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Historical Simulations with
the MONASH Regional
Equation System

by

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Preliminary Working Paper No. OP-95 December 2000

ISSN 1 031 9034

ISBN 0 7326 1527 5

The Centre of Policy Studies (COPS) is a research centre at Monash University devoted to quantitative analysis of issues relevant to Australian economic policy.

ABSTRACT

MONASH-RES combines a top-down regional equation system with the MONASH dynamic model of Australia to produce regional forecasts or policy analysis. Experience indicates that MONASH-RES gives acceptable rankings of regional economic prospects but understates inter-regional differences. We investigate the model's properties by attempting to reproduce observed patterns of State/Territory economic performance from 1986-87 to 1993-94.

Industries are classified either as *national*, producing commodities that are readily traded between regions, or as *local*, producing goods or services that are not traded between regions. Regional outputs of *national* industries are assumed to be independent of regional demand for them but regional outputs of *local* industries must meet regions' demands.

The results demonstrate that MONASH-RES forecasts are improved significantly by the inclusion of region-specific macro data and accurate information about the regional distribution of output changes in *national* industries. They confirm that the treatment of *local* industries in MONASH-RES is satisfactory.

JEL classification: D58, R11, R13

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Historical Simulations with the MONASH Regional Equation System¹

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1 Introduction

As part of forecast and policy analyses produced with the MONASH model, researchers at the Centre of Policy Studies (CoPS) have used a top-down Regional Equation System (RES) to produce results for States and Commonwealth Territories and for statistical divisions (Adams and Dixon, 1995). How reliable are these regional projections? Our forecasting experience to date indicates that while MONASH-RES gives accurate projections of the ranking of regional economic prospects, it may understate the scale of inter-regional differences. In this paper, we investigate the reasons for apparent problems with the MONASH-RES system by attempting to make it reproduce observed patterns of regional economic performance over a recent historical period. This is an extension of earlier historical simulations in which the MONASH model was forced to reproduce observed patterns of structural change at the national level (Dixon and McDonald, 1993).

The paper is organised as follows. In Section 2, we outline the structure of MONASH-RES. Section 3 contains an explanation of the design of the historical simulations. The data used in the simulations are set out in Section 4. Section 5 provides a discussion of the simulation results. Overall conclusions are given in Section 6.

¹ Financial support for this research was provided by the Productivity Commission and the Monash University Research Fund. However, the views expressed do not necessarily reflect the views of the funding institutions. We thank Daina McDonald for assistance with data mobilisation.

2 The structure of MONASH-RES

2.1 Overview

The RES that has been incorporated into MONASH-RES was developed originally for use with ORANI (Dixon, Parmenter, Sutton and Vincent, 1982, Chapter 6). It is a top-down method (Parmenter, Pearson and Jagielski, 1985) that, with minimal requirements for regional data, allows us to infer from national-level results (generated in MONASH or ORANI) the implications of forecasting scenarios or policy shocks for growth of output and employment at the regional level.

Following a method originally applied by Leontief *et al.* (1965), the RES first divides the industries distinguished in the national-level model into two groups, *national* industries and *local* industries. *National* industries produce commodities that are readily traded between regions (e.g., most agricultural, mineral and non-perishable manufactured goods and some services such as Public administration). *Local* industries produce perishable goods or services that are not traded between the regions. The full list of local and national industries is presented in Table 2.1.

In the RES, the regional outputs of *national* industries are assumed to be independent of regional demand for them. Using the system in conjunction with MONASH, percentage changes in the regional outputs of *national* industries are assigned exogenously in ways that are compatible with the relevant MONASH national-level results. In this context, these percentage changes could be growth rates through time corresponding to a forecasting or historical simulation with MONASH, or deviations from control in a policy simulation. An obvious default assignment is to assume that for a given *national* industry all regional percentage changes are the same as the national-level percentage change, i.e.,

$$g(j,r) = g(j), \text{ for all } r, \quad (1)$$

where:

$g(j,r)$ is the percentage change in the output of *national* industry j in region r ; and

$g(j)$ is the percentage change in the industry's economy-wide output in the relevant MONASH simulation.

Assignments in which (1) does not apply for all regions are also possible so long as they conform to the constraint:

$$\sum_r S(j,r) g(j,r) = g(j), \quad (2)$$

where $S(j,r)$ is the share of region r in the aggregate national output of industry j . In forecasting with MONASH-RES, we use assignments of the latter kind to allow us to incorporate information available from the Australian Bureau of Agricultural and

Resource Economics and other sources about the location of new mines and mineral processing plants or the closure of existing ones. In policy analysis, such assignments allow us to investigate scenarios about the geographical pattern of the responses of industries affected directly by the policy shocks. For example, for the Productivity Commission's 1996-97 inquiry into tariff protection for the Australian motor-vehicle industry, we computed two sets of projections of the effects of tariff reductions (Dixon, *et al*, 1997). In the first, we assumed that the induced contraction in motor-vehicle output was spread evenly across the motor-vehicle-producing states (i.e., we used assignment (1)). In the second set of projections, we departed from assignment (1) to examine the possibility that the industry might respond to the tariff cuts by closing down its operations in South Australia and consolidating in Victoria.

