the regional location of Commonwealth government investment.

We assume that each investor minimizes the cost of assembling capital units subject to capital formation production functions of the type depicted in Figure 2.2. Note that no primary factors are involved in the assembling of capital units, although they can be seen as entering indirectly through inputs from the construction industry. The solution of a regional industry's capital formation problem parallels the problem of selecting produced inputs for current production. We thus find equations (2.11), (2.12) and (2.13) have the same form as equation (2.1). In

Figure 2.2

Technology for the Formation of Units of Fixed Capital in FEDERAL



the absence of relative price changes, equation (2.11) says that the percentage change in the demand for commodities from all sources for the purpose of private capital formation in regional industry (jr) is equal to the percentage change in (jr)'s private investment. A change in relative prices between sources will result in substitution towards the cheaper source(s). Equations (2.12) and (2.13) follow the same pattern.

The last two equations in this section, (2.14) and (2.15), are introduced to obtain the percentage change in the demand for each commodity by each government for investment purposes. This information is used in the calculation of government capital expenditure (see section 2.2.12 dealing with government budgets).

2.2.3 Household Demands

The first three equations of this section are concerned with the determination of regional household demands for each of the commodities from all three sources. Commodity demands are derived using the simplification of solving a utility maximization problem for a single representative household in each region. Thus we assume regional consumption will be allocated across commodities and sources to maximize average utility subject to an aggregate budget constraint and the assumption that demand by a regional household for an effective unit of commodity i is a CRESH combination of its demands for i from each of the three geographic sources.

The first of the resultant household demand equations, (2.16), says that, in the absence of relative price changes between sources, consumers in region r will change their demand for commodity i from source s in proportion to their demand for effective units of good i. With a change in relative prices between sources, regional consumers will substitute in favour of the cheaper sources.

Equation (2.17) determines the percentage change in the price to region r households of an effective unit of commodity i as a weighted sum of the percentage changes in the prices of commodity i to region r households from all three sources.

The LHS of equation (2.18) is equal to the percentage change in demand for an effective unit of commodity i by the average household in region r; q^r being the percentage change in the number of households in region r. Equation (2.18) shows that the percentage change in this demand is determined as a function of the percentage change in the nominal consumption expenditure of the average household in region r and relative price changes between different types of commodities (undifferentiated by source). ε_i^r can be seen to give the responsiveness of household demand for effective units of commodity i to a change in average household expenditure in the region and can therefore be interpreted as an expenditure elasticity. η_{ik}^r gives the responsivenes of household demands for effective units of commodity i to a change in the general price of good k. For $i = k$, η_{ik} can be interpreted as an own-price elasticity and for $i \neq k$ it can be interpreted as a cross-price elasticity. The elasticities obey homogeneity and symmetry restrictions and satisfy Engel's aggregation.

The number of households is normally taken as given. Unlike a change in aggregate nominal regional consumption, C^r, a change in Q^r will not initially effect total regional consumption but will alter the commodity composition of regional consumption. An exogenous rise in Q^r with no corresponding shock to C^r is equivalent to a fall in average regional income per household. We see from equation (2.18) that this will result in a decline in regional household demands for commodities for which expenditure elasticities are greater than unity and a rise in demand for those commodities for which ε_i^r is less than unity.

We have not dealt with the $a_i^{(3)r}$ and $a_{(is)}^{(3)r}$ terms on the RHS of (2.18). These are percentage changes in scaling parameters introduced to enable changes in commodity-i-augmenting and commodity-(is)-augmenting tastes of region r households.

Equation (2.19) relates total nominal regional consumption to total regional income. We assume

$$C^r = F_C^r D_1^r$$

where D_1^r is aggregate nominal disposable income of region r residents and F_C^r is the average propensity to consume in region r. Putting this equation in percentage change form we get equation (2.19).

We obtain the percentage change in real consumption in a region via equation (2.20). This equation is based on the assumption that real consumption in a region is equal to the region's nominal consumption divided by the FEDERAL index of consumer prices for that region.

The final equation in this section, equation (2.21), determines the percentage change in real consumption economy-wide as a weighted sum of the percentage changes in real consumption for each region.

2.2.4 Government Demands

Although a major rationale for the existence of the FEDERAL model is to examine the effects of government fiscal changes we have no well developed theory on how governments determine their demands for individual commodities. To a degree the size and composition of government demands could be considered to depend on the political market. In section 2.2.12 we do endogenize expenditure on unemployment benefits, for instance, in a way which makes intuitive economic sense. However, straightforward economic explanations of that kind do not appear to exist for current consumption expenditure. Equation (2.22) is based on the assumption that state governments will change the level of consumption of all commodities in line with real regional consumption. Equation (2.23) has a similar underlying assumption that changes in real Commonwealth government expenditure will be in line with changes in real consumption for the nation as a whole. The exact link between the percentage change in a government's real expenditure on a particular commodity (from a particular source) and the percentage change in the relevant real consumption variable is achieved through the value assigned to the appropriate h term. Exogenous changes in the total and pattern of a government's current consumption expenditure can be achieved by exogenously assigning non-zero values to the shift variables. The $f_{(is)}^{(5,1)r}$ and $f_{(is)}^{(6,1)}$ allow us to shift the percentage change in any particular government commodity expenditure while the other f's allow us to shift the expenditure of a single government uniformly or of all governments uniformly. The f's will normally be exogenous variables. However we may wish to make the percentage change in the public sector borrowing requirement of a particular government exogenous and we could then make the appropriate $f^{(5,1)r}$ or $f^{(6,1)}$ endogenous and allow the model to determine the required percentage change in that government's current expenditure. A useful future extension to FEDERAL would be the introduction of a shift variable common to the determination of a government's current expenditure and its capital expenditure.

2.2.5 Overseas Export Demands

The FEDERAL specification of overseas export demands are covered by equations (2.24) to (2.27). Equation (2.24) deals with the demand for Australian exports of a particular commodity, independent of the region in which it was produced. It is a linearization of assumed constant-elasticity demand functions. γ_i is the (non-negative) reciprocal of the foreign elasticity of demand for exports of commodity i from Australia in general. The variable, f_i^e, is a shift variable which allows for movements in the overseas export demand curves.

It is assumed that a unit of Australian export commodity i is a CES combination of exports of commodity i from the two domestic regions. Foreigners are assumed to decide the share of i they will buy from each region so as to minimize the cost of their total purchases of i from Australia subject to the CES constraint. This yields equation (2.25) which implies that if the relative cost of exports of i from both regions is fixed the percentage change in exports of i will be the same for both regions. However if the price of, say, exports of i from region 1 rise relative to those from region 2, foreigners will substitute in favour of the region 2 source. We explain the presence of the term, $f_{(ir)}^{(4)}$, on the right-hand side of (2.25), below.

Equation (2.26) merely explains the percentage change in the price of an effective unit of Australian export i as a weighted average of the price from the two regional sources.

Equations (2.24) to (2.26) are based on the assumption that export commodity i from region 1 and export commodity i from region

2 are commodities of basically the same type and are (imperfect) substitutes. However one may wish to create versions of FEDERAL which incorporate quite aggregated sectors where it is likely that there will often be very limited substitution possibilities between regional sources of exports of commodity i. In this case (and this is the case for our first version of FEDERAL implemented for this thesis) it is desirable that there be separate foreign export demand functions for each regional source of good i. Equation (2.27) allows for this. We can not, of course, have two competing explanations of $x^{(4)}_{(ir)}$. This is avoided by selecting, for each i, either the two $f^{(4)}_{(ir)}$'s or the two $f^{e}_{(ir)}$'s as endogenous, the other two being exogenous. Thus if we set the $f^{e}_{(ir)}$'s exogenously the $f^{(4)}_{(ir)}$'s would take on whatever values required for the $x^{(4)}_{(ir)}$'s determined by equation (2.25) to be consistent with those determined by equation (2.27).

2.2.6 Margin Demands

About one-fifth of value added generated in Australia occurs in the "margins" industries. These industries' outputs are required merely to enable the distribution of other commodities from producers to consumers and comprise wholesaling, retailing, transport and associated insurance costs. In section 17 of DPSV the reasons for treating demand for these commodities separately from direct demands are outlined. DPSV explain that two alternative methods for the treatment of margins are unsatisfactory. One method would be to treat margins on the sale of a commodity as a cost of production to the industry producing the commodity. Abstracting from the treatment of sales taxes this would be equivalent to valuing direct flows at purchasers' prices. The problem with this approach is that it fails to recognize that the amount of margin required to facilitate the flow of a commodity from producer to purchaser depends heavily on the nature of the purchaser. For instance, the retail trade margins required for sales of fruit and vegetables to householders are much greater than those required to sell the same product to fruit and vegetable processors. If retailing were treated as an input to the production of fresh fruit and vegetables the model would show no effect on retail trade activity of a switch in the pattern of demanders for fruit and vegetables from householders to processors. An alternative treatment of margins is to assume that purchasers treat them as just another commodity. This would work reasonably well for intermediate inputs provided that there was no technological change. However, imagine technological change which reduced a regional industry's requirement for coal. By treating margins as just another good the model would not capture an obvious reduction in the demand for transport. For consumer goods the problem would be compounded. FEDERAL does not allow substitution between material inputs but it does allow household consumers to substitute between commodities. Thus if demands for margins are treated no differently than demands for any other commodity a change in relative prices might induce a substitution of, say, wholesale trade for electrical goods.

A satisfactory explicit modelling of margins is, if anything, more important in a multi-regional model, such as FEDERAL, than it is in ORANI. The requirement for transport margins, for instance, will depend heavily on the location of buyer and purchaser. In FEDERAL not only can a region of purchase supply margins on overseas imports but it can also supply them on interstate imports. Thus the margin commodities form an important avenue of regional effects.

Equations (2.28) to (2.32) explain the demand for margins to facilitate flows of commodities from all sources to current producers, capital creators, household consumers, and state governments in both regions, while equations (2.31) and (2.32) deal with the use of margins for deliveries of domestic and imported goods to the Commonwealth government and the delivery of domestic goods to ports of export.

It is assumed for all classes of flows that, in the absence of technical change, margin flows are proportional to commodity flows. The "a" terms appear on the right hand side of the equations to allow for technological change such as improvements in the productivity of retailing or transport. For instance, a reduction in the requirements for margin commodity u from region t to facilitate the flow of commodity i from region s to regional industry (jr) for use in current production can be simulated by assigning a negative value to the term $a^{(is)(jr)1}_{(ut)}$.

2.2.7 Price Equations

Two broad types of prices appear in FEDERAL, basic prices and purchasers' prices. For domestic commodities the basic price is the price of the commodity received by the producer. For imports it is the price received by the Australian importer, including import duties but excluding the cost of delivery from the port of entry to the final user. Purchasers' prices include the margin on top of the basic price which covers the cost of delivery to the user together with any sales tax paid. It is necessary to form equations which give the relationship between the prices in these two broad sets and a number of other sets comprising foreign currency import and export prices and the prices of capital units.

The primary assumption used to form the price relationships is that of perfect competition. This implies that the suppliers of all commodities earn zero pure profits. A further aspect of the price equations is that while purchasers' prices for any commodity can vary across users, basic prices can not. We thus observe that the basic prices on the left hand side of equations (2.33) and (2.38) do not include user sub-scripts. Nor is there any producer sub-script as it is assumed that a commodity's price does not vary with its industry of origin.

The assumption of zero pure profits implies that an industry's total revenue is equal to the sum of its costs. We use this relationship to derive equations (2.33) and (2.34). If, in equation (2.33), a_j^r is equal to zero (no technical change) we have the percentage change in the basic prices of current commodities explained by a weighted sum of the percentage change in the prices of the various inputs used to produce them. The absence of output terms is a result of the constant returns to scale production function employed in FEDERAL. The $H_{(ir)j}^{0}$ terms on the left hand side are revenue shares and for a single-product industry are equal to zero for all i except for where i is equal to j, in which case the term is equal to unity. The H terms on the right hand side are cost shares and add to unity. The a_j^r term is a weighted sum of the percentage changes in the various technical-change coefficients in regional industry (jr)'s production function and is explained by equation (2.34). The weights on the right-hand side of (2.34) are revenue and cost shares which indicate the degree to which a particular technical change term which an H premultiplies will effect the costs or revenue of a unit of activity of regional industry (jr) at initial prices.

Equations (2.35) to (2.37) determine the percentage change in the unit price of capital in regional industries for private, state government and Commonwealth government investors respectively. Again, abstracting from the technical change terms, the percentage change in the price of a unit of capital in regional industry (jr) to a particular class of investor is a weighted sum of the percentage change in the price they pay for the inputs that they purchase in order to form capital. The weights, the H terms, are the cost shares of inputs in capital formation. Again, the weights associated with the technical change terms indicate the degree to which the associated "a" term will initially affect the cost of producing a unit of capital in the $(jr)^{th}$ industry for the particular class of investor.

The percentage change in the basic price of imports of commodity i is determined by equation (2.38) as a weighted sum of the percentage change in the foreign-currency c.i.f. price of i converted (by means of the exchange rate) to $A and the percentage change in the amount of duty payable in $A on each unit of i imported. $\zeta_1(i3,0)$ and $\zeta_2(i3,0)$ are the shares in the basic price of the c.i.f. price and the tariff respectively. Note that ϕ is the percentage change in the exchange rate of the $A per unit of foreign currency, so that a devaluation of Australia's currency by one per cent is equivalent to $\phi = 1$ (which, in the absence of changes to foreign-currency price and assuming g(i3,0) is unity via equation (2.39) will result in an increase in the basic price of the import by 1 per cent).[5]

The variable, g(i3,0) is explained in equation (2.39). This equation allows tariffs to be set in real, <u>ad valorem</u> or specific terms. Thus if $h_1(i3,0)$ were set at unity and the other two h's were set at zero, the amount of tariff levied on each unit of imported i would be set in real terms. Usually, however, $h_1(i3,0)$ would be set at zero and either $h_2(i3,0)$ would be set at unity with $h_3(i3,0)$ being set at zero or the reverse. For the former of these alternatives, the tariff on commodity i is an ad valorem one on the c.i.f. \$A import price. Thus the percentage change in the dollar amount payable on a unit of import of i will depend on percentage changes in the ad valorem tariff rate, the foreign currency import price and the exchange rate. For the latter alternative the percentage change in the dollar amount payable on a unit of import i is equal to the percentage change in the specific tariff rate.

It should be noted that in FEDERAL the interpretation of g(i3,0) is more restricted than the corresponding variable in ORANI. In that model it is possible to broadly interpret the variable as including not only tariffs but all trade restrictions which act to raise the price of imports. This is not possible in FEDERAL. If, for instance, we wished to model good i as being subject to a quota by assigning a value to g(i3,0) as if the variable was actually the percentage change in the tariff equivalent of the quota this would have the effect of directing the quota rent to the Commonwealth government (via equation (2.106)). This would only be sensible where the government sold the quota and was able to acquire the full quota rent (e.g. through a tender system). In general, therefore, to model quotas one would need to add an extra term to equation (2.38) that had the effect of changing the domestic price of imports of i and to alter appropriate equations to ensure that the quota rent affects at least disposable income and Commonwealth tax on that extra income but not the amount of tariff collections. One could, of course, simulate a change to voluntary restrictions of imports (where foreigners acquired the "quota" rent) by applying an appropriate shock to $p^{m}_{(i3)}$.

We turn now to a group of equations which determine the percentage change in prices paid by purchasers. In each case the percentage change in purchasers' prices is a weighted sum of the percentage changes in basic prices, the costs of the services of each of the margin commodities and, where payable, net taxes (or subsidies). This is consistent with our assumption of no pure profits in distribution. The percentage change in the cost of margin service u required to deliver a unit of good i from source s to regional industry (jr) for purpose k is the sum of the percentage change in the basic price of u and the percentage change in the amount of u required.[6] As was the case with tariffs we also include equations which allow for the flexible handling of taxes and subsidies. We commence discussion of this group of equations by considering the first two which deal with the foreign currency price before considering the remainder which concern the prices paid by domestic users.

Equation (2.40) explains the percentage change in the f.o.b. prices of exports of units of good i from region r in Australian dollars as a weighted sum of the percentages changes in the basic price of i produced in region r, Commonwealth government export taxes and the costs of margins services to deliver a unit of good i from the region r producer to the port of export. Looking at the LHS of the equation we see the percentage change in the commodity i f.o.b. export price in Australian dollars is written as the sum of the percentage changes in the foreign currency export price and the exchange rate. With regard to the RHS we note $\zeta_1(ir,4)$, $\zeta_2(ir,4)$ and $\zeta_3(ir,4)$ are the shares of the basic price, net export taxes and margins, respectively, in the \$A f.o.b. export price of good i produced in region r while the M's are the shares of each margin good in total margin services on the export of commodity (ir). If, for commodity i, the net amount of export tax is negative in the base year (i.e. there is an export subsidy) this will have the effect of causing $\zeta_2(ir,4)$ to be negative.

Equation (2.41) which explains g(ir,4) can be seen to have basically the same form as equation (2.39) and thus equation (2.41) allows export taxes and subsidies to be determined in real, ad valorem or specific terms.

One may note that both the overseas export demand equations and equations (2.40) and (2.41) run over all g commodities (for both regions). These equations may appear to be inconsistent for those commodities for which we wish exports to be exogenous. However by treating export taxes as specific and making both g(ir,4) and v(io,4) endogenous (or if we are employing the alternative overseas export demand specification outlined in section 2.2.5, v(ir,4) is endogenous and v(i0,4) exogenous) we can solve for whatever percentage change in export tax or subsidy might be required to produce a required exogenous percentage change in export volumes of (ir). For many exogenous export commodities, those which are non-exportables (or for which exports make up an insignificant part of sales) this is simply a modelling device and we would not wish the change in net tax expenditure to enter the Commonwealth Government receipts equations. We prevent this unwanted effect in equation (2.109) by providing a parameter which allows the user to give changes in export taxes on particular commodities a weight in

Commonwealth government export receipts of zero. (The matter turns out to be slightly more complex; see sections 2.2.12.1.2 and 2.2.13 for details.)

We turn now to the determination of prices payable by domestic purchasers. Equation (2.42) determines the prices paid for good (is) by regional industry (jr) for use in current production (k= 1) and private capital formation (k = 2) while equation (2.43) deals with prices paid by regional consumers. The next two equations concern the prices paid by State governments. Equation (2.44) deals with the prices paid for expenditure on commodities for current consumption and equation (2.45) relates to prices paid by state governments for commodities used to assemble units of capital for different regional industries. Equations (2.46) and (2.47) deal with the corresponding Commonwealth expenditures. It can be seen that the first two equations, those which deal with private sector purchasers, contain both State government and Commonwealth government tax terms. Looking at the State government tax terms (g(is,jrk1) and g(is,3r1)) we find an identifier for the region of origin of commodity i, namely s, and its region of purchase, r. There is, however, no explicit identifier to indicate which of the two State governments collects the tax. The implicit assumption is that a State government is only able to levy sales taxes on commodities which are purchased in the region it administers and thus the State government applying the tax must also be located in region r. In the case of Commonwealth taxes there is no identifier of region of purchase as we assume that Commonwealth taxes per unit of commodity are identical for both regions. We also see that no tax terms appear in equations (2.44) to (2.47), the assumption being that all government purchasers are exempt of sales taxes. This assumption corresponds very closely to reality and the FEDERAL data-base does not allow for sales taxes on government purchases. Apart from the modifications mentioned in this paragraph the RHS of equations (2.42) to (2.47) are of the same form as equation (2.40).

Equations (2.48) to (2.51) allow for flexible handling of State government taxes on producers (equation (2.48)) and consumers (equation (2.50)) and for the corresponding Commonwealth government taxes (equations (2.49) and (2.51)). The form of these equations differs from equation (2.41) only in respect of the ad valorem tax terms. In these equations t is a tax rate applying to the basic price of commodity (is) whereas in equation (2.41) t is a tax rate applicable to the purchasers' price.

2.2.8 Regional Industry Investment

In this section the industry and regional allocations of investment by the three classes of investors described in section 2.2.2 are determined. In the case of private investors we employ a theory based on relative rates of return, while for government investors changes in the patterns of investment across (regional) industries are determined exogenously.

The first equation in the set dealing with the allocation of private investment, equation (2.52), shows the percentage change in the current net rate of return on fixed capital in regional industry (jr) as determined by the relative movement in the post-tax rental price of a unit of its capital and the cost of assembling that capital unit. The coefficient $Q_j^{(1)r}$ is the ratio of (jr)'s rate of return before depreciation to its rate of return net of depreciation (in a typical year). The appearance of this coefficient arises from our assumption that the gross (before depreciation, but after tax) rate of return is proportional to the ratio, for a unit of capital, of the (post-tax) rental price to the construction cost. With an assumed fixed depreciation rate this means that the percentage change in the <u>net</u> rate of return must be greater than the difference between the percentage changes in rental price and in the cost of a unit of capital.

Equation (2.53) explains the percentage change in the post-tax rental value of a unit of capital in terms of the percentage changes in the pre-tax rental price and the various taxes payable (out of the rental price) per unit of capital. To derive this equation we first note that the post-tax rental value of a unit of capital in regional industry (jr) is

$$P_j^{(9)r} = P_{(g+1,2)j}^{(1)r} - P_{(g+1,2)j}^{(4)r} - P_j^{(7)r} - P_j^{(8)r} \qquad (2.53.1)$$

where $P_{(g+1,2)j}^{(1)r}$ is the pre-tax rental price of unit of capital in regional industry (jr), $P_{(g+1,2)j}^{(4)r}$ is the dollar value of income tax payable on returns from each unit of capital employed in (jr), $P_j^{(8)r}$ is the commercial land tax payable on each unit of (jr) capital and $P_j^{(7)r}$ is the amount of residential land tax payable on a unit of capital in a regional industry. In only one industry in each region will the last of these terms have a non-zero value. The industry concerned is the one covering the activity, ownership of dwellings.

Equation (2.53) is the percentage change form of equation (2.53.1). $(SP)_{(g+1,2)j}^{(4)r}$, $(SP)_j^{(7)r}$ and $(SP)_j^{(8)r}$ are the shares of income, residential-land and commercial-land taxes in the pre-tax rental price of (jr) capital and $Q_j^{(2)r}$ is the ratio of the pre-tax to the post-tax rental price.

Equation (2.54) is derived under the assumption that private sector investment is allocated across regional industries in such a way as to achieve equality in expected industry rates of return in that sector. The LHS of (2.54) is equal to the percentage change in the expected rate of return on capital employed in regional industry (jr) while the RHS is the percentage change in the economy-wide expected rate of return on capital. Looking further at the LHS of (2.54) we see that it implies that investors are cautious about the effects of net investment in a regional industry. They behave as if an expansion in (jr)'s capital stock will give rise to a decline in the regional industry's expected rate of return. Thus, we note that, since β_j^r is a positive parameter, an increase in $K_j^r(1)$, future (jr) capital stocks, by a greater percentage than $K_j^r(0)$, current (jr) capital stocks, will act to lower the expected rate of return in regional industry (jr). We also note, however, that a rise in (jr)'s current rate of return will act to increase its expected rate of return. Example expected rate-of-return schedules are depicted in Figure 2.3 and are further discussed in the paragraphs accompanying that diagram at the end of this sub-section.

One matter in need of further explanation is the possibility, allowed for in the previous paragraph, of a change in a regional industry's current capital stock. This possibility only exists in long-run experiments. In the short-run the percentage change in current capital stocks, $k_j^r(0)$, is always set exogenously equal to zero. In long-run simulations we can assume that either regional-industry rates of return or rentals on capital are fixed and allow the $k_j^r(0)$'s to be endogenous. We interpret FEDERAL variables in a long-run simulation as the percentage change in what would otherwise have been the levels of the variables in the solution year of the simulation. The long run may be say 1989 to 1999, the latter being the solution year. $k_j^r(0)$ should therefore be interpreted as the percentage change from what would have been the regional industry's capital stock at the commencement of 1999 (assuming for the moment it takes a year to install units of capital), not 1989.

Equation (2.55) relates the percentage changes in the future and current capital stocks in regional industry (jr) to the percentage change in (jr)'s investment. The (GY)'s are the shares of a class of investor in total regional industry investment. The G_j^r coefficient (ratio of gross investment in (jr) to the regional industry's future capital stock) appears in equation (2.55) because we allow depreciation to erode the current period capital stock. Underlying equation (2.55) is the assumption that (jr)'s future capital stock is the sum of only the depreciated current capital stock and current investment by private and public investors. We justify the omission of any effects of past period investment decisions as follows. In developing our investment theory we have assumed that $K_j^r(1)$ is measured at the end of the period of time it takes to install the capital units implied by current period investment. This assumption is consistent with the notion that past period investment has already been fully accounted for in current period capital stocks.

The next three equations each involve a particular investment budget. The first, equation (2.56), equates a weighted sum of percentage changes in private sector investment expenditures in all regional industries with the percentage change in the total (economy-wide) nominal investment budget for those industries. The second equation, (2.57), has a similar form. Its function is to compute the percentage change in nominal private investment in each region as a weighted sum of investment expenditure made by the private-sector in industries within the region. Since i^r affects only real investment in the region, which would normally be endogenous, the sole purpose of equation (2.57) is to compute a particular aggregate result. Equation (2.58), however, is intended to provide an alternative aggregate investment constraint. Equation (2.56) only ensures that there is a constraint on private-sector capital expenditure and, indeed, not necessarily on investment in all regional industries. It constrains private sector investment only for what we shall term the "endogenous-investment" industries, namely a set of J industries which conform with that part of the FEDERAL investment theory covered by equation (2.54). As shall be seen below we provide a mechanistic alternative which users can employ instead of the rate-of-return theory underlying equation (2.54). Industries which are treated according to the alternative theory we shall call "exogenous-investment" industries.

Equation (2.58) constrains private sector investment in both types of industries as well as all government investment in regional industries. It thus allows for the crowding-out of private investment expenditure by government investment expenditure at the aggregate level. Looking at the equation in more detail we see that it equates a weighted average of the percentage changes in investment expenditure in regional industries by the Commonwealth government, by the state governments and by the private sector (in both endogenous-investment and exogenous-investment regional industries) with the percentage change in the total economy-wide investment budget. The coefficients, (SY)'s, are shares of the appropriate type of regional industry investment in all investment expenditure undertaken in the economy. Note, however, that in equations (2.56) and (2.57) the T coefficients are regional industry private investment shares in total private-sector investment economy-wide. The aggregation of the shares over endogenous-investment industries on the RHS of (2.56) and (2.57) is to ensure that the LHS of those equations are weighted over only the endogenous-investment industries.

The alternative treatments of constraining investment through equations (2.56) and (2.58) can best be seen by considering some basic choices available to the FEDERAL user in regard to the selection of endogenous and exogenous variables. In general, model users will declare one of f_R, i_R, ΔBT, i or i_A to be exogenous and the remainder to be endogenous. If f_R is made exogenous then i_R will move with real consumption, c_R, (see section 2.2.11 below) and i_R will in turn determine the value of i (via an indexing equation). Consequently i will constrain investment by endogenous-investment industries via equation (2.56) with equation (2.58) serving merely to compute the value of i_A. If the user makes i_R exogenous then the nexus between real investment and real consumption is broken but the mechanism constraining investment via equation (2.56) is essentially the same. A third alternative is for the user to make the change in the balance of trade, ΔBT, exogenous. In this case industry investment is constrained by neither equation (2.56) nor (2.58) but rather it is restricted indirectly via the balance of trade constraint. With the last two alternatives the user directly fixes the percentage change in one or other of the aggregate nominal investment variables. If i is exogenous only private investment in the endogenous-investment industries will be constrained (via equation (2.56)) with equation (2.58) again just computing i_A. However, if i_A is made exogenous all private and public investment will be constrained via equation (2.58), while equation (2.56) will compute i which will only affect the values of i_R and f_R.

Whether or not the model user sets the FEDERAL environment to permit crowding-out of private sector investment at the economy-wide level, private investors consider the effects of both private and public investment on the expected rate of return when allocating their investment across industries. That is, it's the change in total (over all investors) capital stocks for a regional industry which enters the rates of return equation, (2.54). Thus, for instance, if a state government builds a new school this affects the decision by private persons whether or not to build a new school.

We now turn to private investment in those industries not in the set of J industries covered by equation (2.54). The determination of investment by these industries is covered by equation (2.59) which reflects the assumption that private investment by an exogenous-investment regional industry is indexed to total real investment by the private sector in endogenous-investment industries for the appropriate region. In general, users would exclude an industry from the set J only if they wished to set the (relative) movement in that industry's investment themselves, for example, to simulate a resources boom.[7] A user could set $h_j^{(2)r}$ at zero and exogenously determine y_j^r via the shift parameter $f_j^{(2)r}$. Alternatively, $h_j^{(2)r}$ could be set at unity and $f_j^{(2)r}$ assigned the desired difference between y_j^r and the percentage change in all endogenous-investment private investment in the appropriate region.

Equations (2.60) and (2.61) deal with investment by State government and Commonwealth government in (regional) industries respectively. To determine government investment by the market mechanism used for endogenous-investment private industries would seem inappropriate. As with current expenditure by government we do not have a theory with which to treat the determination of government investment by (regional) industry and consequently use a mechanistic method. Equations (2.60) and (2.61) take the same form as (2.59). With the h parameter set at unity and the f variable at zero the FEDERAL user forces State (Commonwealth) government investment in the (regional) industry to move in line with private sector endogenous-investment in the region (nation). The f variable enables users to vary the industry pattern of government investment and the percentage change in government investment in total.

The final two equations in this section serve to define the real investment variables appearing in equations (2.59) to (2.61). Real investment is defined as nominal investment divided by a price index. Thus in equation (2.62) we have the percentage change in real private investment for region r equal to the percentage change in nominal private investment for the region minus the percentage change in an index of the price of private capital goods employed in the region. Equation (2.63) which defines real private investment economy-wide has a similar form.

Before leaving this section it is useful to consider in an intuitive fashion how the dozen equations described above work together to determine private investment by each endogenous-investment regional industry. To do this we explore the effects on endogenous private industry investment of an imaginary FEDERAL simulation. Imagine that there is only one endogenous-investment industry, industry j. Investors will allocate investment expenditure over the two regional industries (j1) and (j2) according to the rate-of-return theory. Suppose that we simulate an increase in a production subsidy to regional industry (j1). We would expect an increase in demand for (j1) capital relative to the demand for other types of capital and a consequent relative rise in the rental rate of (j1) capital. Given the absence of income and property tax changes and abstracting from changes in relative costs of assembling units of capital, this will result in a rise in (j1)'s current rate of return relative to other industries. Turn now to Figure 2.3 which depicts rate-of-return schedules for each of the two industries drawn to conform with the type of schedules underlying equation (2.54). These schedules relate, for each regional industry, its ratio of future to current industry capital stocks and its expected rate of return. Now, given it turns out that the percentage change in (j1)'s current rate of return is positive ($r_{(j1)}(0) > 0$) and supposing for (j2) it is negative ($r_{(j2)}(0) < 0$). This implies a vertical upward shift of (j1)'s rate-of-return schedule from AA to, say, A'A' and a vertical downward shift of (j2)'s schedule to, say, B'B'. At ratios of future to current capital stocks of unity, the expected rate of returns for (j1) and (j2) will be $R^I_{(j1)}(1)$ and $R^I_{(j2)}(1)$ respectively. However, equation (2.54) forces these two rates of return to equalize. At what point they equalize depends ultimately upon the investment constraint.

The method by which investment in the two regional industries is constrained depends upon which of the five relevant variables the user declares exogenous (as discussed above). Let us say that, in this case, investment is constrained by setting i_A exogenously equal to zero. Since the percentage changes in government and private exogenous-investment industry investment are

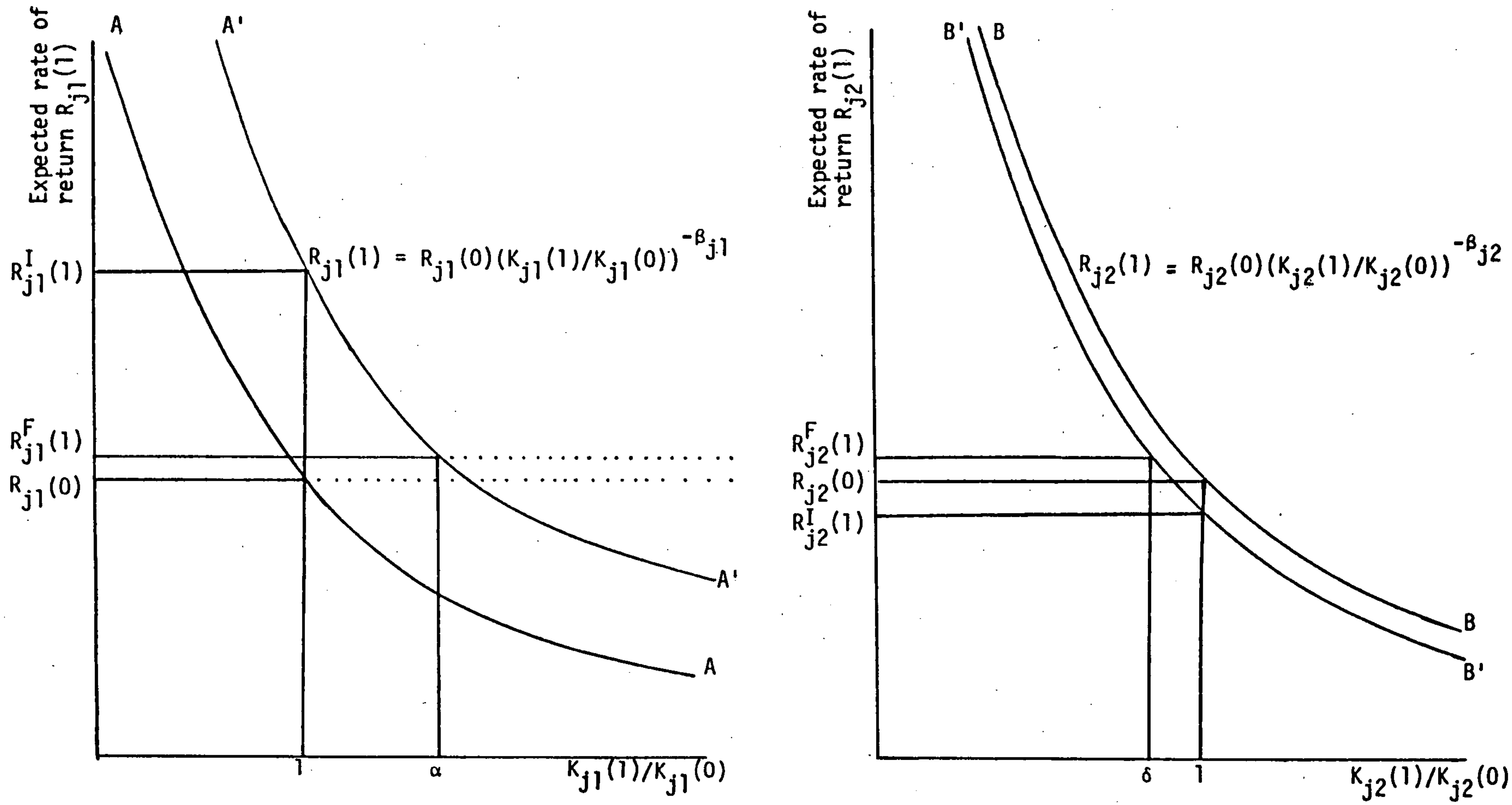


Figure 2.3 Expected Rate-of-Return Schedules for Regional Industries (j1) and (j2)

set exogenously, i_A forms an actual constraint only on the endogenous-investment industry private investment. The greater the expansion in public investment, the tighter the constraint on private endogenous-investment industries (i.e. public expenditure acts to crowd-out private expenditure). The percentage change in the economy-wide rate of return, ω, will settle at a level such that the implied percentage changes in the (future-to-current) capital-stock ratio for both industries determine (via equation (2.55)) percentage changes in regional industry private investment which satisfy the investment constraint. In our example in Figure 2.3 we obtain an expected economy-wide rate of return of $R^F_{j2}(1) = R^F_{j2}(1)$ and capital-stock ratio's of α and δ in regional industries (j1) and (j2) respectively.

Note that a ratio of δ for industry (j2) implies negative net investment. However, for normal rates of depreciation we would expect gross investment to be positive. We should also note that $R^F_{j1}(1) = R^F_{j2}(1)$ could, depending on the investment budget and (j2)'s ratio of gross investment to capital stock, fall below $R^I_{2j}(1)$.

2.2.9 Market Clearing Equations

This section concerns the equating of demand and supply in each of FEDERAL's four types of markets, viz. the market for domestically produced commodities, regional labour markets and the markets for regional industry capital and land.

The LHS of equation (2.64) is the percentage change in the supply of a commodity produced in a particular region. The RHS is a weighted sum of the percentage changes in demand for the commodity by each type of demander (i.e. intermediate purchasers for current production, private investors, households, foreigners, state and Commonwealth government demanders for current and capital purposes, and those requiring the commodity for margin services to facilitate the range of direct commodity flows). The B's are sale shares. Equation (2.65) calculates the percentage change in the supply of a commodity from a region as a weighted sum of the percentage changes in the supply of the commodity by each industry in the region. In this equation the B's are production shares.

Equation (2.66) equates, for a particular region, the percentage change in employment for a skill class to a weighted sum of the percentage changes in demand for labour of that skill class by each of the industries. Here the B's are employment shares. One can set ℓ_m^r exogenously, thus imposing a supply-side constraint (possibly at the full-employment level) on regional employment of skill m. Alternatively, one can fix the real wages of skill class m in region r and its employment level is then set by the aggregate demand for it by the industries in the region. Equation (2. 66) carries the implication that labour of type m is mobile across all industries in the region. The presence of an r subscript on the employment variable allows us to keep track of the percentage changes in regional employment. In the short-run labour would normally be considered immobile between regions and changes in aggregate employment levels would directly affect regional unemployment (see section 2.2.13).

The percentage change in the current stock of regional industry (jr) capital is equated to the percentage change in (jr)'s demand for capital via equation (2.67). This equation carries the underlying assumption that capital units, once assembled for a particular regional industry, cannot be employed by another regional industry.

In FEDERAL land is specific not only to a region but also to an industry. We justify the industry immobility of land as follows. The only land-using industries in FEDERAL are the agricultural industries and they are defined on an essentially regional basis. For instance, two possible FEDERAL agricultural industries might be High-rainfall-zone, which covers agricultural activity over a defined area of south-east Australia, and Northern Beef, which covers agricultural activity across the north of Australia. While Northern Beef only produces Meat Cattle, High Rainfall Zone produces a variety of agricultural commodities such as wool, wheat and meat cattle. Thus FEDERAL allows agricultural land to be mobile across commodities within an industry. For instance, land can be mobile between the production of wheat and meat cattle within the High-rainfall-zone industry/geographical area. By making land industry specific we are thus doing no more than preventing the modelling of land as though it could be shifted between geographically separate areas. Equation (2.68) equates the percentage change in the supply of regional-industry specific land to the percentage change in the demand for it.

2.2.10 FEDERAL Aggregates

Equations (2.69) to (2.72) are concerned with international trade aggregates for the economy as a whole. We do not compute external trade aggregates at a regional level although this could be a useful addition to the model in the future.

The percentage change in the total demand for an imported commodity is calculated in equation (2.69) as the weighted sum of the percentage changes in the demand for that commodity by intermediate users in both regions for current and production, by private investors, by households in both regions and by state and

Commonwealth demanders for current and capital purposes. Imports are not used as margins in FEDERAL and thus this type of demand does not appear on the RHS of (2.69).

Equation (2.70) computes the percentage change in the foreign currency value of all imports into Australia as a weighted sum of the percentage changes in foreign currency expenditure on each commodity. $M_{(u3)}$ is the share in the foreign currency cost of all imports accounted for by commodity u imports. We actually calculate this coefficient using Australian dollars as the foreign currency units since this is convenient. However, m can only be considered to be in Australian dollars in terms of a fixed base-period exchange rate.

The percentage change in the foreign currency value of exports is calculated in equation (2.71) as a weighted share of the percentage changes in export revenue earned from each commodity exported from each region. $E_{(ur)}$ is the share of total Australian export earnings accounted for by export receipts on good u produced in region r.

The change in the economy's trade balance is calculated in equation (2.72). The coefficients E and M are the economy-wide figures for exports and imports respectively in the data base-year. They are the actual levels rather than shares because the LHS of (2.72) is expressed as a change rather than a percentage change. Calculating the change in the balance of trade as the change in the level rather than the percentage change has the advantage of avoiding percentage declines of greater than 100 per cent (B can change sign). However the interpretation of the units in which ΔB is calculated poses some problems. We calculate the coefficients E and M in Australian dollar values and therefore interpret ΔB as being the foreign-currency equivalent at the base-year exchange rate of so many million base-year Australian dollars.

The next four equations are concerned with defining the percentage changes in various price indices. The percentage change in the FEDERAL region r consumer price index is defined by equation (2.73) as a weighted sum of the percentage changes in the prices paid by consumers for commodities from each of the three sources. The weight of good i from source s in the index, $W_{(is)}^{(3)r}$, is the share of spending by the region's consumer on that source-specific commodity.

Equation (2.74) calculates the percentage change in the economy-wide consumer price index as a weighted sum of the percentage changes in the regional indices.

In equation (2.75) the percentage change in the capital-goods price index for a region is defined as a weighted sum of the percentage changes in industry private costs of capital in the region. $\tilde{T}_j^r$ is the share of total (endogenous) private capital expenditure accounted for by regional industry (jr), while $\tilde{T}^r$ is the share of economy-wide (endogenous) private investment represented by aggregate (endogenous) private investment for region r. Equation (2.76) calculates the percentage change in the economy-wide capital-goods price index as a weighted sum of the percentage changes in the indices for the two regions.

The next four equations in this section calculate percentage changes in aggregate employment of labour and the aggregate capital stock at the regional and national levels. Thus regional employment is calculated as a weighted sum of the percentage changes in employment level for each skill group in the region in equation (2.77). In the next equation the percentage change in the national employment level is calculated as a weighted sum of the percentage changes in regional employment. Similarly, in equation (2.79) the percentage change in the region's capital stock is calculated as a weighted sum of the percentage changes in current-capital stocks of each industry in the region while equation (2.80) calculates the percentage change in the economy's aggregate capital stock as a weighted sum of the percentage changes in the regional capital stocks. The ψ's are shares in the appropriate aggregate base-year employment or capital stock.

The final equation in this section, equation (2.81) links, at the economy-wide level, the percentage change in real consumption and the percentage change in real (endogenous) private investment. However, the user can make the link endogenous and, say, fix the change in the balance of trade. The percentage change in all private investment will then adjust in accordance with the percentage change in savings, the percentage changes in the public sector borrowing requirements and the change in the balance of trade.

2.2.11 Price, Wage and Tax Indices

The first five equations in the section concern the indexing of labour costs to the FEDERAL consumer price index. Labour costs are composed in FEDERAL of post-tax wage costs, PAYE taxes and payroll taxes. It is only the first of these which is indexed to the FEDERAL consumer price index directly, the other two being linked to the index via post-tax wage costs.

Equation (2.82) defines for each skill class in regional industry (jr) the percentage change in pre-tax wage costs per labour unit as a weighted sum of the percentage changes in post-tax wage costs per labour unit, PAYE taxes per labour unit and payroll taxes per labour unit. The W's are the shares of the components in pre-tax wage costs of employing a unit of skill-m labour in regional industry (jr). Equation (2.83) allows the post-tax wage per labour unit to be indexed to either the FEDERAL national or regional consumer price index. If one of the h's is set to unity and the other to zero and all the f's are set to zero, nominal post-tax wages are fully indexed to a particular price index. If, alternatively, we wished to fix regional employment for skill m at a particular level (see section 2.2.9) we could make $f^{(1)r,1}_{(g+1,1,m)}$ endogenous. For $h^{(1)r,1}_{(g+1,1,m)j}$ set at unity the value of $f^{(1)r,1}_{(g+1,1,m)}$ would tell us the percentage change in real post-tax wage rates for occupation m in region r required to give the required employment result. Fixed employment at different levels of aggregation can be imposed by making other (appropriate) f's endogenous.

Equation (2.84) indexes PAYE taxes per unit of labour to the (pre-PAYE, but post-payroll, tax) nominal wage per labour unit. The exact nature of the indexation can be varied by the FEDERAL user via the h parameter and the f shift-variable. Similarly payroll taxes are linked to post-payroll-tax wages in equation (2.85). Equation (2.86) serves to calculate the percentage change in pre-PAYE/post-payroll-tax wages as a weighted sum of the percentage changes in post-tax wages and PAYE taxes per labour unit.

It will be noted that in the above set of equations we have allowed only post-tax wages to be indexed to the cpi. However in Australia the current institutional arrangements are that it is pre-(PAYE)-tax wages which are indexed to the cpi. It would be possible to provide model users with such an alternative type of indexation by introducing into FEDERAL a new equation which had the same form as equation (2.83), but with the pre-PAYE (post-payroll)-

tax-wage variable, $p^{(1)r,4}_{(g+1,1,m)j}$, on its LHS. If, for a particular skill class, users wished to use the current form of indexation or fix regional employment the f's on the RHS of the new equation would be made endogenous and nothing would be affected. However if users wished to use the alternative form of indexation the f's on the RHS of the new equation would be set exogenously and the f's on the RHS of (2.83) endogenously.[8]

Equations (2.87) to (2.89) index state and Commonwealth government production taxes per tax ticket and the price of "other costs" tickets to the appropriate FEDERAL regional consumer price index. Note that the shift variable, $f^{(1)}_{g+3,j}$, does not have a regional subscript and thus we only allow the Commonwealth government to make uniform production tax rate changes across regions for a particular industry.

Equations (2.90) and (2.91) indexes income tax rates per unit of capital and land respectively to the rental rates of returns on those units.

Equations (2.92) and (2.93) serve to calculate the price paid by a state government and the Commonwealth government respectively for a source-specific commodity for input to capital formation independent of the industry of purchase. In both cases the RHS is a weighted sum across (regional) industries in which the appropriate government invests. The B's are industry shares in the purchase by a particular government of the source-specific commodity.

Equation (2.94) indexes unemployment benefits to the economy-wide FEDERAL consumer price index while equations (2.95) and (2.96) index residential and commercial land taxes per unit of capital for each regional industry to the regional industry's private capital-goods price. Note that land taxes are made payable on capital units in FEDERAL as it is assumed that this forms the best approximation of a tax on developed land.

2.2.12 Government Budgets

In this section we model the accounts of the three governments that appear in the FEDERAL model. For each government (i.e. the Commonwealth government and each of the two state governments) we model the components of revenue and outlays and calculate the government's borrowing requirement.

2.2.12.1 Commonwealth Government Accounts

2.2.12.1.1 Commonwealth Government Outlays

Commonwealth government outlays are taken to be made up of:

- Commonwealth government current expenditure,
- Commonwealth government capital expenditure,
- unemployment benefits,
- transfers to the state governments,
- transfers to persons (other than unemployment benefits and interest payments),
- interest payments,
- other outlays.

Equation (2.97) is simply the percentage change form of an equation stating the accounting relationship between Commonwealth government outlays and the sum of its components. The S's are shares in total Commonwealth government outlays of the relevant type of outlay. The first two terms deal with Commonwealth expenditures on current and capital commodities, the percentage change in which are calculated elsewhere in the model (see sections 2.2.2 and 2.2.4 for discussion of the percentage change in the quantities and section 2.2.7 for discussion of the percentage changes in the prices). The third term deals with expenditure on unemployment benefits. The percentage changes in the payment per person and in the number unemployed are discussed in sections 2.2.11 and 2.2.13 respectively.

The percentage change in the next two types of Commonwealth outlays, transfers to the states and transfers (other than interest payments and unemployment benefits) to persons in each region, are calculated in equations (2.98) and (2.99). Both types of outlays are indexed to the percentage change in the national consumer price index. The penultimate type of Commonwealth outlay, interest payments by the Commonwealth is not modelled as a function of any other FEDERAL variable. It is assumed that these interest payments are on bonds and thus any change in nominal interest rates consequent on a change in the consumer price index will be reflected in a change in bond prices. It is expected that the percentage change in these interest payments invariably will be exogenously set at zero in FEDERAL simulations. The final outlay type, other Commonwealth government outlays, consists of unrequited outlays overseas, and is indexed, via equation (2.100), to the percentage change in gross domestic product.

2.2.12.1.2 Commonwealth Government Receipts

The percentage change in Commonwealth government receipts is defined by equation (2.101) as being equal to a weighted sum of the percentage changes in its seven components. The weights, $S^{(4,k)}$, are revenue shares and the seven components are: PAYE taxes, other income taxes, import duties, production taxes (less subsidies), commodity taxes (less subsidies), export taxes (less subsidies), and other receipts.

Equation (2.102) defines the percentage change in PAYE tax receipts by the Commonwealth from a region as equal to the weighted sum of the percentage changes in PAYE revenue for each skill group in each industry in the region. The B's are shares of skill type m employed in industry j in total PAYE-taxes collected from region r. The percentage change in PAYE revenue per industry skill group is equal to the percentage change in the tax per labour unit plus the percentage change in the regional industry's skill m employment.

Equation (2.103) says that the percentage change in PAYE tax receipts economy-wide is a weighted sum of the percentage changes in PAYE tax revenue from each of the regions. Similarly, equation (2.104) computes the percentage change in total receipts from income taxes other than PAYE taxes collected by the Commonwealth as a weighted sum of the percentage changes in receipts of that type from residents in each of the two regions. $B^{(4,2)r}$ is the share of tax receipts of this form from residents in region r in total tax receipts of this type.

The percentage change in receipts from income taxes (other than PAYE) from each region is determined by equation (2.105) as a weighted sum of the percentage changes in the tax receipts on returns to land and capital earned by the region's residents from primary factors employed in industries in both regions. The percentage change in tax receipts on income from capital employed in a particular regional industry is equal to the sum of the percentage changes in the amount of tax payable per unit of capital and the percentage change in the current capital stock. Likewise, the percentage change in income tax receipts payable on earnings from land employed in a particular regional industry is equal to the sum of the percentage change in the amount payable per unit of land and the percentage change in the supply of land for that regional industry. We see the percentage changes in these two types of receipts in the two sets of inner brackets in equation (2.105). It is important to understand the coefficients in equation (2.105) since they relate both to the regional industry in which the taxable income is earned and the region of residence of the persons to whom the taxable income accrues. $B^{(4,2)r}_{(jt)}$ is the share in total tax on capital and land income earned by residents of region r of tax that is payable on income generated by industry j in region t. $B^{(4,2)r1}_{(jt)}$ and $B^{(4,2)r2}_{(jt)}$ are the shares of capital tax receipts and land tax receipts respectively in tax receipts of both types from region r residents owning capital and/or land in industry j located in region t.[9]

Equation (2.106) determines the percentage change in total import duty receipts as the weighted sum of the percentage changes in the duty receipts from each import; where the percentage change in duty receipts on an import is equal to the percentage change in the dollar value of duty per unit import plus the percentage change in the volume of imports of that commodity. The coefficient $B^{(4,3)}_{i}$ is the share in total import duty receipts of import duties on good i.

The percentage change in receipts from production taxes (less subsidies) is calculated in equation (2.107) as a weighted share of the percentage changes in the production tax revenue from each industry. The B's are regional industry revenue shares in total production tax receipts. The percentage change in the production tax revenue from a particular industry is equal to the sum of the percentage change in the tax rate per Commonwealth government production tax unit and the percentage change in the demand for tax units.

Equation (2.108) determines the percentage change in Commonwealth total receipts from commodity taxes (less subsidies) as a weighted sum of the percentage changes in commodity tax receipts on sales of each commodity from each source to each type of user. The percentage change in tax receipts on a particular type of sale is equal to the percentage change in the dollar tax per unit sold plus the percentage-change in the volume of those sales. The B's are revenue shares.

The percentage change in total export tax receipts is calculated in equation (2.109) as a weighted sum of the percentage changes in export tax receipts on each commodity. Again, the B's are revenue shares and the percentage change in receipts on an individual commodity is equal to the sum of the percentage changes in the tax per unit exported and the volume. h_i^4 is a user-set parameter which is set to unity for export commodities. One would expect h_i^4 to be set to zero for non-export commodities in order to ensure that only taxes which are actually collected enter government receipts (see explanation of equation (2.41) in section 2.2.7). However, it turns out that for these commodities h_i^4 is set to 0.2. It is convenient to leave the explanation as to why this is so to the discussion of equation (2.127) in section 2.2.13.

The final equation in this section, equation (2.110), indexes the percentage change in other Commonwealth government receipts to the percentage change in the national consumer price index.[10]

2.2.12.2 State Government Accounts

2.2.12.2.1 State Government Outlays

The first equation in this section, equation (2.111), defines the percentage change in a state government's outlays as a weighted sum of the percentage changes in the components of its outlays. The first two terms on the RHS of equation (2.111) cover the percentage changes of the government's expenditures on commodities for current and capital purposes. The next two terms involve the percentage changes in transfers to persons and other outlays (excluding interest payments), while the last term covers state government interest payments. The S's are expenditure shares. The variables in the first two terms on the RHS of (2.111) are determined elsewhere in the model. In equations (2.112) and (2.113) the expenditure on the next two types of outlays are indexed to the national consumer price index and regional factor incomes respectively. The final type of outlay is not modelled as a function of other FEDERAL variables. Its treatment is analogous to Commonwealth government interest payments (see section 2.2.12.1.1).

2.2.12.2.2 State Government Receipts

The receipts of a state government in FEDERAL are taken to consist of payroll tax receipts, residential land-tax receipts, commercial land-tax receipts, other income-reducing taxes, payments from the Commonwealth government, state government commodity tax (less subsidies) receipts, state government production tax (less subsidies) receipts and other state government receipts.

Equation (2.114) says that the percentage change in a state government's total receipts is equal to a weighted sum of the percentage changes in its components. The S's are revenue shares.

The percentage change in the state government's payroll tax receipts is determined in equation (2.115) as a weighted sum of the percentage changes in receipts on each skill class in each industry in the region administered by the state government. The B's are skill m industry j shares in total region r payroll tax receipts.

Residential land-tax in FEDERAL is levied on the current capital stock of the industry ownership of dwellings located in the region. Equation (2.116) equates the percentage change in these tax receipts to the percentage change in the residential land tax per unit of capital plus the percentage change in the current capital stock in the regional industry ownership of dwellings.

Commercial land-tax in FEDERAL is a tax on developed land only. The primary factor land in FEDERAL refers to agricultural land. Commercial land-tax is therefore levied on the current capital-stock of regional industries. Equation (2.117) determines the percentage change in a state government's commercial land-tax receipts as a weighted sum of the percentage changes in receipts from each industry in the region, where the percentage change in an individual industry receipt is the sum of the percentage change in the tax per unit of capital and the percentage change in the current capital stock.

The variable other income-reducing taxes is included in FEDERAL to cover a variety of taxes whose only essential effects are to raise revenue and to reduce income and thus consumption. They are close approximations to lump sum taxes. They include fines, certain fees and death duties. Equation (2.118) indexes the receipts from such taxes to gross state product.

Payments from the Commonwealth were determined in the previous section of this paper. Equation (2.119) merely equates the percentage change in state government receipts of this sort with the percentage change in the Commonwealth's outlays or transfers to the state.

In equation (2.120) the percentage change in receipts from commodity taxes (less subsidies) by a state government is determined in exactly the same manner as was the case for Commonwealth receipts of this type. Likewise, in equation (2.121) the calculation of the percentage change in receipts from production taxes (less subsidies) levied by a state government is handled in the same way as was the case for Commonwealth production taxes.

Finally, movements in other receipts by a state government are linked in equation (2.122) to movements in the national consumer price index.[11]

2.2.12.3 Government Borrowing Requirements

2.2.12.3.1 Commonwealth Government Borrowing Requirement

The change in the Commonwealth government requirement is equated in equation (2.123) to the change in Commonwealth outlays less the change in its receipts. The percentage change form is not used for the borrowing requirement to avoid problems connected with the possibility of it changing signs. B^6 and B^{3r} are naturally the levels of the variables.

2.2.12.3.2 State Government Borrowing Requirement

The change in a state government's borrowing requirement is handled in equation (2.124) in the same manner as was the case for the Commonwealth in equation (2.123).

2.2.13 Regional Income

Gross factor income for residents of region r is taken to be composed of residents' disposable income plus net direct taxes and transfers. The second component covers direct taxes of all types less all transfer payments. Equation (2.125) equates the percentage change in gross factor income to a weighted sum of the percentage changes in its two components.

We wish to calculate the percentage change in disposable income as a residual from equation (2.125) and therefore the next two equations explain the movements in gross factor income and net direct taxes and transfers paid (received) by region r residents.

Gross factor income of residents living in region r is assumed in FEDERAL to comprise gross wage payments, gross returns to capital and gross returns to land. Equation (2.126) determines the percentage change in the gross income of region r residents as a weighted sum of the percentage changes in these components. The D^r's are shares in total gross income of region r residents. $D^r_{(jt)}$ and $D^{rk}_{(jt)}$ require further explanation. $D^{r1}_{(jt)}$ and $D^{r2}_{(jt)}$ are the shares of returns to capital and returns to land respectively in returns of both types to region r residents who own factors of production in industry j located in region t. $D^r_{(jt)}$ is the share of returns of both types in total region r gross income.

Net direct taxes and transfers paid by (or to) regional residents are assumed to consist of (i) the following tax and transfer payments: PAYE taxes, other income taxes, residential and commercial land taxes, fees and fines, personal interest payments overseas, interest payments to the Commonwealth government, interest payments to state government; and (ii) the following transfer receipts: super-normal profits on non-export commodities, unemployment benefits, Commonwealth government transfers to persons, interest payments from Commonwealth government, State government transfers to persons, interest payments from state governments. The percentage change in net direct taxes and transfers payable by (or to) region r residents is determined in equation (2.127) as a weighted sum of the percentage changes in these components. The D's are the shares in net transfers and taxes and thus add to unity. The shares for the payments have a positive sign and the receipts a negative sign.

Most of the terms on the right hand side of (2.127) need no further explanation. An exception relates to the modelling of personal interest payments overseas. We assume that the percentage change in this variable is equal to the percentage change in the exchange rate. That is, we assume the only FEDERAL variable which might affect overseas interest payments is the exchange rate via a revaluation effect.

Another component of net direct taxes and transfers requiring further comment is the one covering what we have termed "super-normal profits on non-export commodities". Recall that in our dicussion of equations (2.40) and (2.41) in section 2.2.7 we noted that for a non-export commodity the export tax/subsidy variable is endogenous and takes whatever value is required to produce a zero change in exports of the commodity. Clearly the tax/subsidy in this case is used as a modelling device and we do not want it to enter the calculation of Commonwealth export tax receipts. On the other hand we can not ignore the question of who collects the tax or pays the subsidy.

Before determining which agent should collect the tax we need to explore the nature of a non-export commodity in FEDERAL. In a sufficiently disaggregated version of the model a non-export commodity would be pretty well what its name implies. In such a case a commodity classed non-export, for instance ready-mixed concrete, being not exported at all would cause no problem. However in our aggregated version of FEDERAL in particular, some of the non-export commodities do, in fact, sell non-trivial values of exports. The matter is a difficult one to which there is really no satisfactory answer. Our approach is to assume that the inability of non-export industries to expand (contract) export volumes will lead to super-normal profits (losses) being made on the constant volume of exports instead. No alteration to our zero pure profits in exporting equation (2.40) is required as the pure profits are immediately acquired by government as a tax. Some of the tax is retained - as part of export taxes under the current specification although in fact it should be viewed as an income tax on the pure profits (indeed the tax rate is set at the estimated rate of tax on returns to capital) - with the remainder being transferred back to owners of capital. It is this component being transferred back which appears in equation (2.127).[12]

The percentage change in the amount transferred back to consumers is a weighted sum of the percentage changes in the export taxes, the g(ir, 4)'s. It will be noted that for all the export commodities, h_i^4 is equal to unity and the weight attached to the export tax variable for that commodity is consequently zero. It will also be noted that the commodity share of export tax receipts terms is adjusted to take account of regional ownership via the $\zeta(r, it)$ share.