The RES includes regional multiplier effects by requiring that the outputs of *local* industries in region *r* meet the region's demand for *local* commodities. In computing a region's demand for *local* commodities, the system includes the intermediate and investment demands of the region's *national* and *local* industries, household demand and government demand. As it does for *national* industries, the system ensures that the percentage changes in the regional outputs of *local* industries are consistent with the economy-wide percentage changes generated by MONASH, i.e., constraint (2) applies for *local* industries.

2.2 A TABLO representation of MONASH-RES

As we will explain in Section 3, the historical simulations that are the subject of this paper required the RES to be run several times using a single set of historical results from MONASH. The calculations performed by the RES have no feedback into the MONASH computations. Hence, we constructed a TABLO input file that allows the RES to be run in stand-alone mode in the GEMPACK computer system. (Notes on the TABLO syntax, vocabulary and other conventions are provided in Dixon and Rimmer, 2000, Section 16).

The TABLO file begins with sections that contain information from MONASH that is required as input to the RES. These list:

- the MONASH data input files that are used in the RES;

- declarations of MONASH coefficients that are used directly or indirectly in the RES equations;

- instructions for assigning numerical values for the MONASH coefficients, either by reading them from the data files or by calculating them in formulae that use data items; and

- declarations of the MONASH variables required in the RES.

As well as this input from MONASH, the RES requires:

an allocation of commodities and industries to the *national* and *local* categories that are fundamental to the RES theory (see Section 2.1, above);

specification of the level of regional disaggregation (six States and two Commonwealth Territories) at which the RES is implemented;

declarations of variables entering the RES equations that are not variables in MONASH;

declarations and numerical specifications of coefficients for the RES equations.

In Appendix 1, we reproduce the sections of the RES TABLO input file that set out the RES equations and define the variables and coefficients appearing in the equations. The structure of the RES equations is as follows.

Regional outputs

We begin with equations $E_{z_reg_B}$ and $E_{z_reg_A}$. The second of these equations sets the percentage changes in the regional outputs of *national* industries equal to the percentage changes in the economy-wide outputs of those industries unless deviations between the regional and economy-wide percentage changes are introduced *via* the shift variables f_{z_reg} and ff_{z_reg} . With these shifters set to zero, the default assignment (1) described in Section 2.1 is implemented. Assignments departing from (1) but obeying the constraint (2) can be implemented by suitable non-zero values for the shifters.

Equation $E_{z_reg_A}$ can be simplified by recognizing that each row and column of the submatrix of B0CI that refers to *local* commodities contains a single 1, with all other entries equal to zero. That is, all *local* commodities are produced by single-product industries. The RHS of the i^{th} component of $E_{z_reg_A}$ picks out the industry that produces local commodity i and the equation sets the percentage change in that industry's output in region r equal to the percentage change in the output of commodity i in region r .

Equations $E_{x0_reg_A}$ and $E_{x0_reg_B}$ set the percentage changes in the regional outputs of *local* commodities equal to the percentage changes in the regions' demands for those commodities. Hence, with suitable procedures for fixing regional demands for *local* commodities, equations $E_{z_reg_A}$, $E_{x0_reg_A}$ and $E_{x0_reg_B}$ together implement the treatment of local industries described in the last paragraph of Section 2.1 (above), including the requirement that constraint (2) be observed.

Regional demands for local commodities

The RHSs of equations $E_{x0_reg_A}$ and $E_{x0_reg_B}$ contain the percentage changes in many categories of regional demand for local commodities (intermediate demands, investment demands, household demands, export demands, government demands and margins demands). Equations E_{x1csi_reg} through E_{x5marg_reg} set the percentage

change in each regional demand equal to the sum of the percentage change in the corresponding economy-wide demand (generated in MONASH) and the percentage change in the relevant regional user's share in the economy-wide demand. Apart from the calculation of some checking and reporting variables, the rest of the equations in the RES concern the determination of the percentage changes in these regional-user shares.

Output shares

Substitution of $E_{z_reg_B}$ into E_{rgshr1} to eliminate z_reg reveals that, consistent with our discussion (above) of $E_{z_reg_B}$, the percentage changes in regional shares in the economy-wide outputs of national industries [$rgshr1(j,r)$ for $j \in NATIND$] are effectively exogenous, i.e., they depend only on the movements of the shift variables f_{z_reg} and ff_{z_reg} . For local industries, our discussion (above) of equations $E_{z_reg_A}$, $E_{x0_reg_A}$ and $E_{x0_reg_B}$ showed that regional outputs (z_reg) are determined by regional demand, independently of economy-wide output ($x0ind$). Hence, the percentage changes in regional shares in the economy-wide outputs of local industries [$rgshr1(j,r)$ for $j \notin NATIND$] are essentially endogenous.

Investment shares

Equations E_{rgshr2} and $E_{rgshr2a}$ give options for the determination of the percentage changes in regional shares in industries' economy-wide levels of investment ($rgshr2$). The default option is to force these shares to move with the regional shares in the industries' economy-wide outputs. This can be implemented by setting the two shift variables ($freg2$ and $ffreg2$) on the RHS of E_{rgshr2} exogenously to zero, with the shift variable f_{y_reg} in E_{y_reg} endogenous. Another option, which we exploit in our historical simulations, is to use the shifters (f_{y_reg} , ff_{y_reg} and fff_{y_reg}) on the RHS of E_{y_reg} to introduce data on the divergence between the percentage changes in industries' regional investments and the percentage changes in their economy-wide investments. In this case, the shifters in E_{y_reg} are all exogenous, $E_{rgshr2a}$ determines the percentage changes in the regional investment shares, and $freg2$ in E_{rgshr2} is endogenous.

Household consumption shares

Equation E_{rgshr3} shows that regional households' shares in the economy-wide consumption of commodities are assumed to move with regional population shares. [The shift variables ($freg3$ and $ffreg3$) on the RHS of E_{rgshr3} are usually exogenous and set to zero.] E_{q_reg} specifies the percentage changes in each region's population as the weighted sum of percentage changes in the region's employment, its retired-age population and its unemployed population. Regional employment is determined by equations E_{labind_reg} and $E_{labindtot_reg}$, using in E_{labind_reg} the assumption that the percentage change in a region's share of economy-wide employment in an industry is equal to the percentage change in the region's share in the industry's economy-wide output. Our default option is to set the regional percentage changes in retired-age population (ner) exogenously. Then, recognizing the adding-up constraint

(E_q) on regional employment, regional unemployment (un) must be endogenous. A second option, which we exploit in our historical simulations, is to introduce data on regional population changes by setting q_{reg} exogenously. Then un is exogenous, and ner and the shifter (f_q) in E_q are endogenous. In this closure, ner is a slack variable that allows E_{q,reg} to accommodate the regional population data and the RES projections of regional employment. Provided that the regional-population data are consistent with assumption in MONASH about the economy-wide population variable (q), the RES will project a value for f_q that is close to zero.

Export shares and government-demand shares

From equations E_{rgshr4} and E_{rgshr5} it is clear that in the RES percentage changes in regions' shares in foreign demands and in government demands are effectively exogenous. The only variables on the RHSs of these equations are shift variables that are usually exogenous.

Checks on aggregation constraints

Equations E_{rsum1} through E_{rsumy_nat} are included to provide checks that the appropriate aggregation constraints are observed in the RES. These require that the projected values for the variables on the RHSs of the checking equations are zero.

Reporting variables

Our preferred method of reporting RES results for a region is to use the difference between the percentage change in the region's real gross product and the percentage change in real GDP at factor cost. We refer to these differences as deviations in growth. The deviations in growth can be decomposed into industry contributions. The contributions to deviations in growth are computed in equation E_{zcon_reg}, with real GDP at factor cost computed in E_{gdp_fc}. To examine the contributions, we will use a simplified notation:

$c(j,r)$ [= zcon_reg(j,r)] is the contribution of industry j to region r's deviation in growth;

$S(j,r)$ [= VALUADD(j,r)/VALUADDTOT(r)] is the share of industry j in region r's aggregate gross product at factor cost;

$S(j)$ [= TOTFACIND(j)/SUM(k,IND, TOTFACIND(k))] is the share of industry j in GDP at factor cost;

$z(j,r)$ [= z_reg(j,r)] is the percentage change in the output of industry j in region r;

$z(j)$ [= x0ind(j)] is the economy-wide percentage change in the output of industry j;

gdpreal_fc is the percentage change in real GDP at factor cost; and

gspreal_fc(r) is the percentage change in real Gross State Product at factor cost in region r.

In the simplified notation, the j^{th} component of E_zcon_reg is:

$$c(j,r) = [S(j,r) - S(j)] [z(j,r) - gdpreal_fc] + S(j) [z(j,r) - z(j)]. \quad (3)$$

Note that, as expected, the sum of (3) over industries is the difference between the percentage change in real gross state product at factor cost in region r and the percentage change in real GDP at factor costs, i.e.,

$$\sum_j c(j,r) = \sum_j S(j,r) z(j,r) - S(j) z(j) = gspreal_fc(r) - gdpreal_fc. \quad (4)$$

Note that (4) justifies our computation of real $gspreal_fc$ via $E_gspreal_fc$.