The penultimate equation in this section, equation (2.128), calculates the percentage change in gross national product (at factor cost) as a weighted sum of the percentage changes in gross regional resident factor income (calculated in equation (2.126)). It should also be noted that the FEDERAL gross national product does not include income earned on Australian primary factors by foreigners not resident in Australia.

One of the variables occurring in equation (2.126) has not been calculated elsewhere in the model, but would normally be considered to be a function of another FEDERAL variable. In the final equation, equation (2.129), we determine this variable, the percentage change in the number unemployed in a region, in terms of the percentage change in regional employment. The derivation of this equation is as follows.

We define the unemployment level, $X^{(6,3)r}$, as the number in the labour force, $F^{(6,3)r}$, less the number employed. Thus for a region:

$$X^{(6,3)r} = F^{(6,3)r} - L^{r} \qquad (2.129.1)$$

where L^{r} is equal to aggregate employment in the region.
In percentage change terms (2.129.1) yields:

$$x^{(6,3)r} = \frac{F^{(6,3)r}}{X^{(6,3)r}} f^{(6,3)r} - \frac{L^{r}}{X^{(6,3)r}} \ell^{r} \quad ,$$

or

$$x^{(6,3)r} = - \S_1^{r} \ell^{r} + \S_2 f^{(6,3)r} \qquad (2.129.2)$$

where $\S_1^{r}$ and $\S_2^{r}$ are the appropriate coefficients.

Equation (2.129.2) is equivalent to our final equation in the FEDERAL system, equation (2.129). Normally the percentage change in the labour force, $f^{(6,3)r}$, would be set exogenously at zero. However, we may on occasions wish to cause a shift in the link between the unemployment and employment percentage changes. For instance, in longer-run simulations we may consider that the effects of a change in regional employment might largely pass through to interstate migration rather than result in a change in the unemployment rate. In these circumstances we might set $x^{(6,3)r}$ exogenously and $f^{(6,3)r}$ endogenously.

Table 2.1

FEDERAL Equation Structure

Regional industry demands for intermediate inputs by geographical source

$$(2.1) \quad x^{(1)r}_{(is)j} = z^r_j - \sigma^{(1)r}_{(is)j}(p^{(1)r}_{(is)j} - \sum_{s=1}^{3} S^{*(1)r}_{(is)j}p^{(1)r}_{(is)j})$$

$$+ a^{(1)r}_j + a^{(1)r}_{ij} + a^{(1)r}_{(is)j}$$

$$- \sigma^{(1)r}_{(is)j}(a^{(1)r}_{(is)j} - \sum_{s=1}^{3} S^{*(1)r}_{(is)j}a^{(1)r}_{(is)j})$$

$i = 1,\ldots,g$
$j = 1,\ldots,h$
$s = 1, 2, 3$
$r = 1, 2$

Demands for tax and "other cost" tickets

$$(2.2) \quad x^{(1)r}_{g+2,j} = z^r_j \qquad j = 1,\ldots,h \quad r = 1, 2$$

$$(2.3) \quad x^{(1)r}_{g+3,j} = z^r_j \qquad j = 1,\ldots,h \quad r = 1, 2$$

$$(2.4) \quad x^{(1)r}_{g+4,j} = z^r_j + a^{(1)r}_j + a^{(1)r}_{(g+4)j} \qquad j = 1,\ldots,h \quad r = 1, 2$$

Regional industry demands for primary factors

$$(2.5) \quad x^{(1)r}_{(g+1,v)j} = z^r_j - \sigma^{(1)r}_{(g+1,v)j}(p^{(1)r}_{(g+1,v)j}$$

$$- \sum_{v=1}^{3} S^{*(1)r}_{(g+1,v)j}p^{(1)r}_{(g+1,v)j})$$

$$+ a^{(1)r}_j + a^{(1)r}_{g+1,j} + a^{(1)r}_{(g+1,v)j}$$

$$- \sigma^{(1)r}_{(g+1,v)j}(a^{(1)r}_{(g+1,v)j}$$

$$- \sum_{v=1}^{3} S^{*(1)r}_{(g+1,v)j}a^{(1)r}_{(g+1,v)j})$$

$v = 1, 2, 3$
$j = 1,\ldots,h$
$r = 1, 2$

Demands for labour by regional industry and occupational group

$$(2.6)\quad x^{(1)r}_{(g+1,1,q)j} = x^{(1)r}_{(g+1,1)j} - \sigma^{(1)r}_{(g+1,1,q)j}(p^{(1)r}_{(g+1,1,q)j} - \sum_{q=1}^{M} S^{*(1)r}_{(g+1,1,q)j} p^{(1)r}_{(g+1,1,q)j}) + a^{(1)r}_{(g+1,1,q)j} - \sigma^{(1)r}_{(g+1,1,q)j}(a^{(1)r}_{(g+1,1,q)j} - \sum_{q=1}^{M} S^{*(1)r}_{(g+1,1,q)j} a^{(1)r}_{(g+1,1,q)j})$$

$q = 1,\ldots,M$
$j = 1,\ldots,h$
$r = 1, 2$

Price to each regional industry of labour in general

$$(2.7)\quad p^{(1)r}_{(g+1,1)j} = \sum_{q=1}^{M} p^{(1)r}_{(g+1,1,q)j} S^{(1)r}_{(g+1,1,q)j} + \sum_{q=1}^{M} a^{(1)r}_{(g+1,1,q)j} S^{(1)r}_{(g+1,1,q)j}$$

$j = 1,\ldots,h$
$r = 1, 2$

Supplies of commodities by regional industry

$$(2.8)\quad x^{(0)r}_{(u*)j} = z^{r}_{j} + \sigma^{(0)r}_{(u*)j}(p^{(0)r}_{(u*)j} - \sum_{u=1}^{N(jr)} H^{*(0)r}_{(u*)j} p^{(0)r}_{(u*)j}) - a^{(0)r}_{j} - a^{(0)r}_{(u*)j} - \sigma^{(0)r}_{(u*)j}(a^{(0)r}_{(u*)j} - \sum_{u=1}^{N(jr)} H^{*(0)r}_{(u*)j} a^{(0)r}_{(u*)j})$$

$u = 1,\ldots,N(jr)$
$j = 1,\ldots,h$
$r = 1, 2$

$$(2.9)\quad x^{(0)}_{(ir)j} = x^{(0)r}_{(u*)j} - a^{(0)}_{(ir)j}$$

$i \in G(u,jr)$
$u = 1,\ldots,N(jr)$
$j = 1,\ldots,h$
$r = 1, 2$

$$(2.10) \quad p^{(0)r}_{(u*)j} = \sum_{i\varepsilon G(u,(jr))} p^{(0)}_{(ir)} S^{(0)}_{(ir)j} - \sum_{i\varepsilon G(u,(jr))} a^{(0)}_{(ir)j} S^{(0)}_{(ir)j}$$

$u = 1,..,N(jr)$
$j = 1,...,h$
$r = 1, 2$

<u>Demands for inputs to capital formation</u>

$$(2.11) \quad x^{(2)r}_{(is)j} = y^{r}_{j} - \sigma^{(2)r}_{(is)j}(p^{(2)r}_{(is)j} - \sum_{s=1}^{3} S^{*(2)r}_{(is)j} p^{(2)r}_{(is)j}) + a^{(2)r}_{j}$$

$$+ a^{(2)r}_{ij} + a^{(2)r}_{(is)j}$$

$$- \sigma^{(2)r}_{(is)j}(a^{(2)r}_{(is)j} - \sum_{s=1}^{3} S^{*(2)r}_{(is)j} a^{(2)r}_{(is)j})$$

$i = 1,...,g$
$j = 1,...,h$
$s = 1, 2, 3$
$r = 1, 2$

$$(2.12) \quad x^{(5,2)r}_{(is)j} = y^{(5)r}_{j} - \sigma^{(5,2)r}_{(is)j}(p^{(5,2)r}_{(is)j} - \sum_{s=1}^{3} S^{*(5,2)r}_{(is)j} p^{(5,2)r}_{(is)j})$$

$$+ a^{(5,2)r}_{j} + a^{(5,2)r}_{ij} + a^{(5,2)r}_{(is)j}$$

$$- \sigma^{(5,2)r}_{(is)j}(a^{(5,2)r}_{(is)j} - \sum_{s=1}^{3} S^{*(5,2)r}_{(is)j} a^{(5,2)r}_{(is)j})$$

$i = 1,...,g$
$j = 1,...,h$
$s = 1, 2, 3$
$r = 1, 2$

$$(2.13) \quad x^{(6,2)}_{(is)j} = y^{(6)}_{j} - \sigma^{(6,2)}_{(is)j}(p^{(6,2)}_{(is)j} - \sum_{s=1}^{3} S^{*(6,2)}_{(is)j} p^{(6,2)}_{(is)j})$$

$$+ a^{(6,2)}_{j} + a^{(6,2)}_{ij} + a^{(6,2)}_{(is)j}$$

$$- \sigma^{(6,2)}_{(is)j}(a^{(6,2)}_{(is)j} - \sum_{s=1}^{3} S^{*(6,2)}_{(is)j} a^{(6,2)}_{(is)j})$$

$i = 1,...,g$
$j = 1,...,h$
$s = 1, 2, 3$

$$(2.14)\quad x_{(is)}^{(5,2)r} = \sum_{j=1}^{h} (WX)_{(is)j}^{(5,2)r} x_{(is)j}^{(5,2)r} \qquad \begin{array}{l} r = 1,\ 2 \\ s = 1,\ 2,\ 3 \\ i = 1,\dots,g \end{array}$$

$$(2.15)\quad x_{(is)}^{(6,2)} = \sum_{j=1}^{h} (WX)_{(is)j}^{(6,2)} x_{(is)j}^{(6,2)} \qquad \begin{array}{l} s = 1,\ 2,\ 3 \\ i = 1,\dots,g \end{array}$$

Regional household demands for commodities by source

$$(2.16)\quad x_{(is)}^{(3)r} = x_i^{(3)r} - \sigma_{(is)}^{(3)r}(p_{(is)}^{(3)r} - \sum_{s=1}^{3} S_{(is)}^{*(3)r} p_{(is)}^{(3)r}) + a_{(is)}^{(3)r})$$

$$- \sigma_{(is)}^{(3)r}(a_{(is)}^{(3)r} - \sum_{s=1}^{3} S_{(is)}^{*(3)r} a_{(is)}^{(3)r}) \qquad \begin{array}{l} i = 1,\dots,g \\ s = 1,\ 2,\ 3 \\ r = 1,\ 2 \end{array}$$

General price of each commodity to regional household

$$(2.17)\quad p_i^{(3)r} = \sum_{s=1}^{3} S_{(is)}^{(3)r} p_{(is)}^{(3)r} \qquad \begin{array}{l} r = 1,\ 2 \\ i = 1,\dots,g \end{array}$$

Household demands for commodities, undifferentiated by source

$$(2.18)\quad x_i^{(3)r} - q^r = \varepsilon_i^r(c^r - q^r) + \sum_{k=1}^{g} \eta_{ik}^r p_k^{(3)r} + a_i^{(3)r}$$

$$+ \sum_{k=1}^{g} \eta_{ik}^r (a_k^{(3)r} + \sum_{s=1}^{3} S_{(ks)}^{(3)r}\, a_{(ks)}^{(3)r}\ ) \qquad \begin{array}{l} i = 1,\dots,g \\ r = 1,\ 2 \end{array}$$

Regional consumption

$$(2.19)\quad c^r = d_1^r + f_C^r \qquad r = 1,\ 2$$

$$(2.20)\quad c_R^r = c^r - \xi^{(3)r} \qquad r = 1,\ 2$$

$$(2.21)\quad c_R = \sum_{r=1}^{2} (CS)^r c_R^r$$

Government demands for commodities classified by source

$$(2.22)\quad x_{(is)}^{(5,1)r} = h_{(is)}^{(5,1)r} c_R^r + f_{(is)}^{(5,1)r} + f^{(5,1)r} + f^{(56)}$$

$r = 1, 2$
$s = 1, 2, 3$
$i = 1,\ldots,g$

$$(2.23)\quad x_{(is)}^{(6,1)} = h_{(is)}^{(6,1)} c_R + f_{(is)}^{(6,1)} + f^{(6,1)} + f^{(56)}$$

$s = 1, 2, 3$
$i = 1,\ldots,g$

Overseas Export demand functions

$$(2.24)\quad p_i^e = -\gamma_i x_i^{(4)} + f_i^e \qquad i = 1,\ldots,g$$

$$(2.25)\quad x_{(ir)}^{(4)} = x_i^{(4)} - \sigma_i^{(4)}(p_{(ir)}^e - \sum_{r=1}^{2} S_{(ir)}^{(4)} p_{(ir)}^e) + f_{(ir)}^{(4)}$$

$i = 1,\ldots,g$
$r = 1, 2$

$$(2.26)\quad p_i^e = \sum_{r=1}^{2} S_{(ir)}^{(4)} p_{(ir)}^e \qquad i = 1,\ldots,g$$

$$(2.27)\quad p_{(ir)}^e = -\gamma_{(ir)} x_{(ir)}^{(4)} + f_{(ir)}^e \qquad i = 1,\ldots,g \quad r = 1, 2$$

Margin demands - commodity flows to producers, capital creators

$$(2.28)\quad x_{(ut)}^{(is)(jr)k} = x_{(is)j}^{(k)r} + a_{(ut)}^{(is)(jr)k}$$

$i,u = 1,\ldots,g$
$j = 1,\ldots,h$
$r,t,k = 1, 2$
$s = 1, 2, 3$

Margin demands - commodity flows to households, government

$$(2.29)\quad x_{(ut)}^{(is)3r} = x_{(is)}^{(3)r} + a_{(ut)}^{(is)3r}$$

$i,u = 1,\ldots,g$
$s = 1, 2, 3$
$r,t = 1, 2$

$$(2.30)\quad x_{(ut)}^{(is)5vr} = x_{(is)}^{(5,v)r} + a_{(ut)}^{(is)5vr}$$

$i,u = 1,\ldots,g$
$s = 1, 2, 3$
$r,t,v = 1, 2$

$$(2.31)\quad x_{(ut)}^{(is)6v} = x_{(is)}^{(6,v)} + a_{(ut)}^{(is)6v} \qquad \begin{array}{l} i,u = 1,\ldots,g \\ s = 1,\ 2,\ 3 \\ t,v = 1,\ 2 \end{array}$$

Margin demands - exports

$$(2.32)\quad x_{(ut)}^{(ir)4} = x_{(ir)}^{(4)} + a_{(ut)}^{(ir)4} \qquad \begin{array}{l} i,u = 1,\ldots,g \\ r,t = 1,\ 2 \end{array}$$

Zero pure profits in production

$$(2.33)\quad \sum_{i=1}^{g} p_{(ir)}^{(0)} H_{(ir)j}^{(0)} = \sum_{i=1}^{g} \sum_{s=1}^{3} p_{(is)j}^{(1)r} H_{(is)j}^{(1)r}$$
$$+ \sum_{m=1}^{M} p_{(g+1,1,m)j}^{(1)r} H_{(g+1,1,m)j}^{(1)r}$$
$$+ \sum_{s=2}^{3} p_{(g+1,s)j}^{(1)r} H_{(g+1,s)j}^{(1)r} + p_{g+2,j}^{(1)r} H_{g+2,j}^{(1)r}$$
$$+ p_{g+3,j}^{(1)r} H_{g+3,j}^{(1)r} + p_{g+4,j}^{(1)r} H_{g+4,j}^{(1)r} + a_j^r$$
$$\begin{array}{l} j = 1,\ldots,h \\ r = 1,\ 2 \end{array}$$

Weighted sums of the technical-change terms affecting production functions of each regional industry

$$(2.34)\quad a_j^r = a_j^{(0)r} + \sum_{u=1}^{N(jr)} a_{(u*)j}^{(0)r} H_{(u*)j}^{(0)r} + \sum_{i=1}^{g} a_{(ir)j}^{(0)} H_{(ir)j}^{(0)}$$
$$+ a_j^{(1)r} + \sum_{i=1}^{g+1} a_{ij}^{(1)r} H_{ij}^{(1)r} + a_{g+4,j}^{(1)r} H_{g+4,j}^{(1)r}$$
$$+ \sum_{i=1}^{g} \sum_{s=1}^{3} a_{(is)j}^{(1)r} H_{(is)j}^{(1)r} + \sum_{s=1}^{3} a_{(g+1,s)j}^{(1)r} H_{(g+1,s)j}^{(1)r}$$
$$+ \sum_{m=1}^{M} a_{(g+1,1,m)j}^{(1)r} H_{(g+1,1,m)j}^{(1)r}$$
$$\begin{array}{l} j = 1,\ldots,h \\ r = 1,\ 2 \end{array}$$

Zero pure profits in capital formation

$$(2.35)\quad \pi_j^r = \sum_{i=1}^{g}\sum_{s=1}^{3} p_{(is)j}^{(2)r} H_{(is)j}^{(2)r} + a_j^{(2)r} + \sum_{i=1}^{g} a_{ij}^{(2)r} H_{ij}^{(2)r}$$

$$+ \sum_{i=1}^{g}\sum_{s=1}^{3} a_{(is)j}^{(2)r} H_{(is)j}^{(2)r} \qquad \begin{array}{l} j = 1,\ldots,h \\ r = 1,\ 2 \end{array}$$

$$(2.36)\quad \pi_j^{(5)r} = \sum_{i=1}^{g}\sum_{s=1}^{3} p_{(is)j}^{(5,2)r} H_{(is)j}^{(5,2)r} + a_j^{(5,2)r}$$

$$+ \sum_{i=1}^{g} a_{ij}^{(5,2)r} H_{ij}^{(5,2)r} + \sum_{i=1}^{g}\sum_{s=1}^{3} a_{(is)j}^{(5,2)r} H_{(is)j}^{(5,2)r}$$

$$\begin{array}{l} j = 1,\ldots,h \\ r = 1,\ 2 \end{array}$$

$$(2.37)\quad \pi_j^{(6)} = \sum_{i=1}^{g}\sum_{s=1}^{3} p_{(is)j}^{(6,2)} H_{(is)j}^{(6,2)} + a_j^{(6,2)} + \sum_{i=1}^{g} a_{ij}^{(6,2)} H_{ij}^{(6,2)}$$

$$+ \sum_{i=1}^{g}\sum_{s=1}^{3} a_{(is)j}^{(6,2)} H_{(is)j}^{(6,2)} \qquad j = 1,\ldots,h$$

Zero pure profits in importing

$$(2.38)\quad p_{(i3)}^{(0)} = (p_{(i3)}^{m} + \phi)\zeta_1(i3,0) + g(i3,0)\zeta_2(i3,0)$$

$$i = 1,\ldots,g$$

Flexible handling of tariff rates

$$(2.39)\quad g_{(i3,0)} = h_1(i3,0)\xi^{(3)} + h_2(i3,0)(t(i3,0) + p_{(i3)}^{m} + \phi)$$

$$+ h_3(i3,0)v(i3,0) \qquad i = 1,\ldots,g$$

Zero pure profits in exporting

$$(2.40)\quad (p_{(ir)}^{e} + \phi) = p_{(ir)}^{(0)}\zeta_1(ir,4) + g(ir,4)\zeta_2(ir,4)$$

$$+ \Big(\sum_{u=1}^{g}\sum_{t=1}^{2} M_{(ut)}^{(ir)4} p_{(ut)}^{(0)}\Big)\zeta_3(ir,4)$$

$$+ \Big(\sum_{u=1}^{g}\sum_{t=1}^{2} M_{(ut)}^{(ir)4} a_{(ut)}^{(ir)4}\Big)\zeta_3(ir,4)$$

$$\begin{array}{l} i = 1,\ldots,g \\ r = 1,\ 2 \end{array}$$

Flexible handling of export taxes (subsidies)

$$(2.41)\quad g(ir,4) = h_1(i0,4)\xi^{(3)} + h_2(i0,4)(t(i0,4) + p^{e}_{(ir)} + \phi) + h_3(i0,4)v(i0,4) + h_4(i0,4)v(ir,4)$$

$i = 1,\ldots,g$
$r = 1, 2$

Zero pure profits in the distribution of goods to domestic users

$$(2.42)\quad p^{(k)r}_{(is)j} = p^{(0)}_{(is)}\zeta_1(is,jrk) + g(is,jrk1)\zeta_2(is,jrk) + g(is,jk2)\zeta_3(is,jrk) + [\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)(jr)k}_{(ut)} p^{(0)}_{(ut)}]\zeta_4(is,jrk) + (\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)(jr)k}_{(ut)} a^{(is)(jr)k}_{(ut)}]\zeta_4(is,jrk)$$

$i = 1,\ldots,g$
$j = 1,\ldots,h$
$r,k = 1, 2$
$s = 1, 2, 3$

$$(2.43)\quad p^{(3)r}_{(is)} = p^{(0)}_{(is)}\zeta_1(is,3r) + g(is,3r1)\zeta_2(is,3r) + g(is,32)\zeta_3(is,3r) + (\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)3r}_{(ut)} p^{(0)}_{(ut)})\zeta_4(is,3r) + (\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)3r}_{(ut)} a^{(is)3r}_{(ut)})\zeta_4(is,3r)$$

$i = 1,\ldots,g$
$s = 1, 2, 3$
$r = 1, 2$

$$(2.44)\quad p^{(5,1)r}_{(is)} = p^{(0)}_{(is)}\zeta_1(is,5r) + (\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)5r}_{(ut)} p^{(0)}_{(ut)})\zeta_2(is,5r) + (\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)5r}_{(ut)} a^{(is)51r}_{(ut)})\zeta_2(is,5r)$$

$r = 1, 2$
$s = 1, 2, 3$
$i = 1,\ldots,g$

$$(2.45)\quad p^{(5,2)r}_{(is)j} = p^{(0)}_{(is)}\zeta_1(isj,5r)$$

$$+ \left(\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)j5r}_{(ut)} p^{(0)}_{(ut)}\right)\zeta_2(isj,5r)$$

$$+ \left(\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)j5r}_{(ut)} a^{(is)52r}_{(ut)}\right)\zeta_2(isj,5r)$$

$r = 1, 2$
$s = 1, 2, 3$
$i = 1,\ldots,g$
$j = 1,\ldots,h$

$$(2.46)\quad p^{(6,1)}_{(is)} = p^{(0)}_{(is)}\zeta_1(is,6) + \left(\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)6}_{(ut)} p^{(0)}_{(ut)}\right)\zeta_2(is,6)$$

$$+ \left(\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)6}_{(ut)} a^{(is)61}_{(ut)}\right)\zeta_2(is,6)$$

$s = 1, 2, 3$
$i = 1,\ldots,g$

$$(2.47)\quad p^{(6,2)}_{(is)j} = p^{(0)}_{(is)}\zeta_1(isj,6) + \left(\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)j6}_{(ut)} p^{(0)}_{(ut)}\right)\zeta_2(isj,6)$$

$$+ \left(\sum_{u=1}^{g}\sum_{t=1}^{2} M^{(is)j6}_{(ut)} a^{(is)62}_{(ut)}\right)\zeta_2(isj,6)$$

$i = 1,\ldots,g$
$s = 1, 2, 3$
$j = 1,\ldots,h$

Flexible handling of taxes (subsidies) on sales to domestic users

$$(2.48)\quad g(is,jrkl) = h_1(is,jrkl)\xi^{(3)r}$$

$$+ h_2(is,jrkl)(t(is,jrkl) + p^{(0)}_{(is)})$$

$$+ h_3(is,jrkl)v(is,jrkl)$$

$i = 1,\ldots,g$
$j = 1,\ldots,h$
$r,k = 1, 2$
$s = 1, 2, 3$

$$(2.49)\quad g(is,jk2) = h_1(is,jk2)\xi^{(3)r}$$

$$+ h_2(is,jk2)(t(is,jk2) + p^{(0)}_{(is)})$$

$$+ h_3(is,jk2)v(is,jk2) \qquad \begin{array}{l} i = 1,\ldots,g \\ j = 1,\ldots,h \\ k = 1,\ 2 \\ s = 1,\ 2,\ 3 \end{array}$$

$$(2.50)\quad g(is,3r1) = h_1(is,3r1)\xi^{(3)r}$$

$$+ h_2(is,3r1)(t(is,3r1) + p^{(0)}_{(is)})$$

$$+ h_3(is,3r1)v(is,3r1) \qquad \begin{array}{l} i = 1,\ldots,g \\ s = 1,\ 2,\ 3 \\ r = 1,\ 2 \end{array}$$

$$(2.51)\quad g(is,32) = h_1(is,32)\xi^{(3)r} + h_2(is,32)(t(is,32) + p^{(0)}_{(is)})$$

$$+ h_3(is,32)v(is,32) \qquad \begin{array}{l} i = 1,\ldots,g \\ s = 1,\ 2,\ 3 \end{array}$$

<u>Rates of return on capital in each regional industry</u>

$$(2.52)\quad r_{(jr)}(0) = Q^{(1)r}_j(p^{(9)r}_j - \pi^r_j) \qquad \begin{array}{l} j = 1,\ldots,h \\ r = 1,\ 2 \end{array}$$

$$(2.53)\quad p^{(9)r}_j = Q^{(2)r}_j(p^{(1)r}_{(g+1,2)j} - (SP)^{(4)r}_{(g+1,2)j}p^{(4)r}_{(g+1,2)j}$$

$$- (SP)^{(7)r}_j p^{(7)r}_j - (SP)^{(8)r}_j p^{(8)r}_j)$$

$$\begin{array}{l} r = 1,\ 2 \\ j = 1,\ldots,h \end{array}$$

<u>Equality of rates of return across regional industries</u>

$$(2.54)\quad -\beta^r_j(k^r_j(1) - k^r_j(0)) + r_{jr}(0) = \omega \qquad \begin{array}{l} j \in J \\ r = 1,\ 2 \end{array}$$

<u>Capital accumulation</u>

$$(2.55)\quad k^r_j(1) = k^r_j(0)(1 - G^r_j) + ((GY)^r_j y^r_j$$

$$+ (GY)^{5r}_j y^{(5)r}_j + (GY)^{6r}_j y^{(6)}_j)G^r_j \qquad \begin{array}{l} j = 1,\ldots,h \\ r = 1,\ 2 \end{array}$$

Investment budgets

$$(2.56)\quad \sum_{r=1}^{2} \sum_{j\epsilon J} (\pi_j^r + y_j^r)T_j^r = (\sum_{r=1}^{2} \sum_{j\epsilon J} T_j^r)i$$

$$(2.57)\quad \sum_{j\epsilon J} (\pi_j^r + y_j^r)T_j^r = (\sum_{j\epsilon J} T_j^r)i^r \qquad r = 1, 2$$

$$(2.58)\quad \sum_{j=1}^{h} (SY)_j^6(\pi_j^{(6)} + y_j^{(6)}) + \sum_{r=1}^{2} \sum_{j=1}^{h} (SY)_j^{(5)r}(\pi_j^{(5)r} + y_j^{(5)r})$$

$$+ \sum_{r=1}^{2} \sum_{j=1}^{h} (SY)_j^r(y_j^r + \pi_j^r) = i_A$$

Exogenous private investment

$$(2.59)\quad y_j^r = h_j^{(2)r} i_R^r + f_j^{(2)r} \qquad r = 1, 2;\ j \not\epsilon J$$

Government investment

$$(2.60)\quad y_j^{(5)r} = h_j^{(5)r} i_R^r + f_{Yj}^{(5)r} \qquad r = 1, 2;\ j = 1,\ldots,h$$

$$(2.61)\quad y_j^{(6)} = h_j^{(6)} i_R + f_{Yj}^{(6)} \qquad j = 1,\ldots,h$$

Real private investment expenditure

$$(2.62)\quad i_R^r = i^r - \xi^{(2)r} \qquad r = 1, 2$$

$$(2.63)\quad i_R = i - \xi^{(2)}$$

Demand equals supply for domestically produced commodities

$$(2.64)\quad x_{(ur)}^{(0)} = \sum_{j=1}^{h} \sum_{t=1}^{2} \sum_{k=1}^{2} x_{(ur)j}^{(k)t} B_{(ur)j}^{(k)t}$$

$$+ \sum_{t=1}^{2} x_{(ur)}^{(3)t} B_{(ur)}^{(3)t} + x_{(ur)}^{(4)} B_{(ur)}^{(4)}$$

$$+ \sum_{t=1}^{2} \sum_{v=1}^{2} x_{(ur)}^{(5,v)t} B_{(ur)}^{(5,v)t}$$

$$+ \sum_{v=1}^{2} x_{(ur)}^{(6,v)} B_{(ur)}^{(6,v)}$$

$$+ \sum_{i=1}^{g} \sum_{s=1}^{3} \sum_{j=1}^{h} \sum_{k=1}^{2} \sum_{t=1}^{2} x_{(ur)}^{(is)(jt)k} B_{(ur)}^{(is)(jt)k}$$

$$+ \sum_{i=1}^{g} \sum_{s=1}^{3} \sum_{t=1}^{2} x_{(ur)}^{(is)3t} B_{(ur)}^{(is)3t} + \sum_{i=1}^{g} \sum_{t=1}^{2} x_{(ur)}^{(it)4} B_{(ur)}^{(it)4}$$

$$+ \sum_{i=1}^{g} \sum_{s=1}^{3} \sum_{v=1}^{2} \sum_{t=1}^{2} x_{(ur)}^{(is)5vt} B_{(ur)}^{(is)5vt}$$

$$+ \sum_{i=1}^{g} \sum_{s=1}^{3} \sum_{v=1}^{2} x_{(ur)}^{(is)6v} B_{(ur)}^{(is)6v}$$

$u = 1,\ldots,g$
$r = 1, 2$

Total output of good u in a region

$$(2.65) \quad x_{(ur)}^{(0)} = \sum_{j=1}^{h} x_{(ur)j}^{(0)} B_{(ur)j}^{(0)} \qquad u = 1,\ldots,g \quad r = 1, 2$$

Regional demand equals regional supply of each labour skill

$$(2.66) \quad \ell_m^r = \sum_{j=1}^{h} x_{(g+1,1,m)j}^{(1)r} B_{(g+1,1,m)j}^{(1)r} \qquad m = 1,\ldots,M \quad r = 1, 2$$

Demand equals supply for capital

$$(2.67) \quad k_j^r(0) = x_{(g+1,2)j}^{(1)r} \qquad j = 1,\ldots,h \quad r = 1, 2$$

Demand equals supply for agricultural land

$$(2.68) \quad n_j^r = x_{(g+1,3)j}^{(1)r} \qquad r = 1, 2 \quad j = 1,\ldots,h$$

Import volumes

$$(2.69)\quad x^{(0)}_{(u3)} = \sum_{k=1}^{2}\sum_{j=1}^{h}\sum_{r=1}^{2} x^{(k)r}_{(u3)j}B^{(k)r}_{(u3)j} + \sum_{r=1}^{2} x^{(3)r}_{(u3)}B^{(3)r}_{(u3)}$$

$$+ \sum_{r=1}^{2}\sum_{v=1}^{2} x^{(5,v)r}_{(u3)}B^{(5,v)r}_{(u3)}$$

$$+ \sum_{v=1}^{2} x^{(6,v)}_{(u3)}B^{(6,v)}_{(u3)} \qquad u = 1,\ldots,g$$

Foreign currency value of imports

$$(2.70)\quad m = \sum_{u=1}^{g} (p^{m}_{(u3)} + x^{(0)}_{(u3)})M_{(u3)}$$

Foreign currency value of exports

$$(2.71)\quad e = \sum_{u=1}^{g}\sum_{r=1}^{2} (p^{e}_{(ur)} + x^{(4)}_{(ur)})E_{(ur)}$$

The balance of trade

$$(2.72)\quad 100\Delta B = Ee - Mm$$

FEDERAL consumer price indices

$$(2.73)\quad \xi^{(3)r} = \sum_{s=1}^{3}\sum_{i=1}^{g} W^{(3r)}_{(is)}\, p^{(3)r}_{(is)} \qquad r = 1, 2$$

$$(2.74)\quad \xi^{(3)} = \sum_{r=1}^{2} W^{(3)}_{r}\xi^{(3)r}$$

FEDERAL capital-goods price indices

$$(2.75)\quad \xi^{(2)r} = \sum_{j\in J} T^{r*}_{j}\pi^{r}_{j} \qquad r = 1, 2$$

$$(2.76)\quad \xi^{(2)} = \sum_{r=1}^{2} T^{r*}\xi^{(2)r}$$

Aggregate employment

$$(2.77)\quad \ell^{r} = \sum_{m=1}^{M} \ell^{r}_{m}\psi^{r}_{1m} \qquad r = 1, 2$$

$$(2.78)\quad \ell = \sum_{r=1}^{2} \ell^r \psi_1^r$$

Aggregate capital stock

$$(2.79)\quad k(0)^r = \sum_{j=1}^{h} k_j^r(0)\psi_{2j}^r \qquad r = 1, 2$$

$$(2.80)\quad k(0) = \sum_{r=1}^{2} k(0)^r \psi_2^r$$

Ratio of real investment to real consumption

$$(2.81)\quad f_R = i_R - c_R$$

Flexible handling of wages by occupation and regional industry

$$\begin{aligned}(2.82)\quad p^{(1)r}_{(g+1,1,m)j} &= (WP)^{(1)r,1}_{(g+1,1,m)j}p^{(1)r,1}_{(g+1,1,m)j} \\ &+ (WP)^{(1)r,2}_{(g+1,1,m)j}p^{(1)r,2}_{(g+1,1,m)j} \\ &+ (WP)^{(1)r,3}_{(g+1,1,m)j}p^{(1)r,3}_{(g+1,1,m)j} \qquad \begin{array}{l} r = 1, 2 \\ m = 1,\ldots,M \\ j = 1,\ldots,h \end{array}\end{aligned}$$

$$\begin{aligned}(2.83)\quad p^{(1)r,1}_{(g+1,1,m)j} &= h^{(1)r,1}_{(g+1,1,m)j}\xi^{(3)r} + h^{(1)1}_{(g+1,1,m)j}\xi^{(3)} \\ &+ f^{(1)1}_{(g+1,1)} + f^{(1)r,1}_{(g+1,1)} + f^{(1)1}_{(g+1,1,m)} + f^{(1)r,1}_{(g+1,1,m)} \\ &+ f^{(1)1}_{(g+1,1)j} + f^{(1)r,1}_{(g+1,1)j} + f^{(1)1}_{(g+1,1,m)j} + f^{(1)r,1}_{(g+1,1,m)j} \\ & \qquad \begin{array}{l} r = 1, 2 \\ m = 1,\ldots,M \\ j = 1,\ldots,h \end{array}\end{aligned}$$

$$(2.84)\quad p^{(1)r,2}_{(g+1,1,m)j} = h^{(1)2}_{(g+1,1,m)j}p^{(1)r,4}_{(g+1,1,m)j} + f^{(1)2}_{(g+1,1)} \qquad \begin{array}{l} r = 1, 2 \\ m = 1,\ldots,M \\ j = 1,\ldots,h \end{array}$$

$$(2.85)\quad p^{(1)r,3}_{(g+1,1,m)j} = h^{(1)r,3}_{(g+1,1,m)j}p^{(1)r,4}_{(g+1,1,m)j} + f^{(1)r,3}_{(g+1,1)} + f^{(1)r,3}_{(g+1,1,m)} + f^{(1)r,3}_{(g+1,1)j} + f^{(1)r,3}_{(g+1,1,m)j}$$

$$r = 1, 2 \quad m = 1,\dots,M \quad j = 1,\dots,h$$

$$(2.86)\quad p^{(1)r,4}_{(g+1,1,m)j} = \frac{(WP)^{(1)r,1}_{(g+1,1,m)j}}{\sum_{v=1}^{2}(WP)^{(1)r,v}_{(g+1,1,m)j}}\, p^{(1)r,1}_{(g+1,1,m)j} + \frac{(WP)^{(1)r,2}_{(g+1,1,m)j}}{\sum_{v=1}^{2}(WP)^{(1)r,v}_{(g+1,1,m)j}}\, p^{(1)r,2}_{(g+1,1,m)j}$$

$$r = 1, 2 \quad m = 1,\dots,M \quad j = 1,\dots,h$$

<u>Indexing of the prices of "other cost" tickets, unemployment benefits and taxes</u>

$$(2.87)\quad p^{(1)r}_{g+2,j} = h^{(1)r}_{g+2,j}\xi^{(3)r} + f^{(1)r}_{g+2,j} \qquad j = 1,\dots,h \quad r = 1, 2$$

$$(2.88)\quad p^{(1)r}_{g+3,j} = h^{(1)r}_{g+3,j}\xi^{(3)r} + f^{(1)}_{g+3,j} \qquad j = 1,\dots,h \quad r = 1, 2$$

$$(2.89)\quad p^{(1)r}_{g+4,j} = h^{(1)r}_{g+4,j}\xi^{(3)r} + f^{(1)}_{g+4,j} + f^{(1)r}_{(g+4,j)} \qquad j = 1,\dots,h \quad r = 1, 2$$

$$(2.90)\quad p^{(4)r}_{(g+1,2)j} = h^{(4)}_{(g+1,2)j}p^{(1)r}_{(g+1,2)j} + f^{(4)}_{(g+1,2)j} \qquad j = 1,\dots,h \quad r = 1, 2$$

$$(2.91)\quad p^{(4)r}_{(g+1,3)j} = h^{(4)}_{(g+1,3)j}p^{(1)r}_{(g+1,3)j} + f^{(4)}_{(g+1,3)j} \qquad j = 1,\dots,h \quad r = 1, 2$$

Miscellaneous Equations

(2.92) $$p^{(5,2)r}_{(is)} = \sum_{j=1}^{h} p^{(5,2)r}_{(is)j} B^{(5,2)r}_{(is)j}$$ $r = 1, 2$; $s = 1, 2, 3$; $i = 1,\ldots g$

(2.93) $$p^{(6,2)}_{(is)} = \sum_{j=1}^{h} p^{(6,2)}_{(is)j} B^{(6,2)}_{(is)j}$$ $s = 1, 2, 3$; $i = 1,\ldots,g$

(2.94) $$p^{(6,3)} = h^{(6,3)}\xi^{(3)} + f^{(6,3)}$$

(2.95) $$p^{(7)r}_{j} = h^{(7)r}\pi^{r}_{j} + f^{(7)r}$$ $r = 1, 2$; $j = 1,\ldots,h$

(2.96) $$p^{(8)r}_{j} = h^{(8)r}_{j}\pi^{r}_{j} + f^{(8)r}_{j}$$ $r = 1, 2$; $j = 1,\ldots,h$

Commonwealth Government Outlays

(2.97) $$\begin{aligned} b^{6} = {} & \sum_{i=1}^{g}\sum_{s=1}^{3} S^{(6,1)}_{(is)} (p^{(6,1)}_{(is)} + x^{(6,1)}_{(is)}) \\ & + \sum_{i=1}^{g}\sum_{s=1}^{3} S^{(6,2)}_{(is)} (p^{(6,2)}_{(is)} + x^{(6,2)}_{(is)}) \\ & + \sum_{r=1}^{2} S^{(6,3)r} (p^{(6,3)} + x^{(6,3)r}) \\ & + \sum_{r=1}^{2} t^{(6)r}_{1} S^{(6,4)r} + \sum_{r=1}^{2} t^{(6)r}_{2} S^{(6,5)r} \\ & + \sum_{r=1}^{2} t^{(6)r}_{3} S^{(6,6)r} + t^{(6)}_{4} S^{(6,7)} \end{aligned}$$

(2.98) $$t^{(6)r}_{1} = h^{(6,4)r}\xi^{(3)} + f^{(6,4)r}$$ $r = 1, 2$

(2.99) $$t^{(6)r}_{2} = h^{(6,5)r}\xi^{(3)} + f^{(6,5)r}$$ $r = 1, 2$

(2.100) $$t^{(6)}_{4} = h^{(6,6)}d + f^{(6,6)}$$

Commonwealth Government Receipts

(2.101) $$b^4 = b^{(4,1)}S^{(4,1)} + b^{(4,2)}S^{(4,2)} + b^{(4,3)}S^{(4,3)} + b^{(4,4)}S^{(4,4)} + b^{(4,5)}S^{(4,5)} + b^{(4,6)}S^{(4,6)} + b^{(4,7)}S^{(4,7)}$$

(2.102) $$b^{(4,1)r} = \sum_{j=1}^{h}\sum_{m=1}^{M} B^{(1)r,2}_{(g+1,1,m)j}(p^{(1)r,2}_{(g+1,1,m)j} + x^{(1)r}_{(g+1,1,m)j})$$

$r = 1,\ 2$

(2.103) $$b^{(4,1)} = \sum_{r=1}^{2} B^{(4,1)r} b^{(4,1)r}$$

(2.104) $$b^{(4,2)} = \sum_{r=1}^{2} B^{(4,2)r} b^{(4,2)r}$$

(2.105) $$b^{(4,2)r} = \sum_{j=1}^{h}\sum_{t=1}^{2} B^{(4,2)r}_{(jt)}\{B^{(4,2)r1}_{(jt)}(p^{(4)t}_{(g+1,2)j} + k^t_j(0)) + B^{(4,2)r2}_{(jt)}(p^{(4)t}_{(g+1,3)j} + n^t_j)\}$$

$r = 1,\ 2$

(2.106) $$b^{(4,3)} = \sum_i (g(i3,0) + x^{(0)}_{(i3)})B^{(4,3)}_i$$

(2.107) $$b^{(4,4)} = \sum_{j=1}^{h}\sum_{r=1}^{2} B^{(4,4)r}_j(p^{(1)r}_{g+3,j} + x^{(1)r}_{g+3,j})$$

(2.108) $$b^{(4,5)} = \sum_{i=1}^{g}\sum_{s=1}^{3}\sum_{j=1}^{h}\sum_{r=1}^{2}\sum_{k=1}^{2} (g(is,jk2) + x^{(k)r}_{(is)j})B^{(4,5)kr}_{(is)j} + \sum_{i=1}^{g}\sum_{s=1}^{3}\sum_{r=1}^{2} (g(is,32) + x^{(3)r}_{(is)})B^{(4,5)3r}_{(is)}$$

(2.109) $$b^{(4,6)} = \sum_{i=1}^{g}\sum_{r=1}^{2} (g(ir,4) + x^{(4)}_{(ir)})B^{(4,6)r}_i h^4_i$$

(2.110) $$b^{(4,7)} = h^{(4,7)}\xi^{(3)} + f^{(4,7)}$$

State Government Outlays

$$(2.111)\quad b^{5r} = \sum_{i=1}^{q} \sum_{s=1}^{3} S_{(is)}^{(5,1)r} \left(p_{(is)}^{(5,1)r} + x_{(is)}^{(5,1)r}\right)$$

$$+ \sum_{i=1}^{g} \sum_{s=1}^{3} S_{(is)}^{(5,2)r} \left(p_{(is)}^{(5,2)r} + x_{(is)}^{(5,2)r}\right) + t_1^{(5)r} S^{(5,3)r}$$

$$+ t_2^{(5)r} S^{(5,4)r} + \sum_{u} t_3^{(5)ru} S^{(5,5)ru}$$

$$r = 1, 2$$

$$(2.112)\quad t_1^{(5)r} = h_1^{(5)r} \xi^{(3)} + f_1^{(5)r} \qquad r = 1, 2$$

$$(2.113)\quad t_2^{(5)r} = h_2^{(5)r} d^{r} + f_2^{(5)r} \qquad r = 1, 2$$

State Government Receipts

$$(2.114)\quad b^{3r} = \sum_{k=1}^{8} b^{(3,k)r} S^{(3,k)r} \qquad r = 1, 2$$

$$(2.115)\quad b^{(3,1)r} = \sum_{m=1}^{M} \sum_{j=1}^{h} B_{mj}^{(3,1)r} \left(p_{(g+1,1,m)j}^{(1)r,3} + x_{(g+1,1,m)j}^{(1)r}\right)$$

$$r = 1, 2$$

$$(2.116)\quad b^{(3,2)r} = p_d^{(7)r} + k_d^{r}(0)$$

$r = 1, 2$
d = regional industry covering ownership of dwellings

$$(2.117)\quad b^{(3,3)r} = \sum_{j=1}^{h} B_j^{(3,3)r} \left(p_j^{(8)r} + k_j^{r}(0)\right) \qquad r = 1, 2$$

$$(2.118)\quad b^{(3,4)r} = h^{(3,4)r} d^{r} + f^{(3,4)r} \qquad r = 1, 2$$

$$(2.119)\quad b^{(3,5)r} = t_1^{(6)r} \qquad r = 1, 2$$

$$(2.120)\ b^{(3,6)r} = \sum_{i=1}^{g}\sum_{s=1}^{3}\sum_{j=1}^{h}\sum_{k=1}^{2}(g(is,jrkl) + x_{(is)j}^{(k)r})B_{(is)j}^{(3,6)kr}$$

$$+ \sum_{i=1}^{g}\sum_{s=1}^{3}(g(is,3rl) + x_{(is)}^{(3)r})B_{(is)}^{(3,6)3r}$$

$$r = 1, 2$$

$$(2.121)\ b^{(3,7)r} = \sum_{j=1}^{h} B_j^{(3,7)r}(p_{g+2,j}^{(1)r} + x_{g+2,j}^{(1)r}) \qquad r = 1, 2$$

$$(2.122)\ b^{(3,8)r} = h^{(3,8)r}\xi^{(3)} + f^{(3,8)r} \qquad r = 1, 2$$

Commonwealth Public Sector Borrowing Requirement

$$(2.123)\ 100\Delta B^2 = B^6b^6 - B^4b^4$$

State Public Sector Borrowing Requirement

$$(2.124)\ 100\Delta B^{1r} = B^{5r}b^{5r} - B^{3r}b^{3r} \qquad r = 1, 2$$

Disposable Income

$$(2.125)\ d^r = (SD)_1^r d_1^r + (SD)_2^r d_2^r \qquad r = 1, 2$$

$$(2.126)\ d^r = \sum_{m=1}^{M}\sum_{j=1}^{h}(p_{(g+1,1,m)j}^{(1)r,4} + x_{(g+1,1,m)j}^{(1)r})D_{(g+1,1,m)j}^{r}$$

$$+ \sum_{j=1}^{h}\sum_{t=1}^{2} D_{(jt)}^{r}\{D_{(jt)}^{r1}(p_{(g+1,2)j}^{(1)t} + k_j^t(0))$$

$$+ D_{(jt)}^{r2}(p_{(g+1,3)j}^{(1)t} + n_j^t)\} \qquad r = 1, 2$$

$$(2.127)\ d_2^r = D_1^{(2)r}b^{(4,1)r} + D_2^{(2)r}b^{(4,2)r} + D_3^{(2)r}b^{(3,2)r}$$

$$+ D_4^{(2)r}b^{(3,4)r}$$

$$+ \sum_{j=1}^{h}\sum_{t=1}^{2}(p_j^{(8)r} + k_j^r(0))D_{jt}^{(2)r} + D_5^{(2)r}\phi + D_6^{(2)r}b^{(4,7)}$$

$$+ D_7^{(2)r}b^{(3,8)r}$$

$$- D_8^{(2)r} \sum_i \sum_t (B_i^{(4,6)t} \zeta(r,it)(1 - h_i^4)$$

$$/ \sum_u \sum_s B_u^{(4,6)s} \zeta(r,us)(1 - h_u^4))g(it,4)$$

$$- D_9^{(2)r}(p^{(6,3)} + x^{(6,3)r}) - D_{10}^{(2)r} t_2^{(6)r} - D_{11}^{(2)r} t_3^{(6)r}$$

$$- D_{12}^{(2)r} t_1^{(5)r} - D_{13}^{(2)r} \sum_u \lambda_u^r t_3^{(5)ur} \qquad r = 1,\ 2$$

(2.128) $$d = \sum_{r=1}^{2} (GD)^r d^r$$

Unemployment

(2.129) $$x^{(6,3)r} = -\ell^r \S_1^r + \S_2^r f^{(6,3)r} \qquad r = 1,\ 2$$

Table 2.2

FEDERAL Percentage Change Variables

Variable	Subscript Range	Number	Description
a_j^r	r = 1, 2 j = 1,...,h	2h	Weighted sum of technical-change terms affecting the production function of a regional industry
$a_j^{(0)r}$	r = 1, 2 j = 1,...,h	2h	Neutral output-augmenting technical change
$a_{(ir)j}^{(0)}$	r = 1, 2 i = 1,...,g j = 1,...,h	2gh	Commodity output augmenting technical change
$a_{(u*)j}^{(0)r}$	r = 1, 2 u = 1,...,N(jr) j = 1,...,h	$\sum_{j=1}^{h} \sum_{r=1}^{2} N(jr)$	Composite-commodity-augmenting technical change
$a_j^{(1)r}$	r = 1, 2 j = 1,...,h	2h	Neutral-input-augmenting technical change
$a_{ij}^{(1)r}$	i = 1,...,g+1 j = 1,...,h r = 1, 2	2(g+1)h	Input-i-augmenting technical change
$a_{(is)j}^{(1)r}$	i = 1,...,g s = 1, 2, 3 r = 1, 2 j = 1,...,h	6gh	Input-(is)-augmenting technical change
$a_{(g+1,v)j}^{(1)r}$	v = 1, 2, 3 r = 1, 2 j = 1,...,h	6h	Labour-, capital- and agricultural-land-augmenting technical change
$a_{(g+1,1,q)j}^{(1)r}$	q = 1,...,M r = 1, 2 j = 1,...,h	2Mh	Specific-skill-augmenting technical change
$a_{g+4,j}^{(1)r}$	r = 1, 2 j = 1,...,h	2h	"Other costs" input-augmenting technical change
$a_j^{(2)r}$	r = 1, 2 j = 1,...,h	2h	Neutral input-augmenting technical change in capital formation

Variable	Subscript Range	Number	Description
$a_{ij}^{(2)r}$	r = 1, 2 i = 1,...,g j = 1,...,h	2gh	Input-i-augmenting technical change in capital formation
$a_{(is)j}^{(2)r}$	i = 1,...,g r = 1, 2 s = 1, 2, 3 j = 1,...,h	6gh	Input-(is)-augmenting technical change in capital formation
$a_{i}^{(3)r}$	r = 1, 2 i = 1,...,g	2g	Commodity-i-augmenting change in household preferences
$a_{(is)}^{(3)r}$	r = 1, 2 i = 1,...,g s = 1, 2, 3	6g	Commodity-(is)-augmenting change in household preferences
$a_{j}^{(5,2)r}$	r = 1, 2 j = 1,...,h	2h	Neutral input-augmenting technical change in capital formation by a state government in a regional industry
$a_{ij}^{(5,2)r}$	r = 1, 2 i = 1,...,g j = 1,...,h	2gh	Input-i-augmenting technical change in capital formation by a state government in a regional industry
$a_{(is)j}^{(5,2)r}$	r = 1, 2 s = 1, 2, 3 i = 1,...,g j = 1,...,h	6gh	Input-(is)-augmenting technical change in capital formation by a state government in a regional industry
$a_{j}^{(6,2)}$	j = 1,...,h	h	Neutral input-augmenting technical change in capital formation by the Commonwealth government in industry j
$a_{ij}^{(6,2)}$	i = 1,...,g j = 1,...,h	gh	Input-i-augmenting technical change in capital formation by the Commonwealth government in industry j
$a_{(is)j}^{(6,2)}$	i = 1,...,g s = 1, 2, 3 j = 1,...,h	3gh	Input-(is)-augmenting technical change in capital formation by the Commonwealth government in an industry

Variable	Subscript Range	Number	Description
$a_{(ut)}^{(is)6v}$	i,u = 1,...,g v,t = 1, 2 s = 1, 2, 3	$12g^2$	Technical change associated with the use of margin services in facilitating commodity flows to the Commonwealth government
$a_{(ut)}^{(is)(jr)k}$	r,t,k = 1, 2 i,u = 1,...,g j = 1,...,h s = 1, 2, 3	$24hg^2$	Technical change associated with the use of margin services in facilitating input flows to producers of current and capital goods
$a_{(ut)}^{(is)3r}$	r,t = 1, 2 i,u = 1,...,g s = 1, 2, 3	$12g^2$	Technical change associated with the use of services in facilitating commodity flows to households
$a_{(ut)}^{(ir)4}$	r,t = 1, 2 i,u = 1,...,g	$4g^2$	Technical change associated with the use of margin services on export flows from producers to the ports of exit
$a_{(ut)}^{(is)5vr}$	i,u = 1,...,g s = 1, 2, 3 r,t,v = 1, 2	$24g^2$	Technical change associated with the use of margin services on commodity flows to state governments
ΔB^{1r}	r = 1, 2	2	State Government Borrowing Requirement
ΔB^{2}			Commonwealth Government Borrowing Requirement
b^{3r}	r = 1, 2	2	State government receipts
$b^{(3,1)r}$	r = 1, 2	2	State government payroll tax receipts
$b^{(3,2)r}$	r = 1, 2	2	State government residential land-tax receipts
$b^{(3,3)r}$	r = 1, 2	2	State government commerical land-tax receipts
$b^{(3,4)r}$	r = 1, 2	2	Other state government income-reducing tax receipts

Variable	Subscript Range	Number	Description
$b^{(3,5)r}$	r = 1, 2	2	Payments to a state from the Commonwealth government
$b^{(3,6)r}$	r = 1, 2	2	State government commodity tax (less subsidies) receipts
$b^{(3,7)r}$	r = 1, 2	2	State government production tax (less subsidies) receipts
$b^{(3,8)r}$	r = 1, 2	2	Other state government receipts
b^{4}		1	Commonwealth government receipts
$b^{(4,1)}$		1	Commonwealth government PAYE-tax receipts
$b^{(4,1)r}$	r = 1, 2	2	Commonwealth government PAYE-tax receipts by region
$b^{(4,2)}$		1	Other Commonwealth government income-tax receipts
$b^{(4,2)r}$	r = 1, 2	2	Other income-tax receipts from a region by the Commonwealth
$b^{(4,3)}$		1	Commonwealth government receipts from import duties
$b^{(4,4)}$		1	Commonwealth government receipts from production taxes (less subsidies)
$b^{(4,5)}$		1	Commonwealth government receipts from commodity taxes (less subsidies)
$b^{(4,6)}$		1	Commonwealth government receipts from export taxes (less subsidies)
$b^{(4,7)}$		1	Other Commonwealth Government receipts
b^{5r}	r = 1, 2	2	State government outlays

Variable	Subscript Range	Number	Description
b^6		1	Commonwealth Government outlays
ΔB		1	The balance of trade
c^r	r = 1, 2	2	Aggregate nominal household expenditure in region r
c_R		1	Economy-wide real aggregate household consumption
c_R^r	r = 1, 2	2	Real aggregate household expenditure in region r
d		1	Nominal gross national product
d^r	r = 1, 2	2	Nominal gross income of residents in a region
d_1^r	r = 1, 2	2	Nominal disposable income of a region's residents
d_2^r	r = 1, 2	2	Amount of direct taxes paid by and direct transfers paid to residents of a region
e		1	Foreign currency value of exports
$f_{(g+1,1)}^{(1)1}$		1	Shift variable for post-tax wages
$f_{(g+1,1)j}^{(1)1}$	j = 1,...,h	h	Variable which allows the same change in industrial post-tax wage relativities in each region
$f_{(g+1,1,m)}^{(1)1}$	m = 1,...,M	M	Shift variable for variations in post-tax relativities between occupations
$f_{(g+1,1,m)j}^{(1)1}$	m = 1,...,M j = 1,...,h	Mh	Shift variable for economy-wide changes in both occupational and industrial post-tax wage relativities

Variable	Subscript Range	Number	Description
$f^{(1)r,1}_{(g+1,1)}$	r = 1, 2	2	Shift variable for regional variations in post-tax wages
$f^{(1)r,1}_{(g+1,1,m)}$	r = 1, 2 m = 1,...,M	2M	Variable allowing shifts in both occupational and regional post-tax wage relativities
$f^{(1)r,1}_{(g+1,1)j}$	r = 1, 2 j = 1,...,h	2h	Shift variable for changing post-tax wage relativities between regional industries
$f^{(1)r,1}_{(g+1,1,m)j}$	r = 1, 2 m = 1,...,M j = 1,...,h	2Mh	Shift variable for simulating changes in post-tax wage relativities between regions, occupations and industries
$f^{(1)2}_{(g+1,1)}$		1	Shift variable for PAYE taxes per unit of labour
$f^{(1)r,3}_{(g+1,1)}$	r = 1, 2	2	Shift variable for change in payroll tax rate per unit of labour for a region in general
$f^{(1)r,3}_{(g+1,1,m)}$	r = 1, 2 m = 1,...,M	2M	Shift variable for change in relative payroll tax rates between occupations in a region
$f^{(1)r,3}_{(g+1,1)j}$	r = 1, 2 j = 1,...,h	2h	Shift variable for change in payroll rate for regional industries
$f^{(1)r,3}_{(g+1,1,m)j}$	r = 1, 2 m = 1,...,M j = 1,...,h	2Mh	Shift variable allowing changes in the payroll tax per unit of labour between regions, occupations and industries
$f^{(1)r}_{(g+2,j)}$	r = 1, 2 j = 1,...,h	2h	Shift variables for changing the real component of State government production tax rates
$f^{(1)}_{(g+3,j)}$	j = 1,...,h	h	Shift variables for changing the real component of Commonwealth government production tax rates

Variable	Subscript Range	Number	Description
$f^{(1)}_{(g+4,j)}$	$j = 1,\ldots,h$	h	Shift terms for changing the real price of "other cost" tickets by regional industry
$f^{(1)r}_{(g+4,j)}$	$r = 1, 2$ $j = 1,\ldots,h$	2h	Shift terms for changing the real price of "other cost" tickets by regional industry
$f^{(2)r}_{j}$	$r = 1, 2$ $j \notin J$	2(h-J)	Exogenous private investment terms
$f^{(3,4)r}$	$r = 1, 2$	2	Shift term for receipts from other income-reducing taxes imposed by a state government
$f^{(3,8)r}$	$r = 1, 2$	2	Shift term for other receipts by a state government
$f^{(4,7)}$		1	Shift term for other Commonwealth government receipts
$f^{(4)}_{(ir)}$	$i = 1,\ldots,g$ $r = 1, 2$	2g	Shift variable for regional export demands
$f^{(4)}_{(g+1,2)j}$	$j = 1,\ldots,h$	h	Shift term for income tax rate per unit of capital
$f^{(4)}_{(g+1,3)j}$	$j = 1,\ldots,h$	h	Shift term for income tax rate per unit of land
$f^{(5)r}_{1}$	$r = 1, 2$	2	Shift terms for state government transfers to persons
$f^{(5)r}_{2}$	$r = 1, 2$	2	Shift terms for other state government outlays
$f^{(5)r}_{Yj}$	$r = 1, 2$ $j = 1,\ldots,h$	2h	Exogenous state government investment terms
$f^{(5,1)r}$	$r = 1, 2$	2	Shift term for aggregate current expenditure by a state government
$f^{(5,1)r}_{(is)}$	$r = 1, 2$ $s = 1, 2, 3$ $i = 1,\ldots,g$	6g	Shift terms for state government current expenditures

Variable	Subscript Range	Number	Description
$f^{(56)}$		1	Shift term for current expenditure by all governments
$f^{(6)}_{Yj}$	j = 1,...,h	h	Exogenous Commonwealth government investment terms
$f^{(6,1)}$		1	Shift term for aggregate Commonwealth government expenditure
$f^{(6,1)}_{(is)}$	s = 1, 2, 3 i = 1,...,g	3g	Shift terms for Commonwealth government current expenditures
$f^{(6,3)}$		1	Shift term for unemployment benefits rate
$f^{(6,3)r}$	r = 1, 2	2	Regional labour force
$f^{(6,4)r}$	r = 1, 2	2	Shift terms for amount of transfers from Commonwealth to State government
$f^{(6,5)r}$	r = 1, 2	2	Shift terms for amount of Commonwealth transfers to persons in a region (other than unemployment benefits)
$f^{(6,6)}$		1	Shift term for other Commonwealth government outlays
$f^{(7)r}$	r = 1, 2	2	Shift variable for residential land tax
$f^{(8)r}_{j}$	r = 1, 2 j = 1,...,h	2h	Shift variable for commercial land tax
f_R		1	The economy-wide ratio of real private investment expenditure to real household consumption expenditure
f^{e}_{i}	i = 1,...,g	g	Shifts in foreign export demands
$f^{e}_{(ir)}$	i = 1,...,g r = 1, 2	2g	Shifts in foreign demands for regional exports