An alternative expression for the contribution of industry j to region r's deviation in growth is:

$$c(j,r) = [S(j,r) - S(j)] [z(j) - gdpreal_fc] + S(j,r) [z(j,r) - z(j)]. \quad (5)$$

This is exactly equivalent to (3). Note that (4) also follows from (5). An advantage of (5) is that it demonstrates more starkly than (3) the mechanisms at work in the RES.

The first term on the RHS of (5) shows that:

an industry with an economy-wide percentage change in output exceeding the percentage change in real GDP [i.e., $z(j) - gdpreal_fc > 0$] increases GRP growth (relative to GDP growth) in regions in which the industry's share of GRP exceeds its share of GDP [i.e., $S(j,r) - S(j) > 0$] but reduces GRP growth (relative to GDP growth) in regions in which the industry's share of GRP is less than its share of GDP [i.e., $S(j,r) - S(j) < 0$]; and

an industry with an economy-wide percentage change in output that is less than the percentage change in real GDP [i.e., $z(j) - gdpreal < 0$] increases GRP growth (relative to GDP growth) in regions in which the industry's share of GRP is less than its share of GDP [i.e., $S(j,r) - S(j) < 0$] but reduces GRP growth (relative to GDP growth) in regions in which the industry's share of GRP exceeds its share of GDP [i.e., $S(j,r) - S(j) > 0$].

Note that the second term is irrelevant when the default assignment (1) (where output changes are uniform across all regions) is applied.

The second term on the RHS of (5) indicates that an industry with a percentage output change in a region exceeding (smaller than) its economy-wide change [i.e., $z(j,r) - z(j) > (<) 0$] makes a positive (negative) contribution to that region r's deviation in growth. Note that this contribution is greater the larger is the industry's share of GRP. In the

RES, this mechanism is relevant only for local industries or for national industries for which the assignment of the regional outputs has been made by a method other than the default.

As well as regions' real gross product and contributions to deviations in growth, we also commonly report results for regional employment or wage bills. The former are calculated in *E_labindtot_reg* (already discussed above in relation to the determination of regional household-consumption shares). Equation *E_labrev_reg* computes regional wage bills.

3 Design of the Historical Simulations










Our historical simulations with RES project the regional implications of a MONASH historical simulation covering the period 1986-87 to 1993-94. In all, we report seven simulations. They all use the same economy-wide projections from MONASH but differ in the amount of additional regional information that is used. Simulations 1-6 use the standard version of the RES, including the *national/local* split of industries that is set out in Appendix 1. For the seventh simulation, the RES was configured with all industries treated as *national*.

Figure 3.1 gives a schematic account of simulations 1-6. It shows that they are cumulative in the sense that each adds information to the one immediately preceding it. The purpose is to examine how the performance of RES in tracking regions' historical growth rates improves with the addition of exogenous regional information. Simulation 1, which is described as a "basic" RES run, includes no shocks to regional variables. The only input is the changes to economy-wide variables taken from MONASH, listed in Appendix 1. The regional assignment of the percentage changes in the outputs of *national* industries is according to the default (1). This is typically how RES is used for policy analysis with MONASH.

In making forecasts with MONASH-RES, we usually impose region-specific forecasts of government demands, population growth (at least for non-working groups such as retired persons) and investment (at least for sectors such as mining and mineral processing, for which details of the location of planned developments are readily available). The same sort of regional information is available for the historical period that is the subject of the historical simulations (see Section 4). In simulations 2-4 we introduce historical data for regional macro variables but we continue to assign changes in the outputs of *national* industries according to the default (1). For simulation 5, we overwrite this default in the case of agricultural and mineral industries, replacing it with historical data on the industries' regional growth rates. In simulation 6, we impose historical data on regional growth rates for all *national* industries.

As noted in the first paragraph of this section, we conducted a seventh simulation. It differed from the first six by treating all industries as *national* industries. In assigning regional growth rates, we imposed historical data for all industries, just as we did for the standard set of national industries in simulation 6. Hence, by comparing

Figure 3.1 Shocks for Historical Simulations

Variable	Simulation 1: basic RES	Simulation 2: includes aggregate government demand by region	Simulation 3: includes population by region	Simulation 4: includes aggregate investment by region	Simulation 5: includes output by region for agric. and mineral industries	Simulation 6: includes output by region for all <i>national</i> industries
MONASH variables listed in Appendix 1						
Shifters in government demand share equations [fff5reg(r) in E_rgshr5]						
Population by region [q_reg(r) in E_q_reg]						
Shifters in regional investment equations [fff_y_reg(r) in E_y_reg]						
Shifters in agricultural and mineral output equations [f_z_reg(j,r) in E_z_reg_B for j=1-8, 12-16, 63 and 64]						
Shifters in all <i>national</i> industry output equations [f_z_reg(j,r) in E_z_reg_B for j ∈ NATIND]						

simulations 6 and 7 we can obtain a picture of the effectiveness of the standard RES treatment of *local* industries.