Variable	Subscript Range	Number	Description
f_C^r	r = 1, 2	2	Average propensity to consume in region r
g(i3,0)	i = 1,...,g	g	Tariffs per unit of imports
g(is,3r1)	r = 1, 2 i = 1,...,g s = 1, 2, 3	6g	State taxes per unit of household purchases
g(is,32)	i = 1,...,g s = 1, 2, 3	3g	Commonwealth taxes per unit of household purchases
g(ir,4)	i = 1,...,g r = 1, 2	2g	Taxes per unit of exports
g(is,jrk1)	k,r = 1, 2 i = 1,...,g s = 1, 2, 3 j = 1,...,h	12gh	State government taxes on the purchase of inputs by regional industries for current production and capital creation
g(is,jk2)	k = 1, 2 i = 1,...,g s = 1, 2, 3 j = 1,...,h	6gh	Commonwealth taxes on the purchase of inputs by regional industries for current production and capital creation
i		1	Economy-wide private investment expenditure (endogenous industries only)
i_A		1	Aggregate economy-wide investment expenditure
i^r	r = 1, 2	2	Regional private investment expenditure (endogenous industries only)
i_R		1	Economy-wide real private investment expenditure (endogenous industries only)
i_R^r	r = 1, 2	2	Regional real private investment expenditure (endogenous industries only)
k(0)		1	Economy-wide capital stock

Variable	Subscript Range	Number	Description
$k(0)^r$	$r = 1, 2$	2	Regional capital stock
$k_j^r(0)$	$j = 1,\ldots,h$ $r = 1, 2$	2h	Current regional industry capital stock
$k_j^r(1)$	$j = 1,\ldots,h$ $r = 1, 2$	2h	Future regional industry capital stock
m		1	Foreign currency value of imports
n_j^r	$j = 1,\ldots,h$ $r = 1, 2$	2h	Use of agricultural land in each regional industry
$p_{(is)}^{(0)}$	$s = 1, 2, 3$ $i = 1,\ldots,g$	3g	Basic prices of commodities from each source
$p_{(t*)j}^{(0)r}$	$r = 1, 2$ $t = 1,\ldots,N(jr)$ $j = 1,\ldots,h$	$\sum_{j=1}^{h} \sum_{r=1}^{2} N(jr)$	Prices of composite commodities
$p_{(g+1,v)j}^{(1)r}$	$r = 1, 2$ $v = 1, 2, 3$ $j = 1,\ldots,h$	6h	Prices paid by each regional industry for labour in general, rental of capital and rental of land
$p_{(g+1,1,m)j}^{(1)r}$	$r = 1, 2$ $m = 1,\ldots,M$ $j = 1,\ldots,h$	2Mh	Prices paid by regional industries for units of labour of different occupational categories
$p_{g+2,j}^{(1)r}$	$r = 1, 2$ $j = 1,\ldots,h$	2h	Tax rate per state government production tax unit
$p_{g+3,j}^{(1)r}$	$r = 1, 2$ $j = 1,\ldots,h$	2h	Tax rate per Commonwealth government production tax unit
$p_{g+4,j}^{(1)r}$	$r = 1, 2$ $j = 1,\ldots,h$	2h	Prices of "other cost" tickets to each industry
$p_{(g+1,1,m)j}^{(1)r,1}$	$r = 1, 2$ $m = 1,\ldots,M$ $j = 1,\ldots,h$	2Mh	Post-tax nominal wage per labour unit
$p_{(g+1,1,m)j}^{(1)r,2}$	$r = 1, 2$ $m = 1,\ldots,M$ $j = 1,\ldots,h$	2Mh	PAYE tax per labour unit

Variable	Subscript Range	Number	Description
$p^{(1)r,3}_{(g+1,1,m)j}$	$r = 1, 2$ $m = 1,\ldots,M$ $j = 1,\ldots,h$	2Mh	Payroll tax per labour unit
$p^{(1)r,4}_{(g+1,1,m)j}$	$r = 1, 2$ $m = 1,\ldots,M$ $j = 1,\ldots,h$	2Mh	Pre-(PAYE) tax nominal wage per labour unit
$p^{(3)r}_{i}$	$r = 1, 2$ $i = 1,\ldots,g$	2g	Purchasers' prices in region r paid by consumers for commodities by type only
$p^{(3)r}_{(is)}$	$s = 1, 2, 3$ $r = 1, 2$ $i = 1,\ldots,g$	6g	Purchaser prices in region r for consumer commodities by type and source
$p^{(4)r}_{(g+1,2)j}$	$j = 1,\ldots,h$ $r = 1, 2$	2h	Commonwealth taxes on returns to capital per unit of capital
$p^{(4)r}_{(g+1,3)j}$	$j = 1,\ldots,h$ $r = 1, 2$	2h	Commonwealth taxes on returns to land per unit of land
$p^{(5,1)r}_{(is)}$	$r = 1, 2$ $s = 1, 2, 3$ $i = 1,\ldots,g$	6g	Prices paid by a state government for current consumption purchases by type and source
$p^{(5,2)r}_{(is)}$	$r = 1, 2$ $s = 1, 2, 3$ $i = 1,\ldots,g$	6g	Prices paid by a state government in general for inputs into capital formation by type and source
$p^{(5,2)r}_{(is)j}$	$r = 1, 2$ $i = 1,\ldots,g$ $s = 1, 2, 3$ $j = 1,\ldots,h$	6gh	Prices paid by a state government for inputs into capital formation in a regional industry
$p^{(6,1)}_{(is)}$	$i = 1,\ldots,g$ $s = 1, 2, 3$	3g	Price paid by Commonwealth Government for commodities for current consumption
$p^{(6,2)}_{(is)}$	$s = 1, 2,3$ $i = 1,\ldots,g$	3g	Prices paid by Commonwealth Government for produced inputs for capital formation by type and source

Variable	Subscript Range	Number	Description
$p_{(is)j}^{(6,2)}$	i = 1,...,g s = 1, 2, 3 j = 1,...,h	3gh	Prices paid by a Commonwealth government for inputs into capital formation in a regional industry
$p^{(6,3)}$		1	Unemployment benefits per person
$p_j^{(7)r}$	r = 1, 2 j = 1,...,h	2h	State government residential land tax per unit of current capital in ownership of dwellings
$p_j^{(8)r}$	r = 1, 2 j = 1,...,h	2h	State government commercial land tax per unit of current capital in an industry
$p_j^{(9)r}$	r = 1, 2 j = 1,...,h	2h	Post-tax rental price for regional industry capital
p_i^e	i = 1,...,g	g	F.o.b. foreign currency export prices for a good regardless of region of manufacture
$p_{(ir)}^e$	r = 1, 2 i = 1,...,g	2g	F.o.b. foreign currency export prices for good originating from a particular region
$p_{(is)j}^{(k)r}$	i = 1,...,g j = 1,...,h r,k = 1, 2 s = 1, 2, 3	12gh	Purchasers' prices for produced inputs for current production and private capital formation
$p_{(i3)}^m$	i = 1,...,g	g	C.i.f. foreign currency import prices
q^r	r = 1, 2	2	Number of households in region r
$r_{(jr)}(0)$	j = 1,...,h r = 1, 2	2h	Current rates of return on fixed capital
t(i0,4)	i = 1,...,g	g	Term allowing for ad valorem treatment of export taxes
t(i3,0)	i = 1,...,g	g	Term allowing for ad valorem treatment of import duties

Variable	Subscript Range	Number	Description
$t_1^{(5)r}$	r = 1, 2	2	State government transfers to persons
$t_2^{(5)r}$	r = 1, 2	2	Other state government outlays (excluding interest payments to persons)
$t_3^{(5)ru}$	r = 1, 2 u = 1, 2	4	State government r interest payments to region u residents
$t_1^{(6)r}$	r = 1, 2	2	Amount of transfers from Commonwealth to a state government
$t_2^{(6)r}$	r = 1, 2	2	Amount of transfers to persons in a region (other than interest payments and benefits)
$t_3^{(6)r}$	r = 1, 2	2	Interest payments by Commonwealth government to persons
$t_4^{(6)}$		1	Other Commonwealth government outlays
t(is,jrk1)	k,r = 1, 2 i = 1,...,g s = 1, 2, 3 j = 1,...,h	12gh	Term allowing for ad valorem treatment of state government taxes on industry purchases
t(is,jk2)	k = 1, 2 i = 1,...,g s = 1, 2, 3 j = 1,...,h	6gh	Term allowing for ad valorem treatment of Commonwealth government taxes on industry purchases
t(is,3r1)	r = 1, 2 i = 1,...,g s = 1, 2, 3	6g	Term allowing for ad valorem treatment of state government taxes on household purchases
t(is,32)	i = 1,...,g s = 1, 2, 3	3g	Term allowing for ad valorem treatment of Commonwealth taxes on household purchases
v(ir,4)	i = 1,...,g r = 1, 2	2g	Term allowing for export taxes on regional commodities to be treated as specific

Variable	Subscript Range	Number	Description
$v(io,4)$	$i = 1,\ldots,g$	g	Term allowing for economy-wide export tax on a regional commodity to be treated as specific
$v(i3,0)$	$i = 1,\ldots,g$	g	Term allowing for import duties to be treated as specific
$v(is,jrk1)$	$k,r = 1, 2$ $i = 1,\ldots,g$ $s = 1, 2, 3$ $j = 1,\ldots,h$	$12g$	Term allowing for state government taxes on industry purchases to be treated as specific
$v(is,jk2)$	$k = 1, 2$ $i = 1,\ldots,g$ $s = 1, 2, 3$ $j = 1,\ldots,h$	$6gh$	Term allowing for Commonwealth taxes on industry purchases to be treated as specific
$v(is,3r1)$	$r = 1, 2$ $i = 1,\ldots,g$ $s = 1, 2, 3$	$6g$	Term allowing state government taxes on household purchases to be treated as specific
$v(is,32)$	$i = 1,\ldots,g$ $s = 1, 2, 3$	$3g$	Term allowing for Commonwealth taxes on household purchases to be treated as specific
$x^{(0)}_{(ur)}$	$r = 1, 2$ $u = 1,\ldots,g$	$2g$	Total supplies of domestic commodities in a region
$x^{(0)}_{(u3)}$	$u = 1,\ldots,g$	g	Aggregate imports by commodity
$x^{(0)}_{(ir)j}$	$r = 1, 2$ $j = 1,\ldots,h$ $i = 1,\ldots,g$	$2gh$	Supplies of commodities by regional industry
$x^{(0)r}_{(u*)j}$	$r = 1, 2$ $j = 1,\ldots,h$ $u = 1,\ldots,N(jr)$	$\sum_{j=1}^{h} \sum_{r=1}^{2} N(jr)$	Supplies of composite commodities by regional industry
$x^{(1)r}_{(g+1,v)j}$	$v = 1, 2, 3$ $r = 1, 2$ $j = 1,\ldots,h$	$6h$	Regional industry demands for labour in general, capital and agricultural land
$x^{(1)r}_{(g+1,1,q)j}$	$q = 1,\ldots,M$ $j = 1,\ldots,h$ $r = 1, 2$	$2Mh$	Demands for labour inputs by occupational group and regional industry

Variable	Subscript Range	Number	Description
$x^{(1)r}_{g+2,j}$	j = 1,...,h r = 1, 2	2h	Demand for state government production tax units
$x^{(1)r}_{g+3,j}$	j = 1,...,h r = 1, 2	2h	Demand for Commonwealth government production tax units
$x^{(1)r}_{g+4,j}$	r = 1, 2 j = 1,...,h	2h	Demand for "other cost" tickets
$x^{(3)r}_{i}$	r = 1, 2 i = 1, ...,g	2g	Regional household demands in each region for commodities by type, undifferentiated by source
$x^{(3)r}_{(is)}$	r = 1, 2 s = 1, 2, 3 i = 1,...,g	6g	Regional household demands for commodities by type and source
$x^{(4)}_{i}$	i = 1,...,g	g	Export volumes
$x^{(4)}_{(ir)}$	r = 1, 2 i = 1,...,g	2g	Export volumes by region of manufacture
$x^{(5,2)r}_{(is)j}$	r = 1, 2 i = 1,...,g s = 1, 2, 3 j = 1,...,h	6gh	State government industry demands for commodities by type and source
$x^{(5,v)r}_{(is)}$	v,r = 1, 2 s = 1, 2, 3 i = 1,...,g	12g	State government demands for commodities by type and source
$x^{(6,2)}_{(is)j}$	i = 1,...,g s = 1, 2, 3 j = 1,...,h	3gh	Commonwealth government industry demands for commodities by type and source
$x^{(6,3)r}$	r = 1, 2	2	Number of unemployed persons in region r
$x^{(6,v)}_{(is)}$	v = 1, 2 i = 1,...,g s = 1, 2, 3	6g	Commonwealth government demands for goods by type and source
$x^{(k)r}_{(is)j}$	i = 1,...,g j = 1,...,h s = 1, 2, 3 r,k = 1, 2	12gh	Input demands for current production and private capital formation

Variable	Subscript Range	Number	Description
$x_{(ut)}^{(is)(jr)k}$	r,t,k = 1,2 i,u = 1,...,g j = 1,...,h s = 1, 2, 3	$24g^2h$	Demand for margin services on flows of commodities to current production and private capital formation
$x_{(ut)}^{(is)3r}$	r,t = 1, 2 i,u = 1,...,g s = 1, 2, 3	$12g^2$	Demand for margin services on commodity flows to households
$x_{(ut)}^{(ir)4}$	r,t = 1, 2 i,u = 1,...,g	$4g^2$	Demand for margin services on the flow of export commodities to point of export
$x_{(ut)}^{(is)5vr}$	r,t,v = 1, 2 i,u = 1,...,g s = 1, 2, 3	$24g^2$	Demand for margins to facilitate commodity flows to state governments
$x_{(ut)}^{(is)6v}$	i,u = 1,...,g v,t = 1, 2 s = 1, 2, 3	$12g^2$	Demand for margins to facilitate commodity flows to Commonwealth government
y_j^r	r = 1, 2 j = 1,...,h	2h	Private capital formation by regional industry
$y_j^{(5)r}$	r = 1, 2 j = 1,...,h	2h	Capital formation by a state government in a regional industry
$y_j^{(6)}$	j = 1,...,h	h	Capital formation by the Commonwealth government in a regional industry
z_j^r	r = 1, 2 j = 1,...,h	2h	Regional industry activity levels
$\xi^{(2)}$		1	FEDERAL capital-goods price index
$\xi^{(2)r}$	r = 1, 2	2	FEDERAL regional capital-goods price index
ξ^3		1	FEDERAL economy-wide consumer price index
$\xi^{(3)r}$	r = 1, 2	2	FEDERAL consumer price index for region r
ϕ		1	The exchange rate, \$A per foreign unit of currency
ℓ		1	Economy-wide employment

Variable	Subscript Range	Number	Description
ℓ^r	$r = 1, 2$	2	Regional employment
ℓ^r_m	$m = 1,\ldots,M$ $r = 1, 2$	2M	Employment of labour by occupational group in region r
π^r_j	$j = 1,\ldots,h$ $r = 1, 2$	2h	Costs of units of private capital in a regional industry
$\pi^{(5)r}_j$	$r = 1, 2$ $j = 1,\ldots,h$	2h	Cost of units of capital to a state government investing in a regional industry
$\pi^{(6)}_j$	$j = 1,\ldots,h$	h	Cost of units of capital to the Commonwealth government investing in an industry
ω		1	Economy-wide expected rate of return on capital

Chapter 3

Derivation of Coefficients and Parameters

3.1 Introduction

In order to implement the equation system described in the last chapter it is necessary to establish numerical values for the model's coefficients and parameters.[1] For the purpose of this thesis we wish to implement a model with Tasmania as one region and the Australian mainland as the other. As noted in Chapter 1, we call this first version of our model, FEDERAL (TASMAIN).

For coefficients, such as cost, sales, revenue and government expenditure shares, this process consists of three stages. These are: the establishment of the basic data sets; the construction of the FEDERAL (TASMAIN) input-output and government expenditure data files; the derivation of the coefficient values from these data files. Parameters, such as substitution elasticities and indexing parameters, are, on the other hand, handled in basically a single stage, with a value for each parameter, either estimated or user-set, being stored directly in the parameters file.

In this chapter we limit ourselves to describing the FEDERAL data base and explaining how the coefficients and parameters in the equation system set out in Table 2.1 are derived from that data base. These matters are general to any version of FEDERAL. We leave to the next chapter the description of how the actual FEDERAL data base for the TASMAIN version of the model was derived.

Our description of the format of the FEDERAL data base is limited to explaining the input-output and government accounts file.

The organization of the parameters file is immaterial and no discussion of that matter is required.

3.2. Input-Output and Government Accounts Data Files

3.2.1 Input-Output Data Files

The structure of the input-output files is illustrated in Figure 3.1. This figure is too large to be placed on a single page and has therefore been broken into several diagrams. There are four diagrams, 3.1(a) to 3.1(d). Map 3.1 depicts how these four diagrams fit together to form Figure 3.1.

Diagram 3.1(a) deals with the first nine rows of matrices in Figure 3.1, i.e. the matrices dealing with direct commodity flows and the use of margins of the first type. The position of the group of matrices for margin types 2 to g is shown in Map 3.1. There is no separate diagram for these matrices, since for each margin there exists six rows of matrices in the same format as depicted for the last six rows of matrices in Diagram 3.1(a). Diagram 3.1(b) deals with the nine rows of matrices following the margin matrices. These matrices deal with state and Commonwealth commodity taxes. The next diagram, Diagram 3.1(c) deals with the primary input matrices, while finally, Diagram 3.1(d) deals with the matrices which relate commodity outputs to regional industries.

Henceforth, reference will be made to Figure 3.1 as though it were a single figure with all its component diagrams joined together in the way indicated by Map 3.1.

The structure of the input-output data-base is now described by proceeding across each row of matrices, considering each matrix individually and then, where appropriate, the meaning of certain row and column sums are examined.

Figure 3.1: Input-Output Data Base for FEDERAL

Map 3.1: Map of Component Diagrams of Figure 3.1

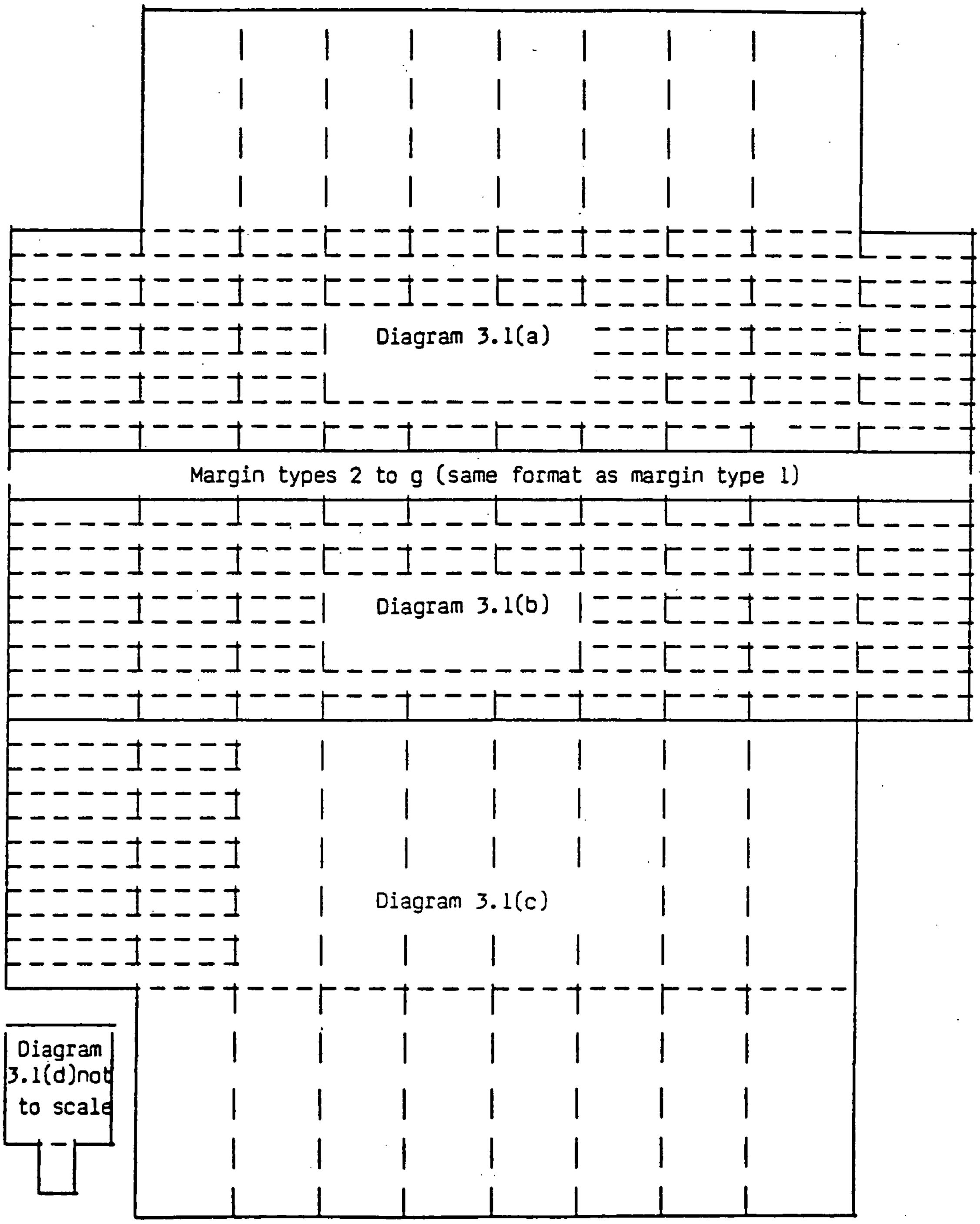


Diagram 3.1(a)

			Final Demand							
			Regional Industries Capital Formation					Government Current Consumption		
		Regional Industries (Current Production)	Private Investors	State Government Investors	Commonwealth Government Investors	Household Consumption	Overseas Exports	State Governments	Commonwealth	
		← 2h →	← 2h →	← 2h →	← h →	← 2 →	← 1 →	← 2 →	← 1 →	
Domestic Commodities	Region 1 commodities	↑ g ↓ $\tilde{A}^1$	$\tilde{B}^{11}$	$\tilde{B}^{12}$	$\tilde{B}^{13}$	$\tilde{C}^1$	$\tilde{D}^1$	$\tilde{E}^{11}$	$\tilde{E}^{12}$	Row sums = total direct usage of region 1 commodities
	Region 2 commodities	↑ g ↓ $\tilde{A}^2$	$\tilde{B}^{21}$	$\tilde{B}^{22}$	$\tilde{B}^{23}$	$\tilde{C}^2$	$\tilde{D}^2$	$\tilde{E}^{21}$	$\tilde{E}^{22}$	Row sums = total direct usage of region 2 commodities
Overseas imports		↑ g ↓ $\tilde{F}$	$\tilde{G}^1$	$\tilde{G}^2$	$\tilde{G}^3$	$\tilde{H}$	$\underline{0}$	$\tilde{J}^1$	$\tilde{J}^2$	Duty $-\tilde{Z}$ / Row sums = total imports (c.i.f.)
Margin Type 1 — Region 1 Supplier	On region 1 flows	↑ g ↓ $\tilde{K}^1_{11}$	$\tilde{L}^{11}_{11}$	$\tilde{L}^{12}_{11}$	$\tilde{L}^{13}_{11}$	$\tilde{M}^1_{11}$	$\tilde{N}^1_{11}$	$\tilde{O}^{11}_{11}$	$\tilde{O}^{12}_{11}$	Row sums = total margin (type 1) supplied by region 1 on sales of each region 1 commodity
	On region 2 flows	↑ g ↓ $\tilde{K}^2_{11}$	$\tilde{L}^{21}_{11}$	$\tilde{L}^{22}_{11}$	$\tilde{L}^{23}_{11}$	$\tilde{M}^2_{11}$	$\tilde{N}^2_{11}$	$\tilde{O}^{21}_{11}$	$\tilde{O}^{22}_{11}$	Row sums = total margin (type 1) supplied by region 1 on sales of each region 2 commodity
	On import flows	↑ g ↓ $\tilde{P}_{11}$	$\tilde{Q}^1_{11}$	$\tilde{Q}^2_{11}$	$\tilde{Q}^3_{11}$	$\tilde{R}_{11}$	$\underline{0}$	$\tilde{T}^1_{11}$	$\tilde{T}^2_{11}$	Row sums = total margin (type 1) supplied by region 1 on sales of each imported commodity
Margin Type 1 — Region 2 Supplier	On region 1 flows	↑ g ↓ $\tilde{K}^1_{12}$	$\tilde{L}^{11}_{12}$	$\tilde{L}^{12}_{12}$	$\tilde{L}^{13}_{12}$	$\tilde{M}^1_{12}$	$\tilde{N}^1_{12}$	$\tilde{O}^{11}_{12}$	$\tilde{O}^{12}_{12}$	Row sums = total margin (type 1) supplied by region 2 on sales of each region 1 commodity
	On region 2 flows	↑ g ↓ $\tilde{K}^2_{12}$	$\tilde{L}^{21}_{12}$	$\tilde{L}^{22}_{12}$	$\tilde{L}^{23}_{12}$	$\tilde{M}^2_{12}$	$\tilde{N}^2_{12}$	$\tilde{O}^{21}_{12}$	$\tilde{O}^{22}_{12}$	Row sums = total margin (type 1) supplied by region 2 on sales of each region 2 commodity
	On import flows	↑ g ↓ $\tilde{P}_{12}$	$\tilde{Q}^1_{12}$	$\tilde{Q}^2_{12}$	$\tilde{Q}^3_{12}$	$\tilde{R}_{12}$	$\underline{0}$	$\tilde{T}^1_{12}$	$\tilde{T}^2_{12}$	Row sums = total margin (type 1) supplied by region 2 on sales of each imported commodity

Diagram 3.1(b)

Margin type (g+1) - state tax	Region 1 tax	On region 1 flows	↑ g ↓	$\tilde{K}^1_{g+1,1}$	$\tilde{L}^{11}_{g+1,1}$	$\underline{0}$	$\underline{0}$	$\tilde{M}^1_{g+1,1}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	Row sums = total region 1 tax on sales of each region 1 commodity
		On region 2 flows	↑ g ↓	$\tilde{K}^2_{g+1,1}$	$\tilde{L}^{21}_{g+1,1}$	$\underline{0}$	$\underline{0}$	$\tilde{M}^2_{g+1,1}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	Row sums = total region 1 tax on sales of each region 2 commodity
		On import flows	↑ g ↓	$\tilde{P}_{g+1,1}$	$\tilde{Q}_{g+1,1}$	$\underline{0}$	$\underline{0}$	$\tilde{R}_{g+1,1}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	Row sums = total region 1 tax on sales of each imported commodity
	Region 2 tax	On region 1 flows	↑ g ↓	$\tilde{K}^1_{g+1,2}$	$\tilde{L}^{11}_{g+1,2}$	$\underline{0}$	$\underline{0}$	$\tilde{M}^1_{g+1,2}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	Row sums = total region 2 tax on sales of each region 1 commodity
		On region 2 flows	↑ g ↓	$\tilde{K}^2_{g+1,2}$	$\tilde{L}^{21}_{g+1,2}$	$\underline{0}$	$\underline{0}$	$\tilde{M}^2_{g+1,2}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	Row sums = total region 2 tax on sales of each region 2 commodity
		On import flows	↑ g ↓	$\tilde{P}_{g+1,2}$	$\tilde{Q}^1_{g+1,2}$	$\underline{0}$	$\underline{0}$	$\tilde{R}_{g+1,2}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	Row sums = total region 2 tax on sales of each imported commodity
Margin type (g+2)	Commonwealth tax	On region 1 flows	↑ g ↓	$\tilde{K}^1_{g+2}$	$\tilde{L}^{11}_{g+2}$	$\underline{0}$	$\underline{0}$	$\tilde{M}^1_{g+2}$	$\tilde{N}^1_{g+2}$	$\underline{0}$	$\underline{0}$	Row sums = total Commonwealth tax on sales of each region 1 commodity
		On region 2 flows	↑ g ↓	$\tilde{K}^2_{g+2}$	$\tilde{L}^{21}_{g+2}$	$\underline{0}$	$\underline{0}$	$\tilde{M}^2_{g+2}$	$\tilde{N}^2_{g+2}$	$\underline{0}$	$\underline{0}$	Row sums = total Commonwealth tax on sales of each region 2 commodity
		On import flows	↑ g ↓	$\tilde{P}_{g+2}$	$\tilde{Q}^1_{g+2}$	$\underline{0}$	$\underline{0}$	$\tilde{R}_{g+2}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	Row sums = total Commonwealth tax on sales of each imported commodity

Diagram 3.1(c)

Primary Factors	Labour	Wages (post -tax)	m	$\tilde{U}^1$							
		PAYE tax	m	$\tilde{U}^2$							
		Payroll tax	m	$\tilde{U}^3$							
	Capital	Income (post -tax)	3	$\tilde{V}^1$							
		Income tax on capital	3	$\tilde{V}^2$							
		Fixed tax on capital	3	$\tilde{V}^3$	0	0	0	0	0	0	0
	Land	Land (post -tax)	2	$\tilde{W}^1$							
		Income tax on land	2	$\tilde{W}^2$							
State government production tax			1	$\tilde{X}^1$							
Commonwealth Government production tax			1	$\tilde{X}^2$							
Other costs			1	$\tilde{X}^3$							
				Column sums = outputs of domestic industries at basic values	Column sums = private investment expenditure by regional industry	Column sums = state government investment expenditure by each regional industry	Column sums = Commonwealth government investment expenditure by each industry	Column sums = total household expenditure in each region	Column sums = total exports	Column sums = total commodity expenditure by each state government	Column sums = total commodity expenditure by the Commonwealth government

Diagram 3.1(d)

	← h →	← h →	
Region 1 Commodities	↑ g ↓ $\tilde{Y}^1$	$\underline{0}$	Row sums = region 1 output by commodity
Region 2 Commodities	↑ g ↓ $\underline{0}$	$\tilde{Y}^2$	Row sums = region 2 output by commodity
	Column sums = region 1 output by industry	Column sums = region 2 output by industry	

The system for naming the matrices follows that of Figure 25.1 of DPSV - which is reproduced as Figure 4.1 in this paper. All matrix identifiers contain tildes in order to clearly distinguish the notation for matrices from that for various coefficients and parameters. Because of the larger number of economic agents and the more detailed treatment of taxes and government expenditure in FEDERAL compared with ORANI it has been necessary to introduce a considerable number of subscripts and superscripts. Where there are two superscripts, the first superscript distinguishes between regional sources of commodities while the second superscript distinguishes between the class of purchaser (e.g. non-government, state government, Commonwealth government). Subscripts are considered in the discussions of the margin matrices below. The dimension of each matrix can be read at the left and top of the matrix grid in Figure 3.1.

The first matrix in Figure 3.1, $\tilde{A}^1$, contains the base-year direct flows of commodities from region 1 producers to the 2h regional industries for use as intermediate inputs in the production of current output. Matrics $\tilde{B}^{11}$, $\tilde{B}^{12}$, $\tilde{B}^{13}$ give the direct flow of region 1 commodities into capital formation in (regional) industries by private investors, state government investors and Commonwealth government investors respectively. The matrices $\tilde{C}^1$, $\tilde{D}^1$, $\tilde{E}^{11}$ and $\tilde{E}^{12}$ give the flows of region 1 commodities to households in each region, exports, state governments (current production) and the Commonwealth government (current production) respectively. The second row of matrices, $\tilde{A}^2$, $\tilde{B}^{21}$, $\tilde{B}^{22}$, $\tilde{B}^{23}$, $\tilde{C}^2$, $\tilde{D}^2$, $\tilde{E}^{21}$, $\tilde{E}^{22}$, show direct flows to the same purchasers as the first row, but in this case the flows are of commodities produced in region 2.

Similarly the third row matrices, $\tilde{F}$, $\tilde{G}^1$, $\tilde{G}^2$, $\tilde{G}^3$, $\tilde{H}$, $\tilde{J}^1$, $\tilde{J}^2$, show direct flows of imported commodities.

The entries in all the above matrices show flows valued at basic prices, i.e. at the prices received by the producers for a domestic good or landed duty paid in the case of imports. Thus these matrices show only the value of direct flows of goods and exclude the value of margins (such as retail services, transport and insurance) required to facilitate the direct flow of the commodity from producer to purchaser. They also exclude the value of indirect taxes. Both of these types of excluded values are dealt with in matrices described below. The vector of row sums of the first row of matrices in Figure 3.1 provides the total direct usage of each region 1 commodity in basic prices.

The matrix marked $\underline{0}$ in the imports row of matrices is a null matrix, since the data base is constructed not to allow any direct exports of imports. The final matrix in the imports row, $-\tilde{Z}$, is a vector of the negative of the import duty paid on the g imported commodities. By adding across the rows of $\tilde{F}$, $\tilde{G}^1$, $\tilde{G}^2$, $\tilde{G}^3$, $\tilde{H}$, $\tilde{J}^1$, $\tilde{J}^2$ and $-\tilde{Z}$ the vector of commodity imports landed at c.i.f. (cost insurance freight or landed duty free) prices is obtained.

Next follows g+1 blocks of six rows of matrices each and then a final block of three rows of matrices. The first g blocks contain the use of margins to facilitate the direct flows described above while the last two blocks involve taxes on those direct flows. Turning to the first block of matrices we see that the first three rows of matrices involve the provision of margin commodity 1 supplied by region 1 and the second three rows of matrices concern margin commodity 1 supplied by region 2. There are no imported margins in the FEDERAL model. Thus the first row of matrices in this first block, $\tilde{K}^1_{11}$, $\tilde{L}^{11}_{11}$, $\tilde{L}^{12}_{11}$, $\tilde{L}^{13}_{11}$, $\tilde{M}^1_{11}$, $\tilde{N}^1_{11}$, $\tilde{O}^{11}_{11}$ and $\tilde{O}^{12}_{11}$, are the flows of commodity 1 produced in region 1 which are used as margins to facilitate each of the direct flows in matrices, $\tilde{A}^1$, $\tilde{B}^{11}$, $\tilde{B}^{12}$, $\tilde{B}^{13}$, $\tilde{C}^1$, $\tilde{D}^1$, $\tilde{E}^{11}$ and $\tilde{E}^{12}$ respectively. For instance, the i(jr)th element of $\tilde{K}^1_{11}$ is the flow of good 1 from region 1 used as a margin in the delivery of intermediate input i produced in region 1 to industry j located in region r. Matrix $\tilde{K}^1_{12}$ differs from $\tilde{K}^1_{11}$ only in that it concerns the use of margin good 1 produced in region 2.

The next (g-1) blocks of matrices follows the same pattern, except that they relate to the use of other commodities for margin purposes. Thus $\tilde{K}^1_{21}$ differs from $\tilde{K}^1_{11}$ only in that it concerns the use of margin good 2 rather than margin good 1. In the implemented nine-industry/commodity TASMAIN version of FEDERAL there is only one margin commodity, commodity 7, and thus the only none-zero block of margin matrices are those with the first subscript equal to 7. Thus as a further example, look at $\tilde{K}^1_{72}$. This matrix covers the use of commodity 7 produced in region 2 to facilitate flows of the g commodities produced in region 1 to producers in both regions (the first h columns relating to region 1 purchasers; the second h columns to region 2 purchasers). Margins on imported commodities are covered in the $\tilde{P}$ matrices for intermediate flows, the $\tilde{Q}$ matrices for the flows to capital formation and the $\tilde{R}$ matrices for facilitating flows to household consumption. So $\tilde{R}_{71}$ shows the use of commodity 7 produced in region 1 as a margin on flows of g imported commodities to households.

The penultimate block of the g+2 blocks follows the same pattern as for the previous g blocks except that rather than involving the provision of a commodity as a margin it shows the state government tax (or if the entry is negative, the subsidy) associated with the corresponding direct flow. Just as a commodity can be supplied as a margin from two regions, state government tax can be payable to each region's state government. Thus the g+1st block of equations consists of six rows of matrices. However the final block differs from the previous ones in that it consists of only three rows of matrices since the Commonwealth government is independent of a region of location.

It will be noticed that a large number of the matrices in the last two blocks are zero matrices, principally because we assume that governments do not levy sales taxes on their own purchases or on the purchases of other governments. (National accounts tables reveal such taxes to be negligible.)

The next eleven matrices appear only in the domestic industries purchases column of matrices and give a break down of value added. Absences of corresponding matrices in the final demand columns result from the assumption underlying FEDERAL that primary factors are only used in current production. The first three of these matrices $\tilde{U}^1$, $\tilde{U}^2$ and $\tilde{U}^3$ provide the costs of employing labour. $\tilde{U}^1$ shows post-tax wage cost, $\tilde{U}^2$ shows PAYE taxes and $\tilde{U}^3$ shows pay-roll tax. Thus a typical element of $\tilde{U}^1$ is the data-base year after-tax cost of regional industry (jr) employing labour of m.

The next three vectors, $\tilde{V}^1$, $\tilde{V}^2$ and $\tilde{V}^3$ contain the components of the rental value of each regional industry's fixed capital. $\tilde{V}^1$ supplies the after-tax component, $\tilde{V}^2$ the income-tax component and $\tilde{V}^3$ a "fixed"-tax component. The latter tax component comprises commercial and residential land-taxes which are assumed in

FEDERAL to be applied as a tax on fixed-capital (see sections 2.2.8 and 2.2.11 for details). There are three rows in each matrix to distinguish between capital owned by region 1 residents, region 2 residents and foreigners.

Matrix $\tilde{W}^1$ shows the after-tax rental value of agricultural land used by each industry while $\tilde{W}^2$ gives the income-tax paid on the rental value of land. The $\tilde{W}$ matrices only have two rows each to distinguish region of ownership as FEDERAL assumes no foreign-owned land. Finally $\tilde{X}^1$, $\tilde{X}^2$ and $\tilde{X}^3$ give the cost to each regional industry of state government (net) production taxes (payable only to the government in the region of production), Commonwealth government (net) production taxes and other costs (i.e. working capital and sales by final buyers).

At the bottom of Figure 3.1 (Diagram 3.1(d)) is the $\tilde{Y}$ matrix which consists of two sub-matrices $\tilde{Y}^1$ and $\tilde{Y}^2$. This matrix shows the commodity composition of each regional industry's output. The ijth element of $\tilde{Y}^r$ shows the basic value of commodity i produced by regional industry (jr). The row sums of $\tilde{Y}$ provide the aggregate of each commodity i production over all industries in a region. Totals for commodity i usage from region r suppliers could also have been obtained by summing across the ith rows of $\tilde{A}^r$, $\tilde{B}^{r1}$, $\tilde{B}^{r2}$, $\tilde{B}^{r3}$, $\tilde{C}^r$, $\tilde{D}^r$, $\tilde{E}^{r1}$, $\tilde{E}^{r2}$ and adding to this the sum of all the elements in the matrices $\tilde{K}^1_{ir}$, $\tilde{L}^{11}_{ir}$, $\tilde{L}^{12}_{ir}$, $\tilde{L}^{13}_{ir}$, $\tilde{M}^1_{ir}$, $\tilde{N}^1_{ir}$, $\tilde{O}^{11}_{ir}$, $\tilde{O}^{12}_{ir}$, $\tilde{K}^2_{ir}$, $\tilde{L}^{21}_{ir}$, $\tilde{L}^{22}_{ir}$, $\tilde{L}^{23}_{ir}$, $\tilde{M}^2_{ir}$, $\tilde{N}^2_{ir}$, $\tilde{O}^{21}_{ir}$, $\tilde{O}^{22}_{ir}$, $\tilde{P}_{ir}$, $\tilde{Q}^1_{ir}$, $\tilde{Q}^2_{ir}$, $\tilde{Q}^3_{ir}$, $\tilde{R}_{ir}$, $\tilde{T}^1_{ir}$, $\tilde{T}^2_{ir}$. That is the sum of direct flows and margins usage. Note that the meaning of all individual row sums are given at the right of Figure 3.1.

The meaning of the column sums are outlined at the bottom of each column of matrices in Figure 3.1. In particular it should be noted that the basic price value of output of regional industry (jr) can be obtained either by summing down the (jr)th column of the matrices $\tilde{A}^1$, $\tilde{A}^2$, $\tilde{F}$, $\tilde{K}^1_{11}$, $\tilde{K}^2_{11}$, ..., $\tilde{P}_{g+2}$, $\tilde{U}^1$, $\tilde{U}^2$, $\tilde{U}^3$, $\tilde{V}^1$, $\tilde{V}^2$, $\tilde{V}^3$, $\tilde{W}^1$, $\tilde{W}^2$, $\tilde{X}^1$, $\tilde{X}^2$ and $\tilde{X}^3$ or by adding the elements of the j^{th} column of $\tilde{Y}^r$.

3.2.2 Government Accounts Data Files

Table 3.1 gives the structure of the government accounts data files. This data is required to fill in certain data used by FEDERAL and which would be present in a full social accounting framework. The reader may note that certain of the government accounts items can be calculated from the input-output data base, while others can not. The question of over-lap and the maintenance of consistency between data files is considered in section 4.2.3 on the construction of the government accounts file. All types of government receipts and expenditures appear in the government accounts files, whether they can be calculated from other data files or not, for completeness.

The description of each of the government accounts matrices is largely self-explanatory and discussion of the exact nature of each category is deferred to section 4.2.3. In the case of Commonwealth Government matrices, each matrix is a scalar representing a total figure for the particular category, except for certain outlays, where the figure for the payments in the particular category is shown separately for each region. In the case of the state government accounts, each matrix is a row vector with two elements, one for each of the two state governments.

3.3 Source of Coefficients and Parameters

Having outlined the input-output files format we are able to describe how the FEDERAL coefficients and parameters are derived

Table 3.1

Government Accounts Data Base

Commonwealth Government

Receipts			Outlays		
Description	Matrix	Dimension	Description	Matrix	Dimension
PAYE Taxes	CGR_1	scalar	Current outlays	CGO_1	scalar
Other income Taxes	CGR_2	scalar	Capital formation	CGO_2	scalar
Import Duties	CGR_3	scalar	Unemployment benefits	CGO_3	2 x 1
Production Taxes	CGR_4	scalar	Transfers to State Govt's	CGO_4	2 x 1
Commodity Taxes	CGR_5	scalar	Transfers to persons	CGO_5	2 x 1
Export Taxes	CGR_6	scalar	Interest payments	CGO_6	2 x 1
Other Receipts	CGR_7	2 x 1	Other outlays	CGO_7	scalar

State Government

Receipts			Outlays		
Description	Matrix	Dimension	Description	Matrix	Dimension
Payroll taxes	SGR_1	2 x 1	Current outlays	SGO_1	2 x 1
Residential taxes	SGR_2	2 x 1	Capital formation	SGO_2	2 x 1
Commercial land taxes	SGR_3	2 x 1	Transfers to persons	SGO_3	2 x 1
Fees, fines, etc.	SGR_4	2 x 1	Interest payments	SGO_4	2 x 1
Commonwealth payments	SGR_5	2 x 1	Other net outlays	SGO_5	2 x 1
Commodity taxes	SGR_6	2 x 1			
Production taxes	SGR_7	2 x 1			
Other receipts	SGR_8	2 x 1			

from the FEDERAL data files. We do this in the same way as DSPV undertake the same task for ORANI. In Table 3.2 all of the coefficients and parameters are listed with their associated equation and are carefully described. In the case of parameters, the source of the parameter value is simply given as the parameters file with an explanation of how the value was estimated being delayed to Chapter 4 (except for user-set parameters, the value of which is set at run-time and is discussed in Chapter 5). In the case of coefficients, the method of calculating the coefficient from the FEDERAL data files is provided. Table 3.2 parallels Table 27.1 of DPSV as closely as possible, so that different methods of calculating comparable coefficients for FEDERAL and ORANI can be easily examined.

Table 3.2

List of FEDERAL Coefficients and Parameters

Equation	Coefficient or Parameter	Description	Source
(2.1)	$\sigma^{(1)r}_{(is)j}$	CRESH parameter reflecting the degree of substitutability between region 1 (s = 1), region 2 (s = 2) and foreign (s = 3) sources of good i as a current input in the production of regional industry (jr).	Estimates stored in parameters file.
	$S^{*(1)r}_{(is)j}$	Modified share of purchasers value of good i from source s in regional industry (jr)'s total purchases of good i for use as an input to current production. It is defined as a function of an unmodified share ($S^{(1)r}_{(is)j}$) and the CRESH substitution parameter ($\sigma^{(1)r}_{(is)j}$), i.e. $S^{*(1)r}_{(is)j} = \sigma^{(1)r}_{(is)j} S^{(1)r}_{(is)j} \Big/ \sum_{t=1}^{3} \sigma^{(1)r}_{(it)j} S^{(1)r}_{(it)j}$.	The $\sigma^{(1)r}_{(is)j}$ are dealt with above and the unmodified shares calculated from the input-output data files. To calculate the (is)(jr)th component of the unmodified share, first sum the i(jr)th elements of matrices $\tilde{A}^1$, $\tilde{A}^2$, $\tilde{F}$, $\tilde{K}^1_{11}$, ..., $\tilde{P}_{g+2}$ to obtain the total value at purchasers prices of regional industry (jr)'s current inputs of commodity i. The corresponding value for region 1 inputs is then calculated as the sum of the i(jr)th elements of $\tilde{A}^1$, $\tilde{K}^1_{11}$, $\tilde{K}^1_{12}$, ..., $\tilde{K}^1_{g+2}$. $S^{(1)}_{(i1)j}$ can then be computed as the ratio of the region 1 sum to the total sum. $S^{(1)}_{(i2)j}$ is calculated as the ratio of the sum of the i(jr)th elements of $\tilde{A}^2$, $\tilde{K}^2_{11}$, ..., $\tilde{K}^2_{g+2}$ to the total. $S^{(1)}_{(i3)j}$ is equal to $1 - S^{(1)}_{(i1)j} - S^{(1)}_{(i2)j}$.

Equation	Coefficient or Parameter	Description	Source
(2.2)	None		
(2.3)	None		
(2.4)	None		
(2.5)	$\sigma^{(1)r}_{(g+1,v)j}$	CRESH parameter reflecting the degree of substitutability between primary factor v (v = 1 for labour, v = 2 for capital, v = 3 for agricultural land) and the other primary factors as inputs into regional industry (jr).	Estimates stored in parameters file.
	$S^{*(1)r}_{(g+1,v)j}$	Modified share of primary factor v in regional industry (jr)'s total usage of primary factors. It is defined as a function of the unmodified share ($S^{(1)r}_{(g+1,v)j}$) and the CRESH substitution parameter ($\sigma^{(1)r}_{(g+1,v)j}$), i.e. $S^{*(1)r}_{(g+1,v)j} = \sigma^{(1)r}_{(g+1,v)j} S^{(1)r}_{(g+1,v)j} \Big/ \sum_{u=1}^{3} \sigma^{(1)r}_{(g+1,u)j} S^{(1)r}_{(g+1,u)j}$.	The $\sigma^{(1)r}_{(g+1,v)j}$ are dealt with above and the unmodified shares are calculated from the input-output files. First, for each regional industry sum down the $(jr)^{th}$ column of $\tilde{U}^1$, $\tilde{U}^2$, $\tilde{U}^3$ and then calculate the sum of each of the $(jr)^{th}$ columns of $\tilde{V}^1$, $\tilde{V}^2$ and finally calculate the sum of each of the $(jr)^{th}$ columns of $\tilde{W}^1$ and $\tilde{W}^2$. Then for each $(jr)^{th}$ industry, $S^{(1)r}_{(g+1,1)j}$ is the ratio of the first sum to the total of all three sums, $S^{(1)r}_{(g+1,2)j}$ the second sum over the total and $S^{(1)r}_{(g+1,3)j}$ is computed as $1 - S^{(1)r}_{(g+1,1)j} - S^{(1)r}_{(g+1,2)j}$.

Equation	Coefficient or Parameter	Description	Source
(2.6)	$\sigma^{(1)r}_{(g+1,1,q)j}$	CRESH parameter reflecting the degree of substitutability between labour of skill type q and other skill types in regional industry (jr)'s production process.	Estimates stored in parameters file.
	$S^{*(1)r}_{(g+1,1,q)j}$	Modified share of type q labour in regional industry (jr)'s total labour cost. It is defined as a function of the unmodified shares ($S^{(1)r}_{(g+1,1,q)j}$) and the CRESH substitution parameters ($\sigma^{(1)r}_{(g+1,1,q)j}$, i.e. $$S^{*(1)r}_{(g+1,1,q)j} = \sigma^{(1)r}_{(g+1,1,q)j}\, S^{(1)r}_{(g+1,1,q)j} \Big/ \sum_{m=1}^{M} \sigma^{(1)r}_{(g+1,1,m)j}\, S^{(1)r}_{(g+1,1,m)j}.$$	The $\sigma^{(1)r}_{(g+1,1,q)j}$ are dealt with above and the unmodified shares are calculated from the input-output data files. $S^{(1)r}_{(g+1,1,q)j}$ is calculated by summing the q(jr)th elements of $\tilde{U}^1$, $\tilde{U}^2$, $\tilde{U}^3$ and dividing by the sum of the (jr)th column totals of those matrices.
(2.7)	$S^{(1)r}_{(g+1,1,q)j}$	Dealt with under (6) above.	
(2.8)	$\sigma^{(0)r}_{(u*)j}$	CRETH parameter reflecting the ease of transformability between composite commodity u and other composite commodities in regional industry (jr)'s output bundle.	Estimates stored in parameters file.

Equation	Coefficient or Parameter	Description	Source
	$H^{*(0)r}_{(u*)j}$	Modified share of composite commodity u in regional industry (jr)'s total revenue. It is defined as a function of the unmodified shares ($H^{(0)r}_{(u*)j}$) and the CRETH transformation parameters ($\sigma^{(0)r}_{(u*)j}$), i.e. $H^{*(0)r}_{(u*)j} = \sigma^{(0)r}_{(u*)j} H^{(0)r}_{(u*)j} \Big/ \sum_{v=1}^{N(jr)} \sigma^{(0)r}_{(v*)j} H^{(0)r}_{(v*)j}$.	The $\sigma^{(0)r}_{(u*)j}$ are dealt with above and the unmodified shares are calculated from the input-output data files. To calculate $H^{(0)r}_{(u*)j}$ first obtain total revenue for regional industry (jr) by summing the j^{th} column of $\tilde{Y}^{r}$. To get $H^{(0)r}_{(u*)j}$ divide this sum into the sum of those elements in the column whose rows correspond to the commodities which constitute the u^{th} composite commodity for regional industry (jr).
(2.9)	None		
(2.10)	$S^{(0)}_{(ir)j}$	Share of commodity i in total composite commodity u revenue by industry (jr); where $i \epsilon G(u,(jr))$, the set of commodities forming the u^{th} composite commodity for regional industry (jr).	Calculate $S^{(0)}_{(ir)j}$ for $i \epsilon G(u,jr))$ from input-output data files by first summing those elements in the j^{th} column of matrix $\tilde{Y}^{r}$ whose row numbers correspond to identifiers for commodities which make up composite commodity u for regional industry (jr). $S^{(0)}_{(ir)j}$ for $i \epsilon G(u,(jr))$ is the share of the i^{th} element in the column to this sum.
(2.11)	$\sigma^{(2)r}_{(is)j}$	CRESH parameter reflecting the degree of substitutability between region 1, region 2 and foreign sources of good i for use as an input to capital formation by private investors in regional industry (jr).	Estimates stored in parameters file.

Equation	Coefficient or Parameter	Description	Source
	$S^{*(2)r}_{(is)j}$	Modified share of purchasers value of good i from source s in regional industry (jr)'s total purchases of good i for input to capital formation by private investors. It is defined as a function of an unmodified share ($S^{(2)r}_{(is)j}$) and the CRESH substitution parameter ($\sigma^{(2)r}_{(is)j}$), i.e. $S^{*(2)r}_{(is)j} = \sigma^{(2)r}_{(is)j} S^{(2)r}_{(is)j} \Big/ \sum_{t=1}^{3} \sigma^{(2)r}_{(it)j} S^{(2)r}_{(it)j}$.	The $\sigma^{(2)r}_{(is)j}$ are dealt with above and the unmodified shares are calculated from the input-output data files. To calculate the $(is)(jr)^{th}$ component of the latter, first sum the $i(jr)^{th}$ elements of the matrices $\tilde{B}^{11}$, $\tilde{B}^{21}$, $\tilde{G}^{1}$, $\tilde{L}^{11}_{11}$, ..., $\tilde{Q}^{1}_{g+2}$ to find total purchases of i by this demander. Then sum the $i(jr)^{th}$ elements of $\tilde{B}^{11}$, $\tilde{L}^{11}_{11}$, $\tilde{L}^{11}_{12}$, ..., $\tilde{L}^{11}_{g+2}$. The fraction of this latter sum in the total is $S^{(2)r}_{(i1)j}$. $S^{(2)r}_{(i2)j}$ is the fraction of the sum of the $i(jr)^{th}$ elements of $\tilde{B}^{21}$, $\tilde{L}^{21}_{11}$, ..., $\tilde{L}^{21}_{g+2}$ in the total. $S^{(2)r}_{(i3)j}$ can then be calculated as $1 - S^{(2)r}_{(i1)j} - S^{(2)r}_{(i2)j}$.
(2.12)	$\sigma^{(5,2)r}_{(is)j}$	CRESH parameter reflecting the degree of substitutability between region 1, region 2 and foreign sources of good i as an input to capital formation by state government r in regional industry (jr).	Estimates stored in parameters file.
	$S^{*(5,2)r}_{(is)j}$	Modified share of purchasers value of good i from source s in industry (jr)'s total purchases of good i for input to capital formation by state government r. it is defined as a function of an	The $\sigma^{(5,2)r}_{(is)j}$ are dealt with above and the unmodified shares are calculated from the input-output data files. To calculate the $(is)(jr)^{th}$ component of the latter, first sum the $i(jr)^{th}$ elements of

Equation	Coefficient or Parameter	Description	Source
		unmodified share ($S^{(5,2)r}_{(is)j}$ and the CRESH substitution parameter ($\sigma^{(5,2)r}_{(is)j}$, i.e. $S^{*(5,2)r}_{(is)j} = \sigma^{(5,2)r}_{(is)j} S^{(5,2)r}_{(is)j} \Big/ \sum_{t=1}^{3} \sigma^{(5,2)r}_{(it)j} S^{(5,2)r}_{(it)j}$.	the matrices $\tilde{B}^{12}$, $\tilde{B}^{22}$, $\tilde{G}^{2}$, $\tilde{L}^{12}_{11}$, ..., $\tilde{Q}^{2}_{g2}$ to find total purchases of i by this demander. Then sum the $i(jr)^{th}$ elements of $\tilde{B}^{12}$, $\tilde{L}^{12}_{11}$, ..., $\tilde{L}^{12}_{g2}$. The fraction of this latter sum in total is $S^{(5,2)r}_{(i1)j}$. The fraction of the sum of the $i(jr)^{th}$ elements of $\tilde{B}^{22}$, $\tilde{L}^{22}$, ..., $\tilde{L}^{22}_{g2}$ in the total is $S^{(5,2)r}_{(i2)j}$. $S^{(5,2)r}_{(i3)j}$ can then be calculated as $1 - S^{(5,2)r}_{(i1)j} - S^{(5,2)r}_{(i2)j}$.
(2.13)	$\sigma^{(6,2)}_{(is)j}$	CRESH parameter reflecting the degree of substitutability between region 1, region 2 and foreign sources of good i for use as an input to capital formation by the Commonwealth government in industry j.	Estimates stored in parameters file.
	$S^{*(6,2)}_{(is)j}$	Modified share of purchasers value of good i from source s in industry j's total purchases of good i for input to capital formation by the Commonwealth government. It is defined as a function of an unmodified share ($S^{(6,2)}_{(is)j}$ and the CRESH substitution parameter ($\sigma^{(6,2)}_{(is)j}$), i.e.	The $\sigma^{(6,2)}_{(is)j}$ are dealt with above and the unmodified shares are calculated from the input-output data files. To calculate the $(is)j^{th}$ component of the latter, first sum the ij^{th} elements of the matrices $\tilde{B}^{13}$, $\tilde{B}^{23}$, $\tilde{G}^{3}$, $\tilde{L}^{13}_{11}$, ..., $\tilde{Q}^{3}_{g2}$ to find total purchases of i by this demander. Then, for

Equation	Coefficient or Parameter	Description	Source
		$S^{*(6,2)}_{(is)j} = \sigma^{(6,2)}_{(is)j} S^{(6,2)}_{(is)j} \Big/ \sum_{t=1}^{3} \sigma^{(6,2)}_{(it)j} S^{(6,2)}_{(it)j}$.	t = 1, 2, sum the ijth elements of $\tilde{B}^{t3}$, $\tilde{L}^{t3}_{11}$, ..., $\tilde{L}^{t3}_{g2}$. The fraction of this latter sum in the total is $S^{(6,2)}_{(it)j}$. $S^{(6,2)}_{(i3)j}$ can then be calculated as $1 - S^{(6,2)}_{(i1)j} - S^{(6,2)}_{(i2)j}$.
(2.14)	$(WX)^{(5,2)r}_{(is)j}$	Share of regional industry (jr)'s purchase of good i from source s for input to capital formation by state government r in purchases of all state government r's purchases of good i from source s for input to capital formation.	To calculate the (is)(jr)th component, sum across the j elements for the appropriate region in the ith row of $\tilde{B}^{12}$ (for s = 1) or $\tilde{B}^{22}$ (for s = 2) or $\tilde{G}^{2}$ (for s = 3) and then divide the i(jr)th element of the corresponding matrix by the total.
(2.15)	$(WX)^{(6,2)}_{(is)j}$	Share of industry j's purchase of good i from source s for input to capital formation by the Commonwealth government in total Commonwealth purchases of good i from source s for input to capital formation.	To calculate the (is)jth component, sum the the ith row of $\tilde{B}^{13}$ (for s = 1) or $\tilde{B}^{23}$ (for s = 2) or $\tilde{G}^{3}$ (for s = 3) and then divide the ijth element of the corresponding matrix by the total.
(2.16)	$\sigma^{(3)r}_{(is)}$	CRESH parameter reflecting the degree of substitutability between region 1, region 2 and foreign sources of good i for use by households in a region.	Estimates stored in parameters file.
	$S^{*(3)r}_{(is)}$	Modified share of purchases value of good i from source s in the total purchases of good i by a household in a region. It is defined as a function of an	The $\sigma^{(3)r}_{(is)}$ are dealt with above and the unmodified shares are calculated from the input-output data files. To calculate $S^{(3)r}_{(is)}$ begin by

Equation	Coefficient or Parameter	Description	Source
		unmodified share ($S^{(3)r}_{(is)}$) and the CRESH substitution parameter ($\sigma^{(3)r}_{(is)}$), i.e. $S^{*(3)r}_{(is)} = \sigma^{(3)r}_{(is)} S^{(3)r}_{(is)} \Big/ \sum_{t=1}^{3} \sigma^{(3)r}_{(it)} S^{(3)r}_{(it)}$.	obtaining total regional household purchases by summing down the r^{th} columns of matrices $\tilde{C}^1, \tilde{C}^2, \tilde{H}, \tilde{M}^1_{11}, \ldots, \tilde{R}_{g+2}$. Then $S^{(3)r}_{(i1)}$ is the region r total divided into the sum down the r^{th} columns of $\tilde{C}^1, \tilde{M}^1_{11}, \tilde{M}^1_{12}, \ldots, \tilde{M}^1_{g+2}$. $S^{(3)r}_{(i2)}$ is the region r total divided into the sum down the r^{th} columns of $\tilde{C}^2, \tilde{M}^2_{11}, \tilde{M}^2_{12}, \ldots, \tilde{M}^2_{g+2}$. $S^{(3)r}_{(i3)}$ can then be computed as $1 - S^{(3)r}_{(i1)} - S^{(3)r}_{(i2)}$.
(2.17)	$S^{(3)r}_{(is)}$	Dealt with under (2.16) above.	
(2.18)	ε^r_i	Regional household expenditure elasticity of demand for good i from all three sources.	Current implemented version of FEDERAL (TASMAIN) assumes Cobb-Douglas utility functions. All ε^r_i set equal to unity in parameters file.[2]
	η^r_{ik}	Regional household elasticities of demand for good i in general with respect to changes in the general household purchasers price for good k.	Current implemented verison of FEDERAL (TASMAIN) assumes Cobb-Douglas utility functions. All η^r_{ii} set equal to -1 and all $\eta^r_{ik(i \neq k)}$ set equal to zero in parameters file.
	$S^{(3)r}_{(ks)}$	Dealt with under (2.16) above.	

Equation	Coefficient or Parameter	Description	Source
(2.19)	None		
(2.20)	None		
(2.21)	$(CS)^r$	Share of each region in total real consumption.	Input-output data files. For each r sum down the r^{th} column of $\tilde{C}^1$, $\tilde{C}^2$, $\tilde{H}$, $\tilde{M}^1_{11}$, ..., $\tilde{R}_{g+2}$. Then sum the two regional totals. $(CS)^r$ is the ratio of the regional sub-total to the overall total.
(2.22)	$h^{(5,1)r}_{(is)}$	Indexing parameter which fixes the relationship between movements in state government current expenditure on good i from source s and aggregate real private consumption in the region.	User specified value is stored in parameters file.
(2.23)	$h^{(6,1)}_{(is)}$	Indexing parameter which fixes the relationship between Commonwealth government current expenditure on good i from source s and economy-wide real private consumption.	User specified value is stored in parameters file.
(2.24)	γ_i	Reciprocal of foreign elasticity of demand for domestic good i.	Estimates stored in parameters file. (Note γ_i is stored as a positive number.)
(2.25)	$\sigma^{(4)}_i$	Elasticity of substitution between region 1 and region 2 sources of exports of good i.	Estimates stored in parameters file.
	$S^{(4)}_{(ir)}$	Share of region r exports of good i in total exports of good i.	Calculated from input-output data files. $S^{(4)}_{(ir)}$ is the sum of the i^{th} elements of $\tilde{D}^r$, $\tilde{N}^r_{11}$, $\tilde{N}^r_{12}$, ..., $\tilde{N}^r_{g+2}$ divided by the sum of the i^{th} elements of $\tilde{D}^1$, $\tilde{D}^2$, $\tilde{N}^1_{11}$, $\tilde{N}^2_{11}$, $\tilde{N}^1_{12}$, ..., $\tilde{N}^2_{g+2}$.

Equation	Coefficient or Parameter	Description	Source
(2.26)	$S^{(4)}_{(ir)}$	Dealt with under (2.25) above.	
(2.27)	$\gamma_{(ir)}$	Reciprocal of foreign elasticity of demand for domestic good i produced in region r.	Estimates stored in parameters file. (Note γ_{ir} is a positive number.)
(2.28)	None		
(2.29)	None		
(2.30)	None		
(2.31)	None		
(2.32)	None		
(2.33)	$H^{(0)}_{(ir)j}$	Share of commodity i in the total revenue of regional industry (jr).	Calculated from input-output data files. $H^{0}_{(ir)j}$ is the ratio of the i^{th} element in the j^{th} column of $\tilde{Y}^r$ to the column sum.
	$H^{(1)r}_{(is)j}$	Share of purchasers value of good i from source s in the total costs of regional industry (jr).	Calculated from input-output data files. Industry (jr)'s total costs is first calculated by summing the $(jr)^{th}$ columns of matrices $\tilde{A}^1$, $\tilde{A}^2$, $\tilde{F}$, $\tilde{K}^1_{11}$,..., $\tilde{P}_{g+2}$, $\tilde{U}^1$, $\tilde{U}^2$, $\tilde{U}^3$, $\tilde{V}^1$, $\tilde{V}^2$, $\tilde{V}^3$, $\tilde{W}^1$, $\tilde{W}^2$, $\tilde{X}^1$, $\tilde{X}^2$, $\tilde{X}^3$. $H^{(1)r}_{(i1)j}$ is the sum of the $i(jr)^{th}$ elements of $\tilde{A}^1$, $\tilde{K}^1_{11}$, $\tilde{K}^1_{12}$,...., $\tilde{K}^1_{g+2}$ expressed as a fraction of

Equation	Coefficient or Parameter	Description	Source
			total costs. $H^{(1)r}_{(i2)j}$ is the sum of the $i(jr)^{th}$ elements of $\tilde{A}^2$, $\tilde{K}^2_{11}$, $\tilde{K}^2_{12}$, ..., $\tilde{K}^2_{g+2}$ expressed as a fraction of total costs. $H^{(1)r}_{(i3)j}$ is the sum of the $i(jr)^{th}$ elements of $\tilde{F}$, $\tilde{P}_{11}$, $\tilde{P}_{12}$, ..., $\tilde{P}_{g+2}$ expressed as a fraction of total costs.
	$H^{(1)r}_{(g+1,1,m)j}$	Share of type m labour inputs in the total cost of regional industry (jr).	Calculated from input-output data files. $H^{(1)r}_{(g+1,1,m)j}$ is the sum of the $m(jr)^{th}$ elements of $\tilde{U}^1$, $\tilde{U}^2$, $\tilde{U}^3$ expressed as a fraction of the total costs in industry (jr).
	$H^{(1)r}_{(g+1,s)j}$	Shares of inputs of capital (s = 2) and land (s = 3) in the total costs of regional industry (jr).	Calculated from input-output data files. $H^{(1)r}_{(g+1,2)j}$ is the sum over the $(jr)^{th}$ columns of $\tilde{V}^1$, $\tilde{V}^2$ and $\tilde{V}^3$ expressed as a fraction of total costs. $H^{(1)}_{g+1,3)j}$ is the sum over the $(jr)^{th}$ column of $\tilde{W}^1$ and $\tilde{W}^2$ expressed as a fraction of total costs of industry (jr).
	$H^{(1)r}_{g+2,j}$	Share of state government production taxes in the total costs of regional industry (jr).	Calculated from input-data files. $H^{(1)r}_{g+2,j}$ is the $(jr)^{th}$ element of the vector $\tilde{X}^1$ as a fraction of regional industry (jr)'s total costs.

Equation	Coefficient or Parameter	Description	Source
	$H^{(1)r}_{g+3,j}$	Share of Commonwealth government production taxes in the total costs of regional industry (jr).	Calculated from input-output data files. $H^{(1)r}_{g+3,j}$ is the (jr)th element of the vector $\tilde{X}^2$ as a fraction of regional industry (jr)'s total costs.
	$H^{(1)r}_{g+4,j}$	Share of "other costs" in the total cost of regional industry (jr).	Calculated from input-output data files. $H^{(1)r}_{g+4,j}$ is the (jr)th element of the vector $\tilde{X}^3$ as a fraction of regional industry (jr)'s total costs.
(2.34)	$H^{(0)r}_{(u*)j}$	Dealt with under (2.8) above.	
	$H^{(0)}_{(ir)j}$	Dealt with under (2.33) above.	
	$H^{(1)r}_{ij}$	For i = 1, ..., g, $H^{(1)r}_{ij}$ is share of purchasers value of intermediate inputs of good i in regional industry (jr)'s total costs. For i = g+1, it is the share of all primary factors (labour, capital and land) in total costs.	$H^{(1)r}_{ij} = \sum_{s=1}^{2} H^{(1)r}_{(is)j}$, i = 1, ..., g, and $H^{(1)r}_{g+1,j} = \sum_{m=1}^{M} H^{(1)r}_{(g+1,1,m)j} + \sum_{s=2}^{3} H^{(1)r}_{(g+1,s)j}$ where $H^{(1)r}_{(is)j}$, $H^{(1)r}_{(g+1,1,m)j}$ and $H^{(1)r}_{(g+1,s)j}$ are defined under (2.33) above.
	$H^{(1)r}_{g+4,j}$	Dealt with under (2.33) above.	
	$H^{(1)r}_{(is)j}$	Dealt with under (2.33) above.	
	$H^{(1)r}_{(g+1,s)j}$	Share of primary factor s in the total costs of regional industry (jr).	Calculated from input-output data files. $H^{(1)r}_{(g+1,2)j}$ and $H^{(1)r}_{(g+1,3)j}$ dealt with under (2.33). $H^{(1)r}_{(g+1,1)j} = \sum_{m=1}^{M} H^{(1)r}_{(g+1,1,m)j}$ where $H^{(1)r}_{(g+1,1,m)j}$ defined under (2.33) above.

Equation	Coefficient or Parameter	Description	Source
	$H^{(1)r}_{(g+1,1,m)j}$	Dealt with under (2.33) above.	
(2.35)	$H^{(2)r}_{(is)j}$	Share in the total costs of private capital formation for regional industry (jr) represented by the purchasers value of inputs of good i from source s.	Calculated from input-output data files. The total costs of regional industry (jr)'s capital formation is first calculated by summing the (jr)th columns of $\tilde{B}^{11}$, $\tilde{B}^{21}$, $\tilde{G}^{1}$, $\tilde{L}^{11}_{11}$, $\tilde{L}^{21}_{11}$, ..., $\tilde{Q}^{1}_{g+2}$. $H^{(2)r}_{(i1)j}$ is the sum of the i(jr)th elements of $\tilde{B}^{11}$, $\tilde{L}^{11}_{11}$, $\tilde{L}^{11}_{12}$, ..., $\tilde{L}^{11}_{g+2}$ expressed as a fraction of the total costs of private capital formation in industry (jr). $H^{(2)r}_{(i2)j}$ is the sum of the i(jr)th elements of $\tilde{B}^{21}$, $\tilde{L}^{21}_{11}$, $\tilde{L}^{21}_{12}$, ..., $\tilde{L}^{21}_{g+2}$ expressed as a fraction of the total costs of (jr)'s private capital formation and $H^{(2)r}_{(i3)j}$ is the sum of the i(jr)th elements of $\tilde{G}^{1}$, $\tilde{Q}^{1}_{11}$, $\tilde{Q}^{1}_{12}$, ..., $\tilde{Q}^{1}_{g+2}$ expressed as a fraction of the total costs of (jr)'s private capital formation.
	$H^{(2)r}_{ij}$	Share of the purchasers value of inputs of good i from all sources in regional industry (jr)'s total costs of private capital formation.	$H^{(2)r}_{ij} = \sum_{s=1}^{3} H^{(2)r}_{(is)j}$.

Equation	Coefficient or Parameter	Description	Source
(2.36)	$H^{(5,2)r}_{(is)j}$	Share in the total costs of capital formation by region r state government in regional industry (jr) represented by the purchasers value of inputs of good i from source s.	Calculated from input-output data files. First the total costs of regional industry (jr)'s capital formation by state government r is calculated by summing the (jr)th columns of $\tilde{B}^{12}$, $\tilde{B}^{22}$, $\tilde{G}^{2}$, $\tilde{L}^{12}_{11}$, $\tilde{L}^{22}_{11}$, ..., $\tilde{Q}^{2}_{g2}$. For s = 1, 2, $H^{(5,2)r}_{(is)j}$ is the sum of the i(jr)th elements of $\tilde{B}^{s2}$, $\tilde{L}^{s2}_{11}$, $\tilde{L}^{s2}_{12}$, ..., $\tilde{L}^{s2}_{g2}$ expressed as a fraction of the total costs of capital formation by state government r in regional industry (jr). $H^{(5,2)r}_{(i3)j}$ is the sum of the i(jr)th elements of $\tilde{G}^{2}$, $\tilde{Q}^{2}_{11}$, $\tilde{Q}^{2}_{12}$, ..., $\tilde{Q}^{2}_{g2}$ expressed as a fraction of the total costs of (jr)'s state government capital formation.
	$H^{(5,2)r}_{ij}$	Share of the purchasers value of inputs of good i from all sources in regional industry (jr)'s total costs of capital formation by state government r.	$H^{(5,2)r}_{ij} = \sum_{s=1}^{3} H^{(5,2)r}_{(is)j}$
(2.37)	$H^{(6,2)}_{(is)j}$	Share in the total costs of capital creation by Commonwealth government in industry j represented by the purchasers value of good i from source s.	Calculated from input-output data files. The total cost of industry j's Commonwealth government capital formation is first calculated by summing the jth columns of $\tilde{B}^{13}$, $\tilde{B}^{23}$, $\tilde{G}^{3}$, $\tilde{L}^{13}_{11}$, $\tilde{L}^{23}_{11}$, ..., $\tilde{Q}^{3}_{g2}$. For s = 1, 2, $H^{(6,2)}_{(is)j}$ is the sum of the ijth elements of $\tilde{B}^{s3}$, $\tilde{L}^{s3}_{11}$, $\tilde{L}^{s3}_{12}$, ..., $\tilde{L}^{s3}_{g2}$

Equation	Coefficient or Parameter	Description	Source
			expressed as a fraction of the total costs in Commonwealth capital formation in industry j. $H^{(6,2)}_{(i3)j}$ is the sum of the ijth elements of $\tilde{G}^3$, $\tilde{Q}^3_{11}$, $\tilde{Q}^3_{12}$, ..., $\tilde{Q}^3_{g2}$ expressed as a fraction of the total costs of j's Commonwealth capital formation.
	$H^{(6,2)}_{ij}$	Share of the purchasers value of inputs of good i from all sources in industry j's total costs of Commonwealth government capital formation.	$H^{(6,2)}_{ij} = \sum_{s=1}^{3} H^{(6,2)}_{(is)j}$.
(2.38)	$\zeta_1(i3,0)$	Share of the landed, duty-free value in the basic value (i.e., the landed, duty paid value) of imports of good i.	Calculated from input-output data files. The basic value of imports of good i is calculated first by summing the ith rows of matrices $\tilde{F}$, $\tilde{G}^1$, $\tilde{G}^2$, $\tilde{G}^3$, $\tilde{H}$, $\tilde{J}^1$ and $\tilde{J}^2$. The landed, duty-free value is computed by adding the ith element of the vector $-\tilde{Z}$ to this sum. $\zeta_1(i3,0)$ is then computed as the ratio of the duty-free value to the basic value.
	$\zeta_2(i3,0)$	Share of duty in the basic value of imports of good i.	$\zeta_2(i3,0) = 1 - \zeta_1(i3,0)$.
(2.39)	$h_1(i3,0)$	Indexing parameter which fixes the relationship between movements in the tariff per unit import of good i and in the consumer price index.	User specified value stored on parameters file.

Equation	Coefficient or Parameter	Description	Source
	$h_2(i3,0)$	Parameter which allows the tariff per unit import of good i to be treated as ad valorem.	User specified value stored on parameters file.
	$h_3(i3,0)$	Parameter which allows the tariff per unit import of good i to be treated as specific.	User specified value stored on parameters file.
(2.40)	$\zeta_1(ir,4)$	Basic value share in the value at port of exit of good i exports from region r.	Calculated from input-output data files. $\zeta_1(ir,4)$ is the ratio of the i^{th} element of $\tilde{D}^r$ to the sum of the i^{th} elements of $\tilde{D}^r$, $\tilde{N}^r_{11}$, $\tilde{N}^r_{12}$, ..., $\tilde{N}^r_{g+2}$. i.e. the at-port value of good i exports from region r.
	$\zeta_2(ir,4)$	Share in the at-port value of good i exports from region r represented by export taxes or subsidies. In the case of export subsidies $\zeta_2(ir,4)$ will be negative.	Calculated from input-output data files. $\zeta_2(ir,4)$ is the share of the i^{th} element of the vector $\tilde{N}^r_{g+2}$ in the at-port value of exports from region r of good i.
	$\zeta_3(ir,4)$	Share of total margins (excluding export taxes) in the at-port price of exports from region r of good i.	Calculated from input-output data files. $\zeta_3(ir,4)$ is the sum of the i^{th} elements of the vectors $\tilde{N}^r_{11}$, $\tilde{N}^r_{12}$, $\tilde{N}^r_{21}$, ..., $\tilde{N}^r_{g2}$ expressed as a fraction of the at-port value of exports from region r of good i.

Equation	Coefficient or Parameter	Description	Source
	$M_{(ut)}^{(ir)4}$	Share of good u supplied by region t in the total cost of margins (excluding export taxes) required to transfer exports of good i from producers in region r to the port of exit.	Calculated from input-output data files. $M_{(ut)}^{(ir)4}$ is the share of the i^{th} element of $\tilde{N}_{ut}^{r}$ in the total value margins (excluding taxes) of region r exports of good i.
(2.41)	$h_1(i0,4)$	Indexing parameter which fixes the relationship for both regions between the percentage change in taxes (subsidies) per unit of export of good i and in the economy-wide consumer price index.	User specified value stored on parameters file.
	$h_2(i0,4)$	Parameter which allows the export tax (subsidy) per unit of export (from both regions) of good i to be treated as ad valorem.	User specified value stored on parameters file.
	$h_3(i0,4)$	Parameter which allows for a specific export tax (subsidy) per unit of export (regardless of regional origin) of good i.	User specified value stored on parameters file.
	$h_4(i0,4)$	Parameter which allows for a specific export tax (subsidy) per unit of export of good i for each region	User specified value stored on parameters file.
(2.42)	$\zeta_1(is,jrk)$	Basic-value share in the purchasers value of good i from source s used as an input by regional industry (jr) for purpose k (k = 1 for current production, k = 2 for private capital formation).	Calculated from input-output data files. The six purchasers of good i flowing to regional industry (jr) are computed first. The purchasers value of domestic region s (s = 1, 2) flow for current purposes (k = 1) is the sum $[(\tilde{A}^{s})_{i(jr)} + (\tilde{K}_{11}^{s})_{i(jr)} + \dots + (\tilde{K}_{g+2}^{s})_{i(jr)}]$. The purchasers value of domestic region s (s = 1, 2) flow for private capital purposes (k = 2) is the sum $[(\tilde{B}^{s1})_{i(jr)} + (\tilde{L}_{11}^{s1})_{i(jr)} + \dots$

Equation	Coefficient or Parameter	Description	Source
			+ $(\tilde{L}^{s1}_{g+2})_{i(jr)}]$. The two purchasers values (k = 1 and 2) of the imported flows (s = 3) are the sums $[(\tilde{F})_{i(jr)} + (\tilde{P}_{11})_{i(jr)} + \dots + (\tilde{P}_{g+2})_{i(jr)}]$ and $[(\tilde{G}^1)_{i(jr)} + (\tilde{Q}^1_{11})_{i(jr)} + \dots + (\tilde{Q}^1_{g+2})_{i(jr)}]$ respectively. ζ_1(is,jrk) are then the shares of $(\tilde{A}^1)_{i(jr)}$, $(\tilde{A}^2)_{i(jr)}$, $(\tilde{B}^{11})_{i(jr)}$, $(\tilde{B}^{21})_{i(jr)}$, $(\tilde{F})_{i(jr)}$ and $(\tilde{G}^1)_{i(jr)}$ in these six sums respectively.
	ζ_2(is,jrk)	Share of state government r commodity taxes in the purchasers value of inputs of good i from source s used by regional industry (jr) for purpose k.	Calculated from input-output data files. The ζ_2(is,jrk) are the shares of the i(jr)th elements of $\tilde{K}^1_{g+1,r}$ (for s = 1, k = 1), $\tilde{K}^2_{g+1,r}$ (for s,= 2, k = 1), $\tilde{L}^{11}_{g+1,r}$ (for s = 1, k = 2), $\tilde{L}^{21}_{g+1,r}$ (for s = 2, k = 2), $\tilde{P}_{g+1,r}$ (for s = 3, k = 1) and $\tilde{Q}_{g+1,r}$(for s = 3, k = 2) in the corresponding six purchasers values of good i flowing to regional industry (jr).
	ζ_3(is,jrk)	Share of Commonwealth government commodity taxes in the purchasers value of inputs of good i from source s used by regional industry (jr) for purpose k.	Calculated from input-output data files. The ζ_3(is,jrk) are the shares of the i(jr)th elements of $\tilde{K}^1_{g+2)}$ (for s = 1, k = 1), $\tilde{K}^2_{g+2}$ (for s = 2,

Equation	Coefficient or Parameter	Description	Source
			k = 1), $\tilde{L}^{11}_{g+2}$ (for s = 1, k = 2), $\tilde{L}^{21}_{g+2}$ (for s = 2, k= 2), $\tilde{P}_{g+2}$ (for s = 3, k = 1) and $\tilde{Q}_{g+2}$ (for s = 3, k = 2) in the corresponding six purchasers values of good i flowing to regional industry (jr).
	ζ_4(is,jrk)	Share of total margins (exluding taxes) in the purchasers value of inputs of good i from source s used by regional industry (jr) for purpose k.	Calculated from input-output data files. The total value of non-tax margins on the flows of of good i from domestic region s (s = 1, 2) to regional industry (jr) are, for k = 1, $[(\tilde{K}^s_{11})_{i(jr)} + (\tilde{K}^s_{12})_{i(jr)} + (\tilde{K}^s_{21})_{i(jr)} +\ldots+ (\tilde{K}^s_{g2})_{i(jr)}]$ and, for k = 2, $[(\tilde{L}^{s1}_{11})_{i(jr)} + (\tilde{L}^{s1}_{12})_{i(jr)} + \ldots + (\tilde{L}^{s1}_{g2})_{i(jr)}]$. The corresponding total margins on the flows of imports (s = 3) of good i to regional industry (jr) are $[(\tilde{P}_{11})_{i(jr)} + (\tilde{P}_{12})_{i(jr)} + \ldots + (\tilde{P}_{g2})_{i(jr)}]$ and $[(\tilde{Q}^1_{11})_{i(jr)} + (\tilde{Q}^1_{12})_{i(jr)} + \ldots + (\tilde{Q}^1_{g2})_{i(jr)}]$. The ζ_4(is,jrk) are the shares of these six sums in the six corresponding purchasers values of good i flowing to regional industry (jr).
	$M^{(is)(jr)k}_{(ut)}$	Share of inputs of good u from region t in the total cost of non-tax margins required to facilitate flows of good i from source s from the producer (or port of entry) to regional industry (jr) for purpose k.	Input-output data files. The $M^{(is)(jr)k}_{(ut)}$ are the shares of the i(jr)th elements of $\tilde{K}^s_{ut}$ (for s = 1, 2 and k = 1), $\tilde{L}^{s1}_{ut}$ (for s = 1, 2 and

Equation	Coefficient or Parameter	Description	Source
			k = 2), $\tilde{P}_{ut}$ (for s = 3, k = 1) and $\tilde{Q}^{1}_{ut}$ (for s = 3 and k = 2) in the total values of non-tax margins associated with the six corresponding types of flows of good i to regional industry (jr).
(2.43)	$\zeta_1(ir,3r)$	Basic-value share in the purchasers value of good i from source s used by householders in region r.	Calculated from input-output data files. The purchasers value of good i from domestic sources (s = 1, 2) flowing to region r households are calculated first. They are the sum $[(\tilde{C}^{s})_{ir} + (\tilde{M}^{s}_{11})_{ir} + (\tilde{M}^{s}_{12})_{ir} + \dots + (\tilde{M}^{s}_{g+2})_{ir}]$. The corresponding value for the import flow (s = 3) is $[(\tilde{H})_{ir} + (\tilde{R}_{11})_{ir} + (\tilde{R}_{12})_{ir} + \dots + (\tilde{R}_{g+2})_{ir}]$. $\zeta_1(is,3r)$ are the shares of $(\tilde{C}^{1})_{ir}$, $(\tilde{C}^{2})_{ir}$ and $(\tilde{H})_{ir}$ in the three corresponding purchasers values.
	$\zeta_2(is,3r)$	Share of state government commodity taxes in the purchasers value of good i from source s used by households in region r.	Calculated from input-output data files. The $\zeta_2(is,3r)$ are the shares of $[(\tilde{M}^{s}_{g+1,1})_{ir} + (\tilde{M}^{s}_{g+1,2})_{ir}]$ for (s = 1, 2) $[(\tilde{R}_{g+1,1})_{ir} + (\tilde{R}_{g+1,2})_{ir}]$ (for s = 3) in the purchasers values of the three flows of good i to households in region r.

Equation	Coefficient or Parameter	Description	Source
	$\zeta_3(is,3r)$	Share of Commonwealth government commodity taxes in the purchasers value of good i from source s used by households in region r.	Calculated from input-output data files. $\zeta_3(is,3r)$ are the shares of ir^{th} elements of $\tilde{M}^s_{g+2}$ (for s = 1, 2) and $\tilde{R}_{g+2}$ (for s = 3) in the purchasers values of the three flows of good i to households in region r.
	$\zeta_4(is,3r)$	Share of total value of non-tax margins in the purchasers value of good i from source s used by households in region r.	Calculated from input-output data files. The total value of non-tax margins on the flow of good i from domestic region s to households in region r is the sum $[(\tilde{M}^s_{11})_{ir} + (\tilde{M}^s_{12})_{ir} + \ldots + (\tilde{M}^s_{g2})_{ir}]$. The total value of non-tax margins on the flow of imported good to households in region r is the sum $[(\tilde{R}_{11})_{ir} + (\tilde{R}_{12})_{ir} + \ldots + (\tilde{R}_{g2})_{ir}]$. The $\zeta_4(is,3r)$ are the shares of these sums in the corresponding purchasers values of the three flows of good i to households in region r.
	$M^{(is)3r}_{(ut)}$	Share of inputs of good u supplied by region t in the total cost of non-tax margins required to transfer flows of good i from source s to households in region r.	Calculated from input-output data files. The $M^{(is)3r}_{(ut)}$ are the shares of the ir^{th} elements of $\tilde{M}^s_{ut}$ (for s = 1, 2) and R_{ut} in the total values of non-tax margins associated with the three types of flows of good i to households in region r.

Equation	Coefficient or Parameter	Description	Source
(2.44)	$\zeta_1(is,5r)$	Basic-value share in the purchasers value of good i from source s used by region r state government for current consumption.	Calculated from input-output data files. The purchasers value of the good i flows to region r are calculated first. For domestic regions (s = 1, 2) the purchasers value flow is $[(\tilde{E}^{s1})_{ir} + (\tilde{O}^{s1}_{11})_{ir} + ,\dots, + (\tilde{O}^{s1}_{g2})_{ir}]$ and for imports (s = 3) the purchasers value is $[(\tilde{J}^{1})_{ir} + (\tilde{T}^{1}_{11})_{ir} + \dots + (\tilde{T}^{1}_{g2})_{ir}]$. $\zeta_1(is,5r)$ are the shares of $(\tilde{E}^{s1})_{ir}$ and $(\tilde{J}^{1})_{ir}$ in the corresponding purchasers values.
	$\zeta_2(is,5r)$	Share of total value of margins in the purchasers value of good i from source s used by region r state government for current consumption.	Calculated from input-output data files. The total value of margins on the flow of good i from domestic region s to region r state government for current purposes is the sum $[(\tilde{O}^{s1}_{11})_{ir} + (\tilde{O}^{s1}_{12})_{ir} + \dots + (\tilde{O}^{s1}_{g2})_{ir}$. The total value of margins on the flow of imported good i to region r state government current consumption is the sum $[(\tilde{T}^{1}_{11})_{ir} + (\tilde{T}^{1}_{12})_{ir} + \dots + (\tilde{T}^{1}_{g2})_{ir}]$. The $\zeta_2(is,5r)$ are the shares of these sums in the corresponding purchasers values.

Equation	Coefficient or Parameter	Description	Source
	$M_{(ut)}^{(is)5r}$	Share of input of good u supplied by region t in the total cost of non-tax margins required to transfer flows of good i from source s to region r state government for current consumption.	Calculated from input-output data files. The $M_{(ut)}^{(is)5r}$ are the shares of the irth elements of $\tilde{O}_{ut}^{s1}$ (for s = 1, 2) and $\tilde{T}_{ut}^{1}$ (for s = 3) in the associated total value of non-tax margins calculated above.
(2.45)	$\zeta_1(isj,5r)$	Basic-value share in the purchasers value of good i from source s used as an input by regional industry (jr) for capital formation by state government r.	Calculated from input-output data files. First compute the purchasers value of the flows. The purchasers value of the region s (s = 1, 2) flow is $[(\tilde{B}^{s2})_{i(jr)} + (\tilde{L}_{11}^{s2})_{i(jr)} + ,\ldots, + (\tilde{L}_{g2}^{s2})_{i(jr)}]$ while for imported flows it is $[(\tilde{G}^{2})_{i(jr)} + (\tilde{Q}_{11}^{2})_{i(jr)} + \ldots + (\tilde{Q}_{g2}^{2})_{i(jr)}]$. $\zeta_1(isj,5r)$ is calculated by dividing $(\tilde{B}^{s2})_{i(jr)}$ (for s = 1, 2) or $(\tilde{G}^{2})_{i(jr)}$ (for s = 3) by the corresponding purchasers value.
	$\zeta_2(isj,5r)$	Share of total margins in the purchasers value of inputs of good i from source s used by regional industry (jr) for capital formation by state government r.	$\zeta_2(isj,5r)$ is computed as $1 - \zeta_1(isj,5r)$.
	$M_{(ut)}^{(is)j5r}$	Share of inputs of good u from region t in the total costs of margins required to facilitate flows of good i from source s from the producer (or port of entry) to regional industry (jr) for	Calculated from input-output data files. First the total value of margins on the flow of good i to regional industry (jr) for state government r capital formation is calculated. Margins on flows from domestic region s (s = 1, 2) are

Equation	Coefficient or Parameter	Description	Source
		capital formation by state government r.	$[(\tilde{L}^{s2}_{11})_{i(jr)} + (\tilde{L}^{s2}_{12})_{i(jr)} + \dots + (\tilde{L}^{s2}_{g2})_{i(jr)}]$ and from foreign sources (s = 3) are $[(\tilde{Q}^{2}_{11})_{i(jr)} + (\tilde{Q}^{2}_{12})_{i(jr)} + \dots + (\tilde{Q}^{2}_{g2})_{i(jr)}]$. The $M^{(is)j5r}_{(ut)}$ are the shares of the $i(jr)^{th}$ elements of $\tilde{L}^{s2}_{ut}$ (for s = 1, 2) and $\tilde{Q}^{2}_{ut}$ (for s = 3) in the total value of margins associated with the three corresponding types of flows of good i.
(2.46)	$\zeta_1(is,6)$	Basic-value share in the purchasers value of good i from source s used by the Commonwealth government for current consumption.	Calculated from input-output data files. First compute the purchasers value of the flows. The purchasers value of the region s (s = 1, 2) flow is the sum of the i^{th} elements of $\tilde{E}^{s2}$, $\tilde{O}^{s2}_{11}$, ..., $\tilde{O}^{s2}_{g2}$ while for imported flows it is the sum of the i^{th} elements of $\tilde{J}^{2}$, $\tilde{T}^{2}_{11}$, .., $\tilde{T}^{2}_{g2}$. $\zeta_1(is,6)$ is calculated by dividing the i^{th} element of $\tilde{E}^{s2}$ (for s = 1, 2) or $\tilde{J}^{2}$ (for s = 3) by the corresponding purchasers value.
	$\zeta_2(is,6)$	Share of total margins in the purchasers value of inputs of good i from source s used by the Commonwealth government for current consumption.	$\zeta_2(is,6)$ is computed as $1 - \zeta_1(is,6)$.

Equation	Coefficient or Parameter	Description	Source
	$M^{(is)6}_{(ut)}$	Share of inputs of good u from region t in the total costs of margins required to facilitate flows of good i from source s from the producer (or port of entry) to the Commonwealth government for current consumption.	Calculated from input-output data files. The total value of margins on the flows of good i to the Commonwealth government for current consumption are calculated first. Margins on flows from domestic region s (s = 1, 2) are the sum of the i^{th} elements of $\tilde{O}^{s2}_{11}, \tilde{O}^{s2}_{12}, \ldots, \tilde{O}^{s2}_{g2}$ and from foreign sources (s = 3) they are the are the sum of the i^{th} elements of $\tilde{T}^{2}_{11}, \tilde{T}^{2}_{12}, \ldots, \tilde{T}^{2}_{g2}$. The $M^{(is)6}_{(ut)}$ are the shares of the i^{th} elements of $\tilde{O}^{s2}_{ut}$ (for s = 1, 2) and $\tilde{T}^{2}_{ut}$ (for s = 3) in the total value of margins associated with the three corresponding types of flows of good i.
(2.47)	$\zeta_1(isj,6)$	Basic-value share in the purchasers value of good i from source s used as an input by industry j for capital formation by the Commonwealth government.	Calculated from input-output data files. First compute the purchasers value of the flows. The purchasers value of the region s (s = 1, 2) flow is $[(\tilde{B}^{s3})_{ij} + (\tilde{L}^{s3}_{11})_{ij} + \ldots + (\tilde{L}^{s3}_{g2})_{ij}]$ while for imported flows it is $[(\tilde{G}^{3})_{ij} + (\tilde{Q}^{3}_{11})_{ij} + \ldots + (\tilde{Q}^{3}_{g2})_{ij}]$. ζ_2 is calculated by dividing $(\tilde{B}^{s3})_{ij}$ (for s = 1, 2) or $(\tilde{G}^{3})_{ij}$ (for s = 3) by the corresponding purchasers value.

Equation	Coefficient or Parameter	Description	Source
	$\zeta_2(isj,6)$	Share of total margins in the purchasers value of inputs of good i from source s used by industry j for capital formation by the Commonwealth government.	$\zeta_2(isj,6)$ is computed as $1 - \zeta_1(isj,6)$.
	$M_{(ut)}^{(is)j6}$	Share of inputs of good u supplied by region t in the total cost of margins required to transfer flows of good i from source s from the producer (or port of entry) to industry j for capital formation by the Commonwealth government.	Calculated from input-output data files. The total value of margins on the flows of good i to industry j for capital formation by the Commonwealth government is calculated first. Margins on flows from domestic region s are $[(\tilde{L}_{11}^{s3})_{ij} + (\tilde{L}_{12}^{s2})_{ij} + \ldots + (\tilde{L}_{g2}^{s2})_{ij}]$ and from foreign sources are $[(\tilde{Q}_{11}^{s2})_{ij} + (\tilde{Q}_{12}^{2})_{ij} + \ldots + (\tilde{Q}_{g2}^{2})_{ij}]$. $M_{(ut)}^{(is)j6}$ are the shares of the i^{th} elements of $\tilde{L}_{ut}^{s3}$ (for s = 1, 2) and $\tilde{Q}_{ut}^{3}$ (for s = 3) in the total values of margins associated with the three types of flows of good i.
(2.48)	$h_1(is,jrkl)$	Indexing parameter which fixes the relationship between movements in the State government tax on the flow of good i from source s to regional industry (jr) for purpose k and in the regional consumer price index.	User specified value stored on parameters file.
	$h_2(is,jrkl)$	Parameter which allows state government taxes on intermediate and private investment flows to be treated as ad valorem.	User specified value stored on elasticities file.
	$h_3(is,jrkl)$	Parameter which allows state government taxes on intermediate and private investment flows to to be treated as specific.	User specified value stored on parameters file.

Equation	Coefficient or Parameter	Description	Source
(2.49)	$h_1(is,jk2)$	Indexing parameter which fixes the relationship between movements in the Commonwealth government tax on the flow of good i from source s to regional industry (jr) for purpose k and in the regional consumer price index.	User specified value stored on parameters file.
	$h_2(is,jk2)$	Parameter which allows Commonwealth government taxes on intermediate and investment flows to be treated as ad valorem.	User specified value stored on parameters file.
	$h_3(is,jk3)$	Parameter which allows Commonwealth taxes on intermediate and private investment flow to be treated as specific.	User specified value stored on parameters file.
(2.50)	$h_1(is,3r1)$	Indexing parameter which fixes the relationship between movements in the state government tax on the flow of good i from source s to households in region r and in the regional consumer price index.	User specified value stored on parameters file.
	$h_2(is,3r1)$	Parameter which allows state government taxes on flows of good i to regional households to be treated as ad valorem.	User specified value stored on parameters file.
	$h_3(is,3r1)$	Parameter which allows state government taxes on flows of good i to regional households to be treated as specific.	User specified value stored on parameters file.
(2.51)	$h_1(is,32)$	Indexing parameter which fixes the relationship between movements in the Commonwealth government tax on the flow of good i from source s to households in region r and in the regional consumer price index.	User specified value stored on parameters file.

Equation	Coefficient or Parameter	Description	Source
	$h_2(is,32)$	Parameter which allows Commonwealth government taxes on flows of good i to regional households to be treated as ad valorem.	User specified value stored on parameters file.
	$h_3(is,32)$	Parameter which allows Commonwealth government taxes on flows of good i to regional households to be treated as specific.	User specified value stored on parameters file.
(2.52)	$Q_j^{(1)r}$	Ratio of gross (before depreciation) to net (after depreciation) post-tax rate of return in regional industry (jr) for a typical year.	Estimates stored on the parameters file.
(2.53)	$Q_j^{(2)r}$	Ratio of the pre-tax rental price of a unit of capital in industry (jr) to its post-tax rental price.	Calculated from input-output data files. First for each regional industry obtain the column sum for $\tilde{V}^1$, $\tilde{V}^2$ and $\tilde{V}^3$. Then $Q_j^{(2)r}$ is the ratio of the sum of the three column sums for regional industry (jr) to the corresponding $\tilde{V}^1$ column sum.
	$(SP)_{(g+1,2)j}^{(4)r}$	Share of income-tax component in rental price of a unit of capital in regional industry (jr).	Calculated from input output data files. $(SP)_{(g+1,2)j}^{(4)r}$ is the ratio of the $(jr)^{th}$ column sum of $\tilde{V}^2$ to the sum of the three column sums of $\tilde{V}^1$, $\tilde{V}^2$ and $\tilde{V}^3$ for regional industry (jr).
	$(SP)_j^{(7)r}$	Share of residential-land tax component in rental-price of a unit of capital in regional industry (jr).	Calculated from input-output data files. First calculate the share of all land taxes in the rental-price of a unit of capital in regional industry (jr) as the ratio of the $(jr)^{th}$ column sum of $\tilde{V}^3$ to the sum of the three

Equation	Coefficient or Parameter	Description	Source
			column sums of $\tilde{V}^1$, $\tilde{V}^2$ and $\tilde{V}^3$ for regional industry (jr). This share is then split between residential and commercial land taxes according to an estimated proportion. For all industries other than that covering ownership of dwellings the residential land tax proportion is zero.
	$(SP)_j^{(8)r}$	Share of commercial-land tax component in rental price of a unit of capital in regional industry (jr).	Calculated from input-output data files as explained for $(SP)_j^{(7)r}$.
(2.54)	β_j^r	Elasticity of the expected marginal rate of return on capital in regional industry (jr) with respect to increases in regional industry (jr)'s planned stock of capital.	Estimates stored on parameters file.
(2.55)	G_j^r	A typical value for the ratio of regional industry (jr)'s gross investment to its capital stock of the following year.	Estimates stored on parameters file.
	$(GY)_j^r$	Share of private investment in all investment in regional industry (jr).	Calculated from input-output data files. First calculate a vector of regional industry investment for each of the three classes of investors. The vector for private investment is formed by adding down the columns of $\tilde{B}^{11}$, $\tilde{B}^{21}$, $\tilde{G}^1$, $\tilde{L}^{11}_{11}$, $\tilde{L}^{21}_{11}$, ..., $\tilde{Q}^1_{g+2}$. The state government vector is obtained by adding down the columns of $\tilde{B}^{12}$, $\tilde{B}^{22}$, $\tilde{G}^2$, $\tilde{L}^{12}_{11}$, ..., $\tilde{Q}^2_{g2}$. The Commonwealth vector is obtained by first

Equation	Coefficient or Parameter	Description	Source
			adding down the columns $\tilde{B}^{13}$, $\tilde{B}^{23}$, $\tilde{G}^{3}$, $\tilde{L}^{13}_{11}$, ..., $\tilde{Q}^{3}_{g2}$ and then expanding this (1 x h) vector to (1 x 2h) by disaggregating Commonwealth investment by industry into regional components by use of the regional shares for private investment by industry. $(GY)^{r}_{j}$ is then the share of the $(jr)^{th}$ element of the private investment vector in the sum of the $(jr)^{th}$ elements in all three vectors.
	$(GY)^{5r}_{j}$	Share of state government investment in regional industry (jr).	Using the investment vectors calculated above, $(GY)^{5r}_{j}$ is the share of the $(jr)^{th}$ element in the state government investment vector in the sum of the $(jr)^{th}$ elements in all three vectors.
	$(GY)^{6r}_{j}$	Share of Commonwealth government investment in regional industry (jr).	Using the investment vectors calculated above, $(GY)^{6r}_{j}$ is the share of the $(jr)^{th}$ element in the Commonwealth government investment vector in the sum of the $(jr)^{th}$ elements in all three vectors.
(2.56)	T^{r}_{j}	Share of economy-wide private investment accounted for by regional industry (jr).	Using the private investment vector calculated in (2.55) above, T^{r}_{j} is the share of the $(jr)^{th}$ element in the sum of all elements in the private investment vector.

Equation	Coefficient or Parameter	Description	Source
	J	Set of integers identifying those industries for which in both regions FEDERAL is allowed to determine investment according to relative rates of return.	User specified value stored on parameters file.
(2.57)	T_j^r	Dealt with in (2.56) above.	
	J	Dealt with in (2.56) above.	
(2.58)	$(SY)_j^6$	Share of economy-wide investment accounted for by Commonwealth government investment in industry j.	Calculated from the investment vectors computed under (2.55) above. $(SY)_j^6$ is the fraction of the sum of the (j1) and (j2) components of the Commonwealth investment vector in the sum of the elements of all three investment vectors.
	$(SY)_j^{(5)r}$	Share of economy-wide investment accounted for by state government r investment in regional industry (jr).	Using the investment vectors calculated in (2.55), $(SY)_j^{(5)r}$ is the share of the $(jr)^{th}$ element of the state government investment vector in the sum of the elements of all three investment vectors.
	$(SY)_j^r$	Share of economy-wide investment accounted for by private investment in regional industry (jr).	Using the investment vector calculated in (2.55), $(SY)_j^r$ is the share of the $(jr)^{th}$ element of the private investment vector in the sum of the elements of all three investment vectors.

Equation	Coefficient or Parameter	Description	Source
(2.59)	$h_j^{(2)r}$	Indexing parameter which fixes the relationship between movements in real private investment economy-wide and in regional industry (jr) where $j \notin J$.	User specified value stored on parameters file.
(2.60)	$h_j^{(5)r}$	Indexing parameter which fixes the relationship between movements in aggregate real private investment for region r and in state government r real investment in industry (jr).	User specified value stored on parameters file.
(2.61)	$h_j^{(6)}$	Indexing parameter which fixes the relationship between movements in economy-wide real private investment and in Commonwealth government real investment in industry j.	User specified value stored on parameters file.
(2.62)	none		
(2.63)	none		
(2.64)	$B_{(ur)j}^{(1)t}$	Share of total sales of good u produced in region r which is absorbed by regional industry (jt) as a direct input into current production.	Calculated from input-output data files as the $u(jt)^{th}$ element of $\tilde{A}^r$ divided by the total sales of good u by region r producers, i.e. the sum over the u^{th} rows of $\tilde{A}^r$, $\tilde{B}^{r1}$, $\tilde{B}^{r2}$, $\tilde{B}^{r3}$, $\tilde{C}^r$, $\tilde{D}^r$, $\tilde{E}^{r1}$, $\tilde{E}^{r2}$ plus the sum of all entries in $\tilde{K}^1_{ur}$, $\tilde{K}^2_{ur}$, $\tilde{P}_{ur}$, $\tilde{L}^{11}_{ur}$, $\tilde{L}^{21}_{ur}$, $\tilde{Q}^1_{ur}$, $\tilde{L}^{12}_{ur}$, $\tilde{L}^{22}_{ur}$, $\tilde{Q}^2_{ur}$, $\tilde{L}^{13}_{ur}$, $\tilde{L}^{23}_{ur}$, $\tilde{Q}^3_{ur}$, $\tilde{M}^1_{ur}$, $\tilde{M}^2_{ur}$, $\tilde{R}_{ur}$, $\tilde{N}^1_{ur}$, $\tilde{N}^2_{ur}$, $\tilde{O}^{11}_{ur}$, $\tilde{O}^{21}_{ur}$, $\tilde{T}^1_{ur}$, $\tilde{O}^{12}_{ur}$, $\tilde{O}^{22}_{ur}$, $\tilde{T}^2_{ur}$.

Equation	Coefficient or Parameter	Description	Source
	$B_{(ur)j}^{(2)t}$	Share of total sales of good u produced in region r which is absorbed by regional industry (jt) as a direct input to private capital formation.	Calculated from input-output data files as the $u(jt)^{th}$ elementof $\tilde{B}^{r1}$ divided by the total sales of good u by region r producers.
	$B_{(ur)}^{(3)t}$	Share of total sales of good u produced in region r which is absorbed as a direct input to region t household consumption.	Calculated from input-output data files as the ut^{th} element of $\tilde{C}^{r}$ divided by the total sales of good u by region r producers.
	$B_{(ur)}^{(4)}$	Share of total sales of good u produced in region r which is absorbed as a direct input to exports.	Calculated from input-output data files as the u^{th} element of $\tilde{D}^{r}$ divided by the total sales of good u by region r producers.
	$B_{(ur)}^{(5,v)t}$	Share of total sales of good u produced in region r which is absorbed as a direct input to state government t for current consumption (v = 1) and for capital formation (v = 2).	Calculated from input-output data files. $B_{(ur)}^{(5,1)t}$ is computed as the ut^{th} element of $\tilde{E}^{r1}$ divided by the total sales of good u from region r producers. $B_{(ur)}^{(5,2)t}$ is computed as the sum of the h elements of the appropriate t^{th} sub-vector in the u^{th} row of $\tilde{B}^{r2}$ divided by the total sales of good u by region r producers.
	$B_{(ur)}^{(6,v)}$	Share of total sales of good u produced in region r which is absorbed as a direct input to Commonwealth government current consumption (v = 1) and Commonwealth government capital formation (v = 2).	Calculated from input-output data files. $B^{(6,1)}$ is computed as the u^{th} element of $\tilde{E}^{r2}$ divided by the total sales of good u from region r producers. $B_{(u,r)}^{(6,2)}$ is computed as the sum of the elements in the u^{th} row of $\tilde{B}^{r3}$ divided by the total sales of good u by region r producers.

Equation	Coefficient or Parameter	Description	Source
	$B^{(is)(jt)k}_{(ur)}$	Share of total sales of good u produced in region r which is absorbed as a margin on the sale of good i from source s to regional industry (jt) for purpose k.	Calculated from input-output data files. $B^{(is)(jt)1}_{(ur)}$ is computed, for s = 1, 2, as the $i(jt)^{th}$ element of $\tilde{K}^{s}_{ur}$ divided by total sales of good u by region r producers. For s = 3, $B^{(is)(jt)1}_{(ur)}$ is computed as the $i(jt)^{th}$ element of $\tilde{P}_{ur}$ divided by total sales of good u by region r producers. $B^{(i1)(jt)2}_{(ur)}$, $B^{(i2)(jt)2}_{(ur)}$ and $B^{(i3)(jt)2}_{(ur)}$ are, respectively, the $i(jt)^{th}$ elements of $\tilde{L}^{11}_{ur}$, $\tilde{L}^{21}_{ur}$ and $\tilde{Q}^{1}_{ur}$ divided by total sales of good u by region r producers.
	$B^{(is)3t}_{(ur)}$	Share of total sales of good u produced in region r which is absorbed as a margin on the sale of good i from source s to households in region t.	Calculated from input-output data files. $B^{(i1)3t}_{(ur)}$, $B^{(i2)3t}_{(ur)}$ and $B^{(i3)3t}_{(ur)}$ are computed as the it^{th} elements of $\tilde{M}^{1}_{ur}$, $\tilde{M}^{2}_{ur}$ and $\tilde{R}_{ur}$, respectively, divided by total sales of good u by region r producers.
	$B^{(it)4}_{(ur)}$	Share of total sales of good u produced in region r which is absorbed as a margin on the transfer of exports of good i from producers in region t to the ports of exit.	Calculated from input-output data files. $B^{(it)4}_{(ur)}$ is computed as the i^{th} element of $\tilde{N}^{t}_{ur}$ divided by total sales of good u by region r producers.

Equation	Coefficient or Parameter	Description	Source
	$B_{(ur)}^{(is)5vt}$	Share of total sales of good u produced in region r which is absorbed as a margin on the sale of good i from source s to state government t for current consumption (v = 1) and for capital formation (v = 2).	Calculated from input-output data files. $B_{(ur)}^{(is)51t}$ is computed as the ratio of the it^{th} element of $\tilde{O}_{ur}^{s1}$ (for s = 1, 2) and $\tilde{T}_{ur}^{1}$ (for s = 3) to the total sales of good u by region r producers. $B_{(ur)}^{(is)52t}$ is computed as the ratio of the sum of the h elements of the appropriate t^{th} sub-vector in the i^{th} row of $\tilde{L}_{ur}^{s2}$ (for s = 1, 2) and $\tilde{Q}_{ur}^{2}$ (for s = 3) to the total sales of good u by region r producers.
	$B_{(ur)}^{(is)6v}$	Share of total sales of good u produced in region r which is absorbed as a margin on the sale of good i from source s to the Commonwealth government for current consumption (v = 1) and for capital formation (v = 2).	Calculated from input-output data files. $B_{(ur)}^{(is)61}$ is computed as the ratio of the i^{th} element of $\tilde{O}_{ur}^{s2}$ s = 1, 2) and $\tilde{T}_{ur}^{2}$ (for s = 3) to the total sales of good u by region r producers. $B_{(ur)}^{(is)62}$ is computed as the ratio of the sum of the i^{th} row of $\tilde{L}_{ur}^{s3}$ (for s = 1, 2) and $\tilde{Q}_{ur}^{3}$ (for s = 3) to the total sales of good u by region r producers.

Equation	Coefficient or Parameter	Description	Source
(2.65)	$B^{(0)}_{(ur)j}$	Share of the total region r output of good u which is produced by the j^{th} industry.	Calculated from input-output data files. Total sales of domestic good by region r producers is first recomputed as the sum of the u^{th} row of $\tilde{Y}^r$. $B^{(0)}_{(ur)j}$ is the ratio of the uj^{th} element of $\tilde{Y}^r$ to this sum.
(2.66)	$B^{(1)r}_{(g+1,1,m)j}$	Share of region r employment in occupation m which is accounted for by the j^{th} industry	Calculated from input-output data files. First assume pre-(income) tax wage rates for each occupation are uniform across industries within the region. Then compute the regional wage-bill (net of payroll tax) for occupation m as the sum of the h elements in the appropriate r sub-vector of the m^{th} row of $\tilde{U}^1$ plus the corresponding sum for $\tilde{U}^2$. $B^{(1)r}_{(g+1,1,m)j}$ is computed as the sum of the $(jr)^{th}$ elements in the m^{th} rows of $\tilde{U}^1$ and $\tilde{U}^2$ divided by the occupation m regional wage-bill.
(2.67)	None		
(2.68)	None		

Equation	Coefficient or Parameter	Description	Source
(2.69)	$B^{(k)r}_{(u3)j}$	Share of total imports of good u which is absorbed by regional industry (jr) for purpose k.	Calculated from input-output data files. Total imports of good u is first calculated by summing all the elements in the u^{th} rows of $\tilde{F}$, $\tilde{G}^1$, $\tilde{G}^2$, $\tilde{G}^3$, $\tilde{H}$, $\tilde{J}^1$, $\tilde{J}^2$. $B^{(1)r}_{(u3)j}$ and $B^{(2)r}_{(u3)j}$ are then computed by dividing the $u(jr)^{th}$ element of $\tilde{F}$ and the $u(jr)^{th}$ element of $\tilde{G}^1$ respectively by this sum.
	$B^{(3)r}_{(u3)}$	Share of total imports of good u which is absorbed by region r households.	Calculated from input-output data files. $B^{(3)r}_{(u3)}$ is computed by dividing the ur^{th} element of $\tilde{H}$ by total imports of good u.
	$B^{(5,v)r}_{(u3)}$	Share of total imports of good u which is absorbed by state government r for purpose v.	Calculated from input-output data files. $B^{(5,1)r}_{(u3)}$ is computed by dividing the ur^{th} element of $\tilde{J}^1$ by total imports of good u. $B^{(5,2)r}_{(u3)}$ is computed by dividing the sum of the h elements in the r^{th} sub-vector of the u^{th} row of $\tilde{G}^2$ by total imports of good u.

Equation	Coefficient or Parameter	Description	Source
	$B^{(6,v)}_{(u3)}$	Share of total imports of good u which is absorbed by the Commonwealth government for purpose v.	Calculated from input-output data files. $B^{(6,1)}_{(u3)}$ is computed by dividing the u^{th} element of $\tilde{J}^2$ by total imports of good u. $B^{(6,2)}_{(u3)}$ is computed by dividing the sum of the u^{th} row of $\tilde{G}^3$ by total imports of good u.
(2.70)	$M_{(u3)}$	Share in the foreign currency cost of total imports which is accounted for by imports of good u.	Calculated from input-output data files. First calculate the foreign currency value of total imports as the sum of all elements of $\tilde{F}$, $\tilde{G}^1$, $\tilde{G}^2$, $\tilde{G}^3$, $\tilde{H}$, $\tilde{J}^1$, $\tilde{J}^2$ and $(-\tilde{Z})$. $M_{(u3)}$ is then computed by dividing this total into the sum across the u^{th} rows of these eight matrices.
(2.71)	$E_{(ur)}$	Share of export earnings which is accounted for by exports of good u produced in region r.	Calculated from input-output data files. E_{ur} is equal to the sum of the u^{th} elements of $\tilde{D}^r$, $\tilde{N}^r_{11}$, $\tilde{N}^r_{12}$, ..., $\tilde{N}^r_{g+2}$ divided by the sum of all elements of the vectors $\tilde{D}^1$, $\tilde{D}^2$, $\tilde{N}^1_{11}$, $\tilde{N}^2_{11}$, ..., $\tilde{N}^2_{g+2}$.
(2.72)	E	Aggregate foreign currency value of exports.	Calculated from input-output data files. E is the sum of the elements in $\tilde{D}^1$, $\tilde{D}^2$, $\tilde{N}^1_{11}$, $\tilde{N}^2_{11}$, $\tilde{N}^1_{12}$, ..., $\tilde{N}^2_{g+2}$.
	M	Aggregate foreign currency value of imports.	Calculated from input-output data files. M is the sum of the elements in $\tilde{F}$, $\tilde{G}^1$, $\tilde{G}^2$, $\tilde{G}^3$, $\tilde{H}$, $\tilde{J}^1$, $\tilde{J}^2$ and $(-\tilde{Z})$.

Equation	Coefficient or Parameter	Description	Source
(2.73)	$W_{(is)}^{(3r)}$	Weight of good i from source s in the FEDERAL region r consumer price index.	Calculated from input-output data files. First form a 3g x 2 matrix of household demand (in purchasers prices) by commodity and region by summing the matrices $\begin{bmatrix} \tilde{C}^1 \\ \tilde{C}^2 \\ \tilde{H} \end{bmatrix}, \begin{bmatrix} \tilde{M}_{11}^1 \\ \tilde{M}_{11}^2 \\ \tilde{R}_{11} \end{bmatrix}, \begin{bmatrix} \tilde{M}_{12}^1 \\ \tilde{M}_{12}^2 \\ \tilde{R}_{12} \end{bmatrix}, \ldots, \begin{bmatrix} \tilde{M}_{g+2}^1 \\ \tilde{M}_{g+2}^2 \\ \tilde{R}_{g+2} \end{bmatrix}$. $W_{(is)}^{(3r)}$ is the ratio of the $(((s-1)g+i)r)^{th}$ element of this matrix to the sum of the elements in the r^{th} column.
(2.74)	$W_r^{(3)}$	Weight of region r purchases of commodities by consumers in the FEDERAL economy-wide consumer price index.	Calculated from input-output data files. First sum the two columns of the household demands matrix formed in (2.73) above. $W_r^{(3)}$ is the share of the r^{th} column total in the sum of the two column totals.
(2.75)	T_j^{r*}	Share of region r aggregate private investment represented by investment in industry j.	Calculated from input-output data files. $T_j^{r*} = T_j^r / \sum_{j \epsilon J} T_j^r$ where T_j^r has been dealt with under (2.56) above.

Equation	Coefficient or Parameter	Description	Source
(2.76)	T^{r*}	Share of economy-wide aggregate private investment represented by region r private investment.	T^{r*} calculated as $\sum_{j\epsilon J} T^r_j$.
(2.77)	ψ^r_{1m}	Share of occupation m in aggregate employment for region r.	Estimates stored on parameters file.
(2.78)	ψ^r_1	Share of region r employment in economy-wide aggregate employment.	Estimates stored on parameters file.
(2.79)	ψ^r_{2j}	Share of capital employed in industry j in region r's aggregate capital stock.	Estimates stored on parameters file.
(2.80)	ψ^r_2	Share of region r's capital stock in the national economy's aggregate capital stock.	Estimates stored on parameters file.
(2.81)	None		
(2.82)	$(WP)^{(1)r,1}_{(g+1,1,m)j}$	The share of post-tax wage costs in regional industry (jr)'s total costs of employing occuation-m-type labour.	Calculated from input-output data files. $(WP)^{(1)r,1}_{(g+1,1,m)j}$ is computed as the share of the $m(jr)^{th}$ element of $\tilde{U}^1$ in the sum of the $m(jr)^{th}$ elements of $\tilde{U}^1$, $\tilde{U}^2$ and $\tilde{U}^3$.

Equation	Coefficient or Parameter	Description	Source
	$(WP)^{(1)r,2}_{(g+1,1,m)j}$	The share of PAYE-taxes in regional industry (jr)'s total costs of employing occupation-m-type labour.	Calculated from input-output data files. $(WP)^{(1)r,2}_{(g+1,1,m)j}$ is computed as the share of the m(jr)th element of $\tilde{U}^2$ in the sum of the m(jr)th elements of $\tilde{U}^1$, $\tilde{U}^2$ and $\tilde{U}^3$.
	$(WP)^{(1)r,3}_{(g+1,1,m)j}$	The share of payroll taxes in regional industry (jr)'s total costs of employing occupation-m-type labour.	Calculated from input-output data files. $(WP)^{(1)r,3}_{(g+1,1,m)j}$ is computed as the share of the m(jr)th element of $\tilde{U}^3$ in the sum of the m(jr)th of $\tilde{U}^1$, $\tilde{U}^2$ and $\tilde{U}^3$.
(2.83)	$h^{(1)r,1}_{(g+1,1,m)j}$	Indexing parameter which fixes the relationship between movements in the post-tax wage rate of occupation m in regional industry (jr) and in the FEDERAL region r consumer price index.	User specified value stored on parameters file.
	$h^{(1)1}_{(g+1,1,m)j}$	Indexing parameter which fixes the relationship between movements in the post-tax wage rate of occupation m in regional industry (jr) and in the FEDERAL economy-wide consumer price index.	User specified value stored on parameters file.
(2.84)	$h^{(1)2}_{(g+1,1,m)j}$	Indexing parameter which fixes the relationship between movements in PAYE-tax per labour unit for occupation m in regional industry (jr) and in the corresponding pre-(PAYE) tax wage rate.	User specified value stored on parameters file.

Equation	Coefficient or Parameter	Description	Source
(2.85)	$h^{(1)r,3}_{(g+1,1,m)j}$	Indexing parameter which fixes the relationship between movements in the payroll tax per unit of labour of type m in regional industry (jr) and in the corresponding pre-(PAYE) tax wage rate.	User specified value stored on parameters file.
(2.86)	$(WP)^{(1)r,v}_{(g+1,1,m)j}$	Dealt with under (2.82) above.	
(2.87)	$h^{(1)r}_{g+2,j}$	Indexing parameter which fixes the relationship between movements in the region r state government production tax rate on regional industry (jr) and in the FEDERAL region r consumer price index.	User specified value stored on parameters file.
(2.88)	$h^{(1)r}_{g+3,j}$	Indexing parameter which fixes the relationship between movements in the Commonwealth government production tax rate on regional industry (jr) and in the FEDERAL region r consumer price index.	User specified value stored on parameters file.
(2.89)	$h^{(1)r}_{g+4,j}$	Indexing parameter which fixes the relationship between movements in the price of "other cost" tickets to regional industry (jr) and in the FEDERAL region r consumer price index.	User specified value stored on parameters file.
(2.90)	$h^{(4)}_{(g+1,2)j}$	Indexing parameter which fixes the relationship between movements in the income tax rate per unit of capital employed in regional industry (jr) and in the rental rate on (jr) capital.	User specified value stored on parameters file.