The RES closures used for the simulations are set out in Appendix 2. It is divided into two tables. The first lists all the variables that do not change status between simulations. The second lists the variables that do change status. The changes of status for the first four of these variables are necessary to accommodate the imposition of regional population data in simulations 3-6. For the last two variables, the changes facilitate the introduction of regional investment data in simulations 4-6. (See the subsections on “Household consumption shares” and “Investment shares” in Section 2.2, above).

4 Data for Regional Simulations

4.1 Regional data for RES

Four items of regional data are read into the RES. These are:

the shares of the States and Territories in outputs by industry (REGSHR1);

investment by industry (REGSHR2);

exports by commodity (REGSHR4); and

government demand by commodity (REGSHR5).

These data were compiled by mainly from *Census 91*. Full documentation of the procedure used to map the *Census 91* data to *MONASH* industries and regions is given in Kenderes (1993). This procedure follows the method described in Fallon (1981 and 1982).

4.2 Main features of MONASH historical projections

As mentioned in Section 3, our RES simulations take as input results for a wide variety of economy-wide variables from a *MONASH* historical simulation covering the period 1986-87 to 1993-94. Table 4.1 presents some key macro results from this historical simulation. Table 4.2 contains the corresponding results for output by industry.

Table 4.1 shows that through the historical period there was moderate growth of real GDP with strong growth of private consumption but sluggish growth of investment. Aggregate exports and aggregate imports both grew at more than twice the rate of growth of GDP.

According to Table 4.2, the strongest growing industries were *Non-Ferrous Ores* and *Metals* (13 and 64), *Communication* (98) and *Electronic Equipment* (73), *Air Transport* (96) and industries in the financial-services sector (99-102). A number of industries suffered output contractions through the historical period, notably arid-zone agriculture (1 and 4), *Oils and Fats* (20) *Bakery and Confectionary* products (23 and 24), *Beer and Tobacco*, industries in the textiles, clothing, footwear and leather-products sector (31-39 and 79), *Sawmill Products* (40), *Fertiliser* (49), *Locomotives* (70) and *Agricultural* and *Construction* machinery (76 and 77).

Note that these output movements reflect the major changes in technology and consumer preferences that have occurred in recent years, e.g., the communication and electronics revolution, the shift to healthy foods and the increased popularity of Australia as a tourist destination.

4.3 Regional macroeconomic data

As explained in Section 3, in simulations 2-4 we introduce shocks to regional shares in aggregate government consumption, to regional employment growth and to regional shares in aggregate investment. The shocks are listed in Table 4.3. The table indicates that during the period 1986-87 to 1993-94:

real government consumption grew more slowly in NSW, Victoria, South Australia and Tasmania than in Australia as a whole but more rapidly in Queensland and the two Commonwealth Territories;

population grew more slowly in NSW, Victoria, South Australia and Tasmania than in Australia as a whole but more rapidly in all other regions; and

investment grew more slowly in Victoria, South Australia, Tasmania and the two Commonwealth Territories than in Australia as a whole but more rapidly in NSW, Queensland and Western Australia.

4.4 Estimates of historical movements in regional industry outputs

Labour force growth data over the period 1986-87 to 1993-94 were used to distribute the growth in national output of a sector across the regions. This was done in a way that ensures that the sum of the output changes for a given industry across all regions equals the change in the output of that industry at the national level (obtained from MONASH) while retaining the dispersion in regional growth rates evident from the labour force growth information. The formula for calculating the regional changes in industry output is:

$$q(j,r) = q_mon(j) + lfgr(j,r) - \sum_r S(j,r) lfgr(j,r) \quad (6)$$

where:

$q(j,r)$ is the percentage change in output in industry j in region r ;

$q_mon(j)$ is the percentage change in industry j 's output from MONASH;

$lfgr(j,r)$ is the percentage change in the labour force growth rate in industry j in region r ;
and

$S(j,r)$ is the share of industry j in region r in the RES data.

5 Results of the RES Historical Simulations

In reporting the results of our historical simulations with the RES, we concentrate on two issues: the ability of the model to reproduce observed growth rates of real gross regional product (GRP) at factor cost, and industries' contributions to deviations in regional from national growth of gross product (see the subsection on Reporting variables in Section 2.2, above).