Equation	Coefficient or Parameter	Description	Source
(2.91)	$h^{(4)}_{(g+1,3)j}$	Indexing parameter which fixes the relationship between movements in the income tax rate per unit of land employed in regional industry (jr) and in the rental rate on (jr) land.	User specified value stored on parameters file.
(2.92)	$B^{(5,2)r}_{(is)j}$	Share of region r state government purchases of good i from source s for capital formation which are accounted for by purchases in regional industry (jr).	Calculated from input-output data files. First calculate total region r state government purchases of good i from source s for capital formation by summing the h elements of the appropriate r sub-vector of the i^{th} row of $\tilde{B}^{s2}$ (for s = 1, 2) or $\tilde{G}^{2}$ for (s = 3). $B^{(5,2)r}_{(is)j}$ is computed by dividing the $i(jr)^{th}$ element of $\tilde{B}^{s2}$ (for s = 1, 2) or $\tilde{G}^{2}$ (for s = 3) by total region r state government capital purchases of good i from source s.
(2.93)	$B^{(6,2)}_{(is)j}$	Share of Commonwealth government purchases of good i from source s for capital formation which are accounted for by industry j purchases.	Calculated from input-output data files. First calculate total Commonwealth government capital purchases of good i from source s by summing the elements of the i^{th} row of $\tilde{B}^{s3}$ (for s = 1, 2) or $\tilde{G}^{3}$ (for s = 3). $B^{(6,2)}_{(is)j}$ is computed by dividing the ir^{th} element of $\tilde{B}^{s3}$ (for s = 1, 2) or $\tilde{G}^{3}$ (for s = 3) by the total Commonwealth government capital purchases of good i from source s.
(2.94)	$h^{(6,3)}$	Indexing parameter which fixes the relationship between movements in the unemployment benefits rate and in the FEDERAL economy-wide consumer price index.	User specified value stored on parameters file.

Equation	Coefficient or Parameter	Description	Source
(2.95)	$h^{(7)r}$	Indexing parameter which fixes the relationship between movements in the region r state government residential land tax rate on industry j and in the cost of assembling a unit of private capital in regional industry (jr).	User specified value stored on parameters file. (Note: The value assigned to this indexing parameter is relevant only for the industry in each region covering ownership of dwellings.)
(2.96)	$h_j^{(8)r}$	Indexing parameter which fixes the relationship between movements in the region r state government commercial land tax rate on industry j and in the cost of assembling a unit of private capital in regional industry (jr).	User specified value stored on parameters file.
(2.97)	$S_{(is)}^{(6,1)}$	Share in total Commonwealth government outlays accounted for by current expenditure at purchasers prices of good i from source s.	Calculated from input-output and government accounts data files. First add the elements of CGO_1 to CGO_7 to obtain total Commonwealth government outlays. For s = 1, 2, $S_{(is)}^{(6,1)}$ is equal to the sum of the i^{th} elements of $\tilde{E}^{s2}$, $\tilde{O}_{11}^{s2}$, $\tilde{O}_{12}^{s2}$, ...; $\tilde{O}_{g2}^{s2}$ divided by total Commonwealth government outlays. $S_{(i3)}^{(6,1)}$ is equal to the sum of the i^{th} elements of $\tilde{J}^{2}$, $\tilde{T}_{11}^{2}$, $\tilde{T}_{12}^{2}$, ..., $\tilde{T}_{g2}^{2}$ divided by total Commonwealth government outlays.
	$S_{(is)}^{(6,2)}$	Share in total Commonwealth government outlays accounted for by expenditure at purchasers prices on good i from source s for use as a direct input to capital formation.	Calculated from input-output and government accounts data files. $S_{(is)}^{(6,1)}$ is computed as the sum of the i^{th} elements of $\tilde{B}^{s3}$, $\tilde{L}_{11}^{s3}$, $\tilde{L}_{12}^{s3}$, ..., $\tilde{L}_{g2}^{s3}$ (for

Equation	Coefficient or Parameter	Description	Source
			s = 1, 2) and $\tilde{G}^3$, $\tilde{Q}^3_{11}$, $\tilde{Q}^3_{12}$, ..., $\tilde{Q}^3_{g2}$ (for s = 3) divided by total Commonwealth government outlays.
	$S^{(6,3)r}$	Share of total Commonwealth government outlays accounted for by outlays on unemployment benefits in region r.	Calculated from government accounts data files. $S^{(6,3)r}$ is computed by dividing the r^{th} element of CGO_3 by total Commonwealth government outlays.
	$S^{(6,4)r}$	Share of total Commonwealth government outlays accounted for by transfers to region r state government.	Calculated from government accounts data files. $S^{(6,4)r}$ is computed by dividing the r^{th} element of CGO_4 by total Commonwealth government outlays.
	$S^{(6,5)r}$	Share of total Commonwealth government outlays accounted for by transfers to persons in region r.	Calculated from government accounts data files. $S^{(6,5)r}$ is computed by dividing the r^{th} element of CGO_5 by total Commonwealth government outlays.
	$S^{(6,6)r}$	Share of total Commonwealth government outlays accounted for by interest payments to persons in region r.	Calculated from government accounts data files. $S^{(6,6)r}$ is computed by dividing the r^{th} element of CGO_6 by total Commonwealth government outlays.
	$S^{(6,7)}$	Share of total Commonwealth government outlays accounted for by Other Outlays.	Calculated from government accounts data files. $S^{(6,7)}$ is computed by dividing the figure in CGO_7 by total Commonwealth government outlays.

Equation	Coefficient or Parameter	Description	Source
(2.98)	$h^{(6,4)r}$	Indexing parameter which fixes the relationship between movements in Commonwealth transfers to the region r state government and in the FEDERAL economy-wide consumer price index.	User specified value stored on parameters file.
(2.99)	$h^{(6,5)r}$	Indexing parameter which fixes the relationship between movements in Commonwealth transfers to persons in region r and in the FEDERAL economy-wide consumer price index.	User specified value stored on parameters file.
(2.100)	$h^{(6,6)}$	Indexing parameter which fixes the relationship between movements in Other outlays by the Commonwealth government and in total Commonwealth government outlays.	User specified value stored on parameters file.
(2.101)	$S^{(4,1)}$	Share of total Commonwealth government receipts accounted for by PAYE taxes.	Calculated from government accounts data files. First add the figures for CGR_1 to CGR_7 to obtain total Commonwealth government receipts. $S^{(4,1)}$ is then the share of CGR_1 in that total.
	$S^{(4,2)}$	Share of total Commonwealth government receipts accounted for by other income taxes.	Calculated from government accounts data files. $S^{(4,2)}$ is the share of CGR_2 in total Commonwealth government receipts.
	$S^{(4,3)}$	Share of total Commonwealth government receipts accounted for by import duties.	Calculated from government accounts data files. $S^{(4,3)}$ is the share of CGR_3 in total Commonwealth government receipts.
	$S^{(4,4)}$	Share of total Commonwealth government receipts accounted for by production taxes (less subsidies).	Calculated from government accounts data files. $S^{(4,4)}$ is the share of CGR_4 in total Commonwealth government receipts.

Equation	Coefficient or Parameter	Description	Source
	$S^{(4,5)}$	Share of total Commonwealth government receipts accounted for by commodity taxes (less subsidies).	Calculated from government accounts data files. $S^{(4,5)}$ is the share of CGR_5 in total Commonwealth government receipts.
	$S^{(4,6)}$	Share of total Commonwealth government receipts accounted for by export taxes (less subsidies).	Calculated from government accounts data files. $S^{(4,6)}$ is the share of CGR_6 in total Commonwealth government receipts.
	$S^{(4,7)}$	Share of total Commonwealth government receipts accounted for by other receipts.	Calculated from government accounts data files. $S^{(4,7)}$ is the share of CGR_7 in total Commonwealth government receipts.
(2.102)	$B^{(1)r,2}_{(g+1,1,m)j}$	Share of PAYE taxes on labour units of skill type m employed in industry j in total PAYE-tax collections from region r.	Calculated from input-output data files. First decompose the matrix $\tilde{U}^2$ into two sub-matrices, one for each region r. $B^{(1)r,2}_{(g+1,1,m)j}$ is then computed by dividing the mj^{th} element of the region r sub-matrix of $\tilde{U}^2$ by the sum of all the elements in that sub-matrix (i.e. by total PAYE taxes from region r).
(2.103)	$B^{(4,1)r}$	Share of PAYE-tax collections from region r in total PAYE-tax collections economy-wide.	Calculated from input-output and government accounts data files. $B^{(4,1)r}$ is the share of region r PAYE taxes, calculated in (2.102) above in total PAYE-tax collections, CGR_1.

Equation	Coefficient or Parameter	Description	Source
(2.104)	$B^{(4,2)r}$	Share of (non-PAYE) income taxes received from residents of region r in total (non-PAYE) income taxes collected economy-wide.	Calculated from input-output data files. To compute total (non-PAYE) income taxes paid by residents of region r, sum all the elements of the r^{th} rows (for r = 1, 2) of $\tilde{V}^2$ and $\tilde{W}^2$. $B^{(4,2)r}$ is the ratio of the r^{th} of these two totals to the sum of the two totals.
(2.105)	$B^{(4,2)r}_{(jt)}$	Share of (non-PAYE) income taxes received from residents of region r accounted for by income taxes on returns to capital and land in regional industry (jt).	Calculated from input-output data files. $B^{(4,2)r}_{(jt)}$ is computed as the sum of the $r(jt)^{th}$ elements of $\tilde{V}^2$ and $\tilde{W}^2$ divided by total (non-PAYE) income taxes paid by residents of region r.
	$B^{(4,2)r1}_{(jt)}$	Share of (non-PAYE) income taxes on returns to capital and land inputs to regional industry (jt) accounted for by taxes on returns to capital.	Calculated from input-output data files. $B^{(4,2)r1}_{(jt)}$ is computed as the $r(jt)^{th}$ element of $\tilde{V}^2$ divided by the sum of the $r(jt)^{th}$ elements of $\tilde{V}^2$ and $\tilde{W}^2$.
	$B^{(4,2)r2}_{(jt)}$	Share of (non-PAYE) income taxes on returns to capital and land inputs on regional industry (jt) accounted for by taxes on returns to land.	Calculated from input-output data files. $B^{(4,2)r2}_{(jt)}$ is computed as the $r(jt)^{th}$ element of $\tilde{W}^2$ divided by the sum of the $r(jt)^{th}$ elements of $\tilde{V}^2$ and $\tilde{W}^2$.
(2.106)	$B^{(4,3)}_i$	Share of total receipts from import duties accounted for by import duty receipts on good i.	Calculated from input-output and government accounts data files. $B^{(4,3)}_i$ is calculated as the ratio of the i^{th} element of $\tilde{Z}$ to total import duty receipts, CGR_3.

Equation	Coefficient or Parameter	Description	Source
(2.107)	$B_j^{(4,4)r}$	Share of total Commonwealth government receipts from production taxes accounted for by production tax receipts from regional industry (jr).	Calculated from input-output and government accounts data files. $B_j^{(4,4)r}$ is computed as the $(jr)^{th}$ element of $\tilde{X}^2$ divided by total Commonwealth production tax receipts, CGR_4.
(2.108)	$B_{(is)j}^{(4,5)kr}$	Share of Commonwealth government commodity tax receipts accounted for by commodity tax receipts on sales of good i from source s to regional industry (jr) for purpose k.	Calculated from input-output and government accounts data files. $B_{(is)j}^{(4,5)1r}$ is computed as the $i(jr)^{th}$ element of $\tilde{K}^s_{g+2}$ (for s = 1, 2) and $\tilde{P}_{g+2}$ (for s = 3) divided by total Commonwealth commodity tax receipts, CGR_5. $B_{(is)j}^{(4,5)2r}$ is computed as the $i(jr)^{th}$ element of $\tilde{L}^{s1}_{g+2}$ (for s = 1, 2) and $\tilde{Q}^1_{g+2}$ (for s = 3) divided by total Commonwealth commodity tax receipts.
	$B_{(is)}^{(4,5)3r}$	Share of Commonwealth government commodity tax receipts accounted for by commodity tax receipts on sales of good i from source s to households in region r.	Calculated from input-output and government accounts data files. $B_{(is)}^{(4,5)3r}$ is computed as the $(ir)^{th}$ element of $\tilde{M}^s_{g+2}$ (for s = 1, 2) and $\tilde{R}_{g+2}$ (for s = 3) divided by total Commonwealth commodity tax receipts.
(2.109)	$B_i^{(4,6)r}$	Share of receipts from export taxes (less subsidies) accounted for by tax receipts from the export of good i from region r.	Calculated from input-output and government accounts data files. $B_i^{(4,6)r}$ is computed as the i^{th} element of $\tilde{N}^r_{g+2}$ divided by total export tax (less subsidies) receipts, CGR_6.

Equation	Coefficient or Parameter	Description	Source
	h_i^4	Parameter indicating the proportion of export taxes received by the (Commonwealth) government.	User specified value stored in parameters file. Set equal to unity if commodity i an export commodity. Otherwise it is set equal to the proportion of income tax in returns to capital in general.
(2.110)	$h^{(4,7)}$	Indexing parameter which fixes the relationship between movements in other Commonwealth Government Receipts and in the economy-wide FEDERAL consumer price index.	User specified value stored on parameters file.
(2.111)	$S_{(is)}^{(5,1)r}$	Share in total region r state government outlays of current expenditure at purchasers prices of good i from source s.	Calculated from input-output and government accounts data files. First add the r^{th} elements of the vectors SGO_1 to SGO_5 to obtain total region r state government outlays. For s = 1, 2, $S_{(is)}^{(5,1)r}$ is equal to the sum of the $(ir)^{th}$ elements of $\tilde{E}^{s1}$, $\tilde{O}_{11}^{s1}$, $\tilde{O}_{12}^{s1}$, ..., $\tilde{O}_{g2}^{s1}$ divided by total region r state government outlays. $S_{(i3)}^{(5,1)r}$ is equal to the sum of the $(ir)^{th}$ elements of $\tilde{J}^1$, $\tilde{T}_{11}^1$, $\tilde{T}_{12}^1$, ..., $\tilde{T}_{g2}^1$ divided by total region r state government outlays.
	$S_{(is)}^{(5,2)r}$	Share in total region r state government outlays of expenditure at purchasers prices on good i from source s for use as a direct input to capital formation.	Calculated from input-output and government accounts data files. $S_{(is)}^{(5,2)r}$ is computed as the sum of the $(ir)^{th}$ elements of $\tilde{B}^{s2}$, $\tilde{L}_{11}^{s2}$, $\tilde{L}_{12}^{s2}$, ..., $\tilde{L}_{g2}^{s2}$ (for

Equation	Coefficient or Parameter	Description	Source
			s = 1, 2) and $\tilde{G}^2$, $\tilde{Q}^2_{11}$, $\tilde{Q}^2_{12}$, ..., $\tilde{Q}^2_{g2}$ (for s = 3) divided by total region r state government outlays.
	$S^{(5,3)r}$	Share of total region r state government outlays accounted for by transfers to persons in state r.	Calculated from government accounts data files. $S^{(5,3)r}$ is computed by dividing the r^{th} element of SGO_3 by total region r state government outlays.
	$S^{(5,4)r}$	Share of total region r state government outlays accounted for by other outlays by the region r state government.	Calculated from government accounts data files. $S^{(5,4)r}$ is computed by dividing the r^{th} element of SGO_5 by total region r state government outlays.
	$S^{(5,5)ru}$	Share of total region r state government outlays accounted for by interest payments to residents of domestic region u.	Calculated from government accounts data files. For r = u, $S^{(5,5)ru}$ is computed by dividing the r^{th} element of SGO_4 by total region r state government outlays. For $r \neq u$, $S^{(5,5)ru} = 0$.
(2.112)	$h_1^{(5)r}$	Indexing parameter which fixes the relationship between movements in region r state government transfers to persons in region r and in the FEDERAL economy-wide consumer price index.	User specified value stored on parameters file.
(2.113)	$h_2^{(5)r}$	Indexing parameter which fixes the relationship between movements in other outlays by the region r state government and nominal gross income of region r residents.	User specified value stored on parameters file.

Equation	Coefficient or Parameter	Description	Source
(2.114)	$S^{(3,k)r}$	Share of total region r state government receipts accounted for by receipts of type k (k = 1 for payroll taxes, k = 2 for residential land taxes, k = 3 for commercial land taxes, k = 4 for other income reducing taxes (fees, fines etc.), k = 5 for payments from the Commonwealth Government, k = 6 for commodity taxes, k = 7 for production taxes and k = 8 for other receipts).	Calculated from government accounts data files. First add the r^{th} elements of the vectors SGR_1 to SGR_8 to obtain total region r state government receipts. $S^{(3,k)r}$ is the share of the r^{th} element of SGR_k in total region r state government receipts.
(2.115)	$B^{(3,1)r}_{mj}$	Share of total payroll tax collections by region r state government accounted for by payroll taxes on labour units of skill type m employed in regional industry (jr).	Calculated from input-output data files and government accounts. $B^{(3,1)r}_{mj}$ is computed by dividing the $m(jr)^{th}$ element of $\tilde{U}^3$ by the r^{th} element of SGR_1.
(2.116)	None		
(2.117)	$B^{(3,3)r}_{j}$	Share of total receipts from commercial land taxes by state government r accounted for by commercial land taxes paid by regional industry (jr).	Calculated from input-output data files and government accounts. First calculate a modified $\tilde{V}^3$ by reducing entries in the columns for the two regional industries covering ownership of dwellings by an estimated proportion of residential land tax receipts in total land tax receipts. $B^{(3,3)r}$ is then computed by dividing the $(jr)^{th}$ column sum of the modified $\tilde{V}^3$ by the r^{th} element of SGR_3.

Equation	Coefficient or Parameter	Description	Source
(2.118)	$h^{(3,4)r}$	Indexing parameter which fixes the relationship between movements in the region r state government's other income reducing tax receipts and in the gross nominal income of region r residents.	User specified value stored on parameters file.
(2.119)	None		
(2.120)	$B^{(3,6)kr}_{(is)j}$	Share of region r state government commodity tax receipts accounted for by commodity tax receipts on sales of good i from source s to regional industry (jr) for purpose k.	Calculated from input-output and government accounts data files. $B^{(3,6)1r}_{(is)j}$ is computed as the $i(jr)^{th}$ element of $\tilde{K}^{s}_{g+1,r}$ (for s = 1, 2) and $\tilde{P}_{g+1,r}$ (for s = 3) divided by total region r state government commodity taxes, the r^{th} element of SGR_6. $B^{(3,6)2r}_{(is)j}$ is computed as the $i(jr)^{th}$ element of $\tilde{L}^{s1}_{g+1,r}$ (for s = 1, 2) and $\tilde{Q}^{1}_{g+1,r}$ (for s = 3) divided by the r^{th} element of SGR_6.
	$B^{(3,6)3r}_{(is)}$	Share of region r state government commodity tax receipts accounted for by commodity tax receipts on sales of good i from source s to households in region r.	Calculated from input-output and government accounts data files. $B^{(3,6)3r}_{(is)}$ is computed as the $(ir)^{th}$ element of $\tilde{M}^{s}_{g+1,r}$ (for s = 1, 2) and $\tilde{R}_{g+1,r}$ (for s = 3) divided by the r^{th} element of SGR_6.

Equation	Coefficient or Parameter	Description	Source
(2.121)	$B_j^{(3,7)r}$	Share of total region r receipts from production taxes accounted for by production tax receipts from regional industry (jr).	Calculated from input-output and government accounts data files. $B_j^{(3,7)r}$ is computed as the $(jr)^{th}$ element of $\tilde{X}^1$ divided by the r^{th} element of SGR_7, total region r state government production tax receipts.
(2.122)	$h^{(3,8)r}$	Indexing parameter which fixes the relationship between movements in other receipts by region r state government and in the FEDERAL economy-wide consumer price index.	User specified value stored on parameters file.
(2.123)	B^6	Aggregate Commonwealth government outlays.	Calculated under (2.97) above.
	B^4	Aggregate Commonwealth government receipts.	Calculated under (2.101) above.
(2.124)	B^{5r}	Aggregate region r state government outlays.	Calculated under (2.111) above.
	B^{3r}	Aggregate region r state government receipts.	Calculated under (2.114) above.
(2.125)	$(SD)_1^r$	The share in gross income of region r residents accounted for by disposable income.	Calculated from input-output, government accounts data files and parameters file. First calculate the total region r wage-bill (net of payroll tax) by adding the sum of the h elements in the appropriate r^{th} sub-vector of each row of $\tilde{U}^1$ and $\tilde{U}^2$. Returns to capital owned by region r residents are then calculated by summing all elements in the r^{th} row of $\tilde{V}^1$, $\tilde{V}^2$ and $\tilde{V}^3$. Returns to land

Equation	Coefficient or Parameter	Description	Source
			owned by region r residents is computed by summing the elements in the r^{th} rows of $\tilde{W}^1$ and $\tilde{W}^2$. Total region r gross income can then be calculated as the sum of these three totals. Disposable income can then be calculated by subtracting from region r gross income the following items: PAYE taxes from region r (calculated under (2.102) above), other income taxes collected from region r (calculated under (2.104) above), residential land taxes (the r^{th} element of SGR_2), commercial land taxes paid on capital owned by region r residents (computed as the sum over the r^{th} row of the modified $\tilde{V}^3$ matrix calculated under (2.117) above), net interest payments overseas by region r residents (stored on the parameters file), other payments to the Commonwealth government (r^{th} element of CGR_7), other payments to the region r state government by its residents (r^{th} element of SGR_8) and adding the following items: the amount of export taxes levied on non-export commodities returned to region r owners of capital (calculated in the following way: multiply each element of the two vectors $\tilde{N}^t_{g+2}$ by an associated ownership factor - obtained by taking a weighted sum of the ownership shares in each industry producing commodity (it)

Equation	Coefficient or Parameter	Description	Source
			(industry (jt)'s ownership share is $[\tilde{V}^1]_{r,jt}$ over the jt^{th} column sum of $\tilde{V}^1$), with the weights being the share of the ij^{th} element of $\tilde{Y}^t$ in that matrix's i^{th} row sum - and a factor giving the proportion of the export tax returned to producers (the factor should be equal to $1 - h_i^4$) and then sum the products}, unemployment benefits to region r residents (r^{th} cell of CGO_3), Commonwealth transfers to persons in region r (r^{th} cell of CGO_5) and State government transfers to persons in region r (r^{th} element of SGO_3), Commonwealth interest payments to persons in region r (r^{th} element of CGO_6) and state government interest payments to persons in region r (r^{th} element of SGO_4 - see (2.127) for implied assumption). $(SD)_1^r$ can then be computed by dividing the disposable income total for region r by the gross income total for region r.
	$(SD)_2^r$	Share of region r gross income accounted for by direct taxes and net transfers.	Calculated as $1 - (SD)_1^r$.

Equation	Coefficient or Parameter	Description	Source
(3.126)	$D^r_{(g+1,1,m)j}$	Share of region r gross income accounted for by before-(PAYE) tax labour income earned in occupation m in regional industry (jr).	Calculated from input-output data files. $D^r_{(g+1,1,m)j}$ is computed by dividing the sum of the $m(jr)^{th}$ elements of $\tilde{U}^1$ and $\tilde{U}^2$ by region r gross income.
	$D^r_{(jt)}$	Share of region r gross income accounted for by returns to capital and land located in regional industry (jt).	Input-output data files. $D^r_{(jt)}$ is computed by dividing the sum of the $r(jt)^{th}$ elements of $\tilde{V}^1$, $\tilde{V}^2$, $\tilde{V}^3$, $\tilde{W}^1$ and $\tilde{W}^2$ by region r gross income.
	$D^{r1}_{(jt)}$	Share of returns to capital and land located in regional industry (jt) and owned by region r residents which is accounted for by returns to capital.	Input-output data files. $D^{r1}_{(jt)}$ is computed by dividing the sum of the $r(jt)^{th}$ elements of $\tilde{V}^1$, $\tilde{V}^2$ and $\tilde{V}^3$ by the sum of the $r(jt)^{th}$ elements of $\tilde{V}^1$, $\tilde{V}^2$, $\tilde{V}^3$, $\tilde{W}^1$ and $\tilde{W}^2$.
	$D^{r2}_{(jt)}$	Share of returns to capital and land located in regional industry (jt) and owned by region r residents which is accounted for by returns to land.	$D^{r2}_{(jt)}$ is computed as $1 - D^{r1}_{(jt)}$.
(2.127)	$D^{(2)r}_1$	Share in total direct taxes and net transfers paid by/to region r residents accounted for by PAYE taxes.	Calculated from input-output data files. Total direct taxes and net transfers paid by/to region r residents is the difference between regional gross income and regional disposable income calculated under (2.125) above. $D^{(2)r}_1$ is

Equation	Coefficient or Parameter	Description	Source
			computed by dividing total PAYE taxes paid by region r residents (calculated under (2.102) above) by total direct taxes and net transfers paid by/to region r residents.
	$D_2^{(2)r}$	Share in total direct taxes and net transfers paid by region r residents accounted for by/to other income taxes.	$D_2^{(2)r}$ is calculated by dividing total (non-PAYE) income taxes paid by residents of region r, as computed under (2.104), by total direct taxes and net transfers paid by/to region r residents.
	$D_3^{(2)r}$	Share in total direct taxes and net transfers paid by/to region r residents accounted for by residential land taxes.	Calculated from governments accounts data files. $D_3^{(2)r}$ is computed by dividing the r^{th} element of SGR_2 by total direct taxes and net transfers paid by/to region r residents.
	$D_4^{(2)r}$	Share in total direct taxes and net transfers paid by/to region r residents accounted for by fees and fines.	Calculated from government accounts data files. $D_4^{(2)r}$ is calculated by dividing the r^{th} element of SGR_4 by total direct taxes and net transfers paid by/to region r residents.
	$D_{(jt)}^{(2)r}$	Share in total direct taxes and net transfers paid by/to region r residents accounted for by commercial land taxes paid on capital located in regional industry (jt).	Calculated from input-output data files. $D_{(jt)}^{(2)r}$ is calculated by dividing the $r(jt)^{th}$ element of the modified $\tilde{V}^3$, calculated under (2.117) above, by total direct taxes and net transfers paid by/to region r residents.

Equation	Coefficient or Parameter	Description	Source
	$D_5^{(2)r}$	Share in total direct taxes and net transfers paid by region/to r residents accounted for by interest payments overseas.	$D_5^{(2)r}$ is calculated by dividing interest payments overseas by region r residents, stored on the parameters file, by total direct taxes and net transfers paid by/to region r residents.
	$D_6^{(2)r}$	Share in total direct taxes and net transfers paid by/to region r residents accounted for by other payments to Commonwealth government.	Calculated from governments accounts data files. $D_6^{(2)r}$ is calculated by dividing the r^{th} element of CGR_7 by total direct taxes and net transfers paid by/to region r residents.
	$D_7^{(2)r}$	Share in total direct taxes and net transfers paid by/to region r residents accounted for by other payments to state governments.	Calculated from governments accounts data files. $D_7^{(2)r}$ is calculated by dividing the r^{th} element of SGR_8 by total direct taxes and net transfers paid by/to region r residents.
	$D_8^{(2)r}$	Share in total direct taxes and net transfers paid by/to region r residents accounted for by net amount returned to owners of capital in industries producing non-export commodities of export taxes levied on those commodities.	$D_8^{(2)r}$ is calculated by dividing the amount of export taxes levied on non-export commodities returned to region r owners of capital in industries producing those commodities, calculated under (2.125) above, by total direct taxes and net transfers paid by/to region r residents.
	$B_i^{(4,6)t}$	Dealt with under (2.109) above.	

Equation	Coefficient or Parameter	Description	Source
	$\zeta(r,it)$	Ownership factor indicating the share of region r owners of capital in the amount returned to producers of export taxes levied on non-export commodity i produced in region t.	Calculated under (2.125) above.
	h_i^4	Dealt with under (2.109) above.	
	$D_9^{(2)r}$	Share in total direct taxes and net transfers accounted for by unemployment benefits.	Calculated from government accounts data files. $D_9^{(2)r}$ is computed by dividing the r^{th} element of CGO_3 by total direct taxes and net transfers paid by/to region r residents.
	$D_{10}^{(2)r}$	Share in total direct taxes and net transfers paid by/to region r residents accounted for by transfers to persons from the Commonwealth government.	Calculated from government accounts data files. $D_{10}^{(2)r}$ is computed by dividing the r^{th} element of CGO_5 by total direct taxes and net transfers paid by/to region r residents.
	$D_{11}^{(2)r}$	Share of region r direct taxes and net transfers paid by/to region r residents accounted for by interest payments by the Commonwealth government to region r residents.	Calculated from government accounts data files. $D_{11}^{(2)r}$ is computed by dividing the r^{th} element of CGO_6 by total direct taxes and net transfers paid by/to region r residents.

Equation	Coefficient or Parameter	Description	Source
	$D_{12}^{(2)r}$	Share of region r direct taxes and net transfers paid by/to region r residents accounted for by transfers to persons from the region r state government.	Calculated from government accounts data files. $D_{11}^{(2)r}$ is computed by dividing the r^{th} element of SGO_3 by total direct taxes and net transfers paid by/to region r residents.
	$D_{13}^{(2)r}$	Share of region r direct taxes and net transfers paid by/to region r residents accounted for by interest payments by both state governments to region r residents.	Calculated from government accounts data files. It was implicitly assumed in the calculation of coefficients under (2.111) that region r residents received interest payments only from the region r government. $D_{13}^{(2)r}$ is thus calculated as the r^{th} element of SGO_4 divided by total direct taxes and net transfers paid by/to region r residents.
	λ_u^r	Share of state government u interest payments in total interest payments by both state governments to region r residents.	λ_u^r is equal to unity for r = u, else it is equal to zero.
(2.128)	$(GD)^r$	Share of gross factor income of region r residents in gross national product at factor cost.	Calculate gross factor income of residents of both domestic regions by summing the two region r gross income figures calculated in (2.125) above. $(GD)^r$ is then calculated by dividing the region r gross income figure by this total.
(2.129)	$\S_1^r$	Ratio of aggregate number of persons employed in the region to the number of unemployed persons in the region.	Estimate stored on parameters file.
	$\S_2^r$	Ratio of regional labour force to number of unemployed persons in the region.	Estimate stored on parameters file.

Chapter 4

Construction of the 1978-79 FEDERAL (TASMAIN) Data Base

4.1 Introduction

In this chapter the method of constructing the FEDERAL data files for the TASMAIN version of the model is described. In constructing the data base it was necessary to estimate a value for each cell of the FEDERAL input-output and government accounts data files described in Tables 3.1 and 3.2 of the previous chapter and to estimate a value for each cell of the parameters file.

4.2 Coefficient Values

4.2.1 Basic Data Sets

In order to construct an input-output data base for FEDERAL (TASMAIN) it is necessary to have an input-output table for at least one of the regions. An input-output table was available for one of the regions, Tasmania, but not the other region, the Australian mainland. This posed no significant problem since a national input-output table is available, and thus the required input-output information for the latter region could be calculated as a residual.

Thus the two major sources of data input used to construct the FEDERAL (TASMAIN) input-output data files were the ORANI input-output data files for 1978-79 which related to the nation as a whole and the Tasmanian 1977-78 input-output table. The first task which had to be undertaken was to bring both data bases onto a compatible commodity/industry classification and identical year.

It was decided that the data base year for the TASMAIN version of FEDERAL should be 1978-79, the same year as the ORANI data-base at the time the TASMAIN data base was being constructed.

For the purposes of developing the model it was decided that a much less disaggregated industry structure than that used for ORANI (112 industries and 114 commodities) and the Tasmanian input-output (TIO) model (58 industries) be used in the first version of FEDERAL (TASMAIN). Not only would this economize on computer space, it would ease the process of obtaining a basic understanding of the model's results.

The 9-industry classification decided upon is listed in Table 4.1. As can be seen there is a straightforward mapping of ORANI and TIO classes into the FEDERAL (TASMAIN) industry classes. This was largely aided by both the ORANI and TIO classifications being ASIC-based. It should also be noted that all of the 9-industry TASMAIN version's industries are single-commodity industries.

An appropriate method for bringing the TIO table onto the 1978-79 year had also to be chosen. The ideal way of doing this would have been firstly to expand the TIO table to a 114 commodity by 112 industry table and then update the table to the required financial year via the RAS method.[1] In actuality, a more approximate method was used. The Tasmanian 1977/78 table was first aggregated to a 9 industry table and then updated to 1978/79 by simply expanding each cell by a uniform factor, reflecting the degree of nominal expansion in the Tasmanian economy as a whole over the relevant 12 months. The uniform factor was found from the increase in the combination of wages and GOS, as listed in Tables 4 and 5 of ABS (1987). The ORANI input-output data files were aggregated to the 9-commodity/industry level using the AGGREG program as described in Sutton (1981).

Table 4.1

Mapping of National and Tasmanian Input-Output Industries

to FEDERAL (TASMAIN) Industries

FEDERAL (TASMAIN) 9-industry Classification	National Input-Output Industry (ORANI No.)	TIO Industry Number	ASIC Number
1. Agriculture, Forestry and Fishing	1-11	01-11	0182-0440
2. Mining	12-17	12-15	1111-1620
3. Manufacturing - Import Competing	19-21, 23, 24, 26-29, 31-39, 40(part), 41-62, 65-83	17-19, 21, 23(part), 24-28, 30-40, 42-44	2121-2140, 2161-2163, 2173, 2185-2190, 2343-2536, 2538-2884, 3141-3487
4. Manufacturing - Export	18, 22, 25, 30, 40(part)[a], 63, 64	16, 20, 22, 23(part)[b], 29, 41	2115-2117, 2151-2153, 2171, 2174, 2175, 2176, 2341-2, 2537, 2941-2963
5. Utilities	84-86	45-46	3610-3702
6. Construction	87, 88	47-50	4111-4249
7. Margins (Trade, Transport, Insurance, Restaurants)	89-96, 101, 110	51-53, 54(part)[c], 58(part)[d]	4710-5404, 6231-6234, 6240, 9231-9244
8. Community Services (incl. Public Administration)	104-108	56, 57	7111-8495
9. Other Tertiary	97-100, 102-103, 109, 111, 112	54(part), 55, 58(part)	5600-6172, 6310-6321, 9131-9144, 9340-9364, 9400

a. Hardwood Woodchips.
b. Certain Other Food Products (ASIC 2175-6).
c. Insurance and Services to Insurance (ASIC 6231-4, 6240).
d. Restaurants, Hotels and Clubs (ASIC 9231-44).

Although the TIO table and ORANI data files do not share the same organizational structure, it will be clear from the next section that this presents very little problem. The structure of the ORANI data base is shown in Figure 4.1. It is a reproduction of Figure 25.1 from DPSV. Their detailed explanation of the table is not repeated here, since the explanation in section 3.2.1 of the FEDERAL data files whose structure is based on the ORANI files should make Figure 4.1 quite self-evident. The Tasmanian input-output table has a simpler structure than the ORANI files. The TIO table structure is depicted in Figure 4.2. It should be noted that the Tasmanian table is an industry by industry table.

4.2.2 Constructing the FEDERAL (TASMAIN) Input-Output Data Files

4.2.2.1 Preliminary Tasks

The method of explaining the construction of the input-output files for the TASMAIN version of FEDERAL will be to proceed through the way in which numbers were put into each of the matrices depicted in Figure 3.1, matrix-by-matrix. Before numbers were calculated for the matrices, however, it was necessary to make some adjustment to the 9-industry 1978-79 TIO table. In both the ORANI and FEDERAL (TASMAIN) data files all sales of produced goods are shown in basic values. This is also true of TIO. However in the case of ORANI and FEDERAL (TASMAIN), all commodity sales for the purpose of providing margin services on the direct flow of commodities are contained in separate matrices from those containing the direct flows. For example, in FEDERAL (TASMAIN), the direct flows of region 1 commodities to all (jr) regional industries are shown in matrix $\tilde{A}^1$, while the supplies of margins on those flows are

			Final Demands				
		Domestic Industries (Current Production)	Domestic Industries (Capital Formation)	Household Consumption	Exports	Other	
		← h →	← h →	← 1 →	← 1 →	← 1 →	
Domestic commodities		↑ g ↓ $\tilde{A}$	$\tilde{B}$	$\tilde{C}$	$\tilde{D}$	$\tilde{E}$	Row sums = total direct usage of domestic commodities
Imports		↑ g ↓ $\tilde{F}$	$\tilde{G}$	$\tilde{H}$	$\underset{=}{0}$	$\tilde{J}$	− 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 ↓ $\tilde{P}_1$	$\tilde{Q}_1$	$\tilde{R}_1$	$\underset{=}{0}$	$\tilde{T}_1$	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 ↓ $\tilde{P}_{g+1}$	$\tilde{Q}_{g+1}$	$\tilde{R}_{g+1}$	$\underset{=}{0}$	$\tilde{T}_{g+1}$	Row sums = total tax on sales of each imported commodity
Primary inputs	Labour	↑ M ↓ $\tilde{U}$	$\underset{=}{0}$	$\underset{=}{0}$	$\underset{=}{0}$	$\underset{=}{0}$	
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 4.1 Format of ORANI input-output data base[a]

a. Reproduced from DPSV, p. 151.

Figure 4.2 Structure of Tasmanian Input-Output Table

Using Industry / Supplying Industry	Row Prefix	Intermediate Demand	Personal Consumption	Tourist Expenditure	Public Authorities	Gross Capital Expenditure	Increase in Stocks	Exports Overseas	Exports Interstate	Total Supply
Column Prefix		1,...,h	D1	D2	D3	D4	D5	D6	D7	
Industry Sales	1 . . . h									
Labour	P1									
Gross Operating Surplus	P2									
Indirect Taxes	P3									
Foreign Imports	P4									
Interstate Imports	P5									
TOTAL USAGE										

shown separately in matrices $\tilde{K}^1_{11}$, $\tilde{K}^1_{12}$, $\tilde{K}^1_{21}$, ..., $\tilde{K}^1_{92}$. In the TIO table, however, there are no separate margin matrices. Each industry's sales of good i for the purpose of supplying margins on the flow of good h to user j is shown in the same cell as the direct flow of good i to user j.

Thus the preliminary task to be performed on the TIO table is to remove the margins flows from the table and place them in a separate Tasmanian margins table. An examination of the commodity structure of FEDERAL (TASMAIN) suggests that this task is simplified by there being an industry, industry 7, called Margins. This industry is an aggregation of the retail and wholesale industries, the four transport industries (air, sea, road, rail) and insurance, restaurants and hotels industries. It is indeed the only industry which supplies commodities for use as margins. This means, for instance, that all $\tilde{K}^r_{ut}$ and $\tilde{P}_{ut}$ matrices for $u \neq 7$ and $u \leq 9$ are zero matrices. The same applies to the ORANI data base and it will be assumed that the margins industries row of the TIO table is the only one to contain margins flows.

The method of splitting the margins flows from the TIO table was quite straightforward. The assumption was made that the ratio of margin flows to direct flows was the same for Tasmania as was the case nationally. Thus each cell 7,j (j = 1, 9) of the TIO table was multiplied by the associated ratio of margins to direct flows plus margins calculated from the ORANI data base i.e. $\{(\tilde{K}_7)_{.j} + (\tilde{P}_7)_{.j}\}/\{(\tilde{A})_{7j} + (\tilde{K}_7)_{.j} + (\tilde{P}_7)_{.j}\}$. The resultant estimate, however, was assumed inclusive of margins supplied by interstate industries on Tasmanian intermediate purchases. An adjustment was made to exclude interstate supplied margins and the estimate for Tasmanian supplied margins was then subtracted from the TIO cell.[2] Similarly the ORANI ratio of margins to direct flows for capital formation (total for all industries), household consumption, exports and other final demand were used to adjust TIO Margins cells for gross capital expenditure (D4), Personal Consumption (D1) and Tourist expenditure (D2) , overseas exports (D6) and interstate exports (D7) and public authorities (D3).

It will be recalled that the TIO table is an industry by industry table while FEDERAL (TASMAIN) and ORANI employ industry by commodity input-output data bases. In the normal course of events this is an important distinction. However, in the case of the 9-industry TASMAIN version of FEDERAL, all industries are single commodity industries. Thus for instance industry number 1, Agriculture, Forestry and Fishing, produces a single commodity, Agriculture, Forestry and Fishing. It is for this reason that the above explanation, and indeed all subsequent discussion, makes no essential distinction between industries and commodities. For instance, an ORANI commodity ratio is used to adjust a TIO industry figure. However, in a less aggregated version of FEDERAL featuring multi-commodity industries of the type discussed in the theory, it would be necessary to make appropriate adjustments to the state of interest input-output table to turn it into a commodity by industry table.

Finally it should be noted that in the following discussion we will take region 1 to be Tasmania and region 2 to be the Australian mainland. This is in line with their computer representation in the implemented version.

4.2.2.2 Matrices Containing Inputs for Current Production by Domestic Industries

4.2.2.2.1 Produced Inputs

4.2.2.2.1.1 $\tilde{A}^1$ Matrix

Recall that $\tilde{A}^1$ contains flows of commodities from region 1 producers to the 2h regional industries for use in current production. In the case of the h (i.e. 9) industries in region 1 - i.e. the first h column entries - this information, being the flows of Tasmanian produced commodities to Tasmanian industries, can be taken directly from the TIO table. The relevant cells are those contained in the sub-matrix made up of the first h rows by first h columns of TIO (i.e. industry sales to intermediate demand; conventionally described as the intermediate usage quadrant or quadrant 1).

Turning now to columns h+1 to 2h of $\tilde{A}^1$. These are the flows of Tasmanian produced commodities to mainland industries. Looking at the TIO structure in Figure 4.2 a column, D7, can be seen for Tasmanian interstate exports. However since D7 is a column vector it does not distinguish between classes of purchasers of interstate exports. To fill in the second 9 columns of $\tilde{A}^1$ it was thus necessary to calculate for each commodity that part of Tasmanian interstate exports which were directed to mainland industries. The proportion was obtained for each ijth cell from the ORANI data base (see Figure 4.1) by dividing the ijth element of ORANI $\tilde{A}$ by the ith row sum for domestic direct commodity sales. This proportion was then applied to the ith element of the D7 column. The g x h (i.e. 81) cells of the second h columns of $\tilde{A}^1$ were all filled out in this way.

Thus, the interstate export figures for each Tasmanian commodity are spread over mainland purchasers in accordance with the total Australian demand pattern for the respective commodity. It should be noted that the export figures are spread according to the Australian demand pattern rather than the mainland Australian pattern. Given that the vast bulk of Australia consists of the mainland component there seems little point in attempting to estimate the purely mainland demand pattern for each commodity.[3] Even with the use of estimated mainland demand patterns our estimation procedure would carry the assumption that each class of mainland purchaser sources the same proportion of their purchase of a particular commodity from Tasmania. However, this would appear to be a reasonable assumption and difficult to easily improve upon.[4]

4.2.2.2.1.2 $\tilde{A}^2$ Matrix

The first h columns of this matrix consists of Tasmanian interstate imports. Examination of the TIO table structure in Figure 4.2 reveals only a row vector (i.e. row P5) for this category of flows. It was therefore necessary to estimate the commodity composition of interregional imports by purchasing industry. The method used to perform this estimation basically involves choosing the commodity-mix of interstate imports in such a way as to move Tasmania's domestic material input technology as close as possible to what is the case nationally.[5]

The estimation method is demonstrated using a hypothetical four-commodity case - as illustrated in Table 4.2.

In column (i) of Table 4.2 a vector of intermediate purchases by, let's say, Tasmanian industry 1 can be seen. The first four figures would have been obtained from the top of the

Table 4.2

Estimation of Commodity Composition of Interstate (Interregion) Imports by Industry

Industry	(i) Tasmanian Industry 1 Intermediate Purchases	(ii) National Industry 1 Intermediate Purchases	(iii) Tasmanian Industry 1 Purchases Using National Technology	(iv) As for (iii) Showing Implied Interregion Imports	(v) Tasmanian Industry 1 Purchases With Estimated Interregion Imports
1	8	100	13	8	8
2	4	90	12	4	4
3	10	30	4	10	10
4 (L)	6	50	7	6	6
Interregion Imports 1	8	n.a.	(Interregion imports included in above vector)	5	3
2				8	5
3				-6	0
4 (L)				1	0
Total Intermediate Purchases[a]	36	270	36	36	36

n.a. signifies not applicable.
(L) signifies a "local" commodity.
a. Overseas imports assumed to be zero.

first column of the TIO table, while the fifth figure would come from the P5th position of the same column. Intermediate purchases by the corresponding national industry are shown in column (ii) - obtainable directly from the ORANI $\tilde{A}$ matrix. Column (iii) is generated by applying the national technological proportions derivable from column (ii) to total intermediate purchases by the Tasmanian industry (= 36). Thus the top cell of column (iii) is $36 \times \frac{100}{270} = 13$. Column (iii) thus gives an entry for the purchases of each commodity from both domestic sources combined, based on the assumption that Tasmanian industry 1 used exactly the same domestic intermediate input technology as did industry 1 economy-wide. In column (iv) the first four cells of the column are re-established as the column (i) entries for Tasmanian-sourced intermediate inputs. The next four cells of the column are then calculated by subtracting the first four cells of column (iv) from the corresponding column (iii) entries. These are the value of interstate imports implied if the commodity mix of interstate imports is to be such that Tasmania's domestic input technology is to be identical with the nation's as a whole.

An examination of entries 4 to 8 in column (iv) quickly reveals that not all of these implied interstate import flows are feasible. In particular the flow of commodity 3 has been calculated as being negative. Furthermore, while interstate imports of commodity 4 have been calculated as being 1, it has also been assumed that commodity 4 is a "local" commodity which does not engage in interstate trade. This industry might comprise activities such as retail, building and ready-mixed concrete in which interstate trade is known to be for all practical purposes non-existent. The value of the cells for the usage of interstate imports of commodities 3 and 4 by Tasmanian industry 1 are therefore set to zero in column (v), while the commodity 1 and 2 figures are reduced by a common ratio so that the total value of interstate imports by industry 1 is made equal to the known value of 8.

The second 9 columns of $\tilde{A}^1$ can be deduced from the figures already derived. The sub-matrix contains the flow of commodities produced by mainland industries to mainland industries. For each cell this must be equal to the flow of commodity i to industry j nationally (i.e. ORANI $[\tilde{A}_{ij}]$) less the flow of Tasmanian produced commodity i to Tasmanian industry j (i.e. $[\tilde{A}^1]_{ij}$) less the flow of Tasmanian produced commodity i to Mainland industry j (i.e. $[\tilde{A}^1]_{i,h+j}$) less the flow of mainland produced commodity i to Tasmanian industry j (i.e. $[\tilde{A}^2]_{ij}$). This is clearly so because the ORANI matrix $\tilde{A}$ is the aggregation of the four FEDERAL (TASMAIN) submatrices $\tilde{A}^1_{(r=1)}$, $\tilde{A}^1_{(r=2)}$, $\tilde{A}^2_{(r=1)}$ and $\tilde{A}^2_{(r=2)}$.

4.2.2.2.1.3 $\tilde{F}$ Matrix

The Tasmanian industry purchases of overseas imports was assumed to exhibit the same commodity mix as was the case nationally. Thus the first h columns of the FEDERAL (TASMAIN) $\tilde{F}$ matrix were obtained for each ijth element by multiplying the jth element of vector P4 of the TIO table by the ratio of the ijth element of ORANI $\tilde{F}$ to the jth column sum of ORANI $\tilde{F}$. The second h columns of FEDERAL (TASMAIN) $\tilde{F}$ were obtained as a residual by subtracting the first h columns of FEDERAL (TASMAIN) $\tilde{F}$ from ORANI $\tilde{F}$.

4.2.2.2.2 Margins Inputs

As was pointed out in section 4.2.2.1, a single commodity/industry of all margins supply means that all margins matrices except those pertaining to the supply of commodity 7 (by industry 7) are zero matrices.

In calculating the first h columns of the six non-zero margin matrices relating to current production, a method was chosen so as to be as compatible as possible with that used to correct the Tasmanian input-output table in relation to the direct flow of intermediate inputs. The process was carried out in three stages. First for every commodity i sold to industry j, a (national) ratio of margins to direct flows was calculated from the ORANI data base.[6] The next step was to construct three transitional margin matrices which would hold margin flows irrespective of region of supply. The first matrix was constructed by multiplying each cell i(jr) of (FEDERAL (TASMAIN) matrix) $\tilde{A}^1$ by the ijth element of the matrix of ratios calculated in the first step. For the second matrix the element to be multiplied by the appropriate ratio came from matrix $\tilde{A}^2$ and for the third matrix it came from matrix $\tilde{F}$.

The final step was to turn these three transitional matrices into the required six margin matrices. The first transitional matrix was split into matrices $\tilde{K}^1_{71}$ and $\tilde{K}^1_{72}$ by: (i) for region 1 purchasers (first h columns), allocating all of the value of each cell to $\tilde{K}^1_{71}$ and zero to each cell in $\tilde{K}^1_{72}$ (reflecting the assumption that there were no mainland margins on goods flowing from Tasmanian producer to Tasmanian purchasing industry); (ii) for region 2 purchasers, the value of transitional cells were split between $\tilde{K}^1_{71}$ and $\tilde{K}^1_{72}$ in the arbitrarily assumed ratio of 3 to 7.

The second transitional matrix was split between $\tilde{K}^2_{71}$ and $\tilde{K}^2_{72}$ in the arbitrarily assumed ratio of 6 to 4 for the first h columns while for the last h columns the entire value was attributed to $\tilde{K}^2_{72}$ with $\tilde{K}^2_{71}$ being zero-filled. Thus it is assumed no Tasmanian margins are supplied on mainland to mainland transactions. The arbitrarily assumed ratios for interstate sales represent a best guess in the absence of any indicative data.

The last h cells of the third transitional matrix were allocated entirely to $\tilde{P}_{72}$, reflecting the assumption of zero Tasmanian margins on overseas imports by mainland producers. This assumption appears reasonable, since it is unlikely that imported goods destined for mainland purchasers would be routed through Tasmanian distributors. However, the reverse is not likely to be the case. It was the opinion of ABS officers collecting Tasmanian interstate trade figures in the early 1980's that at least 5 per cent of imports to Tasmanian producers were cleared through Customs by mainland distributors. Thus the first h columns of the third transitional matrix were divided between $\tilde{P}_{71}$ and $\tilde{P}_{72}$ in the proportion of 19 to 1.

4.2.2.2.3 Sales Taxes

The 1978-79 ORANI computer data base contains a single matrix of commodity taxes paid to all governments on all intermediate inputs (regardless of source) by each industry; i.e. ORANI $\tilde{K}_{g+1}$ and $\tilde{P}_{g+1}$ are aggregated. It was necessary to break this matrix into nine g (commodities) x h (purchasing industries) x 2 (purchasing regions) matrices. These would cover the six categories of state taxes (2 regions of taxation on three sources of commodity supply) and three categories of Commonwealth taxes (on three sources of commodity supply).

The above task was simplified by the present assumption underlying equations (2.42) and (2.43) that state governments only levy sales taxes on commodities purchased in their region of jurisdiction.[7] This implies that the last h columns of matrices $\tilde{K}^1_{g+1,1}$, $\tilde{K}^2_{g+1,1}$ and $\tilde{P}_{g+1,1}$ and the first h columns of matrices $\tilde{K}^1_{g+1,2}$, $\tilde{K}^2_{g+1,2}$ and $\tilde{P}_{g+1,2}$ are zero-filled.

The remaining tasks were to split the ORANI sales tax figures for each industry into source of commodity supply and region of purchase and then allocate the resultant figures to the appropriate receiving government. The first task was accomplished simply by splitting the ORANI sales tax figures for each industry according to the proportions for direct flows given in the FEDERAL (TASMAIN) matrices $\tilde{A}^1$, $\tilde{A}^2$ and $\tilde{F}$ which have already been calculated (see sections 4.2.2.2.1.1, 4.2.2.2.2.1.2 and 4.2.2.2.1.3). This mechanical method of disaggregation would appear quite acceptable, at least in relation to apportioning sales taxes between domestically-sourced sales, given that the bulk of sales taxes are levied by the Commonwealth government. It might serve to somewhat overstate the sales taxes on imports in those instances where customs duties might be levied on imports with an excise tax being confined to domestic commodities.

No such suitable ad hoc method of distribution was available for the second disaggregation step, that of splitting the resultant figures among receiving governments. Only the Commonwealth is permitted to levy sales taxes in their strict sense. The component of sales tax receipts in the ORANI data base which should be directed to state governments involves other taxes which act like sales taxes, principally liquor taxes, taxes on gambling, stamp duties and business franchise taxes on petrol, gas and tobacco. Figures are available for these taxes in ABS (1980b) and ABS (1985b). Also, the taxes are in general easily associated with one of the FEDERAL (TASMAIN) nine commodities. However, not all of the tax revenue from any of these taxes can be considered wholly sales tax as only a component of them is related to sales. For instance a licence to sell petrol might involve a flat fee as well as a fee directly connected to the previous year's sales. It is a matter of judgement as to how much of the licence fee should be regarded as sales tax. Moreover the ABS publication does not give any breakdown into the two components.

However, reasonable data for making suitable estimates was obtained. The ABS was able to supply the relevant proportions of the various indirect state taxes which the Bureau was assigning to commodity taxes in their current preparation of the 1983-84 Australian input-output table. It was assumed that these proportions were also applicable to the year 1978-79. Table 4 of ABS (1985b) gave an overall breakdown between direct and indirect taxes at the state and local level. This information, together with some ad hoc judgments on the nature of the particular tax, was used to adjust the 1978-79 section of Table 8 of ABS (1985b) to remove the direct tax component of each type of state and local tax. The ABS proportions between commodity and other indirect taxes could then be applied to obtain estimates of the value of each type of commodity or "sales" tax for Tasmania and the mainland.

A feature of the resultant estimates (and indeed of the initial ABS state tax figures) is that Tasmania did not levy any business franchise taxes on petrol or tobacco in 1978-79. However, since that time, these forms of taxes have become an important source of Tasmanian state government revenue. In 1985-86, the Tasmanian petroleum products franchise tax made up 3.1 per cent of tax collections of this type by all state governments. This compares with Tasmania's share in all state (and local) government's taxes, fees and fines of 2.2 per cent in that year. Tasmania's share of tobacco taxes by all state government's was 5.5 per cent in 1985-86. It was decided that just in the case of these two sales taxes the 1978-79 data base would be adjusted to reflect a recent change. Tasmania was thus given a more current sales tax figure in the case of fuel and tobacco taxes.

Having arrived at a value for the commodity tax component of each type of state government tax the next step was to distribute a portion of these commodity taxes across the state commodity tax matrices relating to intermediate flows, i.e. $\tilde{K}^1_{g+1,1}$, $\tilde{K}^2_{g+1,1}$, ... $\tilde{P}_{g+2}$. The estimation of the portion of the sales taxes to be assigned to intermediate flows in total and the distribution across the elements of the various state sales tax matrices associated with intermediate flows was carried out simultaneously. First each tax was assigned to a particular commodity flow at the 114-commodity level (i.e. liquor taxes to two commodities, Beer and Malt and Other Alcoholic Beverages; tobacco taxes to Tobacco Products; fuel taxes to Petroleum and Coal Products; motor vehicle taxes to Road Transport; stamp duties to Banking and gambling taxes to Entertainment and Recreational Services). The sales taxes were then spread across purchasers in accordance with the 114-commodity/112 industry ORANI input-output data files. An analysis of the resultant state sales tax matrices suggested that in some cases the association between tax-type and commodity might not be as close as desirable (e.g. tobacco makes about 3 per cent of its sales to mining, presumably of by-products). A small number of adjustments were made to the intermediate sales tax matrices to remove a number of apparent (minor) anomolies.

Having filled out the state sales tax matrices associated with intermediate flows to current producers, the Commonwealth tax matrices were calculated as residuals.

4.2.2.2.4 Primary Inputs

4.2.2.2.4.1 Labour Inputs

The task here was to split the m (occupations) by h (industries) ORANI matrix $\tilde{U}$ into three m x 2h matrices $\tilde{U}^1$, $\tilde{U}^2$, $\tilde{U}^3$, covering post-tax wage payments, PAYE taxes and payroll taxes. The Tasmanian data available from the TIO table is a vector of wage bills by industry, the row P1. The figures in that row are exclusive of payroll tax which is included in indirect taxes (row P3). As with the calculation of sales taxes above the lack of separate identification of indirect tax types in row P3 leads to the information in that row being ignored in the calculation of payroll taxes paid by Tasmanian industries.[8]

The first step in calculating the FEDERAL (TASMAIN) labour matrices was to expand the P1 row of the TIO table to m occupations by assuming that each Tasmanian industry had the same skills-pattern as its mainland counterpart.[9] A corresponding transitional mainland matrix was then calculated as a residual by subtracting the Tasmanian matrix from ORANI $\tilde{U}$.

The next step was to subtract the payroll tax component from the two transitional matrices. This was done by applying the industry ratio of payroll taxes to wage bill (which was obtainable by employing a vector of industry payroll tax payments contained in the 1978-79 ORANI computer data base) to the two transitional matrices in order to obtain the m x 2h TASMAIN matrix $\tilde{U}^3$.[10] The regional sub-matrices of $\tilde{U}^3$ could then be subtracted from the appropriate transitional matrices.

The modified transactional matrices were then used to create $\tilde{U}^1$ and $\tilde{U}^2$ by use of an estimated ratio of after-tax wages to PAYE taxes, chosen on the basis of the share of net tax in taxable income for taxpayers not paying any provisional taxes in 1978-79 (see Table 3 of Commonwealth Treasurer (1980)). It was assumed that this ratio would also be suitable for the owner-operator proportion of labour income.

4.2.2.2.4.2 Capital Inputs

The ORANI capital input matrix, $\tilde{V}$, is a vector of each industry's rental value of fixed capital. For FEDERAL this matrix not only has to be broken down by regional industry but also by location of owner of capital and by after-tax and tax components.

The TIO table provides information which will allow the dissection into regional industries, but only after some initial estimation procedures. It will be noted from Figure 4.2 that the TIO table does not show returns to fixed capital separately, but rather they are contained in gross operating surplus (row P2). The GOS row also covers returns to agricultural land and returns to working capital. A first step was to split the TIO GOS vector into three separate vectors showing returns to fixed capital, returns to agricultural land and returns to working capital. This was done merely by applying the ORANI data-base proportions for each of these three components.[11] A 1 x 2h vector of capital inputs could then be formed for the regional industries using the Tasmanian returns to fixed capital vector for the first h entries and the last h being calculated as a residual from ORANI $\tilde{V}$.

The next step was to disaggregate the vector of capital inputs into post-tax returns to fixed capital and income tax on those returns. This was done on the basis of company taxes, withholding tax and other non-labour income taxes (from ABS (1981) and Table 3 in Commonwealth Treasurer (1980)) in non-labour income. Thus the same tax proportion was assumed for capital returns in all regional industries. An adjustment was then made to incorporate into income tax payments an amount for net transfers from Commonwealth public enterprises to the Commonwealth government. Transfers from public financial enterprises was assigned to the industry in each region covering finance (i.e. Other Tertiary) with the regional industry proportion being assigned in line with the region's proportion in Finance, property and business services in gross domestic product at factor cost (Tables 9 and 15 of ABS (1987)). Net transfers from trading enterprises were estimated by the following procedure. First, Commonwealth public trading enterprise gross operating surplus listed by activity on page 583 of ABS (1981) was assigned to FEDERAL (TASMAIN) regional industries. It was then assumed that payments to government were in proportion to gross operating surplus and the regional industry proportions were applied to the figure for aggregate income transferred from public trading enterprises to the Commonwealth government from Table 65 in ABS (1987) to give transfers by regional industry. For each regional industry the estimated figure for transfers from public financial and trading enterprises was added to the appropriate income tax element and subtracted from the appropriate post-tax returns element.