5.1 Results for gross regional product

Table 5.1 contains results for real GRP. The first seven columns refer to our seven MONASH-RES simulations. The eighth column contains our preferred observations of historical growth rates of real GRP. The ABS publishes estimates of nominal GRP at factor cost but not real GRP at factor cost. In the absence of regional constant-price data, our preferred method for generating the observations is to deflate the ABS estimates of growth rates of nominal GRP at factor cost using the national GDP price deflator. That is, we assume implicitly that the (unobserved) deflators for GRP at factor cost all move with the (observed) deflator for GDP at market prices. The results of this calculation are reported in the final column of Table 5.1. Aggregating over regions gives 2.90 per cent as an estimate of the growth rate of real GDP at factor cost. The corresponding growth rate from the MONASH historical simulations is 3.29 per cent. The final step in deriving our preferred observations of growth rates of real GRP at factor cost is to scale all the numbers in the final column of Table 5.1 by $3.29/2.90$. This gives the penultimate column.

Tables 5.2 and 5.3 are different ways of presenting the information given in Table 5.1. For example, Table 5.1 shows that in Simulation 1 the growth rate of NSW GRP is 3.31 per cent (column 1), that the scaled ABS growth rate is 3.15 per cent (column 8) and that the GDP growth rate is 3.29 per cent. Table 5.2 shows deviations between the GRP growth rates and the GDP growth rate. Hence, it indicates that in Simulation 1, NSW GRP growth was 0.02 percentage points (i.e., $3.31 - 3.29$) per annum faster than the GDP growth. Table 5.3 shows for each of our seven simulations the deviations of GRP growth rates from the scaled ABS growth rates. Hence, in Table 5.3 the deviation for NSW in Simulation 1 is 0.16 percentage points ($3.31 - 3.15$). The last rows of Tables 5.2 and 5.3 show the simple averages of the absolute deviations. In Table 5.2 these are measures of the dispersion between regions in their GRP growth rates in the simulations and in the scaled data. In Table 5.3 they are measures of the overall closeness of the simulation results to the scaled data.

The results in Tables 5.1-5.3 can best be considered in two tranches. The first tranche comprises simulations 1-4, which use only national results from MONASH and observed changes in regional macroeconomic variables, namely, government consumption, population and aggregate investment. In the second tranche (simulations 5-7), data on changes in output by region are gradually introduced, first in the agricultural and mining sectors, then for all *national* industries and finally, in Simulation 7, for all industries.

Simulation 1 uses only the MONASH results. Neither in terms of regions' rankings nor in terms of our summary measures does it do very well in reproducing the ABS data. It identifies Western Australia as a relatively fast-growing region and Victoria as relatively slow growing but it fails to identify the ACT and Queensland as fast-growing or the Northern Territory and Tasmania as slow growing. The mean absolute deviation in Table 5.2 indicates that there is far too little dispersion between regional growth rates in this simulation. In Table 5.3, the mean absolute deviation indicates that the growth rates from Simulation 1 deviate from the ABS growth rates by more than do the rates from any of the other simulations.

The main effects of introducing data on regional government demands (Simulation 2) are to increase the growth rates of the ACT and Queensland, and to reduce Victoria's growth rate. This moves the simulated growth rates closer to the ABS data – the mean absolute deviation from Table 5.3 moves from 1.29 to 1.11. It also increases the dispersion between simulated regional growth rates (see the last row of Table 5.2).

The introduction in Simulation 3 of regional population data reduces the simulated growth rates of NSW, South Australia, Tasmania and the two territories, and increases the rates of Queensland and Western Australia. All these changes take the simulated rates closer to the ABS data. The dispersion between regions in their growth rates increases slightly (Table 5.2).

Introducing the regional investment data in Simulation 4 moves most of the simulated growth rates closer to the ABS data, further reducing the mean absolute deviation in Table 5.3. The exceptions are New South Wales and the ACT. But the addition of the regional investment data does not increase the dispersion of the results (Table 5.2).

After all the regional macro data have been incorporated, the Northern Territory and Tasmania still have simulated growth rates much higher than their observed rates, and the ACT, Queensland and Western Australia have simulated growth rates well below their observed rates (see column 4 of Table 5.3). But overall, our conclusion from examining the results of simulations 1-4 is that augmenting MONASH-RES with regional macroeconomic forecasts for changes in government spending, population and investment is likely to produce GRP forecasts that are more credible than those from using the standard MRES procedure. Nevertheless the simulated regional growth rates will still be more compressed than observed rates.

We turn now to the second tranche of simulations (5-7) in which we introduce regional data about growth of output by industry. Using such data for agricultural and mineral industries only (Simulation 5), reduces the deviations of simulated from observed GRP growth rates for Western Australia, South Australia and the Northern Territory but increases the deviation for Queensland. The mean absolute deviation in Table 5.3 falls. There is also a slight increase in the dispersion of the regional growth rates (Table 5.2).