The first of the vectors, that for post-tax capital income, was then disaggregated by estimated ownership proportions to form the matrix $\tilde{V}^1$. Only a small amount of ownership information was employed to form the basis of the estimation of ownership proportions. For Tasmania, Hood and Wilde (1986) surveyed ownership of Tasmanian manufacturing firms. Information from Tables 4 and 13 of that report was used to estimate the interregion ownership split for the two Tasmanian manufacturing industries. For other Tasmanian industries interregion ownership was determined on the basis of ad hoc judgements. For mainland industries it was assumed that Tasmania owned 0.1 per cent of mining and manufacturing but had a negligible ownership share of all other mainland industries. Data on foreign ownership is published irregularly and does not cover all industries. ABS (1984) and ABS (1985a) give foreign ownership shares for ASIC industries for mining and manufacturing respectively and ownership shares were calculated in accordance to the pattern of ASIC industries within the associated regional FEDERAL (TASMAIN) industries. For other industries ad hoc judgements were again made in deciding the foreign ownership proportions to be used, with ABS (1976) and ABS (1978) providing some guide for Other Tertiary. It was assumed that for Utilities and Community Services, foreign ownership was zero and for the rural sector very low (2 per cent for Tasmanian Rural and 3 per cent for Mainland Rural). After completing this task, $\tilde{V}^2$ was formed similarly by disaggregating the second vector by the same ownership shares as used for $\tilde{V}^1$.

Matrix $\tilde{V}^3$ was formed using an industry vector of property taxes from the ORANI computer data base. This vector was expanded to regional industry (2h) proportions by using the regional proportions for each industry in the returns to fixed capital vector calculated above. $\tilde{V}^3$ could then be completed by using the ownership proportions estimated above.

4.2.2.2.4.3 Land Inputs

The returns to agricultural land vector for Tasmania calculated in the previous section was used to obtain the first h entries of a vector of the rental value of agricultural land by regional industries. The next h entries were calculated as a residual from ORANI $\tilde{W}$.

This vector was then split into post-tax returns to land and income tax on land using the income tax ratio for non-labour income estimated in section 4.2.2.2.4.1 above. $\tilde{W}^1$ and $\tilde{W}^2$ were then formed by undertaking an ad hoc disaggregation into ownership.[12]

4.2.2.2.4.4 Other Costs

The first two other cost vectors, $\tilde{X}^1$ and $\tilde{X}^2$, relate to the indirect taxes n.e.c. component of ORANI $\tilde{X}$. Little information is readily available to disaggregate the $\tilde{X}$ vector by region of purchase and taxing government. The task is somewhat simplified in that it can safely be assumed that state governments only tax/subsidise production that occurs within their jurisdiction. Thus we find that $\tilde{X}^1$ is a vector. This contrasts with the case of commodity taxes where it was assumed that state governments only taxed/subsidized purchases in their region of jurisdiction, but provision was made in the data base structure for the removal of this assumption later if sufficient data became available. The first step in estimating the production tax vectors was to expand ORANI $\tilde{X}$ to regional industry dimensions. This was achieved by applying regional proportions for value added in each economy-wide industry (from $\tilde{U}^1$, $\tilde{U}^2$, ..., $\tilde{W}^3$ calculated above) to the associated $\tilde{X}$ element. $\tilde{X}^1$ and $\tilde{X}^2$ were then formed by using a broad estimate of Commonwealth and state government proportions in production tax collections, formed on the basis of indirect tax figures in ABS (1987) after allowing for the commodity tax estimates already made. The proportions used were 0.58 for the state government share in Tasmanian industry production taxes and a corresponding 0.7 share for all mainland industry production taxes.

The first h entries of the vector $\tilde{X}^3$ was obtained by adding to the vector of other costs for Tasmanian industries, calculated in section 4.2.2.2.4.2, a vector of estimates of sales by final buyers by Tasmanian industries.[13] The last h entries of $\tilde{X}^3$ were then calculated as residuals from the sum of the vectors of working capital and sales by final buyers in the ORANI computer data base.

4.2.2.3 Matrices Containing Inputs to Capital Formation

In this section the calculation of the numerical values for three columns of matrices holding the input structure for capital formation are discussed. Each column of matrices concerns capital formation by a particular class of economic agents, i.e. private investors, state governments and the Commonwealth government. The structure of the data base, thus, allows for three different types of capital to be formed in a regional industry, one type for each class. However, as is clear from the structure of primary inputs to current production examined above, only one type of capital is used in an individual regional industry's production. This sets up an apparent conflict within the model.

However this possibility for internal conflict is easily avoided. Lack of data currently prevents a distinction in any sensible manner between the way in which each of the three classes of investors assemble their capital in any industry. The only difference in input structure between private and state government capital formation in a regional industry in the current version of FEDERAL (TASMAIN) is in regard to their payment of sales taxes. The column of matrices for Commonwealth government capital formation does differ from the other two in the sense that FEDERAL does not at present explicitly treat the regional distribution of investment by this class of investor. Thus Commonwealth government capital formation is shown only by industry in the present FEDERAL data base, in line with the assumption (see section 2.2.8) that the regional composition of this class of capital formation does not alter. For each industry, the column for Commonwealth government capital formation is the aggregate of two regional industry columns which, in the case of each region, has the same input technology as the corresponding regional industry column for state government capital formation. Thus there is in effect only one type of capital for each regional industry in the current version of FEDERAL (TASMAIN). The separate columns of matrices currently exist only to distinguish the non-payment of sales tax on inputs to capital formation by the public sector.

If information did become available to distinguish between the three sectors' use of <u>margins</u> in capital formation, this could be incorporated into the three columns of matrices without any further implications. However if the structure of <u>direct</u> commodity inputs or a regional industry's capital formation were to be distinguished between the three sectors the model should be altered to allow for three different types of capital for each regional industry.

The above discussion suggests a straightforward overall approach to estimating the three columns of capital formation matrices. A single capital formation (or investment) column of matrices was estimated first. The resultant investment regional industry columns were then each split into three using the same proportions for every row (except the sales tax rows). The Commonwealth government column of matrices was then contracted from 2h columns to h columns by summing across regions. The proportions used in this exercise were estimated such that the Commonwealth and state government total capital expenditure figures would agree with the appropriate gross fixed capital expenditure figures in the government capital accounts presented in Tables 75, 76 and 82 of ABS (1987). We now turn to the method for estimating each matrix in the single capital formation column of matrices before disaggregation into private and government columns.

4.2.2.3.1 Direct Commodity Input

Although Figure 4.1 shows ORANI matrices, $\tilde{B}$ and $\tilde{G}$, as being g x h matrices, they actually appear in the 1978-79 data base as g x 1 vectors. A preliminary step was to expand these matrices to h columns. This was done by multiplying each cell of the $\tilde{B}$ and $\tilde{G}$ matrix by the corresponding row share of the capital stocks matrix. It was thus assumed that for each commodity used in capital formation, both the domestic and imported commodity had the same industry pattern as the existing capital stock for that commodity.

The first matrix to be considered is $\tilde{B}^{1\cdot}$, the aggreation of $\tilde{B}^{11}$, $\tilde{B}^{12}$ and $\tilde{B}^{13}$. The first h columns of $\tilde{B}^{1\cdot}$ were derived from the Tasmanian input-output table. The first h entries of column D4 in TIO contain the demand for Tasmanian commodities as an input to gross capital expenditure. This column vector was expanded to h columns in just the same way as for ORANI $\tilde{B}$, by using the capital stocks matrix.[14] The second h columns of $\tilde{B}^{1\cdot}$ consist of interstate exports of Tasmanian produced commodities for capital formation on the mainland. Recall from section 4.2.2.2.1.1 that Tasmanian interstate exports consists of a single column in the TIO table, column D7. The proportion of a commodity i's sales, shown in column D7 which are Tasmanian sales to the mainland industry j for capital formation was estimated by dividing the ij^{th} element of ORANI $\tilde{B}$ by the i^{th} row sum for domestic commodity sales in the ORANI data-base.

The first h columns of matrix $\tilde{B}^{2\cdot}$ comprises interstate imports into Tasmania for the purpose of capital formation. The TIO table contains a single figure for interstate imports of all commodities by all industries for capital formation. This figure appears in row P5 of column D4. This was considered too little information to sensibly use the method for estimating the commodity composition of interstate imports developed in the section on inputs into current production. The method used here was simply to: (i) assume that imports from the mainland for capital formation only consists of manufactured goods, commodities 3 and 4; (ii) distribute the single interstate imports figure across these two commodities and Tasmanian industries according to the corresponding shares in the national capital stock matrix. The last h columns of $\tilde{B}^2$ were then calculated as residuals.

In the case of foreign imports used as imports into Tasmanian capital formation, there is again only a single figure (row P4, column D4) which is the total for all commodities purchased by all industries. Exactly the same method as was used for interstate imports into capital formation was used to distribute foreign imports over commodities and industries in order to create the first h columns of $\tilde{G}^{\cdot}$. Again the entries of the last h columns were calculated as residuals.

4.2.2.3.2 Margins

Recall that only one industry in the nine-industry version of FEDERAL (TASMAIN) supplies margins. Thus we need only concern ourselves here with those matrices pertaining to the supply of commodity 7 as a margins input into capital formation.

The estimation of the six columns of margin matrices was undertaken in two stages. The first stage was to estimate the matrices $\tilde{L}^{1\cdot}_{7\cdot}$, $\tilde{L}^{2\cdot}_{7\cdot}$ and $\tilde{Q}^{\cdot}_{7\cdot}$. For the first h cells this was done by: (i) adding the single figure for Tasmanian supplied margins into capital formation in Tasmania estimated in the preliminary tasks outlined in section 4.2.2.1 to the figure for interstate margins on interstate imports purchased for capital formation in Tasmania; (ii) distributing this resultant single figure over the g rows and first h columns of each of the three matrices in accordance with the direct flow proportions available from the matrices calculated in the previous section.

The 1978-79 ORANI data-base contains a g x 1 vector for the matrix $\tilde{L}_7 + \tilde{Q}_7$. A g x 1 vector of mainland purchases of margins on direct inputs into capital formation from all sources was calculated by initially zero-filling the last h columns of $\tilde{L}^{1\cdot}_{7\cdot}$, $\tilde{L}^{2\cdot}_{7\cdot}$ and $\tilde{Q}^{\cdot}_{7\cdot}$ and then subtracting the vector of row sums of the matrix $[\tilde{L}^{1\cdot}_{7\cdot} + \tilde{L}^{2\cdot}_{7\cdot} + \tilde{Q}^{\cdot}_{7\cdot}]$ from the ORANI data-base vector $[\tilde{L}_7 + \tilde{Q}_7]$. This new vector was then split into the last h columns of $\tilde{L}^{1\cdot}_{7\cdot}$, $\tilde{L}^{2\cdot}_{7\cdot}$, $\tilde{Q}^{\cdot}_{7\cdot}$ by applying the corresponding direct flow proportions.

For the first h columns the margins matrices were then broken into region of margin supply as follows. In the case of each cell the value of $\tilde{L}^{1\cdot}_{7\cdot}$ was allocated entirely to $\tilde{L}^{1\cdot}_{71}$ with $\tilde{L}^{1\cdot}_{72}$ being zero-filled, reflecting again the assumption that the mainland does not supply margins on Tasmanian intrastate trade. $\tilde{L}^{2\cdot}_{7\cdot}$ was allocated between $\tilde{L}^{2\cdot}_{71}$ and $\tilde{L}^{2\cdot}_{72}$ on the basis of the ratio of estimates of total Tasmanian to total mainland supplied margins to Tasmanian total capital formation (both numerator and denominator were discussed briefly above). $\tilde{Q}_{7.}$ was allocated entirely to $\tilde{Q}_{71}$. Thus it was assumed that in the case of Tasmanian capital formation no overseas imports are routed through the mainland.

The last h cells of $\tilde{L}^{1\cdot}_{71}$ were calculated using a variant of the method for estimating interstate export flows developed for direct usage. A figure for Tasmanian margins on interstate exports was calculated in the preliminary tasks section. We were not required to use this figure in the calculation of margins on current inputs, but find it useful to make use of it here. The sum of Tasmanian margins on interstate exports to current mainland production was first subtracted from the figure for total Tasmanian margins on interstate exports and the resultant figure was then spread across the remaining types of interstate export margins. In this case the resultant figure was multiplied by the share of the ijth direct domestic commodity flow in all domestic direct flows (excluding those to current production) in the ORANI data-base.

The remainder of the last h columns of $\tilde{L}^{1\cdot}_{7.}$ (after $\tilde{L}^{1\cdot}_{71}$ was subtracted) was then allocated to $\tilde{L}^{1\cdot}_{72}$ and the last h columns of $\tilde{L}^{2\cdot}_{7.}$ and $\tilde{Q}^{\cdot}_{7.}$ were allocated entirely to $\tilde{L}^{2\cdot}_{72}$ and $\tilde{Q}^{\cdot}_{72}$ respectively. The zeroes in the last h columns of $\tilde{L}^{2\cdot}_{71}$ and $\tilde{Q}^{\cdot}_{71}$ reflect the assumption that Tasmania did not supply margins on internal mainland trade and overseas imports by the mainland.

4.2.2.3.3 Sales Taxes

The ORANI 1978-79 data base holds a column vector listing for each of the nine commodities the sales taxes incurred on inputs into capital formation. This column was split into regional industry and source of commodity supply according to the proportions for direct inputs to capital formation. These transitional matrices then had to be further split up among the three governments. As before, the assumption that sales taxes were only incurred in the region of purchase mean that the last h columns of $\tilde{L}^{1\cdot}_{g+1,1}$, $\tilde{L}^{2\cdot}_{g+1,1}$ and $\tilde{Q}^{\cdot}_{g+1,1}$ and the first h columns of $\tilde{L}^{1\cdot}_{g+1,2}$, $\tilde{L}^{2\cdot}_{g+1,2}$ and $\tilde{Q}^{\cdot}_{g+1,2}$ are zero filled. The remaining parts of the six state government matrices were then available from a continuation of the calculations that were performed to obtain state sales taxes on flows to current production in section 4.2.2.2.3. Finally the three Commonwealth government matrices could be calculated as residuals from the transitional matrices.

4.2.2.3.4 Distribution by Class of Investor

Matrices $\tilde{B}^{1\cdot}$, $\tilde{B}^{2\cdot}$, .., $\tilde{Q}^{\cdot}_{g2}$ were then split into three columns of matrices $\tilde{B}^{11}$ to $\tilde{Q}^{1}_{g2}$, $\tilde{B}^{12}$ to $\tilde{Q}^{2}_{g2}$ and $\tilde{B}^{13}$ to $\tilde{Q}^{3}_{g2}$ in the manner described in section 4.2.2.3 above. A different proportion for splitting was used for each regional industry, reflecting the assumed shares of private industry, state government and Commonwealth government in that regional industry's capital formation.

Matrices $\tilde{L}^{1\cdot}_{g+1,1}$ to $\tilde{Q}^{\cdot}_{g+2}$ were allocated entirely to the private industry sub-column of matrices, $\tilde{L}^{11}_{g+1,1}$ to $\tilde{Q}^{1}_{g+2}$ with the other two sub-columns, $\tilde{L}^{12}_{g+1,1}$ to $\tilde{Q}^{2}_{g+2}$ and $\tilde{L}^{13}_{g+1,1}$ to $\tilde{Q}^{3}_{g+2}$ being zero matrices.

4.2.2.4 Household Consumption

The TIO table contains two columns vectors relating to personal consumption in Tasmania, columns D1 (Personal Consumption) and column D2 (Tourist Expenditure). Although tourist expenditure occurs in Tasmania it consists entirely of expenditure by interstate travellers and consequently should be allocated to interstate exports from Tasmania to mainland household consumption.

Thus the first g rows of TIO vectors, D1, were assigned to the first column of FEDERAL (TASMAIN) $\tilde{C}^1$, being the flow of Tasmanian commodities to Tasmanian purchasers. The second column of $\tilde{C}^1$ was then formed as the sum of two vectors. The first vector resulted from the computation of interstate exports as calculated by the method used previously, namely, for each commodity i it was set equal to the multiplicand of the ratio of the i^{th} cell of ORANI $\tilde{C}$ to total direct sales of i and the i^{th} cell of the TIO D7 (interstate exports) column. This vector was then added to the vector of interstate tourist expenditure from column D2 in the TIO table to form the second column of $\tilde{C}^1$.

The first column of $\tilde{C}^2$ was calculated using the method developed in section 4.2.2.2.1.2 for estimating the commodity composition of interstate imports. The TIO figure distributed across commodities was the cell in column D1, row P5. Row P5 of column D2 was not counted as an interstate import since it is actually purchased by mainland residents. This value is implicitly picked up in the mainland to mainland flows calculated as residuals. This comment also applies to overseas imports into interstate tourist expenditure. Margin expenditure on these sales supplied from Tasmania, however, needs to be recognized. A further problem is that, just as interstate tourist expenditure by mainland visitors was classified as Tasmanian interstate exports, Tasmanian interstate imports should include purchases by Tasmanian tourists on the mainland. However it would appear that the TIO table does not make this inclusion and there are no figures available on these purchases. It was therefore assumed that Tasmanian tourists bought an identical bundle of goods (in value terms) interstate as was the case for mainland tourist purchases in Tasmania. The first column of $\tilde{C}^2$ was therefore adjusted by adding to it the second column of $\tilde{C}^1$.[15] Having made this adjustment, the second column of $\tilde{C}^2$ could then be calculated as a residual ($[\tilde{C}^2]_{i2}$ = ORANI $[\tilde{C}]_i - \sum_r [\tilde{C}^1]_{ir} - [\tilde{C}^2]_{i1}$).

The first column of FEDERAL (TASMAIN) $\tilde{H}$ was estimated by applying the commodity pattern of ORANI $\tilde{H}$ to the column D1, row P5 cell of the TIO table. The second column was calculated as residuals.

Turning to the margin inputs to household consumption, the transitional matrices $\tilde{M}^1_{7.}$, $\tilde{M}^2_{7.}$ and $\tilde{R}_{7.}$ were first calculated by applying the ORANI ratio of margins to direct flows to households for commodity i to the ith cell of each column of the FEDERAL direct flow matrices. The left-hand column was then split into region of supply by allocating the full value of each cell of $\tilde{M}^1_{7.}$ to $\tilde{M}^1_{71}$ (with the first column of $\tilde{M}^1_{72}$ being zero-filled), and the left-hand columns of $\tilde{M}^2_{7.}$ and $\tilde{R}_{7.}$ distributed in accordance with assumed ratios of Tasmanian to mainland supplied margins. Turning to the right-hand columns, this column of $\tilde{M}^1_{71}$ was initially estimated in accordance with the method of estimating interstate margins flows discussed in section 4.2.2.3.2 followed by an adjustment to allocate margins on inter-state tourist expenditure. The second column of $\tilde{M}^1_{71}$ was then subtracted from the corresponding column of $\tilde{M}^1_{7.}$ to give the right-hand column of $\tilde{M}^1_{72}$. The right-hand columns of $\tilde{M}^2_{7.}$ and $\tilde{R}_{7.}$ were allocated largely to the corresponding columns of $\tilde{M}^2_{72}$ and $\tilde{R}_{72}$ with the remainder being allocated to the right-hand columns of $\tilde{M}^2_{71}$ and $\tilde{R}_{71}$ to cover margins on mainland imports purchased by interstate tourists in Tasmania.

The sales taxes on commodities to household consumption were calculated in the same manner as for investment (see section 4.2.2.3.3).

4.2.2.5 Exports

Matrix $\tilde{D}^1$ could be obtained directly from the first g entries of column D6 of the TIO table. $\tilde{D}^2$ was then calculated as the residual of ORANI $\tilde{D}$.

It was assumed that margins could only be supplied by the region which exported the commodity and thus $\tilde{N}^2_{71}$ and $\tilde{N}^1_{72}$ were zero matrices. $\tilde{N}^1_{71}$ was estimated by applying the commodity composition of direct Tasmanian exports (from matrix $\tilde{D}^1$) to the figure for total Tasmanian margins on exports calculated in the preliminary tasks section. $\tilde{N}^2_{72}$ was then calculated as the residual from ORANI $\tilde{N}_7$.

The only sales taxes on exports in FEDERAL are levied by the Commonwealth government. The export commodity taxes were estimated by splitting ORANI matrix $\tilde{N}_{g+1}$ into FEDERAL (TASMAIN) $\tilde{N}^1_{g+2}$ and $\tilde{N}^2_{g+2}$ in accordance with the regional distribution of exports of each commodity.

4.2.2.6 Government Current Expenditure

The TIO table contains a column, D3, for the current expenditure by all public authorities in Tasmania. No distinction is made in that table between expenditure by the Commonwealth government and by state (and local) government(s).[16] Consequently it was easiest to calculate the columns for both types of governments concurrently.

The first 9 entries of the D3 column were allocated between $\tilde{E}^{11}$ column 1 and $\tilde{E}^{12}$ in accordance with the estimated share each of the two governments had in public current expenditure of each

Tasmanian commodity.[17] The second column of $\tilde{E}^{11}$ was estimated using the same method for estimating interstate direct flows as for previously discussed categories of purchases.

Column 1 of $\tilde{E}^{21}$ covers interstate imports by the Tasmanian government. Total interstate imports by Commonwealth and state governments into Tasmania are found in TIO cell P5,D3. The proportion of this figure used by the Tasmanian government was assigned the same value as was the case for intrastate usage and the Tasmanian portion was then spread over commodities in line with Tasmanian government usage of Tasmanian produced commodities.[18] $[\tilde{E}^{21}]_{r=2}$ and $\tilde{E}^{22}$ were then calculated from the residual which for each commodity was spread between the mainland and Commonwealth governments in accordance with the single 1978-79 ratio of the six (including Northern Territory) mainland state (and local) governments final consumption expenditure to the corresponding Commonwealth expenditure (Tables 65 to 73 in ABS (1987)).

The first column of matrix $\tilde{J}^1$ was calculated by applying the commodity shares from ORANI $\tilde{J}$ (imports by all Australian governments[19]) to that portion of the P4,D3 cell of the TIO table estimated to be Tasmanian government purchases of imports. $[\tilde{J}^1]_{r=2}$ and $\tilde{J}^2$ could then be calculated from the residual, again employing the ratio of mainland to Commonwealth government current expenditure.

The estimation of the margins matrices, $\tilde{O}^{11}_{11}$ to $\tilde{T}^1_{g2}$ and $\tilde{O}^{12}_{11}$ to $\tilde{T}^2_{g2}$ were handled in a similar way to the method used for the capital formation columns (see section 4.2.2.3.2). As can be seen from Figure 3.1, it is assumed that all of the government current consumption sales tax matrices were zero matrices.

4.2.2.7 Commodity Composition of Regional Industry Output

Since the implemented version of FEDERAL (TASMAIN) contains only single-product industries, the $\tilde{Y}^r$ matrices are simply diagonal matrices with regional output by commodity (equal to output by the associated regional industry) along the diagonal. These cells are calculated according to the method for calculating commodity output described at the end of section 3.2.1.

4.2.3 Constructing the Government Accounts Data Files

4.2.3.1 Commonwealth Government

4.2.3.1.1 Receipts

A considerable amount of the governments account data was able to be derived directly from the FEDERAL (TASMAIN) input-output data base and was placed into the governments account file largely for completeness. This was true of the first receipts item, CGR_1 (total PAYE tax receipts), which was calculated as the sum of the elements of $\tilde{U}^2$. Similarly CGR_2 was obtained by summing over the elements of $\tilde{V}^2$ and $\tilde{W}^2$. Total import duties, CGR_3, was obtained by summing the elements of the FEDERAL (TASMAIN) matrix, $\tilde{Z}$. Obtaining total production taxes (less subsidies), CGR_4 involved summing across the vector, $\tilde{X}^2$. Total commodity taxes, CGR_5 were obtained by aggregating the elements of the nine matrices in the three rows of matrices relating to Commonwealth sales taxes. Summing the elements of $\tilde{N}^1_{g+2}$ and $\tilde{N}^2_{g+2}$ yielded total export tax receipts, CGR_6. The final category of receipts, CGR_7, was estimated for each region by multiplying the region's share of total population in 1979 (see ABS (1980a), p. 96) by interest and dividends received by the Commonwealth from non-state (and local) government sources in 1978-79 (Table 65 of ABS (1987)).

4.2.3.1.2 Outlays

The first outlay figure, current outlays (CGO_1), was obtained by summing down the Commonwealth government current expenditure column, $\tilde{E}^{12}$ to $\tilde{T}^{2}_{g2}$. Similarly, capital formation, CGO_2, was obtained by summing over the column of matrices, $\tilde{B}^{13}$ to $\tilde{Q}^{3}_{g2}$. To fill out CGO_3, the figure for Australia-wide unemployment benefits was obtained directly from the table for unemployment, sickness and special benefits in ABS (1982), p. 182. The two elements of CGO_3 were then estimated by allocating the value of unemployment benefis across regions in accordance with the regional share in persons registered for employment with the Commonwealth Employment Service in 1978 obtained from figures collected by the Department of Employment and Youth Affairs (see ABS (1979) p. 138). The matrix CGO_4 was calculated for each region from current and capital grants from the Commonwealth less interest paid from the states to the Commonwealth as drawn from Tables 66, 72, 76 and 82 of ABS (1987).[20] Tranfers to persons in each region, CGO_5, were calculated by spreading personal benefit payments to residents (Table 65, ABS (1987)) across regions according to population distribution, then subtracting the value of unemployment payments in the region (CGO_3, calculated above). Interest payments by the Commonwealth to region r residents was obtained by spreading the figure for all interest payments by the Commonwealth in Table 65 of ABS (1987) across regions in proportion to population. The use of the entire amount of interest payments reflects the assumption in FEDERAL that all government interest payments are paid to households who in turn are responsible for all interest payments to foreigners. Clearly this assumption is for convenience and has no material effect. The final item CGO_7 consists of unrequited transfers overseas, as recorded in

Table 65 of ABS (1987), and accounts for the remainder of all Commonwealth outlays.

4.2.3.2 State Government

4.2.3.2.1 Receipts

The first state government receipts vector, SGR_1, contains total payroll taxes collected in each region and each cell is calculated by summing across all elements of the appropriate regional sub-matrix of $\tilde{U}^3$ (i.e. across all occupations and industries for the region). The next two matrices are related. Land taxes as a whole are stored by ownership and regional industry in matrix $\tilde{V}^3$.[21] In all but one of the industries land tax is entirely commercial land tax. However, industry 9 includes the sub-industry, "ownership of dwellings", to which residential land tax is applicable. The share of this latter tax in total land tax on that industry was assumed to be 0.87. This share was chosen because it yielded a commercial land tax on Other Tertiary in line with that for the Margins industry which covers retail and wholesale trade. These sectors could be expected to be similar to Other Tertiary in terms of the rate of land tax paid. The sum over ownership of regional industry 9 in $\tilde{V}^3$ was multiplied by this share to give cell 1 of SGR_2 while cell 2 was calculated by performing the same operation with regional industry 18. The SGR_3 matrix of total commercial land taxes was then calculated for each region by summing matrix $\tilde{V}^3$ elements across ownership and industries within the region and then subtracting the value of the corresponding SGR_2 component.

SGR_4 values were obtained directly from the 1978-79 figures for direct taxes,[22] fees and fines in Tables 66 and 72 of ABS (1987).

Matrix SGR_5 is identical with CGO_3 and repeated for convenience only. Each cell of SGR_6 was obtained by summing across all elements in the three rows of sales tax matrices applicable to that region (e.g. for region 1, $\tilde{K}^1_{g+1,1} + \tilde{L}^{11}_{g+1,1} + \ldots + \tilde{R}_{g+1,1}$). Similarly the r^{th} element of SGR_7 was obtained by summing the h industry cells of matrix $\tilde{X}^1$ relating to the r^{th} region.[23] The final matrix of state government receipts, SGR_8 (other receipts), was obtained directly from the 1978-79 figure for interest etc., and dividends received in Tables 66 and 72 of ABS (1987).

4.2.3.2.2 Outlays

Each of the two elements of matrix SGO_1 are calculated by summing down the r^{th} column of the matrices $\tilde{E}^{11}$, $\tilde{E}^{21}$, $\tilde{J}^1$, ..., $\tilde{T}^1_{g2}$. For matrix SGO_2 the first element is obtained by summing down each of the first 9 columns of $\tilde{B}^{12}$, $\tilde{B}^{22}$, $\tilde{G}^2$, ..., $\tilde{Q}^2_{g2}$ and then adding the 9 sums thus obtained together. The second element is similarly obtained except that the appropriate columns are 10 to 18. The figures for SGO_3 were obtained from the 1978-79 figures for personal benefit payments to residents (see Tables 66 and 72 of ABS (1987)). The same tables provided the figures for intrest payments to persons by state government required for SGO_4. The entries for the final matrix, SGO_5 (Other Net Outlays), were obtained by adding all remaining items of state government outlays and subtracting any items of receipts not considered in section 4.2.3.2.1. This category accounted for only about one per cent of outlays and basically comprised capital grants to public enterprises less net transfers from these enterprises.

4.3 Parameter Values

There still remains to be dealt with the parameters listed in Table 3.2 in the previous chapter and for which the source is given there simply as the parameters file. We now discuss how the values thus stored have been estimated.

There are two basic sorts of parameters. Those involving elasticities or other data and those which are user-specified. The latter are not discussed here as, mentioned in Chapter 3, they involve run-time decisions on the values of indexing parameters and the like.

We will proceed through each of the first sort of parameters. It should be noted at the outset that there has not been time to undertake econometric estimates of any elasticities at this stage. There is little regional data readily available and the task of econometric estimation, when undertaken, is likely to prove very large. The approach taken to date has been to choose elasticities in a quite simple manner. Thus, in the case of consumption a Cobb-Douglas utility function was chosen, while in the case of import substitution parameters, CRESH functions were reduced to CES function to allow the ORANI Armington elasticities to be used. There was insufficient time prior to completion of this thesis to conduct sensitivity analysis on parameter choices.

4.3.1 Parameters reflecting the Degree of Substitutability between Sources of Commodity Supply

The parameters relating to substitutability between Tasmanian, Mainland and overseas sources of supply are: $\sigma^{(k)r}_{(is)j}$, $i = 1, \ldots, g$, $s = 1, 2, 3$, $j = 1, \ldots, h$, $k = 1, 2$, $r = 1, 2$; $\sigma^{(5,2)r}_{(is)j}$, $i = 1, \ldots, g$, $s = 1, 2, 3$, $j = 1, \ldots, h$, $r = 1, 2$; $\sigma^{(6,2)}_{(is)j}$, $i = 1, \ldots, g$, $s = 1, 2, 3$, $j = 1, \ldots, h$; $\sigma^{(3)r}_{(is)}$, $i = 1, \ldots, g$, $s = 1, 2, 3$, $r = 1, 2$.

The 1978-79 ORANI computer data-base contains econometric estimates for Armington elasticities. Separate estimates are available for each ORANI commodity, but the same estimate is used for each category of purchaser of the commodity. These elasticities were calculated for the nine-commodity level using the AGGREG computer program. It will be recalled that this program aggregates the full-size ORANI data base in accordance with the methods outlined in Sutton (1981).

Value of these Armington elasticities irrespective of purchaser are:

1.	Rural	1.7
2.	Mining	37.0
3.	Manufacture - import competing	1.8
4.	Manufacture - export	0.7
5.	Utilities	0.0
6.	Construction	0.0
7.	Margins	1.1
8.	Community Services	0.0
9.	Other Tertiary	0.0

It was decided to use these values for the CRESH parameters, regardless of source. This effectively reduces the CRESH functions to CES functions. It was considered that the assumption that all three parameters for the different sources for a particular commodity are equal to the above single value was acceptable at this stage. We take up this matter again in section 6.3.1.1.3.

4.3.2 CRETH Product-product Transformation Parameters

There are no multi-commodity industries in the implemented version of FEDERAL (TASMAIN). Consequently there has been no requirement at this stage to estimate the $\sigma^{(0)r}_{(u*)j}$ parameters.

4.3.3 Substitution Parameters between Primary Factors

The ORANI practice is followed here and all $\sigma^{(1)r}_{(g+1,v)j}$, $v = 1, 2, 3$, $j = 1, \ldots, h$, $r = 1, 2$ are all set equal to 0.5.

4.3.4 Substitution Parameters between Occupations

The simulations with FEDERAL (TASMAIN) reported in Chapter 5 were undertaken using a single value of 0.5 for all $\sigma^{(1)r}_{(g+1,1,q)j}$ $q = 1, \ldots, M$, $j = 1, \ldots, h$, $r = 1, 2$. However superior estimates for the nine economy-wide industries are available by using the AGGREG computer program and it is intended to use the set of parameters thus obtained for industries in both regions for future simulations.

4.3.5 Regional Household Expenditure and Price Elasticities of Demand

In the present version of FEDERAL (TASMAIN) the regional utility functions have been reduced to a Cobb-Douglas form in order to avoid any estimation requirements (see Table 3.2, equation (2.18)). However, it would seem possible to reintroduce the Klein-Rubin form of the utility function without an expensive econometric exercise. Both the ε_i's and η_{ik}'s for a nine-industry commodity version of ORANI (using AGGREG) are available as well as the average economy-wide budget shares. The economy-wide marginal budget shares and subsistence consumption levels could therefore be calculated. Assuming the expenditure elasticities are the same in both regions we could recalculate the marginal budget shares for each region (δ^r_i, $i = 1, \ldots, g$, $r = 1, 2$) after calculating the average budget shares. That is we could adapt equation (14.28) of DPSV (p. 101) as follows:

$$\delta^r_i = \varepsilon^r_i S^{(3)r}_i \qquad i = 1, \ldots, g$$

where $S_i^{(3)r} = \bar{P}_i^{(3)r} \bar{X}_i^{(3)r} / \sum_k \bar{P}_k^{(3)r} \bar{X}^{(3)r}$, $i = 1,\ldots,g$, $r = 1,2$

Assuming $\theta_i^{(3)r} = \theta_i^3$ $i = 1, \ldots, g$, $r = 1, 2$, we can then use regional variants of ORANI (14.29), (14.30) and (14.32) to calculate the η_{ik}^r's.

4.3.6 The Export Demand Elasticities

FEDERAL requires values for two sets of reciprocals of export demand elasticities, γ_i, $i = 1, \ldots, g$ and γ_i^r, $i = 1, \ldots, g$, $r = 1, 2$. It was assumed $\gamma_i^r = \gamma_i$, $i = 1, \ldots, g$, $r = 1, 2$. The γ_i's were available from the aggregated (nine-commodity) ORANI data-base and consequently all the required information was available.

4.3.7 Elasticities of Substitution between Regions of Export

In simulations with the nine-industry version of FEDERAL the model's set of exogenous variables would normally be chosen such that the $\sigma_i^{(4)}$'s played no role in determining results. That is the group of export equations would be set so that each region's export commodities faced their own separate foreign demand curves with no direct substitution between regional sources (i.e. the commodities are considered to be too aggregated for them to be treated as being regionally substitutable). Thus little effort was put into determining the value of these parameters, with all of the $\sigma_i^{(4)}$'s being assigned the value of unity.

4.3.8 Investment Equations Parameters

Values are required for the elasticities of the expected rate of return schedules, β_j^r, $j = 1, \ldots, h$ and for what are in fact two sets of coefficients which appear in the investment equations. The values for these coeficients need to be placed on the parameters file because they cannot be determined from the input-output or government accounts data files. They are the ratio of gross to net rates of return on fixed regional industry investment, $Q_j^{(1)r}$, $j = 1, \ldots, h$, $r = 1, 2$ and the ratios of annual gross investment to future regional industry capital stocks, G_j^r, $j = 1, \ldots, h$, $r = 1, 2$.

The computer program AGGREG provides economy-wide values for all these parameters by the methods outlined in section 6.6 of Sutton (1981). It was assumed that values in both regions for each parameter/coefficient for each industry were the same as their economy-wide counterpart.

4.3.9 Occupational Shares in Aggregate Regional Employment

The nine-industry ORANI computer data base contains a matrix of persons employed by occupation and industry. It was necessary to break this down into two corresponding regional matrices. Tasmanian employment figures by Edwards input-output industry for 1977-78 were available from Table 10 of Edwards (1981). These figures were aggregated to the nine-industry level using the concordance in Table 4.1 above. Where there was not a straightforward mapping of Edwards industries to FEDERAL (TASMAIN) industries, additional employment information was obtained from the estimates of 1977-78 Tasmanian employment by ORANI industry in Table 3.11 of Hagger, Madden and Groenewold (1987). The 1977-78 estimates were brought to 1978-79 estimates by multiplying each Tasmanian industry employment figure by a factor, calculated to result in a total Tasmanian employment figure equal to a weighted average of the August 1978 and 1979 figures for Tasmanian employment recorded in Table 7.4 of ABS (1986a). A matrix of Tasmanian employed persons by industry and occupation was then formed by assuming that occupational shares in a particular industry was the same for Tasmania and Australia. The mainland matrix was then formed as residuals. The occupational shares, ψ^{r}_{1m}, m = 1, ..., M, r = 1, 2 could then be calculated by dividing the sum for the m^{th} occupation row in the region r matrix by the sum of all entries in the region r matrix.

4.3.10 Regional Industry Shares in Aggregate Regional Capital Stock

It was first necessary to create capital stock matrices for each region. This was done on the basis of the regional shares for each commodity to industry capital formation which could be calculated from the combination of the $\tilde{B}^{1\cdot}$, $\tilde{B}^{2\cdot}$ and $\tilde{G}^{\cdot}$ matrices. Having done this the ψ^{r}_{2j}, j = 1, ..., h, r = 1, 2 could be calculated by dividing the sum of the j^{th} column for the region by the sum of all entries for the region's capital stock matrix.

4.3.11 Share of Region's Employment and Capital Stock in Economy-wide Aggregates

The share of region r employment in economy-wide aggregate employment, ψ^{r}_{1}, was calculated by dividing the sum of all entries in the region's occupational employment by industry matrix by the sum of all entries in the corresponding economy-wide matrix.

Similarly, the total of all entries in region r's capital stock matrix was divided by the sum of all entries in the economy-wide capital stock matrix to give the share of region r's capital stock in the national economy aggregate capital stock, ψ^{r}_{2}.

4.3.12 Net Interest Payments Overseas

Although this information does not concern parameters of the model it has been stored in the parameters file for convenience. Interest payable overseas by Australia was calculated from Table 20 of ABS (1985c) as the sum of interest payable on direct investment in Australia, interest on government loans and other property income interest payable. Net interest payable was then calculated by subtracting from this sum interest receivable on Australian direct investment as recorded in Table 19 of ABS (1985c). Net interest payable overseas by region was then calculated by multiplying the Australian net interest figure by the region's share of Australia's population in 1979 (see ABS (1980a) p. 96).

4.3.13 Labour Force Parameters

The method of calculating the parameters in the equation modelling percentage change in regional unemployment level is described in section 2.2.13. The required Tasmanian data for aggregate employed persons, labour force and unemployed was obtained from Table 4 of ABS (1986b). Corresponding figures for Australia were available from Table 1 of the same publication. The required mainland data could thus be calculated by subtraction.

Chapter 5

Illustrative Applications

5.1 Introduction

In this chapter we examine our initial simulations with the FEDERAL model. Three sets of simulations were undertaken. The first set was designed to test the homogeneity properties of the model. They are discussed fully in section 5.2.2 below. The second set consisted of a single simulation which involved an increase in the tariff protection of Australia's Manufacturing Import Competing (hereafter, I.C.) industry. The third set of simulations involved increases in the rates of payroll taxes levied by state governments.

The tariff simulation was chosen as an illustrative application because it is one which has been frequently undertaken with other models. The tariff experiment facilitates a comparison of FEDERAL results for a national shock with results for the same type of experiment conducted with ORANI, ORANI-ORES and ORANI-TAS.

The payroll tax experiments were chosen because they belong to a class of experiments which do not lend themselves at all to analyses with a "top-down" model and for which even a hybrid model is not well suited. The intention of the set of payroll-tax experiments is to demonstrate the advantages of FEDERAL in the analyses of shocks generated at the regional level.

5.2 Computing FEDERAL Solutions

5.2.1 Solution Method

FEDERAL's equation system was solved using the GEMPACK general purpose software packages developed by Pearson and Codsi (see Pearson (1986) and Codsi and Pearson (1988)). The first step was to construct a computer implementation of the linear equation system described in Table 2.1. This was done with the aid of the GEMPACK utility, TABLO. The FEDERAL system can be represented in matrix notation as

$$Az = 0$$

where A is a (m x n) matrix of coefficients, z is a (n x 1) vector of variables and 0 is a (m x 1) null vector.

TABLO was used to generate this matrix on computer with all non-zero elements of the A matrix being calculated in accordance with the method described in Table 3.2.[1]

The n variables of the model are greater than the m equations. The next step was to divide the n variables into m endogenous variables and n-m exogenous variables. In Table 5.1 we show the choice of variables we made for which of the variables listed in Table 2.2 were to be categorized as exogenous for the simulations reported in this chapter. If z_1 denotes the (m x 1) vector of endogenous variables and z_2 the ((n - m) x 1) vector of exogenous variables, the above equations can be re-written as

$$A_1z_1 + A_2z_2 = 0$$

where A_1 is the (m x m) matrix of coefficients formed by choosing those columns of A corresponding to the z_1 sub-set of z and A_2 the (m x (n - m)) matrix of coefficients comprising the columns of A not included in A_1. The following expression can then be obtained

$$z_1 = -A_1^{-1}A_2z_2 .$$

The GEMPACK program, SAGEM, performs these steps for a user chosen set of exogenous variables and then uses the above expression to compute the vector of endogenous (percentage-change) variables for the user chosen values assigned to each element of the vector of exogenous (percentage-change) variables.[2]

5.2.2 Computational Checks

The availability of the TABLO program considerably eased the burden of establishing the FEDERAL linear system on computer. However, the size and complexity of FEDERAL meant that still very large computer tasks remained. There was consequently large scope for error via mis-coding of one sort or another.

One way of checking for this is to conduct some simulations where we already know what the set of endogenous variables should look like. These simulations are the ones that make use of the model's homogeneity properties.

In a CGE model it is necessary to normalize prices (i.e. determine an absolute price level) in order that the model can be solved. In the FEDERAL simulations reported in this chapter we do this by choosing the exchange rate as the numeraire. One expects the algebra of a CGE model to be such that any change in the numeraire would leave real variables unaffected (since the economic theory underlying these models assumes that agents are only affected by relative prices) and would change all nominal variables by the same percentage as the numeraire.

An examination of Table 2.1 indicates that this is basically true for FEDERAL provided that all relevant price indexing parameters are set to unity and the percentage change in Commonwealth and state government interest payments, $t_3^{(6)r}$ and $t_3^{(5)ru}$, are also assigned the same value as the exchange rate. The only exception to the results indicated in the previous paragraphs would be in the variables which were not in percentage change terms, namely the three borrowing requirement variables and the balance of trade. Looking at any of the equations (2.123), (2.124), (2.72) reveals that uniform percentage changes in the value of outlays (imports) and (export) receipts will not lead to a zero change in the borrowing requirement/balance of trade unless its base year value was zero.

A simulation was carried out to test if these results were indeed correctly computed. The split between exogenous and endogenous variables should be immaterial to our result and thus the split nominated in Table 5.1 (and the other run-time choices) were employed in our simulation. It will be noted that Table 5.1 shows the indexing parameters, $h^{(3,8)r}$ and $h^{(4,7)}$, set to zero. Thus in addition to imposing a one per cent shock on ϕ, $t_3^{(6)r}$ and $t_3^{(5)ru}$, it was necessary to impose a one per cent shock on $f^{(3,8)r}$ and $f^{(4,7)}$ so that $b^{(3,8)r}$ and $b^{(4,7)}$ - state and Commonwealth government other (interest) receipts - would move with the one per cent change in price levels. Examination of the results for a simulation with the working version of the model did indeed reveal that the results for all real variables were zero and for all nominal values were unity, with the exception of the four non-percentage change variables mentioned above.[3]

Another test which can be carried out is in a sense the converse of the above nominal homogeneity test. This is the real homogeneity test. Given the constant returns to scale assumption of FEDERAL one would expect that a, say, one per cent increase in all exogenous real variables would result in a one per cent change in all endogenous real variables but leave all endogenous price variables unaffected (given no change in exogenous price variables).

Looking at equation (2.127) it can be seen that we have built a small non-(real) homogeneity property into the FEDERAL model. We have no way to expand the value of real foreign debt in our model and this will affect the value of nominal regional disposable income in our real homogeneity test. In order to confine this non-(real) homogeneity to a very few endogenous variables in our simulation testing the real homogeneity property we change the model closure slightly from that outlined in Table 5.1. Real regional consumption was reassigned to the exogenous category and regional average propensity to consume to the endogenous.

We imposed those shocks necessary to cause a real expansion of the Australian economy by one per cent. This essentially required an expansion of the economy's productive resources and of all exogenous components of demand. Thus we assigned the value one per cent to current capital stocks, $k_j^r(0)$, use of agricultural land, n_j^r, the size of the regional labour force, $f^{(6,3)r}$, the number of households in a region, q^r, regional real consumption, c_R^r, and foreign demands for Australian exports.[4] The export shock actually involved a number of shocks due to the presence of non-export commodities and our provision in FEDERAL for a flexible modelling of exports (see section 2.2.5). In regards to the non-export commodities we assign the value of one per cent to export volumes both economy-wide and regionally (i.e. to $x_i^{(4)}$ and $x_{(ir)}^{(4)}$). In order to keep the export prices of these commodities constant it was necessary to assign the value $\gamma_{(ir)}$ (the reciprocal of the foreign elasticity of demand for domestic good i produced in region r) to each non-export $f_{(ir)}^e$ - this keeps the $p_{(ir)}^e$'s zero and the p_i^e's are held at zero via equation (2.26). The export $f_{(ir)}^e$'s must also be given the value $\gamma_{(ir)}$ to generate an expansion in world demand for the export commodities. Finally in order to ensure that equation (2.24), which under the Table 5.1 scenario should play no role in the determination of export variables, is rendered inactive, we assign the value γ_i to f_i^e for the three export commodities.

Some additional shocks were also necessary to ensure that all the real determinants of disposable income (except foreign debt repayments) expanded by one per cent. As with the nominal homogeneity test, $t_3^{(6)r}$, $t_3^{(5)ru}$, $f^{(3,8)r}$ and $f^{(4,7)}$ were assigned the value unity. Also one per cent shocks were given to the shift terms for state government transfers to persons, $f_1^{(5r)}$, Commonwealth transfers to the states, $f^{(6,4)r}$, and Commonwealth transfers to persons, $f^{(6,5)r}$.

The results of the simulations turned out as expected. The result for the percentage change in all endogenous price variables was zero. All real endogenous variables and all nominal variables which are in value terms (e.g. a government's receipts) were projected to increase by one per cent, with the few expected exceptions. From equation (2.127), we expected the percentage change in regional net personal taxes and transfers, d_2^r, to be equal to $1 - D_5^{(2)r}$, where $D_5^{(2)r}$ is the share of interest paid overseas in net personal taxes and transfers. This is indeed the result we found. The consequence of this is that regional disposable income, d_1^r, expands by slightly more than one per cent, and the regional average propensity to consume, f_C^r, fell slightly. No other variables were affected. The only other exceptions were, as expected, the borrowing requirements and trade balance and the f_i^e's for the non-export commodities (which increased by γ_i).

The successful passing of the nominal and real homogeneity tests has assured us that, at the very least, all share coefficients add to unity across their relevant range. We now proceed to further simulations which will allow us, inter alia, to assess further the computational accuracy of the implemented model.

5.3 Illustrative Applications

5.3.1 The Shocks

5.3.1.1 The Tariff Shock

The tariff rate experiment involved simulating a 10 per cent increase in the tariff rate applying to imports of commodity 3, Manufacturing I.C. The shock was thus imposed by assigning the value 10 to the third element in the vector t(i3,0), the percentage change in the ad valorem rates of import duties appearing in the list of exogenous variables for this experiment.

5.3.1.2 Payroll Tax Shocks

The payroll tax experiments consist of a set of three simulations: (i) a unilateral 10 per cent increase in payroll tax rates for all Tasmanian industries imposed by the Tasmanian Government; (ii) a unilateral 10 per cent increase in payroll tax rates for all Mainland industries imposed by the Mainland Government; (iii) a 10 per cent payroll tax rate increase imposed simultaneously by both governments on all industries within their respective states of jurisdiction.

As with the tariff experiment the method of imposing the shock in each of the three payroll-tax simulations is quite straightforward. Recall that FEDERAL contains for each regional industry a set of M (=10) equations which link payroll taxes to wages (exclusive of payroll tax). These equations are designated as equation (2.85) in Table 2.1 and for convenience we repeat that equation here.

$$p^{(1)r,3}_{(g+1,1,m)j} = h^{(1)r,3}_{(g+1,1,m)j} p^{(1)r,4}_{(g+1,1,m)j} + f^{(1)r,3}_{(g+1,1)} + f^{(1)r,3}_{(g+1,1,m)} + f^{(1)r,3}_{(g+1,1)j} + f^{(1)r,3}_{(g+1,1,m)j} \qquad (2.85)$$

There are 2hM of these equations and their subscript ranges are $r = 1, 2$; $j = 1,\ldots, h$ and $m = 1, \ldots M$. Recall that $p^{(1)r,3}_{(g+1,1,m)j}$ is the percentage change in the payroll tax per labour unit of skill m employed in regional industry (jr), $p^{(1)r,4}_{(g+1,1,m)j}$ is the percentage change in pre-PAYE-tax nominal wage (exclusive of payroll tax) per labour unit of skill m employed in regional industry (jr), $h^{(1)r,3}_{(g+1,1,m)j}$ is an at-choice parameter and the f's are (percentage change) payroll-tax shift variables. Table 5.1 shows each of the $h^{(1)r,3}_{(g+1,1,m)j}$ set equal to unity and, for all intents and purposes, the f's can be interpreted as the percentage change in the payroll tax rate.

We thus impose the shock as follows. Set all $f^{(1)r,3}_{(g+1,1,m)}$, $f^{(1)r,3}_{(g+1,1)j}$ and $f^{(1)r,3}_{(g+1,1,m)j}$ equal to zero. For simulation (i) set $f^{(1)1,3}_{(g+1,1)}$ equal to 10 and $f^{(1)2,3}_{(g+1,1)}$ equal to zero; for simulation (ii) set $f^{(1)1,3}_{(g+1,1)}$ equal to zero and $f^{(1)2,3}_{(g+1,1)}$ equal to 10; for simulation (iii) set $f^{(1)r,3}_{(g+1,1)}$ equal to 10 for all r. All other exogenous variables not mentioned are, of course, assigned the value zero.

5.4 The Scenario

The scenario underlying the four simulations outlined above is encapsulated in the various choices which were made while setting up the experiments which are listed in Table 5.1. We explain the chief elements of the scenario below:

i) The simulations relate to the short run - current capital stocks in each regional industry are fixed;

ii) Labour markets are slack - pre-tax wages (excluding payroll taxes) are effectively 100 per cent indexed with the national cpi[5];

Table 5.1

Choices Made for the FEDERAL (TASMAIN) Simulations

1. List of Exogenous Variables

Variables	Subscript Range	Number	Description
$k_j^r(0)$	j = 1,...,9 r = 1,2	18	Current capital stocks
n_j^r	j = 1,...,9 r = 1,2	18	Regional industry use of agricultural land
$p^m_{(i3)}$	i = 1,...,9	9	c.i.f. foreign currency import prices
f_C^r	r = 1,2	2	Average propensity to consume in region r
q^r	r = 1,2	2	Number of households in region r
t(i0,4)	i = 1,...,9	9	Term allowing for ad valorem treatment of export taxes
t(i3,0), v(i3,0)	i = 1,...,9	18	Ad valorem and specific import duties terms
t(is,jrkl), v(is,jrkl)	k,r = 1,2 i = 1,...,9 s = 1,2,3 j = 1,...,9	1,944	Ad valorem and specific state government (intermediate purchases) sales tax terms
t(is,jk2), v(is,jk2)	k = 1,2 i = 1,...,9 s = 1,2,3 j = 1,...,9	972	Ad valorem and specific Commonwealth (intermediate purchases) sales tax terms
t(is,3rl), v(is,3rl)	r = 1,2 i = 1,...,9 s = 1,2,3	108	Ad valorem and specific state government consumption sales tax terms
t(is,32), v(is,32)	i = 1,...,9 s = 1,2,3	54	Ad valorem and specific Commonwealth consumption sales tax terms
f_R		1	Economy-wide real investment to real consumption ratio
ϕ		1	Exchange rate, $A per foreign unit of currency

Table 5.1 continued

Variables	Subscript Range	Number	Description
$v(i0,4)$	$i = 1,\ldots,9$	9	Complementary selection of export-tax terms, export volumes and shift variables
$x_i^{(4)}$	$i = 3,5,\ldots,9$	6	
f_i^e	$i = 1,2,4$	3	
$v(ir,4)$	$i = 1,2,4$ $r = 1,2$	6	
$f_{(ir)}^{(e)}$	$i = 1,\ldots,9$ $r = 1,2$	18	
$x_{(ir)}^{(4)}$	$i = 3,5,\ldots,9$ $r = 1,2$	12	
f's	See Table 2.2	795	All shift terms, except $f^4_{(ir)}$ (term allowing direct substitution between regions in exports of an industry) and those listed above
a's (except a_j^r)	See Table 2.2	24,579	
		28,584	

2. Values for User Specified Parameters

Parameter	Value
$h_{(is)}^{(5,1)r}$	1.0
$h_{(is)}^{(6,1)}$	1.0
$h_1(i3,0)$	0.0
$h_2(i3,0)$	1.0
$h_3(i3,0)$	0.0
$h_1(i0,4)$	0.0
$h_2(i0,4)$	1.0 for i = 1,2,4; else 0.0
$h_3(i0,4)$	0.0
$h_4(i0,4)$	1.0 for i = 3,5,6,7,8,9 else 0.0

Table 5.1 continued

Parameter	Value
$h_1(is,jrk1)$	0.0
$h_2(is,jrk1)$	1.0
$h_3(is,jrk1)$	0.0
$h_1(is,jk2)$	0.0
$h_2(is,jk2)$	1.0
$h_3(is,jk2)$	0.0
$h_1(is,3r1)$	0.0
$h_2(is,3r1)$	1.0
$h_3(is,3r1)$	0.0
$h_1(is,32)$	0.0
$h_2(is,32)$	1.0
$h_3(is,32)$	0.0
$h_j^{(2)r}$	n.a.
$h_j^{(5)r}$	1.0
$h_j^{(6)}$	1.0
$h_{(g+1,1,m)j}^{(1)r,1}$	0.0
$h_{(g+1,1,m)j}^{(1)1}$	1.0
$h_{(g+1,1,m)j}^{(1)2}$	1.0
$h_{(g+1,1,m)j}^{(1)r,3}$	1.0
$h_{g+2,j}^{(1)r}$	1.0
$h_{g+3,j}^{(1)r}$	1.0
$h_{g+4,j}^{(1)r}$	1.0
$h_{(g+1,2)j}^{(4)}$	1.0
$h_{(g+1,3)j}^{(4)}$	1.0
$h^{(6,3)}$	1.0

Table 5.1 continued

Parameter	Value
$h^{(7)r}$	1.0
$h_j^{(8)r}$	1.0
$h^{(6,4)r}$	1.0
$h^{(6,5)r}$	1.0
$h^{(6,6)}$	1.0
$h^{(4,7)}$	0.0
$h_1^{(5)r}$	1.0
$h_2^{(5)r}$	1.0
$h^{(3,8)r}$	0.0

3. The Export Commodities

$$G = (1, 2, 4)$$

4. The Endogenous Private Investment Industries

$$j \varepsilon J = (1, 2, 3, 4, 5, 6, 7, 8, 9)$$

iii) Real domestic absorption is endogenous -

- real consumption in each region is linked to regional income
- current government real expenditure moves with real consumption (state government expenditure with real regional consumption and Commonwealth government expenditure with economy-wide real consumption)
- total economy-wide real investment moves with real consumption economy-wide;

iv) The nominal exchange rate is the numeraire;

v) Unemployed benefits and unit tax rates are 100 per cent indexed to either the economy-wide or appropriate regional cpi.

vi) There are no exogenous-investment industries for private investment. Commonwealth (state government) capital investment moves with total economy-wide (regional) private investment.

vii) Each regional commodity faces a separate foreign export demand function. This assumption is appropriate for the current version of FEDERAL (TASMAIN) where there are only a small number of sectors - our current implemented version of FEDERAL (TASMAIN) has only nine industries - and the export commodities are sufficiently aggregated for Tasmanian and Mainland exports of a particular commodity to be considered to have very low substitutability. For the alternative theory to be employed for a version of FEDERAL with more disaggregated exports, see section 2.2.5.
Despite the intra-commodity difference in Tasmanian and Mainland output of the same export commodity, it has been

assumed for these experiments that there is no regional difference in export elasticities.

Finally it should be noted that for the simulations reported in this chapter, a different version of the capital accumulation equation from that specified in Chapter 2 was used. The specification employed was equation (55) in Madden (1987) where it was assumed that private investors only consider private capital expenditure when allocating their investment across industries.[6]

5.5 The Results

5.5.1 Tariff Experiment

5.5.1.1 Broad Results

The broad effects of the 10 per cent increase in the Manufacturing Import-Competing tariff rate are shown in Table 5.2. Before discussing these results it is important to comment on the way in which the results are presented. The results of the tariff experiment under the scenario described in the previous section are shown in the fourth column. However, in interpreting these results it will prove helpful to decompose them into two essential components. The first component is the effects resulting from the tariff increase prior to any change in real domestic absorption. The second component is the effects resulting from the induced change in real domestic absorption.

We achieve this decomposition in the following way. We rerun the tariff experiment with a key change in the scenario. Real regional consumption is placed in the exogenous category and its place among the endogenous variables is taken by regional average propensity to consume. The results from this experiment are shown in the left hand column. With real consumption constant in each

Table 5.2

Broad Effects of a 10 per cent Rise in the Manufacturing-Import Competing Tariff

Changes in Variables (per cent)	Primary Effects of Tariff Increase	Effects of Induced Change in Real Consumption Nationally	Effects of Induced Change in Relative Real Regional Consumption	Total Effects of Tariff Increase
Real GDP[a]	-0.046	-0.056	..	-0.101
Real Tasmanian GSP[a]	-0.091	-0.021	0.020	-0.092
Real Mainland GSP[a]	-0.044	-0.057	-0.001	-0.102
Nominal GDP[a]	0.231	-0.268	..	-0.038
Nominal Tas. GSP[a]	0.177	-0.219	0.034	-0.008
Nominal M'land GSP[a]	0.232	-0.270	-0.001	-0.038
Nominal Tas Disposable Income	0.228	-0.215	0.025	0.038
Nominal M'land Disposable Income	0.242	-0.242	-0.001	-0.001
Tas. Direct Taxes/Transfers	-0.308	-0.258	0.120	-0.446
M'land Direct Taxes/Transfers	0.143	-0.523	-0.003	-0.384
Real Consumption	-	-0.154	-	-0.154
Real Tas. Consumption	-	-0.154	0.041	-0.114
Real M'land Consumption	-	-0.154	-0.001	-0.156
Tasmanian apc	0.084	-0.114	0.030	-
Mainland apc	0.098	-0.097	-0.001	-
National Employment	-0.066	-0.074	..	-0.139
Tas. Employment	-0.137	-0.021	0.026	-0.132
M'land Employment	-0.064	-0.075	-0.001	-0.140
cpi	0.339	-0.185	..	0.155
Tasmanian cpi	0.312	-0.175	0.015	0.152
Mainland cpi	0.340	-0.185	..	0.155
Real Investment	-	-0.154	-	-0.154
Real Tas. Investment	-0.009	-0.113	0.041	-0.081
Real M'land Investment	..	-0.155	-0.001	-0.156
ipi	0.387	-0.159	..	0.228
Tasmanian ipi	0.339	-0.159	0.007	0.187
Mainland ipi	0.388	-0.159	..	0.229
Exports[b]	-0.654	0.390	..	-0.264
Imports[b]	-0.369	-0.187	..	-0.556
Change Balance of Trade[c]	-0.052	0.112	..	0.060

a. Measured at factor cost, see section 5.5.1.2.3.
b. Foreign currency value.
c. Percentage of GDP.
.. indicates rounded to zero.
\- indicates zero.

region the regional average propensity to consume rises by the same percentage as regional real disposable income falls.