Extending the data to all *national* industries in Simulation 6 reverses the increase in Queensland's deviation that occurred in Simulation 5. It also reduces the deviations of

simulated from observed growth rates for Victoria, South Australia, Western Australia, Tasmania and the Northern Territory. But it has very little impact on the large negative deviation for the ACT. The mean absolute deviation in Table 5.3 falls to 0.38. The dispersion of the regional results increases from 0.57 to 0.87 (Table 5.2). Overall, Simulation 6 provides a satisfactory representation of the data. Nevertheless, it still underestimates growth for the ACT and Queensland, and overestimates growth for Tasmania.

In Simulation 7, we treated all industries in the RES as *national* industries and imposed growth rates by region that were estimated directly using employment data in the procedure described in Section 4.4. This reduced the deviations of simulated from observed growth rates for Queensland and Tasmania, but increased further the ACT's large negative deviation and introduced a negative deviation for Western Australia. The dispersion of the regional growth rates in this simulation is closer to the dispersion in the ABS data than was the case for any of the other six simulations (Table 5.2). But by the mean average deviation criterion, Simulation 7 is inferior to Simulation 6 in its fit of the simulated regional growth rates to the ABS data (Table 5.3).

An assumption implicit in the procedure described in Section 4.4 is that, for each industry, movements in labour productivity are uniform across regions. One possible explanation for the failure of Simulation 7 to reproduce the ABS GRP data precisely is that this assumption is not empirically valid. In particular, it suggests that growth in labour productivity may have been faster in the ACT than in Australia as a whole over the relevant period. A second possibility is that the industry shares in regions' value added in the RES might be inconsistent with the shares implicit in the ABS data.

5.2 Industry contributions to deviations in growth

We do not have the information necessary to disaggregate the ABS GRP data into industry contributions. In the absence of this information, we will use the contributions in Simulation 7 as a benchmark for examining the contributions in the other simulations. As noted in the previous section, in Simulation 7 we imposed, for all industries, growth rates by region that were estimated directly using employment data in the procedure described in Section 4.4. The GRP results this simulation match the scaled ABS data quite well.

From Table 5.2, we see that in Simulation 7 four regions have GRP growth rates that exceed the growth rate of GDP and four have GRP growth rates below the GDP growth rate. Tables 5.4 and 5.5 contain industry contributions to the deviations of GRP from GDP growth for the fast-growing and slow-growing regions (see the subsection on "Reporting variables" in Section 2.2). The contributions have been aggregated from the 113 industries in MONASH to 22 broader sectors.

For Queensland, we can see in Table 5.4 that there are four main sectors driving the relatively high rate of economic growth: *Construction*, *Community services*, *Trade related* and *Finance related*. All these sectors grew faster than GDP at the national level and all have relatively large weights in the Queensland economy.

In Western Australia, the second-fastest growing region, the *Mining* sector is the main driver of the high rate of growth. This sector is growing fast and is heavily represented in Western Australia. Similar to Queensland, the other significant contributors to the region include the *Construction* and *Finance related*.

GRP growth in New South Wales is only slightly faster than GDP growth. The major contributors to the small positive deviation in growth are the *Agriculture and forestry* sector and the *Construction* sector. *Agriculture and forestry* grows slowly at the national level compared with GDP but it is relatively under-represented in NSW. More importantly, the sector grew faster in NSW than in the rest of Australia. Non-residential construction is similar to the agricultural sector – it grew slowly at the national level compared with GDP but is under-represented in NSW and grew faster in NSW than in the rest of Australia. Residential construction grew faster than GDP at the national level, is relatively over-represented in NSW and grew faster in NSW than in the rest of Australia.

In the ACT, strong positive contributions from *Trade related*, *Community services* and *Utilities*, which grew relatively quickly in the ACT, cushioned the region from the relative underperformance of the *Construction* sector.

Turning now to Table 5.5, we see that most sectors made negative contributions to the region's growth deviation. *Construction*, *Finance related* and *Mining* are all prominent despite growing faster than GDP at the national level. All three are relatively under-represented in SA.

Victoria has only five sectors making positive contributions. These were outweighed by the negative contributions of the other 17 sectors, among which *Construction*, *Community services* and *Public administration* are prominent. These sectors all grew considerably slower in Victoria than elsewhere in Australia. Note that the contribution of the slow-growing TCF sector is only 0.06 percentage points, a function of its small importance to even the Victorian economy.