The two middle columns come by running experiments (again with exogenous real regional consumption) to simulate falls in real regional consumption equal to the falls for that (vector) variable shown in the fourth column. The induced consumption effects have themselves been broken down into two components. The second column provides the results of a simulation in which real consumption in each region is reduced by the percentage fall induced for real consumption at the economy-wide level (-0.154 per cent). However we see from column 4 that the induced real consumption effects from the tariff increase are not equal across regions. Column 3 provides results for the required change in relative real consumption for the two regions. Thus we see that in column 3 real consumption for Tasmania is shocked by 0.040633 (= -0.113839 + 0.154472) per cent while mainland real consumption is shocked by -0.001068 (= -0.155540 + 0.154472) per cent. Thus if we add across the real regional consumption shocks for the first three columns we arrive at the endogenous result for real consumption shown in column 4.

Another way of considering this decomposition is to look at the average propensity to consume. As explained above, the effect of holding real consumption constant in column 1 is that the average propensity to consume rises. This effect is reversed in column 2 by the uniform real consumption shock. However the reversal is not exact - the percentage change in average propensity to consume in Tasmania, for instance, is after the first two shocks equal to -0.030. Thus it is necessary to find the changes in real consumption in each region which will force the combined effects over the first three columns on the average propensities to consume to zero (the column 4 assumption). The required shocks are the solutions to the two equations:

$$\xi_{(f_C^1,\ c_R^1)} c_R^1 + \xi_{(f_C^1,\ c_R^2)} c_R^2 = 0.030$$

$$\xi_{(f_C^2,\ c_R^1)} c_R^1 + \xi_{(f_C^2,\ c_R^2)} c_R^2 = -0.001$$

where $\xi_{(f_C^r,\ c_R^r)}$ is the elasticity of the average propensity to consume in region r to a one per cent shock to c_R^r computed by a FEDERAL simulation under the assumed environment for column 3. Not unexpectedly the solutions are: $c_R^1 = 0.0406$ and $c_R^2 = -0.0011$.

The advantage of carrying out the decomposition of our results into a primary effect (no change in real consumption) and an induced consumption effect becomes clear when we examine the results and see that while the induced consumption effects magnify the results for some variables they reduce the results for other variables, occasionally changing the sign. Further decomposing of the consumption effects into those resulting from a uniform nationwide real consumption change and a change in relative regional real consumption allows for an easier interpretation of the regional results as the uniform change highlights the different way each region reacts to a real consumption shock leaving the relative difference in the real consumption shock to each region to be considered separately. A further advantage of the decomposition is that it allows an easier comparison with published ORANI-(ORES) results.

Turning now to the broad results themselves we note the conventional ORANI macro results for an increase in protection against imports. Economy-wide GDP and employment are projected to fall and the cpi and ipi rise. Both exports and imports decline and, with real domestic absorption constant, the balance of trade deteriorates. This last effect is reversed by the consumption induced effects.[7]

At a national level we note that the deleterious effects on employment and GDP are doubled by the consumption induced effects. The strength of this multiplier effect is enhanced by our linking of real government expenditure and economy-wide real investment to real consumption.

An important result is that while Tasmania is far more adversely affected by the tariff shock under the assumption of constant real domestic absorption, once the induced consumption effects are taken into account Tasmania is projected to fare slightly better (i.e. less badly) than the mainland. As can be seen the induced consumption effects actualy make a very slight improvement to projected Tasmanian employment. It will help our explanation to leave this key result aside for the moment and examine the column 1 results in some depth first. We return to the consumption-induced results in section 5.5.1.3, but will include consumption-induced effects in appropriate tables prior to that section for reasons of conciseness in the use of tables.

5.5.1.2 Primary Effects

5.5.1.2.1 Industry Results

Examining the results of column 1 of Table 5.3, it can be seen that in both regions only two of the nine industries are projected to increase their activity. These are Manufacturing I.C., the industry which receives the increase in protection, and Construction which gains from the way investment is reallocated.

Table 5.3

Percentage Change in Regional Industry Output

Consequent on 10 per cent Increase in Manufacturing I.C. Tariff Rate

Change in Regional Industry Output (per cent)	Primary Effects of Tariff Increase	Effects of Induced Change in Real Consumption Nationally	Effects of Induced Change in Relative Real Regional Consumption	Total Effects of Tariff Increase
Tasmania				
1. Rural	-0.338	0.179	-0.001	-0.160
2. Mining	-0.339	0.176	-0.005	-0.168
3. Manufacturing IC	0.109	-0.050	0.008	0.067
4. Manufacturing Export	-0.654	0.368	-0.016	-0.302
5. Utilities	-0.115	0.016	0.013	-0.085
6. Construction	0.057	-0.155	0.042	-0.056
7. Margins	-0.113	-0.052	0.026	-0.139
8. Community Services	-0.003	-0.151	0.039	-0.115
9. Other Tertiary	-0.019	-0.055	0.020	-0.054
Mainland				
1. Rural	-0.313	0.161	..	-0.153
2. Mining	-0.249	0.132	..	-0.117
3. Manufacturing IC	0.134	-0.061	..	0.073
4. Manufacturing Export	-0.561	0.282	..	-0.279
5. Utilities	-0.027	-0.052	..	-0.080
6. Construction	0.085	-0.207	-0.001	-0.124
7. Margins	-0.064	-0.093	-0.001	-0.158
8. Community Services	-0.004	-0.149	-0.001	-0.154
9. Other Tertiary	-0.005	-0.064	-0.001	-0.070

Worst affected are the export industries (Rural, Mining and Manufacturing Export) which are unable to pass on the bulk of the cost increases.

Comparing the output declines for the export industries across regions, we see Tasmania is projected to suffer a larger decline in all three industries. The explanation for the regional differences surrounds the comparative export performance of the industries between regions and the importance of exports in total output.

Thus we find the following changes in export prices and volumes as listed in Table 5.4.

Table 5.4

Effects of Tariff Increase (Real Domestic Absorption Constant) on Exports

Commodity	Export Price		Export Volume	
	Tasmania %	Mainland %	Tasmania %	Mainland %
1. Rural	0.127	0.047	-1.087	-0.406
2. Mining	0.030	0.033	-0.455	-0.495
4. Manufacturing Export	0.095	0.135	-1.159	-1.646

It is noticeable that export prices increase by much less than the cpi's, as would be expected, given the high export demand elasticities of the three commodities of 8.6, 15.0 and 12.2 respectively. Mining with the highest elasticity experiences only a very small rise in export prices.

Although the activity of Tasmanian Rural is projected to experience only a slightly larger activity decline than its mainland counterpart, its export price is projected to rise considerably more and its export volume decline by considerably more than is the case for Mainland Rural. Two factors contribute to the higher Tasmanian export price. The first is apparent from Table 5.6 which shows that Tasmanian Rural uses a higher proportion of both domestic and imported commodity 3, the commodity receiving the increased protection, than Mainland Rural uses. Secondly, it has a considerably lower export share than its mainland counterpart (0.123 compared with 0.313). The first factor leads directly to greater cost increases for the Tasmanian sector, while the latter implies a lower price elasticity across all sales (domestic and export) and a consequent greater ability to pass on cost increases. However Tasmanian Rural's lower export share also means that its export performance is less important in determining the industry activity result. Multiplying the share by the percentage change in export volume shows the decline in exports to make almost the same contribution to the change in Mainland Rural's output as is the case with Tasmanian Rural, despite the significantly greater decline in Tasmanian Rural's exports.

Mining's high export share and relatively high capital intensity (see Table 5.5) prevent much increase in its export price or decline in export volumes. Mining exports decline by less than half a per cent in both regions. That it is still a noticeable export decline is, of course, due to the high export elasticity. However Tasmanian Mining's higher export share, 0.492 compared with 0.398 for Mainland Mining leads to a larger decline in Tasmania in the activity of that industry.

Manufacturing Export is the most adversely affected of the export industries. Table 5.5 reveals a much lower share of fixed factors (capital and land) than for the other two export industries and thus it has a flatter supply curve.[8] Mainland Manufacturing Export the least fixed factor intensive of the two regional industries and with a greater use of imported commodity 3 (see Table 5.6), is the more adversely affected in regards to exports. However Tasmanian Manufacturing Export with an export share of 0.553, compared with 0.318, experiences the greater decline in activity.

Table 5.5

Input Structure of Regional Industries

Input \ Industry	1	2	3	4	5	6	7	8	9	All Industries
Tasmania										
Intermediate	123.3	116.6	577.6	351.1	23.3	292.2	300.3	89.4	186.7	2060.5
Labour	126.9	77.7	231.7	74.3	41.0	186.0	320.4	366.3	182.0	1606.2
Capital	23.6	74.8	87.0	32.6	47.6	24.1	76.7	11.0	229.1	606.4
(Share[a])	(0.075)	(0.245)	(0.090)	(0.068)	(0.391)	(0.044)	(0.096)	(0.023)	(0.351)	(0.130)
Land	37.5	-	-	-	-	-	-	-	-	37.5
(Share[b])	(0.119)									
Other[c]	3.8	36.3	69.0	19.9	9.9	47.2	100.2	8.5	54.0	349.0
TOTAL	315.1	305.4	965.3	477.9	121.8	549.5	797.6	475.2	651.8	4659.6
Mainland										
Intermediate	2959.7	2359.3	27305.4	10310.5	2198.4	8947.8	12193.3	6658.1	8778.6	81711.1
Labour	3588.9	1255.5	9886.7	2309.1	1233.4	5310.5	15140.0	13717.0	8287.3	60728.2
Capital	997.5	1783.1	2141.8	750.2	1238.0	497.6	2630.0	356.9	10966.0	21361.1
(Share[a])	(0.107)	(0.284)	(0.052)	(0.054)	(0.251)	(0.032)	(0.079)	(0.017)	(0.358)	(0.121)
Land	1588.5	-	-	-	-	-	-	-	-	1588.5
(Share[b])	(0.171)									
Other[c]	157.6	870.2	1707.1	552.2	259.2	991.1	3518.7	278.0	2577.1	10911.4
TOTAL	9292.2	6268.1	41041.0	13922.0	4929.0	15747.0	33482.0	21010.0	30609.0	176300.3

a. Share of capital costs in total input costs for the regional industry.
b. Share of land costs in total input costs for the regional industry.
c. Mainly working capital and production taxes.

Table 5.6

Proportion of Commodity 3 (Manufacturing Import Competing)

in Total Inputs to Current Production[a]

Source of Supply:	Domestic Regions		Overseas		All Sources	
Purchasing Industry \ Region of Purchase	Region 1	Region 2	Region 1	Region 2	Region 1	Region 2
1. Rural	0.123	0.082	0.005	0.018	0.128	0.100
2. Mining	0.107	0.062	0.028	0.032	0.135	0.094
3. Manufacturing IC	0.175	0.229	0.059	0.100	0.235	0.329
4. Manufacturing Export	0.062	0.057	0.009	0.017	0.071	0.074
5. Utilities	0.055	0.039	0.005	0.018	0.060	0.057
6. Construction	0.210	0.332	0.026	0.052	0.236	0.384
7. Margins	0.133	0.104	0.008	0.022	0.141	0.126
8. Community Services	0.053	0.074	0.002	0.038	0.055	0.112
9. Other Tertiary	0.095	0.045	0.009	0.020	0.104	0.065

a. i.e. Share of basic value of commodity 3 inputs in total costs of current production by a regional industry.

The poorer projected performance of Tasmania's export industries, as a whole, also results in greater declines by Tasmanian Margins, Tasmanian Utilities and, to a lesser degree, Tasmanian Other Tertiary than their mainland counterparts. An important use of Margins is in facilitating exports of commodities 1, 2 and 4, while adversely affected industries are important customers of Utilities - particularly in Tasmania where Utilities have a higher sales share to Manufacturing Export than is the case with the mainland.

Finally, we see that Manufacturing I.C. is projeced to increase slightly less in Tasmania than in the mainland. This results from a considerably higher share of fixed factors (capital) in the Tasmanian industry than in Mainland Manufacturing I.C. However, the effects on the relative regional industry results of this difference in factor inputs is likely to have been significantly mitigated by the mainland industry having a considerably higher proportional usage of commodity 3 itself - particularly imported commodity 3 - than the Tasmanian industry.

This last point raises a problem with our aggregated nine-industry implemented version of FEDERAL (TASMAIN). Table 5.6 reveals that almost a quarter of Tasmanian Manufacturing I.C. and almost a third of Mainland Manufacturing I.C. inputs are intermediate inputs of Manufacturing I.C. itself. Thus Manufacturing I.C., while gaining from increased protection, suffers cost increases via its usage of commodity 3. At a much more disaggregated sectoral level, an examination of tariff rates indicates that rates tend to be highest on those products for which household consumption is likely to be important (see Table 1 of

Madden, Challen and Hagger (1981)). That is, tariff rates on intermediate manufactured products appear to be lower than on final products. Thus our aggregated model is likely to have resulted in greater cost increases for Manufacturing I.C. than would have been the case for a more disaggregated model. What the effect would have been with a more disaggregated model on the import-competing manufacturing industries in general is not absolutely clear. For those industries selling for the most part directly to final demand, one would expect a greater substitution (than indicated by FEDERAL) of the domestic good for the imported good with a consequent increase in activity of the domestic industry. For those industries selling basically to producers one would expect the converse. In so far as substitution elasticities and import shares are higher for industries selling to final consumers as opposed to current producers, our aggregated model will have understated the increase in activity of the Manufacturing I.C. industry.

It is useful to examine how each of the regional differences in the percentage change of an industry's activity contributes to the difference between regions in aggregate industrial activity. This is done via Table 5.7. For each region, the percentage change in each industry's activity is multiplied by the base year share of that industry in regional value-added to give the industry's contribution to the percentage change in the region's activity. The total of these contributions is the percentage change in aggregate industrial activity of the region (i.e. it is the weighted average of the industry percentage changes).

The table highlights that industrial composition has a part to play in Tasmania's overall poorer industrial outcome. Tasmania

Table 5.7

Contribution of Each Regional Industry to Regional Industry Activity

Industry	Projected Change %	Proportion of Value Added %	Contribution to State Industrial Activity %
Tasmania			
1. Rural	-0.338	0.0835	-0.028
2. Mining	-0.339	0.0677	-0.023
3. Manufacturing I.C.	0.109	0.1416	0.015
4. Manufacturing Export	-0.654	0.0475	-0.031
5. Utilities	-0.115	0.0394	-0.005
6. Construction	0.057	0.0934	0.005
7. Margins	-0.113	0.1765	-0.020
8. Community Services	-0.003	0.1677	-0.001
9. Other Tertiary	-0.019	0.1827	-0.003
Tasmanian Industrial Activity			-0.090
Mainland			
1. Rural	-0.313	0.0738	-0.023
2. Mining	-0.249	0.0363	-0.009
3. Manufacturing I.C.	0.134	0.1437	0.019
4. Manufacturing Export	-0.561	0.0366	-0.021
5. Utilities	-0.027	0.0295	-0.001
6. Construction	0.085	0.0694	0.006
7. Margins	-0.064	0.2124	-0.014
8. Community Services	-0.004	0.1682	-0.001
9. Other Tertiary	-0.005	0.2301	-0.001
Mainland Industrial Activity			-0.044

has a higher proportion of its activity in the three export industries which are the industries with the largest projected decreases in activity in both regions. The effect of this is particularly evident in the case of mining. Tasmanian Mining is projected to decline by only just over a third more than Mainland Mining. However, Tasmanian Mining's much higher base year share means that it contributes -0.023 to the percentage change in Tasmanian GSP compared with Mainland Mining's contribution of only -0.009 per cent to the percentage change in Mainland GSP. The three export industries contribute -0.082 to the percentage change in Tasmanian activity, whereas if the mainland weights had been applied to the Tasmanian industry activity changes, the contribution of these three industries would have been -0.061. If the mainland weights were applied across all Tasmanian industries the projected change in aggregate Tasmanian industrial activity would have been -0.074 per cent, instead of the -0.091 per cent which results from the use of the correct (Tasmanian) weights.

It will be noted that the regional industrial activity results correspond with the regional GSP figures (evaluated at factor cost) shown in Table 5.2. That, except for rounding errors in our post-simulation calculations, this correspondence should be exact can be esily demonstrated. The percentage change in regional industrial activity, z^r, were calculated by the formula:

$$z^r = \sum_j \frac{W_j^r L_j^r + R_j^r K_j^r + V_j^r N_j^r}{\sum_q W_q^r L_q^r + R_q^r K_q^r + V_q^r N_q^r} z_j^r \qquad (5.1)$$

where z_j^r is as defined in Table 2.2 but the other symbols are not necessarily consistent with that table in order to aid simplicity of explanation in this section (to which their use is confined). W_j^r, R_j^r and V_j^r are the base-year (rental) prices for labour, capital and land in regional industry (jr) and L_j^r, K_j^r and N_j^r are the base-year inputs of labour, capital and land into (jr).

The real GSP figures shown in Table 5.2 were calculated as a weighted average of the percentage changes in primary factor usage. Since the percentage changes in the use of capital and land in the short run are, by assumption, zero, this amounts to the percentage change in real gross state product at factor cost,

$$gsp^r = \frac{\sum_j W_j^r L_j^r}{\sum_j (W_j^r L_j^r + R_j^r K_j^r + V_j^r N_j^r)} \ell^r \qquad (5.2)$$

where ℓ^r, the percentage change in regional industry employment, is calculated as:

$$\ell^r = \sum_j (W_j^r L_j^r / \sum_q W_q^r L_q^r) x_{(g+1,1)j}^{(1)r} \qquad (5.3)$$

recalling that $x_{(g+1,1)j}^{(1)r}$ is the percentage change in regional industry, (jr), employment. It should be noted that this method of calculating ℓ^r differs from that used to obtain the regional employment figures in Table 5.2 which were calculated using employment-person weights. Substituting (5.3) into (5.2) and rearranging gives:

$$gsp^r = \sum_j (W_j^r L_j^r / \sum_q (W_q^r L_q^r + R_q^r K_q^r + V_q^r N_q^r)) x_{(g+1,1)j}^{(1)r} \qquad (5.4)$$

Now, as is shown in the Appendix, under the short-run environment of our tariff experiment the percentage change in regional industry employment is equal to the percentage change in that regional industry's activity divided by its share of labour costs in its primary-factor costs, i.e.

$$x_{(g+1,1)j}^{(1)r} = ((W_j^r L_j^r + R_j^r K_j^r + V_j^r N_j^r)/W_j^r L_j^r) z_j^r \qquad (5.5)$$

Substituting (5.5) into (5.4) and then (5.1) into the resultant equation, we get:

$$gsp^r = z^r.$$

5.5.1.2.2 Regional Investment

Although real investment is held constant at the economy-wide level for the column 1 results, the greater adverse primary effects on Tasmanian industrial activity compared with mainland activity results in a slight decline in overall real investment in Tasmanian industries (and a very slight rise in mainland real investment). Recall from section 2.2.8 that private investors in FEDERAL allocate investment over all regional endogenous-investment industries according to a rate-of-return theory. Regional industries more adversely affected than average should experience a relative decline in demand for their capital and a consequent relative fall in their rental rate. Ignoring tax effects and changes in the relative cost of assembling capital, such industries would experience a decline in their rate of return schedules relative to industries in general and a consequent relative decline in investment.

However, looking at the detailed investment figures we note that three Tasmanian industries whose activity fares worse than the corresponding mainland industries nevertheless are projected to fare better in relation to investment than the corresponding mainland industries. Tasmanian Rural investment falls by 1.762 per cent compared to a 2.137 per cent fall for Mainland Rural, while Tasmanian Manufacturing I.C. and Construction experience projected investment increases of 0.234 and 0.221 per cent compared to 0.217 and 0.213 for the mainland industries. The reason for these results can be found in equation (2.52) of FEDERAL. As can be seen from that equation, the cost of assembling capital in an industry is also important in determining that industry's current rate of return.

Table 5.8

Proportion of Commodity 3 (Manufacturing Import Competing) in Total Inputs to Capital Formation[a]

Source of Supply:	Domestic Regions		Overseas		All Sources	
Purchasing Industry \ Region of Purchase	Region 1	Region 2	Region 1	Region 2	Region 1	Region 2
1. Rural	0.301	0.228	0.046	0.144	0.347	0.372
2. Mining	0.288	0.210	0.004	0.133	0.332	0.343
3. Manufacturing IC	0.534	0.348	0.080	0.220	0.614	0.568
4. Manufacturing Export	0.605	0.387	0.091	0.245	0.696	0.632
5. Utilities	0.362	0.258	0.055	0.163	0.417	0.421
6. Construction	0.529	0.345	0.080	0.219	0.609	0.564
7. Margins	0.373	0.254	0.056	0.161	0.429	0.415
8. Community Services	0.179	0.137	0.027	0.087	0.206	0.224
9. Other Tertiary	0.056	0.043	0.009	0.027	0.065	0.070

a. i.e. Share of basic value of commodity 3 inputs in total purchases for capital formation by a regional industry.

The investment price index in column 1 of Table 5.2 shows that the rise in the cost of assembling units of capital in Tasmanian industries is, in general, projected to be less than the rise in this cost for the corresponding mainland industry. Examination of Table 5.8 indicates the reason for this. It can be seen that although units of capital in Tasmanian industries contain a higher percentage of domestically-produced commodity 3 than their mainland counterparts, the reverse is true for imported commodity 3. However, it is imported commodity 3 which is important to relative costs of assembling capital. The basic price of Tasmanian and Mainland commodity 3 rise by 0.325 per cent and 0.345 per cent respectively, while imported commodity 3's basic price rises by 0.802 per cent.

The effect of this is that the projected percentage increase in the cost of assembling units of capital in all Tasmanian industries is less than for their mainland counterparts and the projected decline in overall Tasmanian real investment is thus smaller than would have been the case if both regions had the same structure of inputs into capital formation.

5.5.1.2.3 Balance of Trade and GDP

It will be noted from Table 5.2 that, despite the increase in protection of the Australian Manufacturing Import-Competing industry against imports, the primary effect on the balance of trade is a deterioration equivalent to 0.05 per cent of GDP. This should not be surprising given the projected fall of 0.05 per cent in the column 1 figure for real GDP. We can see the connection between real GDP and the balance of trade if we examine the percentage change in real GDP from the expenditure side,

$$gdp = (A/GDP)\tilde{a} + (E/GDP)\tilde{e} - (M/GDP)\tilde{m},$$

where $\tilde{a}$ is the percentage change in real domestic absorption, $\tilde{e}$ the percentage change in total economy-wide export volumes, $\tilde{m}$ the percentage change in total economy-wide import volumes, and A, E and M are the levels of nominal domestic absorption, export values and import values (the latter two being in foreign currency prices). Then since $\tilde{a}$ is zero for column 1,

$$gdp = \frac{1}{GDP}(E\tilde{e} - M\tilde{m}).$$

Now, equation (2.72) of FEDERAL gives the change in the balance of trade: $100\ \Delta BT = Ee - Mm$, where e and m are in value terms in foreign currency prices. Given that foreign currency import prices are exogenous and the percentage change in foreign currency export prices are close to zero due to our use of high foreign demand elasticities, we can say:

$$gdp = 100\ \Delta BT/GDP.$$

That is the percentage change in real GDP is equal to the change in the balance of trade measured as a percentage of GDP, ignoring small terms of trade effects.

It will be noticed, however, that there is some discrepancy between the balance of trade result (-0.052) and the real GDP result (-0.046). The major reason is that the GDP figures in Table 5.2, like the GSP figures, have been calculated at factor cost. This differs from the normal definition of GDP (at market prices), that which corresponds with the figure calculated from the expenditure side, in that it excludes net indirect taxes and import duties. In calculating the percentage change in GDP at factor cost we also ignored working capital, as this was convenient and had little effect on our results. Ignoring commodity taxes, the percentage change in real GDP at market prices can be approximately calculated from the income-side as:

$$gdp = S_L \ell + S_K k + S_W w + S_N n + S_T z + S_D m - S_E e$$

where S_L, S_K, S_W, S_N, S_T, S_D and S_E are the shares in real GDP of labour, fixed capital, working capital, land, net production taxes, import duties and net export taxes, respectively; ℓ, k, w, n and z are the percentage changes in economy-wide employment (using wage-bill weights), fixed capital, working capital, land and activity, respectively, and e and m are as defined above. Thus, putting in the appropriate weights:

$$\begin{aligned} gdp = & (0.6325 \times -0.063) + (0.249 \times 0) + (0.1063 \times -0.046) \\ & + (0.019 \times 0) + (0.008 \times -0.046) + (0.0115 \times -0.369) \\ & - (-0.0022 \times -0.654) = -0.051 \end{aligned}$$

Remembering that the tax elements have been handled in the above calculation in an approximate way and we have ignored minor terms of trade effects, we can say that the model provides projections for the percentage change in real gdp from the income and expenditure sides that are quite close.

5.5.1.2.4 Employment Results

Equation (5.5) provides the relationship between regional industry employment and activity when the usage of capital and land is fixed. Since the labour-share of primary-factor inputs is always less than unity, the percentage change in regional industry employment will always exceed the percentage change in regional activity in the short-run.

Although labour shares do vary considerably between industries, the industry pattern of employment results closely resembles that for activity. A higher labour-share in Tasmanian Rural compared to Mainland Rural causes projected employment in the former industry to decline by slightly less than in the latter, while the reverse is true for activity. Tasmanian Rural employment falls by 0.50 per cent compared to a fall of 0.66 per cent for Tasmanian Mining despite an almost identical decline in activity for both industries due to the former industry having a higher labour share - a 0.67 labour-share for Tasmanian Rural and a 0.51 share for Tasmanian Mining. These small differences apart the employment by industry results yield little of interest beyond that which was learnt from the activity results.

We thus turn to employment by occupation at the region-wide level. The percentage changes in these variables are shown in Table 5.9. Only one industry, Skilled Blue Collar Building, shows a projected increase for the primary effects. This skill group gained due to the beneficial effects of investment reallocation for the construction industry. The most severely affected skill group are Rural Workers, 86 per cent of whom work in the Rural industry.

Table 5.9

Projected Effects on Employment by Occupation Consequent on 10 per cent increase in Manufacturing I.C. Tariff

Occupation	Tasmania Primary Effects %	Tasmania Total Effects %	Mainland Primary Effects %	Mainland Total Effects %
1. Professional W.C.	-0.086	-0.135	-0.036	-0.154
2. Para Professional W.C.	-0.056	-0.122	-0.020	-0.145
3. Skilled White Collar	-0.090	-0.126	-0.039	-0.151
4. Semi- and Unskilled W.C.	-0.084	-0.129	-0.035	-0.149
5. Skilled B.C. Metal and Electrical	-0.115	-0.108	-0.025	-0.107
6. Skilled B.C. Building	0.021	-0.066	0.056	-0.108
7. Skilled B.C. Other	-0.309	-0.178	-0.169	-0.147
8. Semi- and Unskilled B.C.	-0.143	-0.122	-0.050	-0.116
9. Rural Workers	-0.467	-0.229	-0.485	-0.251
10. Armed Services	-0.003	-0.119	-0.004	-0.158

5.5.1.3 The Consumption-Induced Effects

The deleterious primary effects of the tariff shock on national employment leads to an induced fall in economy-wide real consumption of 0.154 per cent. Column 2 of Table 5.2 shows the broad effects of the economy-wide fall in real consumption. At the national level employment falls by 0.074 per cent but is accompanied by a projected fall in the FEDERAL consumer price index of 0.185 per cent and a recovery in the balance of trade equal to 0.112 per cent of GDP.

Column 2 of Table 5.3 provides the industry details behind these broad results. Activity in Construction and Community Services falls in line with the fall in real consumption due basically to the linking of real investment and real government current expenditure with real consumption. However, Manufacturing I.C. suffers a much smaller projected decline in activity as it largely passes on the cost decreases it receives via the assumed full wage indexation, and the cut-back in consumption demand for the commodity it produces falls to a substantial degree on imports.

Furthermore, the export industries receive a positive boost from the fall in real consumption. The selling price in these industries is largely set by the world price and they thus receive at their base-year output level an improvement in their price-cost margin. This leads to the 0.39 per cent increase in exports which has a substantial offsetting effect to the column 1 fall in exports.

Thus the improvement in Australia's balance of trade position ameliorates the impact of the fall in real domestic absorption on GDP and employment. The regional impact, however, is not uniform with the more export-oriented Tasmanian economy projected to undergo a smaller decline in activity and employment.

The column 2 results are for an induced fall in real consumption of the same degree across the two regions of the economy. One must also account for any relative movements in real consumption between regions and the effects of this change are shown in column 3. It comes as something of a surprise that, given the more adverse primary efects on Tasmanian activity and employment, the induced fall in real consumption in Tasmania is smaller than for the mainland.

A number of reasons lie behind this counter-intuitive result. First consider the percentage change in nominal gross regional (state) product which is measured as the percentage change in gross factor incomes of residents of the region.[9] Tasmanian nominal GSP is projected to increase by less than mainland nominal GSP (the rise in both regions being considerably below that for the cpi), but the degree of difference is less than would be expected based purely on the basis of wage income. (Note, the percentage change in Tasmanian nominal wage income is 0.211 [cpi + ℓ^{Tas} (using wage-bill weights) = 0.339 - 0.128] and in mainland nominal wage income 0.279.) However, Tasmania has a low degree of ownership of capital in some of those industries which are projected to undergo the greatest declines in activity with accompanying falls in their rental price of capital. The estimated Tasmania ownership share of Tasmanian Manufacturing Export in the FEDERAL (TASMAIN) data-base is 13 per cent and for Tasmanian Mining it is only 5 per cent. The mainland ownership shares of the corresponding Mainland industries are 64 per cent and 49 per cent. The column 1 declines in the rental price of capital for the Tasmanian industries are greater (-1.54 and -0.99 per cent for Manufacturing Export and Mining respectively) than for the mainland industries (-1.15 and -0.87 per cent), but mainland residents also have substantial ownership of Tasmanian Manufacturing Export (52 per cent) and Tasmanian Mining (44 per cent), while Tasmanian ownership of the corresponding mainland industries is negligible. Thus the pattern of interstate ownership of capital leads to a compressing of the differences between regions in nominal factor incomes.

FEDERAL calculates the percentage change in regional nominal disposable income as a weighted difference in the percentage change in nominal gross regional product (factor incomes) and net direct taxes on and transfers to regional residents. As can be seen from column 1 of Table 5.2 the percentage change in net direct Tasmanian taxes/transfers is negative while it is positive for the mainland. This acts to further compress the regional differences in the movements in nominal regional disposable incomes.

To understand why Tasmanian nominal taxes/transfers decline while the corresponding mainland variable increases under the primary effects of the tariff shock, we need to look at the components of the terms on the right-hand side of the equations which determine the percentage change in regional direct taxes/transfers. This is done in Table 5.10. Each row of the table deals with a particular tax or transfer, the percentage change in the total being a weighted sum of these taxes and transfers. For each region the first column gives the weight (which can be positive or negative) of the particular tax-transfer in the regional total, while the second column gives the percentage change in the tax/transfer for the region's residents. The third column is equal to the weight multiplied by the percentage change variable and is thus the contribution of the regional variable to the percentage change in the regional aggregate.

Table 5.10

Contributions Towards Total Direct Taxes and Transfers on/to Regional Residents for 10 per cent increase in Manufacturing I.C. Tariff (Real Consumption Exogenous)

	Tasmania			Mainland		
	Weight	Percentage Change in Variable	Contribution[a]	Weight	Percentage Change in Variable	Contribution[a]
PAYE taxes	1.5421	0.213	0.328	1.4235	0.279	0.397
Other income taxes	0.3944	0.043	0.017	0.4583	0.102	0.047
Residential land taxes	0.0237	0.334	0.008	0.0330	0.364	0.012
Fees and fines	0.1053	0.177	0.019	0.0930	0.232	0.022
Commercial land taxes	0.0904	0.339	0.031	0.1065	0.388	0.041
Interest paid overseas	0.1505	0	0	0.1229	0	0
Interest paid to Commonwealth	0.0932	0	0	0.0793	0	0
Interest paid to State government	0.3737	0	0	0.1301	0	0
After-tax export profits[b]	-0.0001	-587.797	0.036	0.0012	98.642	0.118
Unemployment benefits	-0.1453	2.137	-0.310	-0.1134	1.217	-0.138
Commonwealth transfers to persons	-1.2370	0.339	-0.419	-1.0029	0.339	-0.340
State govt. transfers to persons	-0.0526	0.339	-0.018	-0.0454	0.339	-0.015
Interest received from governments	-0.3385	0	0	-0.2862	0	0
Total taxes and transfers	1.0000	-0.308	-0.308	1.0000	0.143	0.143

a. Contribution to percentage change in total taxes and transfers for regional residents.
b. Losses if weight has positive sign.

A noticeable feature of Table 5.10 is the higher weights for the various transfer payments in the Tasmanian column compared with the mainland column. If one were to examine the underlying absolute tax/transfer figures one would find that Tasmanian residents' shares in economy-wide PAYE and othe income taxes were only 2.6 and 2.1 per cent respectively, whereas their shares of economy-wide State government transfers to persons, Commonwealth government transfers to persons and unemployment benefits were 2.8, 2.9 and 3.0 per cent respectively. The regional pattern of the weightings together with the lower percentage change in the tax variables for Tasmanian residents and the higher percentage change in unemployment benefits to Tasmanian residents are the major factors contributing towards the regional differences in aggregate direct taxes and transfers. The difference in the contribution of unemployment benefits and Commonwealth transfers alone contribute 0.251 percentage points to the regional difference (i.e. over half of the difference).

One would expect that the slightly greater rise in mainland disposable income compared to Tasmanian nominal disposable income, with much higher percentage rises in the cpi's for all geographical areas, would translate into a (slightly) greater percentage increase in Tasmania's average propensity to consume compared to that of the mainland. To see why the mainland experiences a greater increase in its apc we need to look at equations (2.19) and (2.20) which we repeat here:

$$c^r = d_1^r + f_C^r \tag{2.19}$$

$$c_R^r = c^r - \xi^{(3)r} \tag{2.20}$$

Since c_R^r is equal to zero for column 1 results, we have on substitution:

$$-f_C^r = d_1^r - \xi^{(3)r} \qquad (5.6)$$

Putting the relevant column 1 results into equation (5.6), we get:

$$f_C^{Tas} = -(0.228 - 0.312) = 0.084$$

$$f_C^{Ml} = -(0.242 - 0.340) = 0.098$$

Thus, the lesser rise in the Tasmanian cpi, due mainly to a lower usage of the imported manufacturing import-competing commodity in Tasmania, forms the last element in a chain of reasons which sees the projected column 1 rise in the Tasmanian apc as less than that for the mainland despite the considerably greater projected fall in Tasmanian employment and activity.

However, there is a further element, leading to the induced change in relative real regional consumption in favour of Tasmania. As was noted above the effects of the induced economy-wide (i.e. uniform across regions) fall in real consumption fell less heavily on Tasmania. A consequent smaller fall in Tasmanian real disposable income relative to the mainland implies a larger decline in the Tasmanian apc (-0.114) compared with the Mainland apc (-0.097). This results in an even higher figure for the induced relative real consumption increase towards Tasmania, since the Tasmanian apc must be forced up 0.030 per cent by the relative shift, as compared with 0.013 per cent which would have been the case had the economy-wide induced fall in real consumption affected both regions equally.

Looking at the effects of the induced relative real consumption change, it can be seen that, although there are some negative effects on Tasmanian export industries (see Table 5.3), these effects are small since Tasmanian wages are linked to the national cpi (which is practically unaffected for column 3) and thus Tasmanian exporters face little in the way of a cost-price squeeze. Non-traded Tasmanian industries, in particular, gain from the increase in Tasmanian real consumption.

Before leaving this section, it is interesting to look at the total effects of the tariff increase on certain variables. Although both exports and imports are still projected to decline the total projected percentage decrease in exports is considerably less than the percentage decrease in imports, leading to an improvement in the balance of trade. The increase in the cpi is substantially less once the consumption-induced effects are taken into account, but the deterioration in activity and employment for the mainland is substantially worsened.

Looking at the industry results in Table 5.3 it can be seen that only one industry, the tariff protected one, is projected to experience an increase in activity under column 4 and the size of that increase is noticeably smaller than for column 1. The effects on the export industries are mitigated by the induced consumption-changes, while the non-traded industries contractions are nearly all accentuated. The one non-traded industry that was projected to expand under column 1, Construction, is projected to decline in column 4 due to the induced fall in real investment. Tasmanian Utilities, however, is projected to contract slightly less in column 4 than in column 1 due to its strong linkage with Tasmanian Manufacturing Export.

Turning to Table 5.9 we see that all skill groups are now projected to suffer declines. Skilled Blue Collar, the one group to experience a projected increase as a primary effect, is projected to decline under total effects in line with the reversal in Construction industry activity. However the total decline in Rural workers is substantially less than the primary decline due to the smaller total deterioration projected for Rural activity.

5.5.1.4 Government Accounts

Table 5.11 provides results for the Commonwealth Government Accounts and a condensed list of State Government Accounts results. It can be seen that even for the primary simulation that import duty receipts rise by less than 10 per cent, due to a decline in imports - and partly to import duties from Manufacturing I.C. being only 97 per cent of total duty collections - and this effect is exacerbated by the induced-consumption effects.

All other components of Commonwealth receipts either rise by less than the cpi or decline. Export taxes are the worst hit, with a projected fall of 1.64 per cent under primary effects, although the size of the fall is more than halved once the consumption-induced effects are taken into account. Total Commonwealth outlays also rise by more than the cpi, thus reducing the benefits of the tariff increase for the Commonwealth Government Borrowing Requirement. The primary effect on Commonwealth government current and capital expenditures is to increase these variables in line with input prices for these activities, while non-interest transfer payments increase with the cpi. Unemployment benefit payments are projected to increase at a greater rate than the cpi due to the increased number of unemployed. The total (col. 4) increase in nominal Commonwealth outlays remains slightly greater than the (smaller) cpi projected rise - the reduction in

Table 5.11

Effects on Government Accounts of 10 per cent Increase

in Manufacturing I.C. Tariff Rate

Percentage Change in Variable[a]	Primary Tariff Effect	Induced Real Consumption Effect	Total Effect
COMMONWEALTH GOVERNMENT			
Receipts			
PAYE taxes[b]	0.277	-0.262	0.015
Other income taxes[c]	0.101	-0.286	-0.185
Import duties	9.218	-0.232	8.986
Production taxes	0.304	-0.271	0.033
Commodity taxes	0.321	-0.228	0.093
Export taxes[d]	-1.640	0.923	-0.717
Other receipts	-	-	-
Total receipts	0.676	-0.237	0.439
Total outlays	0.345	-0.175	0.170
Change in C'wealth BR[e]	-65.553	9.040	-56.513
TASMANIAN GOVERNMENT			
Receipts			
Payroll tax	0.276	-0.178	0.098
Commonwealth grants	0.339	-0.184	0.155
Other receipts	0.144	-0.097	-0.047
Total receipts	0.313	-0.186	0.127
Total outlays	0.321	-0.275	0.046
Change in Tasmanian BR[e]	0.120	-0.524	-0.404
MAINLAND GOVERNMENT			
Receipts			
Payroll tax	0.361	-0.249	0.112
Commonwealth grants	0.339	-0.184	0.155
Other receipts	0.244	-0.186	0.058
Total receipts	0.336	0.213	0.123
Total outlays	0.349	-0.329	0.020
Change in Mainland BR[e]	7.643	-21.524	-13.881

a. Except for Borrowing Requirement changes.
b. Includes personal income taxes on owner-operators.
c. Includes transfers from public enterprises.
d. Includes income taxes on super-normal profits of non-export industries.
e. Expressed in $million (1978-79 prices).

Commonwealth current and capital activity being offset by an increase in the percentage rise in the number unemployed.

The improvement in the Commonwealth Government borrowing requirement is projected as $56.5 million in 1978-79 prices, despite the fact that 10 per cent of the 1978-79 level of import duties on Manufacturing I.C. amounts to $110 million.

Turning to the State Government accounts, it can be seen that the tariff shock also improves the state governments' borrowing requirements (although they are worsened for the primary effects). However, this partly reflects the Commonwealth increasing its nominal grants to the states in line with the increase in the FEDERAL cpi. The total effect on Commonwealth grants to the states is $0.51 million to Tasmania and $12.45 million to the mainland. The other element in the improvement in state borrowing requirements is the decline in outlays consequent on the decrease in state government current consumption following the induced fall in regional real consumption. If real domestic absorption remained constant following the tariff shock and the Commonwealth did not alter its grants to the states, the Commonwealth Government Borrowing Requirement would improve by some $94 million but the Tasmanian and Mainland borrowing requirements would deteriorate by $1.24 million and $34.87 million respectively. Thus, under these circumstances the Commonwealth would have a greater projected improvement in its own financial position but worsen the financial position of the states.

5.5.1.5 Comparison of FEDERAL Results with Other Models

In Table 5.12 a number of key results from the FEDERAL tariff simulation shown in column 1 of Tables 5.2 and 5.3 are repeated, together with ORANI results for the same experiment. The

Table 5.12

Comparison of FEDERAL and ORANI Results Consequent on a 10 per cent Rise in the Manufacturing I.C. Tariff Rate[a]

Industry	FEDERAL Tasmania %	FEDERAL Mainland %	ORANI Australia %
		Industry Activity	
1. Rural	-0.338	-0.313	-0.309
2. Mining	-0.339	-0.249	-0.252
3. Manufacturing I.C.	0.109	0.134	0.140
4. Manufacturing Export	-0.654	-0.561	-0.559
5. Utilities	-0.115	-0.027	-0.036
6. Construction	0.057	0.085	0.090
7. Margins	-0.113	-0.064	-0.070
8. Community Services	-0.003	-0.004	-0.004
9. Other Tertiary	-0.019	-0.005	-0.006
		Exports	
1. Rural	-1.087	-0.406	-0.345
2. Mining	-0.455	-0.495	-0.419
4. Manufacturing I.C.	-1.159	-1.646	-1.523
		Aggregate Results	
Real GDP (income)	n.a.	-0.046[c]	-0.044
cpi	n.a.	0.339[c]	0.322
Employment	n.a.	-0.066[c]	-0.059
Exports	n.a.	-0.654[c]	-0.597
Imports	n.a.	-0.369[c]	-0.336
Change BT[b]	n.a.	-0.052[c]	-0.041

a. For simulations with real consumption constant.
b. Change in Balance of Trade as a percentage of GDP.
c. Economy-wide result.

ORANI simulation was conducted with essentially the same environment as that which generated the column 1 FEDERAL results; i.e. short-run, slack labour markets, fixed real absorption. The input-output data-base employed by ORANI was the same nine-industry one used to create FEDERAL's input-output data-base. Wherever possible ORANI was given the same parameters as FEDERAL; the same industries were chosen to be export industries; exogenous investment industries for ORANI corresponded to FEDERAL industries the bulk of whose investment was in government investment. Not surprisingly, given the similarity of the relevant parts of the theoretical structures of both models and the compatibility of the data-bases at the economy-wide level, the results for the mainland from the FEDERAL experiment correspond very well with the ORANI results. One would expect the percentage change in an economy-wide variable from ORANI to fall between the two regional results for that variable from FEDERAL, but - since mainland comprises in general just over 97 per cent of the Australian economy - one would expect the ORANI result to be very much at the mainland end of the range.

Examination of Table 5.12 shows quite good agreement between the ORANI and FEDERAL results, particularly for industry activity. The export results show less agreement and the ORANI results in two cases fall outside the expected range. However, export volumes are quite volatile for relatively small price changes and the discrepancies between the model results could not be considered dramatic (keeping in mind the low weight of Tasmanian exports in total exports). Furthermore, there is no difference in the general commodity pattern of the export results between the models.

We turn now to a consideration of a comparison between FEDERAL results and those from the other ORANI-based regional models. To date, only very limited analysis have been done in this area. Projections for a 25 per cent across-the-board tariff increase from ORANI-ORES and ORANI-TAS reported in a draft copy of Higgs, Parmenter and Rimmer (1988) were scaled down to a 9.7 per cent increase - which is approximately the same as the 10 per cent increase in the Manufacturing I.C. tariff we have been examining. These results are shown in Table 5.13.

Table 5.13

Comparison of Effects from ORANI and ORANI-TAS of a 9.7 per cent Across-the-Board Increase in Tariffs

	ORANI-ORES		ORANI-TAS-ORES	
	Gross Product	Aggregate Employment	Gross Product	Aggregate Employment
Tasmania	-0.20	-0.25	-0.54	-0.62
Australia	-0.05	-0.08	-0.04	-0.08

Comparison of these results with those in column 1 of Table 5.2 shows that the negative projections for Tasmanian output and employment are considerably greater for ORANI-ORES and ORANI-TAS than for FEDERAL, which projects Tasmanian output and employment to change by -0.09 and -0.14 per cent respectively.

Interpreting the reasons for the difference between the model projections is difficult for two reasons. Firstly the ORES simulations were conducted with a very strong link between income and consumption, while the FEDERAL column 1 results are based on the assumption of constant real regional consumption. Secondly, in contrast to our ORANI comparison with FEDERAL, the ORANI-ORES (and

ORANI-TAS) simulation results involve a different data base and industry classification to the FEDERAL simulation. The data base year for the ORANI-ORES model was 1968-69 while our FEDERAL (TASMAIN) model employed a 1978-79 data base. Furthermore and more importantly the ORANI-ORES simulation was conducted with the standard 113-industry version of the model. Hagger, Madden and Groenewold (1987) show that at an aggregated industry level the Tasmanian economy differs little in its output pattern from the Australian economy as a whole. However, at the 113-industry level there are some key differences between the Tasmanian and Australian industry patterns, particularly within the manufacturing sector. Given the importance of inter-regional differences in industrial composition for the national industries sector in determining ORES results, it might well be that the difference in levels of aggregation between the two models is a major cause of the difference in results. Thus a significant part of the difference between the Tasmanian results from the different models might arise from factors not related to fundamental differences in model structure.

The best way to remove these extraneous effects is to recompute the ORANI-ORES tariff experiment using a nine-industry 1978-79 data-base. However, it has not been possible to do this before completion of this thesis since it involves a number of non-trivial tasks. The ORANI-ORES computer program has to be changed to handle nine industries and a new regional data-base (consistent with FEDERAL's) is required. Similarly ORANI-TAS would require a new data-base with at least one industry regional disaggregation consistent with FEDERAL's data base.

However there is one comparison between FEDERAL and ORANI-ORES results which can be made immediately. We can construct a contribution matrix (like that for Table 5.7) for ORANI-ORES on the assumption that all industries are national industries. This is shown in Table 5.14.

Table 5.14

Contribution of Each Industry to Total Regional Activity from 9-industry ORANI-ORES Tariff Experiment

All industries assigned to national category

Industry / Region	Contribution Matrix: Tasmania	Contribution Matrix: Mainland	Australian Output[a] (% Change)
1. Rural	-0.026	-0.023	-0.309
2. Mining	-0.017	-0.009	-0.252
3. Manufacturing I.C.	0.020	0.020	0.140
4. Manufacturing Export	-0.027	-0.020	-0.559
5. Utilities	-0.001	-0.001	-0.036
6. Construction	0.008	0.006	0.090
7. Margins	-0.012	-0.015	-0.070
8. Community Services	-0.001	-0.001	-0.004
9. Other Tertiary	-0.001	-0.001	-0.006
State Industrial Activity	-0.057	-0.044	-0.044

a. From column 3, Table 5.12.

Furthermore, there is some analysis we can perform with the results available to us. Firstly we could bring the FEDERAL simulation in line with ORES in regard to including relative regional real consumption effects by adding the column 3 results to the column 1 results in Table 5.2. This lessens the negative results for Tasmania projected by FEDERAL. This moves the FEDERAL result further away from the ORANI-ORES result and highlights a key model difference as we shall see shortly.

We can advance our analysis further by use of ORANI-ORES results for a 25 per cent across-the-board tariff increase presented in Table 45.7 of DPSV. These results pertain to the same data-base and environment as for the results reported in Table 5.13 with the exception that the sensitivity of the ORES results to the local/national dichotemy and the income-consumption link are reported. The Table 5.13 ORANI-ORES result relates to a strong income-consumption link (i.e. the ORES parameter γ set equal to unity). With the consumption-income link broken (i.e. $\gamma = 0$) the DPSV table shows the Tasmanian gsp and employment results (appropriately scaled down, as before, for a 9.7 per cent tariff increase) become -0.13 per cent and -0.19 per cent respectively. If all industries are designated as national, the DPSV table then shows the percentage changes in Tasmanian gsp and employment as -0.11 and -0.17 respectively.

These results strongly support our conjecture that the major difference between the FEDERAL and ORANI-ORES results surrounds the different levels of industry aggregation between the models. The ORANI-ORES results with all industries designated as national shows respective declines in Tasmanian and Australian employment of 0.17 and 0.08 for the 113-industry version, while the corresponding results for the 9-industry version are -0.06 and -0.04 per cent respectively. This suggests that if ORANI-ORES results for $\gamma = 0$ (the appropriate ORES environment for comparison with FEDERAL column 1 results) were available from a 9-industry version of that model the Tasmanian employment result would closely resemble the FEDERAL result.

It can also be noted that the change in ORES assumption from $\gamma = 0$ to $\gamma = 1$ intensifies the projected decline in Tasmanian output and employment. This contrasts with the similar assumption of endogenous relative real consumption at the regional level but fixed real consumption economy-wide for the FEDERAL model. As noted above, for the FEDERAL simulation, the relative move in real consumption improves Tasmania's employment/output situation while worsening the mainland's. The reason for the divergence in results is that ORES only takes into account wage income and misses such cushioning effects on the Tasmanian economy as low Tasmanian capital ownership in some adversely-affected Tasmanian industries and social security payments (upon which Tasmania is relatively more dependent).

Turning to the ORANI-TAS (ORES) results we see that this model projects greater falls in Tasmanian activity and output than ORANI-ORES. Again the reason for the difference with the FEDERAL result lies in the level of disaggregation, including the level at which ORANI-TAS industries are regionalized. For instance, Tasmanian Milk Products is an export industry in ORANI-TAS and has an output projection of -1.59 compared to a percentage change of close to zero for Mainland Milk Products. In FEDERAL Milk Products is included in Manufacturing I.C.

5.5.2 The Payroll Tax Experiment

5.5.2.1 Broad Results

Before examining the results of the payroll tax experiments it is worth looking more closely at the way in which the shock impacts on labour costs. To do this we look at FEDERAL equations (2.82) to (2.86) involving the flexible handling of wages for each occupation in each regional industry. We present a simplified version of these equations here for a representative labour skill group purchased by a representative regional industry. We thus dispense with industry, region and skill superscripts and subscripts. The simplified equations are:

$$p = W_1 w + W_2 t + W_3 r \qquad (5.7)$$

$$w = \xi^{(3)} \qquad (5.8)$$

$$t = w \qquad (5.9)$$

$$r = w + f \qquad (5.10)$$

where p is the percentage change in the price paid for a unit of labour, w is the percentage change in the post-tax nominal wage per labour unit, t is the percentage change in the PAYE tax per labour unit, r is the percentage change in the payroll tax per labour unit, $\xi^{(3)}$ is, as usual, the percentage change in the national consumer price index, f is a shift variable for change in the payroll tax rate and W_1, W_2 and W_3 are the shares of the respective components in total unit labour cost payments. It will be noticed that all shift variables except the one in equation (5.10) have been dropped and this has allowed for the very simple nature of the equations. Substituting $\xi^{(3)}$ for w in (5.9) and (5.10) and then performing the appropriate substitutions into (5.7) we get:

$$p = W_1\xi^{(3)} + W_2\xi^{(3)} \text{ and } W_3(\xi^{(3)} + f), \qquad (5.11)$$

and thus:

$$p = \xi^{(3)} + W_3 f \qquad (5.12)$$

Therefore assignment of a positive value to the exogenous variable f implies a rise in real-wages. Thus a shock to payroll taxes is no more than a shock to real wages (in which government rather than labour gains from the wage rise). However an across-the-board rise in payroll taxes (i.e. a uniform value assigned to f for each regional industry's purchase of labour units of each skill type) does not imply a uniform rise in real wages unless the weight W_3 is identical for each regional industry and for each occupational (skill) group. In actuality there is wide variation in these weights.

Table 5.15 shows the broad effects of state government unilateral and simultaneous across-the-board increases in state payroll tax.

For all three simulations employment and gross state product in both regions are projected to decline. Looking at the first simulation where the Tasmanian government unilaterally raises payroll tax, we see, in the total effects column, projected declines in Tasmanian GSP and employment of 0.283 and 0.395 per cent respectively. Real Tasmanian consumption falls by 0.297 per cent while real investment in the state falls by 0.463 per cent as investment is allocated towards certain mainland industries.[10] The increase in Tasmanian price levels feeds through to the national cpi and there is a very slight negative effect on GSP and employment in the mainland. The slight loss in export competitiveness leads to a very small deterioration in the balance of trade.

In the case of the mainland government increasing payroll taxes unilaterally we find similar effects occurring in the mainland economy. The negative effects on the mainland economy are even greater. This is true even for the primary effects. This partly reflects the lower share of interstate imports in usage of domestic commodities by mainland industries and final demanders. However the main cause is through the effects of wage-indexation. Whereas a unilateral payroll tax increase in Tasmania has only a small effect on the cpi and consequently the rise in Tasmanian nominal wages is confined largely to the rise in the payroll tax component (an

Table 5.15

Broad Effects of a 10 per cent Increase in State Payroll Tax

Change in Variable (per cent)	Only Tas Govt Increases Tax		Only M'land Govt Increases Tax		Both Govts Increase Tax	
	Primary Effect	Total Effect	Primary Effect	Total Effect	Primary Effect	Total Effect
Real GDP[a]	-0.005	-0.009	-0.195	-0.337	-0.200	-0.346
Real Tasmanian GSP[a]	-0.148	-0.283	-0.140	-0.050	-0.288	-0.333
Real Mainland GSP[a]	-0.002	-0.002	-0.196	-0.344	-0.198	-0.346
Nominal GDP[a]	0.002	-0.017	0.156	-0.523	0.158	-0.540
Nominal Tas. GSP[a]	-0.178	-0.434	0.208	-0.090	0.030	-0.524
Nominal M'land GSP[a]	0.006	-0.006	0.155	-0.534	0.161	-0.541
Nom. Tas. Disposable Income	-0.116	-0.309	0.288	-0.067	0.172	-0.376
Nom. M'land Disposable Income	0.007	-0.006	0.216	-0.401	0.223	-0.407
Tas. Direct Taxes/Transfers	-0.761	-1.626	-0.552	-0.303	-1.314	-1.929
M'land Direct Taxes/Transfers	0.002	-0.015	-0.412	-1.758	-0.410	-1.772
Real Consumption	-	-0.011	-	-0.391	-	-0.402
Real Tas. Consumption	-	-0.297	-	-0.085	-	-0.383
Real Ml. Consumption	-	-0.003	-	-0.399	-	-0.402
National Employment	-0.008	-0.014	-0.278	-0.464	-0.286	-0.478
Tas. Employment	-0.212	-0.395	-0.211	-0.070	-0.423	-0.465
M'land Employment	-0.002	-0.003	-0.280	-0.475	-0.282	-0.478
cpi	0.010	-0.003	0.466	-0.002	0.476	-0.005
Tasmanian cpi	0.104	-0.012	0.350	0.018	0.454	0.006
Mainland cpi	0.008	-0.002	0.469	-0.002	0.476	-0.005
Real Investment	-	-0.011	-	-0.391	-	-0.402
Real Tas. Investment	-0.175	-0.463	0.006	0.018	-0.169	-0.445
Real Ml. Investment	0.004	..	..	-0.401	0.004	-0.401
ipi	0.009	-0.002	0.462	0.059	0.471	0.058
Tasmanian ipi	0.060	..	0.423	0.072	0.483	0.072
Mainland ipi	0.008	-0.002	0.463	0.059	0.471	0.057
Exports[b]	-0.023	0.006	-0.921	0.065	-0.945	0.070
Imports[b]	0.006	-0.006	0.236	-0.238	0.242	-0.244
Change BT[c]	-0.006	0.002	-0.223	0.060	-0.229	0.062

a. Measured from income side at factor cost.
b. Foreign currency value.
c. Change in balance of trade as a percentage of GDP.

average primary effect rise in Tasmanian wage rates of 0.467 per cent), the primary effect of a unilateral mainland payroll tax rise is for a rise of 0.466 per cent in the national cpi and an average rise in nominal wage rates of 1.008 per cent. This results in a fall in mainland real consumption of 0.399 per cent (compared with the fall in Tasmanian real consumption for that region's unilateral increase of only 0.297 per cent). The total effect of the mainland unilateral tax increase is for an actual fall in the cpi as the effects of the induced real consumption decrease lead to a total decline in mainland gross state product and employment of 0.344 per cent and 0.475 per cent respectively. The other noticeable effect of the unilateral mainland payroll tax increase is its substantial harmful effects on the Tasmanian economy, particularly in terms of primary effects. This is to be expected given the link between Tasmanian wages and the national cpi.

Turning to the bilateral payroll tax rise simulation, we find that for the primary effects, Tasmania is projected to undergo a markedly worse decline in gsp and employment than the mainland. Thus Tasmania is shown to be more susceptible to a real wage shock than the mainland under the assumption of constant real domestic absorption. This is in line with results from ORANI-ORES simulations (see Dixon, Powell and Parmenter (1979)). Tasmania's greater susceptibility results primarily from its greater export-orientation (i.e. a greater proportion of industries whose output price does not alter greatly, and thus intensifying the real wage rise). The results in Table 5.15 somewhat understate the primary effect of a real wage rise on Tasmania compared with the mainland due to a somewhat higher average payroll tax rate in the latter region and thus a somewhat higher average real wage rise on the mainland.

However, just as was the case for the tariff experiment it is the mainland which fares slightly worse than Tasmania once the consumption-induced effects are taken into account for much the same reasons as explained in section 5.5.1.3.

5.5.2.2 Industry Results

Output projections for regional industries for the three payroll tax simulations are shown in Table 5.16. Comments on this table are confined to the bilateral tax rise results.

Looking at the primary effects, it can be seen that the industries which suffer the worst are export industries. An important component of an industry's supply curve in FEDERAL is its price-wage margin. The export industries face a squeeze in this margin as their wage bill rises but their output price is very close to fixed. Manufacturing I.C. also is quite severely affected since it has the highest payroll tax rate. Two industries not to receive any noticeable projected effect are Construction and Community Services (Mainland Construction actually gains from a reallocation of investment) which both enjoy very low payroll tax rates.

The consumption-induced effects act to even out the total effects on industrial activity across industries. All industries in both regions are projected to undergo noticeable declines, the least affected industry being Mainland Rural (the Rural industry also enjoys a low payroll tax rate and gains considerably from the consumption-induced depression of the cpi).

5.5.2.3 Government Accounts

Table 5.17 provides results for the effects on government accounts of the payroll tax experiments. Looking at the total

Table 5.16

Percentage Change in Regional Industry Activity
Consequent on a 10 per cent Increase in State Payroll Tax

Regional Industry	Only Tas Govt Increases Tax		Only M'land Govt Increases Tax		Both Govts Increase Tax	
	Primary Effect	Total Effect	Primary Effect	Total Effect	Primary Effect	Total Effect
Tasmania						
1. Rural	-0.186	-0.164	-0.483	-0.038	-0.669	-0.203
2. Mining	-0.328	-0.279	-0.426	-0.019	-0.754	-0.298
3. Manufacturing I.C.	-0.336	-0.397	0.020	-0.046	-0.316	-0.444
4. Manufacturing Export	-0.238	-0.099	-0.864	0.053	-1.103	-0.152
5. Utilities	-0.091	-0.182	-0.177	-0.038	-0.269	-0.220
6. Construction	-0.129	-0.436	0.085	-0.009	-0.045	-0.428
7. Margins	-0.118	-0.304	-0.128	-0.066	-0.247	-0.370
8. Community Services	0.004	-0.280	-0.011	-0.102	-0.007	-0.383
9. Other Tertiary	-0.082	-0.227	-0.049	-0.038	-0.131	-0.265
Mainland						
1. Rural	-0.009	0.002	-0.493	-0.086	-0.502	-0.084
2. Mining	-0.006	0.002	-0.529	-0.193	-0.535	-0.191
3. Manufacturing I.C.	..[a]	-0.004	-0.351	-0.505	-0.351	-0.509
4. Manufacturing Export	-0.016	0.002	-0.989	-0.274	-1.005	-0.272
5. Utilities	-0.001	-0.002	-0.133	-0.269	-0.135	-0.271
6. Construction	0.006	-0.001	0.113	-0.420	0.119	-0.420
7. Margins	-0.001	-0.002	-0.152	-0.392	-0.153	-0.395
8. Community Services	..	-0.005	-0.011	-0.394	-0.012	-0.399
9. Other Tertiary	-0.001	-0.001	-0.103	-0.268	-0.103	-0.270

a. .. indicates rounded to zero.

effects of the simultaneous payroll tax rises, we note first that total state government receipts increase in both regions as a result of increased payroll tax collections. The increase in payroll tax receipts is less than 10 per cent in in both regions as a result of the fall in employment and a very slight fall in the cpi. The increases in payroll tax collections slightly more than account for the increase in total receipts for both governments. Each state government's nominal outlays also decline given the fall in most outlay components - real government current expenditure, real capital expenditure and certain nominal outlays fall in line with the declines in real regional consumption, real private investment, and regional nominal disposable income respectively. Both receipt and outlay effects lead to improvements in the state governments' borrowing requirements.

However these improvements in state government borrowing requirements, totalling some $212.15 million are partly matched by a deterioration in the Commonwealth Government's borrowing requirement of $135.52 million. This results from declines in nominal Commonwealth Government receipts consequent on the decline in economic activity and the ultimate fall in the economy-wide cpi. Total outlays, however, increase slightly for the Commonwealth Government as a result of an almost 7 per cent increase in unemployment benefits.

State governments raise payroll tax rates presumably with the aim of decreasing their borrowing requirement for a given amount of outlays and other types of receipts. It would appear that a superior way of improving state governments' borrowing requirements would be by direct grants from the Commonwealth Government equivalent to the deterioration in the Commonwealth borrowing

Table 5.17

Effects on Government Accounts of a 10 per cent Payroll Tax Increase

	Only Tas Govt Increases Tax		Only M'land Govt Increases Tax		Both Govts Increase Tax	
Change in Variable (per cent)[a]	Primary Effect	Total Effect	Primary Effect	Total Effect	Primary Effect	Total Effect
COMMONWEALTH GOVERNMENT						
Receipts						
PAYE taxes	..[b]	-0.02	0.20	-0.47	0.20	-0.48
Other income taxes	..	-0.02	0.02	-0.70	0.02	-0.72
Import duties	0.01	-0.01	0.40	-0.19	0.41	-0.20
Production taxes	0.01	-0.01	0.35	-0.33	0.36	-0.35
Commodity taxes	0.01	-0.01	0.24	-0.34	0.24	-0.35
Export taxes	-0.06	0.01	-2.54	-0.20	-2.59	-0.19
Total receipts	..	-0.01	0.16	-0.44	0.16	-0.46
Total outlays	0.01	..	0.56	0.12	0.57	0.12
Change in C'wealth BR[c]	2.81	3.61	109.16	131.92	111.97	135.52
TASMANIAN GOVERNMENT						
Receipts						
Payroll tax	9.64	9.51	0.29	-0.07	9.94	9.44
Residential land tax	0.07	..	0.42	0.04	0.49	0.04
Commercial land tax	0.06	..	0.43	0.08	0.49	0.08
Commonwealth grants	0.01	..	0.47	..	0.48	..
Commodity taxes	0.09	-0.31	0.32	-0.06	0.41	-0.36
Production taxes	..	-0.30	0.27	-0.03	0.27	-0.33
Fees and fines	-0.18	-0.43	0.21	-0.09	0.03	-0.52
Total receipts	0.79	0.70	0.40	-0.01	1.20	0.69
Total outlays	0.01	-0.32	0.43	-0.05	0.44	-0.37
Change in Tas. BR[c]	-4.03	-5.37	0.24	-0.18	-3.79	-5.55
MAINLAND GOVERNMENT						
Receipts						
Payroll tax	0.01	-0.01	10.06	9.43	10.07	9.42
Residential land tax	0.01	..	0.49	0.04	0.50	0.04
Commercial land tax	0.01	..	0.47	0.06	0.48	0.05
Commonwealth grants	0.01	..	0.47	..	0.48	..
Commodity taxes	0.01	-0.01	0.42	-0.42	0.43	-0.42
Production taxes	0.01	..	0.36	-0.34	0.33	-0.35
Fees and fines	0.01	-0.01	0.15	-0.53	0.16	-0.54
Total receipts	0.01	..	1.61	1.07	1.62	1.06
Total outlays	0.01	..	0.46	-0.38	0.47	-0.38
Change in M'land BR[c]	0.21	-0.26	-151.16	-206.35	-150.95	-206.60

a. Except for Borrowing Requirement changes.
b. .. indicates rounded to zero.
c. Expressed in $million (1978-79 prices).

requirement projected to result from the state payroll tax increases. The state governments' borrowing requirements would improve by almost two thirds of the change consequent on the payroll tax increases, without the damaging effects on Australian output and employment.

5.6 Conclusions

The set of tariff and payroll tax simulations provide some new and interesting results. The tariff increase simulation projections from FEDERAL are seen to be in line with economy-wide projections from ORANI for the same experiment under the assumption of fixed real absorption. Differences in projections for the model's two regions, Tasmania and mainland, are seen to arise from differences in regional technology and sales shares.

A central part of the chapter involves an examination of the tariff simulation with real regional consumption endogenous. Whereas the simulation with fixed real consumption projected Tasmania to be the worst affected region, a result in line with that for previous experiments conducted with ORANI-ORES and ORANITAS-ORES, the simulation with endogenous real consumption projected the mainland to suffer slightly greater losses in gross state product and employment than Tasmania.

The focus in explaining this result was to show why, counter-intuitively, Tasmania which suffers a more adverse primary effect on wage income than the mainland nevertheless had an induced fall in real consumption less than that for the mainland. A chain of reasons lies behind this result. Firstly, the difference in the projected rises in nominal income between the regions was reduced by Tasmanian residents' low ownership of capital in the negatively affected industries. Secondly, the primary effect on Tasmanian residents' net taxes and transfers is a projected decrease compared with an increase for the mainland. This resulted from a lower Tasmanian nominal tax increase than for the mainland, a greater percentage change in unemployment benefits to Tasmanian residents compared with mainland residents, and a larger share of unemployment benefits and transfers to persons in Tasmanian net tax and transfers than was the case for the mainland. Thirdly, a lower usage of imported Manufacturing I.C. in Tasmania resulted in a lower increase in the Tasmanian cpi than for the mainland cpi. Finally the effects of a uniform economy-wide fall in real consumption impacts less heavily on Tasmania, than the rest of Australia. All these effects compounded to provide the overall counter-intuitive result.

The set of payroll tax increase simulations demonstrates FEDERAL's capabilities in the analysis of shocks originating at the regional level. It is shown that, in addition to generating deleterious effects on output and employment both in the region imposing the shock and economy-wide, the payroll tax increases improve the state governments' borrowing requirement at the expense of a substantial deterioration in the Commonwealth government's borrowing requirement.

Chapter 6

Overview and Future Directions

6.1 Introduction

This thesis has involved the construction and testing of a two-region fiscal computable general equilibrium model of the Australian economy, FEDERAL. The linearized equation system of the new model has been described in detail, as has the formation of the model's data base. Two types of illustrative applications were undertaken and analysed at length. These applications involved both national and regional shocks and demonstrated the capabilities of the model. The successful explanation of the results not only shows our understanding of the way the model works but increases confidence in the model having been computed correctly.

The major contribution of this thesis is that it delivers a working two-regional CGE model of the Australian economy which can be used to examine a wide-range of regional issues within a federal economic system. Possible applications are discussed in detail later in this chapter. Indeed, the model has already been used in a very practical sense in a paper commissioned by the Tasmanian Employment Summit Secretariat. In that paper, Madden (1989) looked at seven budget-neutral Tasmanian government fiscal policy packages to examine the efficacy of possible State government policies directed at raising the Tasmanian employment level.

6.2 The Trial Simulations

In Chapter 1 we reviewed the existing CGE regional models in Australia and put forward FEDERAL as a model which would overcome the major deficiencies of these models for regional analysis. The results of the trial simulations allow some kind of measure of how well we have achieved this task. In section 5.5.1.5 model results are compared for the tariff experiment. We note that some mechanisms not present in ORANI-ORES come into play in the determination of FEDERAL results, notably regional differences in certain industries' intermediate input structures, fixed factor shares and export sales shares.

A major payoff from FEDERAL's detailed bottom-up modelling comes via the income-consumption link. In ORES regional income is linked solely to wage income. This was also the case with the bottom-up model, MRSMAE, which because of its lack of detailed variables associated with disposable income was not open to the more sophisticated linkage used by FEDERAL. This in essence means that for the ORANI-ORES, ORANI-TAS-ORES and MRSMAE models, whatever difference in employment results might be projected without a regional income-consumption link (achievable in ORES by setting the at-choice parameter, γ, to zero) is simply magnified by the income-consumption link. FEDERAL stands in sharp contrast on this matter, with its detailed modelling of regional disposable income, taking into account all sources of income and types of direct taxation and recognizing interstate and foreign ownership of capital (and interstate ownership of land).

This detailed modelling produces interesting effects for Tasmanian variables consequent on the two nationwide shocks examined in Chapter 5 (i.e. the tariff shock and the bilateral payroll tax shock). Inter alia, low Tasmanian ownership of certain types of capital and high Tasmanian dependence on social security payments tend to cushion the impact on that state's output and employment of the simulated economic shocks (see section 5.5.1.3 for a detailed analysis and section 5.6 for a summary of this matter). For both simulations the consumption-induced multiplier effect on Tasmania is very small (less than unity in the case of the tariff shock), while the multiplier effect on the mainland is quite large (greater than 2 for the tariff shock - this high value being supported by the economy-wide linkage of real investment and real government spending to real consumption). Users of ORES do have the option of setting $\gamma < 1$ to capture the short-run moderating effects of savings and social security payments on the wage-income link to consumption. However there is no guidance as to the appropriate choice of γ and no provision is made for regional differences in the strength of the linkage.

Arguably the most important contribution of FEDERAL is its ability to handle shocks originating at the regional level. The circumscribed ability to perform simulations of such shocks with ORANITAS-ORES was a key motivation behind the construction of FEDERAL. The payroll tax experiments are illustrative of shocks of this type.[1] Challen, Hagger and Madden (1984) undertook a payroll tax simulation with ORANITAS, but their experiment was necessarily confined to a very small number of industries - those which were separately identified as Tasmanian in ORANITAS. They were only able to come to very limited conclusions and were not able to proceed any further with their analysis of state government employment policy options due to the limitations of ORANITAS.

In the unilateral payroll tax experiments, the consumption-induced effects are again important and differ in accordance with the geographical origin of the shock. In the case of a unilateral <u>Tasmanian</u> payroll tax increase the consumption induced multiplier effects are very strong, with the cushioning effects of social security payments unable to offset a fall in real consumption confined to the Tasmanian economy (and thus no significant beneficial effects on the national cpi). The primary effect on the Tasmanian economy of a unilateral mainland rise in payroll taxes is almost as adverse as it is for the mainland economy itself. However the spillover to the Tasmanian economy of the fall in mainland real consumption has substantial positive effects on the Tasmanian economy largely offsetting the negative effects on that region.

The payroll tax simulations also illustrate the value of the fiscal component within the FEDERAL model. The results show not only how expensive a method of improving a state government's borrowing requirement are payroll tax rises in terms of state economic activity, but also how expensive they are to the Commonwealth government's borrowing requirement. Such a result is by no means surprising once attention is drawn to it, but it could well still be an unanticipated result in the sense that the connection between the Commonwealth budget and state government taxation measures might not have been a matter to come under consideration prior to the FEDERAL model simulation.

Indeed the presence of the government accounts in FEDERAL will often serve as a reminder of well-known or obvious consequences of fiscal measures that are sometimes overlooked. Thus in our tariff experiment we see that the tariff increase improves the Commonwealth deficit. This gives scope for the government to institute an employment-improving fiscal measure. It is possible with the FEDERAL model to conduct an experiment which say reduces income taxes by the required amount to give a change in the

Commonwealth borrowing requirement just equal in absolute value (but opposite in sign) to that from the tariff experiment. Adding the tariff and income tax simulations together allows an examination of the impact of the tariff increase in a budget-neutral (offsetting borrowing requirement outcomes) context.[2]

6.3 Future Research

6.3.1 Improving the Model

6.3.1.1 Data Base

6.3.1.1.1 Interregional Input-Output Data

As Chapter 4 attests, considerable effort has gone into the construction of the FEDERAL (TASMAIN) interregional input-output data base. For the vast bulk of what would appear to be the more important data items either high quality data or sound estimation techniques were developed. However, for a large number of data items which appeared to be less material to simulation results much cruder estimation techniques were employed. In the case of a large proportion of these latter data items the unavailability of sufficient raw data simply meant that the methods used were the best that could have been employed. In these and many other instances it is also often the case that the payoff for most conceivable applications from attempting better estimation techniques is likely to be trifling.

However, there are a number of minor improvements which could be made to our input-output data base which, though unlikely to bring any large returns in improving results, can be implemented reasonably easily. Perhaps the clearest example concerns the split between disposable income and tax components for the labour costs and returns to capital matrices.

For the estimation of the PAYE taxes matrix (see section 4.2.2.2.4.1) we simply use a single ratio of after-tax wages to PAYE taxes, chosen on the basis of published figures for the economy-wide ratio, for all industries and occupational categories. This method ignores the progressive nature of income taxes in Australia. A simple procedure for improving on our current estimation method would be to adjust the ratio for each industry by occupation cell to allow for differences in average wages across occupation/industry categories. A similar crude method of measuring the direct income tax component is used in the estimation of the capital input matrices. More extensive use of available taxation statistics should allow for improved estimation here.

The Tasmanian component of the payroll tax matrix could also be improved. At present the only Tasmanian information used in the estimation of this vector is the aggregate Tasmanian figure. Payroll tax by industry information has recently become available for Tasmania as a by-product of the construction of a new 1985-86 Tasmanian input-output table by the Tasmanian Department of Treasury and Finance (1990). Although there was a change in payroll tax rates during that year, there is likely to be sufficient information available to use the new 1985-86 figures to adjust the 1978-79 payroll tax by Tasmanian industry data items.

Some other areas of the input-output data base might benefit from further analysis. A good example relates to the estimated pattern of commodities imported by Tasmanian industries from overseas. In our explanation of industry results for the tariff simulation in section 5.5.1.2.1 it was seen that the proportion of imported commodity 3 in total inputs of a regional industry had a part to play in the determination of that industry's results. It is also the case (see Table 5.6) that the Tasmanian proportions were markedly lower than was the case for the mainland. One factor affecting these proportions is our estimation of the commodity pattern of each regional industry's imported inputs. The Tasmanian component of the intermediate imports matrix could be improved if the commodity split were performed at the 113-industry level, thus taking account of intra-9-industry differences in activity patterns between the regions. Indeed our interregional input-output estimation in general would be better performed at a disaggregated level, with aggregation to the 9-industry level being performed as a final step. Another amendment to the method of estimating the Tasmanian component of the intermediate overseas imports matrix would be to extend our method of estimating interstate intermediate imports to also cover overseas imports (see section 4.2.2.2.1.2 for our method that spreads interstate imports across commodities in such a way as to force Tasmania's overall domestic material input technology towards the national one). However, the component involved in estimating the imports matrix in which we can have least confidence is the Tasmanian input-output table vector of imports (i.e. our raw data). The new 1985-86 Tasmanian I-O table casts doubts over the 1977-78 table in relation to overseas (and interstate) imports. Given that the vast bulk of overseas imports are assigned to commodity 3, if the relatively low proportion of imported commodity 3 in total Tasmanian industry cost indeed does not mirror reality, then the major source of error must lie in an underestimation of overseas imports to Tasmanian industries in our primary data source. Adjustments made to this primary data on the basis of information from the new 1985-86 table might well be worthwhile.

6.3.1.1.2 Government Accounts Data

These accounts involve very aggregated data and we find that good primary data exist for most items not calculated from the input-output files. However one item that would be worthy of investigation is the split between commercial land taxes and residential land taxes. Lack of data made the investigation of this split difficult. However it is an important data items for experiments involving changes to commercial land taxes in particular (one of the simulations reported in Madden (1989)).

6.3.1.1.3 Elasticities

As is evident from section 4.3 little effort has gone into establishing estimates for the various elasticities for the first verison of FEDERAL. No econometric estimations were made for the purposes of this thesis. There are still a number of improvements which could be made in the use of estimated elasticities from the ORANI data base. Section 4.3.5 contains suggestions for using that data base to obtain elasticities relating to regional household demands based on a Klein-Rubin utility functional form rather than the current Cobb-Douglas form. Superior estimates for the CRESH substitution parameters between occupations are available (see section 4.3.4) and it is intended to use these estimates in future simulations. Another relatively easily implemented minor improvement would be the use of Tasmanian industry weights in aggregating the investment equation parameters (see section 4.3.2) for that state.

One area which requires further investigation is the parameters reflecting the degree of substitutability between sources of commodity supply. At present for each commodity the same parameter is used for all three sources of supply. Data deficiency would make econometric estimation of these parameters very difficult, probably impossible without a specially designed survey. However a useful task would be to test the sensitivity of results to these parameters for the experiments reported in Chapter 5. We have not had time to do a sensitivity analysis for this thesis. A good way of proceeding would be to choose parameters which reflected higher elasticities of substitution between domestic sources than between a domestic region and foreign sources. Such an assumption would reflect commonly held beliefs about what the relevant substitution elasticities might be. At this stage we can say, however, that our use of clearly stated parameters represents an improvement on current Australian regional models.

6.3.1.2 Theoretical Improvements

Three areas of ways in which the theory of the first version of FEDERAL might be improved suggest themselves. Firstly, there are a few straightforward improvements which could be made almost immediately. These are amendments to the model's theoretical structure which have occurred to us since developing our theory and although sometimes raised in the text have not as yet been implemented. Secondly, there is scope for introducing improvements that have been made to our starting point, the ORANI model as specified in DPSV, since 1982. That model is subject to considerable on-going research effort which has obvious spillover advantages for the FEDERAL model. Thirdly there are areas of improvements of a largely regional kind that could well be profitably researched.

6.3.1.2.1 Easily Implemented Improvements

We give two examples of this type of improvement. The first concerns the wage indexing equations discussed in section 2.2.11. At present it is post-tax wages which are indexed to movements in the FEDERAL cpi. This is at odds with institutional reality in Australia and it is suggested in section 2.2.11 that an alternative indexing equation which catered for indexing of pre-tax wages be introduced. However it is clear from section 5.5.2.1 that for most simulations pre- and post-tax wages move together and no harm is done by our current specification if we do not wish to model changes in income tax rates.

A second improvement concerns state government transfers from public enterprises. At present this is very crudely modelled as a residual (see section 4.2.3.2.2). Although only a quite small item, it would be easy to improve this specification by treating these transfers to state government analogously to Commonwealth transfers from public enterprises. These latter transfers are treated as a 100 per cent tax on the transfer portions of capital income to the public enterprises (see section 4.2.2.2.4.2). This feature could be instituted for state government enterprise transfers by providing for a state government income tax on capital levied at a rate that would allow the appropriate transfer payments to be captured.

6.3.1.2.2 General Improvements in CGE Modelling

CGE modelling is a rapidly developing area of economics and there is considerable scope for FEDERAL to take advantage of research on national models. Given the FEDERAL model's structure one would expect the major opportunities for incorporating developments by other researchers to be confined mainly to ORANI model developments. Powell (1985 and 1988) gives a comprehensive account of developments with ORANI since 1982 and we shall not review these developments here. If FEDERAL is to be a successful working regional model, concentration on theoretical updates would best be in the area of those improvements which have been incorporated into the working version of ORANI (currently the ORANI-F model) and those which have particular bearing on the type of regional simulations towards which FEDERAL applied research is most likely to be directed (e.g. incorporating features allowing for projections of income distribution impacts (see Agrawal and Meagher (1987)). The ORANI-F model allows for model applications of a forecasting type rather than just comparative statics, by incorporating minimal dynamics which account for capital and foreign debt accumulation.

6.3.1.2.3 FEDERAL-specific Improvements

There is naturally also considerable scope for research on theoretical developments more specific to FEDERAL itself. We look at two possible tasks of this type here. The first surrounds the modelling of regional unemployment. At present the FEDERAL model user has two choices. Either the regional labour force is chosen to be exogenous and (unless this variable is shocked) the change in aggregate regional employment is entirely taken up by a corresponding change in the number of persons unemployed in the region. Alternatively regional unemployment is treated exogenously and the regional labour force endogenously. It might be argued that the first alternative is an adequate short run assumption and the latter assumption is suitable for long-run simulations. However the possibility of modelling interstate migration, a key component of regional labour force participation, in terms of certain FEDERAL variables might be a useful area for examination.

A second possible area of research relates to the FEDERAL income-consumption relationship. At present FEDERAL models for each region only one representative consumer who earns all regional labour income and (regionally-owned) capital and land income. The single regional average propensity to consume incorporated in the model's data base is likely to present a limitation on simulations involving severe divergences in the movements of capital and labour income, since it is well-known that there is a higher propensity to save out of capital income (particularly via retained earnings). A relatively simple improvement to the model would be to allow for two classes of consumers in each region, one which earned predominantly labour income, the other chiefly capital and land income.[3]

6.3.1.3 Disaggregation

As was explained in section 4.2.1, a nine-industry data base was chosen for our first version of FEDERAL in order to ease the process of reaching a thorough understanding of how the new model worked.

The question arises, however, as to the ideal level of disaggregation of the working model. Many applications of the model will involve regional shocks of a general nature, such as the fiscal shocks reported in Madden (1989). The advantages of a more disaggregated model for such shocks would not appear to be large.

Other applications will be of an industry-specific nature. Two approaches can be adopted here. One is to have a very disaggregated general purpose model available to cover the possibility of modelling a wide variety of industry shocks. This allows an application involving any particular industry which has been separately identified to be undertaken quickly. Another approach is to have a quite aggregated general purpose model, but to undertake very detailed industry modelling appropriate to an individual industry at the time that industry becomes a subject of study.

A more disaggregated industry structure does, however, represent a modelling improvement even for quite aggregate shocks. Consider the modelling of imports and exports. FEDERAL does not distinguish imports of a commodity according to the domestic region of purchase. Thus only one tariff rate applies to a particular commodity import. This presents no problem where there is a fair degree of commodity disaggregation. However with quite aggregate commodities it is likely that imports of a particular commodity group have quite different sub-commodity distributions for the two regions of purchase. Thus in practice different average tariff rates are likely to be attracted to the commodity for imports to the two different regions. This problem can only be overcome under the present FEDERAL theoretical structure by sufficient commodity disaggregation.

A similar problem of non-homogeneity of aggregated commodities occurs with exports. As explained in section 2.2.5 we overcome this problem by setting an economic environment which precludes direct substitution between domestic sources (i.e. only indirect substitution via relative competitiveness on world markets is allowed). Commodity disaggregation would allow this particular restriction to be removed.

Finally, we recall that aggregation presents problems for our tariff experiment as noted in sections 5.5.1.2.1 and 5.5.1.5. Commodity aggregation causes tariffs to fall too lightly on consumer goods and too heavily on intermediate inputs. A more general problem is that industry aggregation results in interregional differences in industry patterns, which in the TASMAIN version of FEDERAL largely occurs at a disaggregated level, playing very little role in the determination of results. Thus there would seem to be definite advantages of introducing a greater level of disaggregation into FEDERAL than exists in the first working version.

6.3.2 Applications

FEDERAL, like ORANI, is a multipurpose model capable of being the vehicle of a wide range of analyses. A list of all potential applications would be a very long one and we will not attempt such a list. It is possible that future applications could include examination of the regional impacts of some of the many national shocks that have been examined with the aid of ORANI over the last dozen years. Repetition of some of the regionally generated shocks previously undertaken with ORANI-ORES and ORANITAS, as mentioned in sections 1.2.1 and 1.2.3, are also possibilities.

One of the major reasons behind the construction of FEDERAL, as explained in sections 1.2.3 and 6.2, was to allow for a considerable expansion of the range of economic shocks emanating at the regional level which could be simulated. We consider just one area of regionally-generated shocks, those shocks relating to state government fiscal policy. Madden (1989) conducted a set of experiments in order to examine the efficacy of state government employment policies based on changes in the composition of the state budget. Simulations conducted involved changes in both state government current and capital expenditure, payroll taxes, production subsidies, commodity taxes on industry inputs and household purchases, residential and commercial land taxes, fees and fines and transfers to persons. Each simulation involved a shock to the policy instrument designed to worsen the Tasmanian borrowing requirement by $20 million in 1989 prices. The policy instruments were then ranked in order of their employment impact. Given the linear nature of FEDERAL, a successful budget-neural employment policy could then be designed by combining a high ranking instrument (as an employment-generating method) with a low-ranking instrument (as a financing method, i.e. this shock now being gven a sign which would improve the state budget by $20 million).

The employment policy packages were of the largest size that could reasonably be contemplated by a state government (given equity and political considerations). The net employment effects of the best package were reasonably small (about a 0.5 per cent increase in Tasmanian employment), suggesting the scope for a state government fiscal policy is limited but also that the employment effects of budgetary changes can still be significant. All of the above shocks involved across-the-board changes in particular policy instruments. Some policy packages which involved shocks which were not uniform across industries were also considered and it was found that this increased the potential efficacy in employment generation of state government fiscal policies. Continued work on the effects of such targetted policies would seem a useful subject for future research.

6.3.3 Other State Versions

Our TASMAIN version of FEDERAL allows us to study a small state of a federal economic system. Many interesting areas of analysis are opened up by the availability of a CGE model at the state level, but the TASMAIN version of FEDERAL benefits only to a limited extent from the multi-regional nature of the model due to the small size of Tasmania relative to the mainland. Spillover effects to the mainland economy (and consequently feedback effects from the mainland) resulting from shocks originating in the Tasmanian economy are trivial.[3]

That is not to say that nothing is gained from building a two-region model focussing on Tasmania rather than just a single-region Tasmanian CGE model. The effects of national and mainland shocks on the Tasmanian economy are made easy to simulate with the FEDERAL model, as seen with the payroll-tax experiments. Furthermore, our method of constructing the interregional data base by treating mainland Australia as the residual region means that the multi-regional aspect of the model has been introduced at a comparatively low cost.

However, it will be the construction of a version of the FEDERAL model focussing on one of the larger states, particularly New South Wales or Victoria, which will bring forward the full benefits of the model's multi-regional features. The intention that FEDERAL (TASMAIN) would form a prototype for such a model formed a major justification behind construction of a two-region model.

APPENDIX

BACK-OF-THE-ENVELOPE EXPLANATION OF ECONOMY-WIDE TARIFF RESULT

In Chapter 5 we simply note that our FEDERAL (TASMAIN) tariff experiment economy-wide results concur with the standard ORANI results. In this appendix we seek to illustrate with a one sector model why FEDERAL and ORANI give the key result that an across-the-board tariff increase leads to an economy-wide decine in activity and employment. We approach this task by developing an equation which gives a rough approximation to the form of the short-run supply function which underlies a regional industry's output responses in FEDERAL under our chosen simulation environment. An ORANI industry short-run supply function would take the same form.

We proceed by restating a simplified version of equation (2.5) covering industry demands for primary factors. We assume here only two primary factors, labour and capital.[1]

$$\ell = z - \sigma(w - S_L w - S_K r) \qquad \text{(A1)}$$

$$k = z - \sigma(r - S_L w - S_K r) \qquad \text{(A2)}$$

where ℓ and k are the percentage changes in the demands for labour and capital respectively by a representative regional industry, z is the percentage change in the activity level of the representative regional industry, w and r are the percentages changes in the prices paid for labour and the rental of capital respectively by the regional industry, σ is the parameter reflecting the degree of substitutability between labour and capital inputs into the regional industry and S_L and S_K are primary factor shares (which sum to unity).

We can simplify equation (A1).

$$\ell = z - \sigma(w(1 - S_L) - S_K r)$$

$$= z - \sigma S_K(w - r) \qquad \text{(A3)}$$

For the short run k = 0 and (A2) becomes:

$$z = \sigma(r - S_L w - S_K r) \qquad \text{(A4)}$$

$$S_K r = -z/\sigma + r - S_L w \qquad \text{(A5)}$$

Substituting (A5) for the term, $S_K r$, in (A3):

$$\ell = z - \sigma(S_K w + z/\sigma - r + S_L w)$$

$$= z - \sigma(w - r + z/\sigma)$$

$$= -\sigma(w - r) \qquad \text{(A6)}$$

We can also rearrange (A4) to give:

$$z = \sigma r - \sigma(1 - S_L)r - \sigma S_L w$$

$$= -\sigma S_L(w - r) \qquad \text{(A7)}$$

Dividing (A6) by (A7) we obtain:

$$\ell/z = 1/S_L$$

or

$$\ell = z/S_L \qquad \text{(A8)}$$

We now write down a simplified form of the zero-pure-profits in production equation (2.33). Here we assume that there are no intermediate inputs or costs other than labour and capital costs.[2]

$$p = S_L w + S_K r \qquad \text{(A9)}$$

where p is the basic price of output from the regional industry.

Rearranging (A6) to solve for r which we then substitute into (A9), we obtain:

$$p = S_L w + S_K(w + \ell/\sigma)$$

$$= S_L w + (1 - S_L)w + (1 - S_L)\ell/\sigma$$

$$= w + (1 - S_L)\ell/\sigma \qquad \text{(A10)}$$

Rearranging (A10) we obtain:

$$\ell = \sigma(p - w)/(1 - S_L) \tag{A11}$$

Using (A8) to substitute for ℓ in (A11) we obtain our short-run supply function:

$$z = \sigma(p - w)S_L/(1 - S_L) \tag{A12}$$

It can thus be seen that the output response of a regional industry is dependent on the ease of primary factor substitutability, the share of non-fixed factors in total factor costs and the margin between the percentage changes in output price and labour costs.

For the purpose of explaining the output response of the whole economy to the tariff shock, let us assume that the economy has only one region containing one industry the output of which is both exported and sold domestically. It is assumed that there is no local production competing with imports. Thus we now take z in equation (A12) to cover the supply response of the whole economy.

Whether the economy's output (and employment) is projected to expand or contract as a result of the tariff increase will now depend solely on a comparison of p and w. An assumption of our tariff experiment is full wage-indexation. Thus, w is equal to the percentage change in the consumer price index, p_c, which itself can be written as:

$$p_c = S_d^c p + (1 - S_d^c)(p_m + t) \tag{A13}$$

where p_m is the percentage change in the basic price of imports, t the percentage change in the power of the tariff (i.e. one plus the tariff rate) and S_d^c is the share of domestic commodities in total household consumption.

In our experiment we assumed $p_m = 0$ and we can also assume the following approximately holds:

$$p = p_x = 0$$

where p_x is the Australian currency f.o.b. export price. That is, we assume that with a one domestic product model the export price sets the domestic price and we further assume that Australia is too small a country for a change in its tariff rate to have any material effects on the terms of trade. Thus from (A13) we have:

$$p_c = (1 - S_d^c)t$$

and since $t > 0$, this means $p_c > p$ and therefore $w > p$.

Thus on the basis of equation (A12) we would expect a contraction in economy-wide output consequent on a tariff increase, and on the basis of (A11) also a contraction in economy-wide employment. This is hardly surprising as we have no import-competing industry to gain from the tariff increase. However, if we do allow some import-competing production, the price of domestically-produced import-competing commodities will rise, improving the position of that class of producers but compounding the problem of others.[3] Given sensible import substitution parameters, we would still expect projected contractions in output and employment, such as we find with our FEDERAL tariff experiment in Chapter 5.

The above explanation relies upon the Australian institutional feature of wage indexation. However a similar argument can be put for an economy without this feature. The argument is that the domestic industry suffers a cost increase for which it is not (fully) compensated. The cost increase in the above argument came via an increase in money wages. However if we allowed for intermediate inputs in our supply equation, the cost increase could come via an increase in the price of inputs of the tariff-laden good.

It should be noted that the above analysis does not necessarily encompass all the major impacts of a tariff increase. It is possible that a tariff increase experiment could lead to a FEDERAL projection of an economy-wide increase in employment. Table 5.2 shows that an across-the-board tariff increase results in a slightly larger increase in the FEDERAL investment price index than the cpi. Imagine a tariff increase that fell entirely on an investment commodity. The FEDERAL cpi is unlikely to show any significant rise in this case. Also our assumption that $p = p_x = 0$, is too severe. Firstly the contraction in exports will mean a slight rise in export prices and, secondly, in our actual simulation the prices of non-exported domestic commodities are not constrained by export prices. Furthermore, a way in which domestic producers could be compensated for the tariff increase is by redistributing the tariff revenue, say by a government subsidy on wages. Thus it is possible that p could exceed w and output and employment expand slightly.

Other possibly significant factors we have assumed away are the relative strengths of elasticities of substitution between domestic and imported commodities and differences in fixed factor shares between export, import-competing and non-traded industries.[4] Nevertheless the back-of-the-envelope explanation of the output/employment result is likely to have captured the main element operating in both the across-the-board tariff experiment we conducted with the FEDERAL model and the one DPSV conducted with the ORANI model.

NOTES

Chapter 1

1. Madden (1987), an early version of Chapter 2 of this thesis, refers to the theoretical structure of the model under the name "TASMAIN". The model has been retitled FEDERAL in order to indicate its applicability to regions other than Tasmania and the Australian mainland which are the two regions of the implemented model.

2. Dervis, De Melo and Robinson (1982) describe CGE models as incorporating "the fundamental general equilibrium links among production structure, incomes of various groups and the pattern of demand" (p. 132). Despite the lack of an income-consumption link in the ORANI model as outlined in Dixon, Parmenter, Sutton and Vincent (1982) we will class that version of ORANI as a CGE model. Later versions of ORANI do incorporate an income-consumption link.

3. While the constancy of regional output shares for national industries is the normal assumption for ORES, all that is actually required is that the percentage change in regional output of national industries be exogenous, provided that they are consistent with the national results. This latter broader assumption was employed by Madden, Challen and Hagger (1938a) as briefly discussed in note 4 below.

4. Dixon, Parmenter, Sutton and Vincent (1982) in forming ORES did incorporate such a shift variable in the case of the equation describing the regional allocation of "other" final demand in order to allow for exogenous changes in the regional allocation of government expenditure. Madden,

Challen and Hagger (1983a) added shift variables for the national industry output and investment equations and export equations. Hagger, Madden and Challen (1984) added a shift variable to the household-demand equations. In all these cases it was necessary to constrain the weighted average of the shift variables across regions to zero so that the ORES results would be consistent with the national results.

5. Another approach to forming a multiregional model is to adapt a multicountry model since there is little difference in the formal structure of both types of model. Jones, Whalley and Wigle (1985) analysed the regional impacts of tariffs in Canada by constructing a small dimensional interregional CGE model based on the seven-region international trade model which Whalley (1982) used to examine global trade liberalization questions.

6. Madden, Oakford and Kerslake (1983) subsequently produced an updated version of ORANI-TAS, which included more regional industries and involved different data estimation techniques which they developed in order to ensure interstate trade flows in the model's data base were consistent with ABS interstate trade figures for Tasmania. A hybrid model has also been constructed for Western Australia by Ernst and Parmenter (1984).

7. If the "local" as well as the "national" industries were separated into Tasmanian and mainland industries then ORES would have to be dispensed with since we would then have competing explanations for output projections (and base year levels) for the local industries.

Chapter 2

1. $\sum_{s=1}^{3} S^{*(1)r}_{(is)j}\, p^{(1)r}_{(is)j}$ is a weighted average of the percentage changes in the prices regional industry (jr) pays for good i from all sources. Note that the $S^{*r}_{(is)j}$'s are modified shares of the value of inputs from all sources in (jr)'s purchase of input i. The form of these shares results from the assumption of a CRESH relationship between material input i from different sources and is described in Table 3.2 under equation (2.1).

2. The weights ($H^{*(0)r}_{(u*)j}$) are modified revenue shares which are described in Table 3.2.

3. Although u does not appear as a subscript to $S^{(0)}_{(ir)j}$, the relevant composite commodities into which commodities are partitioned are non-overlapping sets.

4. Government investors includes only general government while public enterprises are included under private investors.

5. In the absence of a tariff change, the devaluation would result in g(i3, 0) being equal to unity if h_2(i3, 0) were set to unity and the other user-set parameters in equation (2.39) consequently set to zero.

6. We are able to use the basic price of margin commodity u to calculate margin costs since we treat any taxes on margin commodities as production taxes on the margins industry and any delivery charges on the margins services as direct input demands by the margins industries. Since substitution between margins services is not possible in FEDERAL this approach poses no problems.

7. Note that the way equations (2.54) and (2.59) are specified a user must place both regional components of an industry in the same investment category. Thus it is not possible to include regional industry (j1) in the set J while excluding regional industry (j2) from J.

8. No harm is done by our current specification, however, provided the simulation does not involve changes in income tax rates. This can be clearly seen from the discussion in section 5.5.2.1.

9. Transfers from Commonwealth government public enterprises are included in other income tax (see section 4.2.2.2.4.2). It should also be noted that for this and some later equations we implicitly assume privately owned capital stocks in a regional industry move in line with $k_j^r(0)$. This assumption is only relevant to long-run experiments. Thus while our model implies the possibility of variation among classes of investors in the percentage changes in future capital stocks (not in place until the completion of our long-run period), the above assumption means there is no such implied variation in current capital stocks (which are in place by the beginning of the last "year" of the long-run period). To ensure that this assumption (which could involve a substantial implied jump in the investment time-path for each class of investor) plays a minimal role, FEDERAL users should, for long-run simulations, assign those industries with substantial government investment to the exogenous-investment category for private investment and force investment by all investor classes in such a regional industry to move together.

10. These other receipts are composed of interest and dividends receipts from various sources. Although the option is given to the user of indexing these equations to the national cpi, the theoretical justification for doing so would seem slim. Thus we would normally expect the user to set the parameter $h^{(4,7)}$ to zero.

11. The comments applying to other Commonwealth government receipts under note 10 are also applicable to other state government receipts. Thus $h^{(3,8)r}$ would normally be set to zero.

12. Strictly speaking the entire change in super normal profits should have been allocated to the change in gross domestic product at factor cost (via equation (2.126)) and the tax component should then be distributed back to government via equation (2.127). Also, we have not as yet made provision for the export tax/subsidy (super-normal "profit"/"loss") to affect the rental price of capital in the industries selling non-export commodities.

Chapter 3

1. The DPSV distinction between coefficients and parameters is followed here. Coefficients are held constant at base-year values in FEDERAL for computing convenience. However in a possible future large change version of FEDERAL, the value of coefficients would be recalculated during the solution procedure. As with DPSV, the word, parameters, is reserved for genuine constants.

2. Section 4.3.5 outlines a method for estimating the data required in order to employ a Klein-Rubin form of utility function as in ORANI. If this were done, estimates of the

marginal regional budget shares (δ_i^r, i = 1, ..., g) and of the regional minimum expenditure shares for the base-period ($\theta_i^r A_i^{(3)r} Q/X_i^{(3)r}$, i = 1, ..., g) would be stored on the parameters file - θ_i^r is a parameter. These would be combined with the average regional budget shares ($S_i^{(3)r}$, i = 1, ..., g) to form the ε_i^r and the η_{ik}^r via regional equations of the same form as (14.28) to (14.33) of DPSV. The $S_i^{(3)r}$ are obtainable from the input-output data files by expressing for each commodity (ir), the sum down the r^{th} column of $\tilde{C}^1$, $\tilde{C}^2$, $\tilde{H}$, $\tilde{M}_{11}^1$, ..., $\tilde{R}_{g+2}$ as a fraction of the sum over all components of the r^{th} column.

Chapter 4

1. For an outline of the RAS method see Madden and Male (1985).

2. The interstate supplied margins were estimated by assuming these were in proportion to the mainland proportion in the direct flow of the domestic commodity. This proportion in turn had to be estimated by using a first approximation to the methods described below for estimating direct flows.

3. If in a later version of FEDERAL, however, the region of focus were, say, NSW rather than Tasmania, a method of adjusting the Australian data towards an estimated residual region demand pattern might be advisable.

4. In our 9-industry version of FEDERAL (TASMAIN) we could improve upon this assumption at an aggregated level by undertaking the allocation according to the fixed share assumption at a more disaggregated level and then

aggregating. One would then expect, given there is some difference between Tasmanian and mainland sub-commodity proportions, that the fixed shares would no longer exist at the aggregated level. The proportion of a commodity a mainland purchaser sourced from Tasmania would then reflect the effects of the more disaggregated information.

5. This estimation method was devised by Madden (1985).

6. The reader may have expected different ratios for margins to domestic direct flows and margins to imported direct flows. However this was not the case since ORANI matrices $\tilde{K}_7$ and $\tilde{P}_7$ are aggregated in the 1978-79 ORANI computer data base. It was therefore assumed that the ratios are the same for domestic flows and imports and a common ratio was employed.

7. As the sales tax variables also cover negative taxes (subsidies), this assumption also implied that state governments did not pay any commodity-specific subsidies on interstate exports.

8. It would be possible to use the row P3 figure as an upper limit on the payroll tax payment but this was not done. Also no attempt was made to reconcile the row P3 figures with the sum of all types of Tasmanian indirect taxes in the FEDERAL (TASMAIN) data base once they had all been estimated.

9. Although the ORANI $\tilde{U}$ matrix used for this task contained returns to owner-operators in addition to the wage-bill, rows P1 and P2 of the TIO were not adjusted to reallocate any owner-operator returns from row P2 to row P1. This was because the Tasmanian input-output table appeared, from an

examination fo the ORANI files and ABS state accounts, to already be consistent with owner-operator income having been assigned to the wages row, P1.

10. A slight adjustment was made to the $\tilde{U}^3$ matrix in the light of the published Tasmanian payroll tax receipts figure (ABS (1987)).

11. The ORANI computer data-base splits X into working capital, indirect taxes and sales by final buyers. The proportions used were thus from $\tilde{V}$, $\tilde{W}$ and the working capital matrix.

12. Our assumption of no foreign ownership of agricultural land (absence of $\tilde{W}^3$ matrix) could be considered to be at odds with the very small foreign ownership of capital in the rural industry. This is not necessarily so as rural does cover certain non-(private) land using activities such as fishing and forestry on public land. However, the specification of the model would be improved with provision for foreign ownership of agricultural land given that this corresponds with known foreign ownership of cattle stations in Northern Australia.

13. The 1977-78 Tasmanian transactions table published by Edwards (1981) does not contain a row of sales by final buyers (mainly composed of sales of second-hand capital equipment and scrap). Estimates were therefore done on the basis of the new 1985-86 Tasmanian transactions table, compiled by Tasmanian Department of Treasury and Finance (1990), which does contain such a row.

14. An improvement could be made in the estimation of Tasmanian industry capital formation by adjusting the industry weighting pattern to take account of the small regional

differences in industry output structure. This would be particularly advisable for versions of FEDERAL of a greater level of industry dissagregation where the regional differences in output pattern are likely to be much larger.

15. In future versions of FEDERAL (TASMAIN), the vector added to the first column of $\tilde{C}^2$ will also be subtracted from the first column of $\tilde{C}^1$ to maintain the underlying balance from the TIO table.

16. FEDERAL does not recognize the separate existence of local governments and assumes that they form part of the state government in their region.

17. In the initial version of FEDERAL (TASMAIN) the same share was used for all commodities and was obtained from estimates made by Madden and Oakford (1982).

18. This method of estimating the region 1 state government interstate imports commodity composition is not very satisfactory. The internal Tasmanian flows to government are virtually all non-traded commodities while interstate flows would be expected to be in traded commodities.

19. In ORANI theory the purchases are made by other final demanders. However for all intents and purposes in the 1978-79 ORANI data-base these demanders consist entirely of government.

20. Mainland figures here and below sourced from ABS (1987) are calculated by subtracting the Tasmanian state and local government figure from the appropriate figure in the corresponding table for all states.

21. At present FEDERAL (TASMAIN) land taxes relate only to the improved value of land, i.e. the capital installed on it.

This means that agricultural land taxes which appear in the first and $(h+1)^{th}$ columns of $\tilde{V}^3$ are incorrectly tied to returns on capital whereas the vast bulk of this kind of land tax actually falls on returns to land.

22. These are non-income direct taxes such as estate duties.

23. That is by summing across the $((r-1)h+1)^{th}$ to rh^{th} elements of the $\tilde{X}^1$ vector.

Chapter 5

1. The system actually put onto computer differed from that shown in Table 2.1 in two ways. Firstly, the technological change percentage change variables were not included, effectively meaning that they had to be set exgenously at zero by the model user. Also the system was condensed by eliminating the variables, $x^{(1)r}_{(is)j}$, $x^{(2)r}_{(is)j}$, $x^{(5,2)r}_{(is)j}$, $t^{(is)(jr)k}_{(ut)}$, $x^{(is)3r}_{(ut)}$, $x^{(is)5ur}_{(ut)}$, $x^{(is)6r}_{(ut)}$, g(is,jrk1), g(is,jk2), $p^{(k)r}_{(is)j}$, $p^{(6,2)}_{(is)j}$ by substituting for these variables with equations (2.1), (2.11), (2.12), (2.28), (2.29), (2.30), (2.31), (2.48), (2.49), (2.42), (2.47) respectively. These substitutions were performed automatically by TABLO.

2. The SAGEM solution of the linear system employs the Harwell Laboratories sparse matrix routine, MA28 (Duff (1977)).

3. An alternative to conducting this simulation is to use the GEMPACK utility, SUMEQ. This program will add the value of the coefficients of a group of nominated variables across each equation. If nominal homogeneity is to be met the value of all nominal variable coefficients for any equation must equal zero. This method is formally equivalent to

carrying out the nominal homogeneity simulation and was used during early tests with FEDERAL as it directly associates any error relating to nominal homogeneity with an individual equation.

4. The shock to q^r is included only for completeness, since with the Cobb-Douglas utility function in this first version of FEDERAL a shock to q^r has no effect on any of the endogenous variables.

5. See equations (5.8) and (5.9) in section 5.5.2.1.

6. Equation (55) of Madden (1987) is:

$$k_j^r(1) = k_j^r(0)(1 - G_j^r) + y_j^r G_j^r$$

where $k_j^r(1)$ and $k_j^r(0)$ must be interpreted as <u>private</u> future and current regional industry capital stocks. For this specification to be used for long run simulations additional equations for government current capital stocks would be required, together with an alteration to the left hand side of equation (2.67). However for short run experiments of the type reported in this chapter no problem arises with the above specification. Since the percentage change in all current capital stocks is zero, equation (2.67) is adequate to make sure that the percentage changes in the demands for regional industry capital are zero.

7. We discuss the economy-wide output and employment result further in the Appendix.

8. The relationship between the short-run supply response of an industry and its share of fixed factors (and its real basic price increase) can be found in the Appendix.

9. As depreciation charges are assumed to be met out of savings we do not distinguish between pre-tax factor incomes and factor costs here.

10. The rise in mainland industry investment is confined to the export industries which gain from the induced fall in real consumption. The primary effect is actually for a slight fall in investment in these mainland industries and a rise in non-export mainland industry investment, but this is reversed by the consumption-induced effects. In Tasmania, to where the payroll tax rise is confined in this particular experiment, all industries are projected to suffer a marked decline in real investment.

Chapter 6

1. The bilateral payroll tax experiment could of course have been simulated with ORANI-ORES (via the other cost shift term in ORANI). It is analysis of unilateral state payroll tax changes which the introduction of the FEDERAL model opens up.

2. The effects on the state government borrowing requirements may not, of course, be budget neutral.

3. This lack of feedback can lead to some interesting results. In section 5.5.2.1 we see that the negative impact on Tasmanian employment from a unilateral Tasmanian payroll tax increase is less than for the mainland when that region raises its payroll tax. This result is principally due to the Tasmanian shock not noticeably affecting the national cpi and there being no subsequent negative impact via wage indexation. Also Madden (1989) finds that an increase in

Tasmanian government current expenditure has a quite large employment impact, since for a small state like Tasmania, any induced price increases arising from the increased government expenditure hardly have any flow-on effects back to wages.

Appendix

1. In this appendix we use simplified notation which does not necessarily correspond with that used in the rest of the thesis.

2. Readers interested in the ORANI short-run supply function without such simplifying assumptions should consult Appendix A2 of Higgs (1986).

3. Here we assume this occurs through wage indexation. The mechanism would be strengthened if we also took into account tariffs on intermediate inputs as discussed in the next paragraph.

4. A useful exercise would be to undertake for a tariff experiment, a back-of-the-envelope analysis similar to that undertaken by Dixon (1978) who examines the role played by primary factor shares in ORANI projecting an employment increase for a general demand shock.

References

Agrawal, N. and Meagher, G.A. (1987), "Distribution Effects of Alternative Responses to Australia's Terms of Trade Deterioration", Impact Project Preliminary Working Paper, No. IP-31, December.

Australian Bureau of Statistics (1976), "Foreign Ownership and Control of Tourist Accommodation Establishments, 1973-74", ABS Reference No. 11.47, Canberra.

Australian Bureau of Statistics (1978), "Foreign Control of Registered Financial Corporations, 1976", ABS Catalogue No. 5238.0, Canberra.

Australian Bureau of Statistics (1979), Year Book, Australia No. 63, 1979, ABS Catalogue No. 1301.0, Canberra.

Australian Bureau of Statistics (1980a), Year Book Australia, No. 64, 1980, ABS Catalogue No. 1301.0, Canberra.

Australian Bureau of Statistics (1980b), "Taxation Revenue, Australia, 1978-79", ABS Catalogue No. 5506.0, Canberra.

Australian Bureau of Statistics (1981), Year Book, Australia No. 65, 1981, ABS Catalogue 1301.0, Canberra.

Australian Bureau of Statistics (1982), Year Book, Australia No. 66, 1982, ABS Catalogue 1301.0, Canberra.

Australian Bureau of Statistics (1983), "Foreign Ownership and Control of the Mining Industry and Selected Mineral Processing Industries, Australia 1981-82", ABS Catalogue No. 5317.0, Canberra.

Australian Bureau of Statistics (1985a), "Foreign Ownership and Control of the Manufacturing Industry, 1982-83", ABS Catalogue No. 5322.0, Canberra.

Australian Bureau of Statistics (1985b), "Taxation Revenue, Australia,1983-84", ABS Catalogue No. 5506.0, Canberra.

Australian Bureau of Statistics (1985c), "Balance of Payments, Australia, 1983-84", ABS Catalogue No. 5303.0, Canberra.

Australian Bureau of Statistics (1986a), Tasmanian Year Book, 1986, ABS Catalogue No. 1301.6, Hobart.

Australian Bureau of Statistics (1986b), The Labour Force, Australia, 1966 to 1974, ABS Catalogue No. 6204.0, Canberra.

Australian Bureau of Statistics (1987), Australian National Accounts, State Accounts 1985-86, ABS Catalogue No. 5220.0, Canberra.

Challen, D.W., Hagger, A.J. and Madden, J.R. (1984), "The Effectiveness of State Government Subsidy Measures: A Preliminary Ranking from ORANITAS," in A.D. Sorensen et al., Papers of the Eighth Meeting of the ANZ Regional Science Association, Armidale, December 1983, pp. 134-153.

Codsi, G. and Pearson, K.R. (1988), "An Overview of GEMPACK - A Software System for Implementing and Solving Economic Models," GEMPACK Document No. 22, IMPACT Project, University of Melbourne.

Dervis, K., De Melo, J. and Robinson, S. (1982), General Equilibrium Models for Development Policy, Cambridge University Press, New York.

Dixon, P.B. (1978), "Why Does ORANI Produce an Increase in Employment under a General Demand Simulation?", IMPACT Research Memorandum, OA-62.

Dixon, P.B., Parmenter, B.R. and Sutton, J. (1978), "Spatial Disaggregation of ORANI Results: A Regional Balance Method," IMPACT Preliminary Working Paper No. OP-19, Melbourne.

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

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

Duff, I.S. (1977), "MA28 - A Set of FORTRAN Subroutines for Sparse Unsymmetric Linear Equations," Harwell Report R.8730, HMSO, London.

Ernst, W.F. and Parmenter, B.R. (1984), "ORANI-WA: A Model for Analyzing the Impact of Economic Shocks on Western Australia," in T.J. Mules (ed.), Proceedings of the Input-Output Workshop, 9th Meeting of the Australian and New Zealand Section of the Regional Science Association, Melbourne.

Hagger, A.J., Madden, J.R. and Challen, D.W. (1984), "An Analysis of the Impact of a Recession in Tourism on the Tasmanian Economy," CREA Paper - No. RS-07, Centre for Regional Economic Analysis, University of Tasmania.

Hagger, A.J., Madden, J.R. and Groenewold, N. (1987), The Tasmanian Economy: A Survey, Report for the Tasmanian Government, Government Printer, Tasmania.

Higgs, P.J. (1986), Adaptation and Survival in Australian Agriculture, Oxford University Press, Melbourne.

Higgs, P.J., Parmenter, B.R. and Rimmer, R.J. (1988), "A Hybrid Top-Down, Bottom-Up Regional Computable General Equilibrium Model," International Regional Science Review, Volume 11, No. 3, pp. 317-328.

Higgs, P.J., Parmenter, B.R., Rimmer, R.J. and Liew, L. (1981), "Incorporating Regional Dimensions in Economywide Models: A Preliminary Report on a Tasmanian Version of ORANI," in R.E. Glass and K.B. O'Connor (eds.), Papers of the Australian and New Zealand of the Regional Science Association, 6th Meeting, August 1981, Surfers Paradise, pp. 217-240.

Hood, D. and Wilde, P.D. (1986), "The Performance of Non-locally Owned and Indigenous Manufacturing Firms in Tasmania 1980-85", Final Consulting Report to the Tasmanian Development Authority, Department of Geography, University of Tasmania.

Jones, R., Whalley, J. and Wigle, R. (1985), "Regional Impacts of Tariffs in Canada: Preliminary Results for a Small Dimensional Numerical General Equilibrium Model," in J. Piggott and J. Whalley (eds), New Developments in Applied General Equilibrium Analysis, Cambridge University Press, New York.

Klein, L.R. and Glickman, N.J. (1977), "Econometric Model-Building at Regional Level," Regional Science and Urban Economics, Vol. 7, pp. 3-23.

Leontief, W.W., Morgan, A., Polenske, K., Simpson, D. and Tower, E. (1965), "The Economic Consequences - Industrial and Regional - of an Arms Cut," Review of Economics and Statistics, Vol. 47, No. 3, pp. 217-241.

Leontief, W.W. and Strout, A. (1963), "Multiregional Input-Output Analysis", in T. Barna (ed.), Structural Interdependence and Economic Development, Macmillan, London.

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

Liew, L.H. (1984), "A Johansen Model for Regional Analysis," Regional Science and Urban Economics, Vol. 14, No. 1, pp. 129-146.

Madden, J.R. (1985), "Generating an Interregional Input-Output Data-Base for a Two-Region Model", Paper presented to Input-Output Workshop, 10th ANZ Regional Science Association Conference, University of Adelaide, 2 to 4 December 1985.

Madden, J.R. (1987), "The Structure of the TASMAIN Model," CREA Paper No. TS-02, Centre for Regional Economic Analysis, University of Tasmania (Reprinted as IAESR Working Paper No. 11/1987, University of Melbourne).

Madden, J.R. (1989), "Employment Policy Options: Answers from a Large-Scale Economic Model", Paper commissioned by the Tasmanian Employment Summit Secretariat, Tasmanian Employment Summit, Parliament House, Hobart, 28 and 29 November 1989.

Madden, J.R. and Challen, D.W. (1983), "New Technology and Tasmanian Employment," in K.D. Nichols (ed.), Papers of Symposium on Science, Technology and Employment, ANZAAS (Tas. Division), Hobart, pp. 26-37.

Madden, J.R., Challen, D.W. and Hagger, A.J. (1981), "The Effects on the Tasmanian Economy of Some Alternative Trade Liberalization Options", CREA Paper - No. RS-01, Centre for Regional Economic Analysis, University of Tasmania.

Madden, J.R., Challen, D.W. and Hagger, A.J. (1983a), "The Regional Effects of Resource Development; An Application of ORANI-ORES," in C.C. Kissling, et al., Papers of the 7th Meeting of the Australian and New Zealand Section of the Regional Science Association, December 1982, Canberra, pp. 205-219.

Madden, J.R., Challen, D.W. and Hagger, A.J. (1983b), "The Grants Commission's Relativities Proposals: Effects on the State Economies," Australian Economic Papers, Vol. 22, pp. 302-321.

Madden, J.R. and Male, S.E. (1985), "Developing a 1980-81 Tasmanian Input-Output Table of the Tasmanian Economy", CREA Research Memorandum, Centre for Regional Economic Analysis, University of Tasmania.

Madden, J.R. and Oakford, A. (1982), "An Updated Government Final Consumption Expenditure Data Base for ORES", CREA Research Memorandum, Centre for Regional Economic Analysis.

Madden, J.R., Oakford, A. and Kerslake, M.L. (1983), "Construction of the Data Base for the 1974-75 Version of ORANITAS," CREA Research Memorandum, Centre for Regional Analysis, University of Tasmania.

Meagher, G.A. and Parmenter, B.R. (1985), "Some Short Run Effects of Shifts from Direct to Indirect Taxation," IAESR Working Paper No. 10/1985, Institute of Applied Economic and Social Research, University of Melbourne.

Norrie, K.H. and Percy, M.B. (1983), "Freight-Rate Reform and Regional Burden: A General Equilibrium Analysis of Western Freight Rate Proposals", Canadian Journal of Economics, Vol. XVI, No. 2, p. 325-349.

Parmenter, B.R. and Meagher, G.A. (1987), "ORANI-NT: An Economic Model of the Northern Territory," unpublished mimeo.

Parmenter, B.R., Pearson, K.R. and Jagielski, R. (1984), "Bottoms-up, Tops-Down and Hybrid Methods for Regionalizing Computable General Equilibrium Models: Some Comparison", Paper presented to Input-Output Section of the Regional Science Conference, University of Melbourne, December, 1984.

Pearson, K.R. (1986), "Automating the Computation of Solutions of Large Economic Models," IMPACT Preliminary Working Paper, No. IP-27, Melbourne.

Powell, A.A. (1985), "IMPACT Project Report: A Brief Account of Activities over the Period 1st February 1982 to 28th February 1985, with a Prospectus for Further Developments", IMPACT Project Report No. R-05, University of Melbourne, April.

Powell, A.A. (1988), "IMPACT Project Report: A Brief Account of Activities over the Period 31st March 1985 to 31st December 1987, with a Prospectus for Further Developments", IMPACT Project Report No. R-07, University of Melbourne, February.

Sutton, J.M. (1981), "Aggregation of Commodities, Industries and Occupations in ORANI 78", IMPACT Research Memorandum, Canberra.

Tasmanian Department of Treasury and Finance (1990), "An Input-Output Table of the Tasmanian Economy, 1985-86", Tasmanian Government Printer, Hobart, forthcoming.

Whalley, J. (1982), "An Evaluation of the Tokyo Round Table Agreement Using General Equilibrium Computational Methods," Journal of Policy Modelling, Vol. 4, pp. 341-346.