Tasmania has a number of sectors with positive contributions, notably *Public administration* and *Transport equipment*. These sectors grew much more strongly in Tasmania than in the rest of Australia. However, slower-than-average growth in sectors including *Wholesale and retail trade*, *Community services*, *Food* and *Chemicals* restricted Tasmania's GRP growth relative to GDP growth.

Surprisingly, in the Northern Territory, with an annual average growth rate of only 1.7 per cent, most sectors made positive contributions to the region's growth deviation. However, there are large negative contributions from *Agriculture and forestry* (mainly the slow-growing Northern beef industry which is a major industry in the NT), *Construction*, *Finance related* and *Recreation*.

We have generated industries' contributions to regions' growth deviations for all of our seven simulations. Tables 5.6 to 5.8 give three examples: for Queensland, Tasmania and the ACT.

Table 5.6 gives the deviations for Queensland, a region for which our RES simulations consistently underestimate growth, although the fit of the simulation results to the ABS data does improve as we introduce more regional information into the simulations. Consistent with Table 4.3, in Table 5.6:

- the introduction of data on regional government spending (Simulation 2) increases the contributions of *Community services*;
- the introduction of data on regional population (Simulation 3) increases the contributions of *Dwelling ownership*, *Trade related* and *Finance related*; and
- the introduction of data on regional investment (Simulation 4) increases the contribution of *Construction*.

Our data on the regional growth rates of agricultural and mineral industries indicate that these industries grew slower in Queensland than in the rest of Australia. Hence, introducing these data (Simulation 5) makes the contributions of these industries to the deviation of the state's GRP growth from GDP growth. As we noted in explaining Tables 5.3, introducing these data increases the deviation of Queensland's GRP growth from the ABS data on GRP growth, i.e., it reduces the already underestimated deviation from GDP growth (see Table 5.4 or the last row of Table 5.6). Introducing data on regional growth rates for other industries (Simulations 6 and 7) significantly reduces Queensland's deviation from the ABS growth rate mainly by increasing the contributions of *Metal* (Simulation 6), and *Construction* and *Community services* (Simulation 7).

Table 5.7 allows a similar tracing of the sector-dimension consequences of the regional information included in our RES simulations for the case of Tasmania. For Tasmania, the simulations consistently overestimate growth, although with each additional piece of regional information, this overestimation declines until by Simulation 7 the deviation falls from 1.84 to 0.30 (Table 5.3). The main improvements are due to:

- the negative contributions of *Trade related*, *Finance related* and *Dwelling ownership* produced by the introduction of regional population data which indicate that Tasmania's population grew considerably slower than the national average (Table 4.3);
- the negative contribution of the *Construction* sector produced by the introduction of data on the regional investment growth rates in Simulation 4;
- the large negative contributions of *Food*, *Wood-related*, *Chemical/oil* and *Metal* produced by the introduction of data on the regional growth rates of these sectors in Simulation 6; and
- the increase in the size of the negative contributions of *Trade related* and *Community services* that is produced by using data on the regional growth rates of these sectors rather than treating them as *local* industries.

Interestingly, the introduction of regional data on the agricultural and mining sectors in Tasmania had little effect on that state's GRP with the expansion in the Agricultural sector being cancelled out by a decline in the state's mining prospects.

6 Conclusion

The results reported in this paper confirm our earlier view that MONASH-RES forecasts in which no region-specific macroeconomic data are used and in which regions' shares in *national*-industry outputs held constant, will fail to capture important features of regional economic development. In particular, they are likely to underestimate the dispersion between regions' growth rates that typically occurs. On the other hand, the results demonstrate that the performance of MONASH-RES in forecasting is significantly improved by the inclusion of region-specific macro data and accurate information about the regional distribution of output changes in *national* industries. Moreover, the results indicate that the treatment of *local* industries in MONASH-RES is satisfactory.

In Table 5.3, the following specific features of the results are worth noting:

- the importance for Victoria and the ACT of information about government spending;
- the importance for Queensland and Tasmania of recognising population movements;
- the importance for Western Australia and the NT of data on agriculture and mining;
- the apparent relatively slow growth of *national* industries in Victoria and the NT and their apparent relatively fast growth in Queensland and Western Australia; and
- the apparent relatively fast growth of labour productivity in Western Australia and the NT.

A final issue is the extent to which the results are relevant to the use of MONASH-RES for policy analysis as opposed to forecasting. In most applications to policy analysis, we would rely on the model's projections of the effects of the policy change on output by industry at the regional level to determine the regional macroeconomic effects. But the macroeconomic effects of most of the policy changes considered (changes in protection, for example) are in any case likely to be small. The importance of the effects of the policy changes on the regional location of the outputs of *national* industries is usually investigated via scenario analysis. For example, in recent analysis of the effects of tariff reform for the Australian motor-vehicle industry, we considered two scenarios, one in which the reform was assumed not to affect the regional distribution of motor-vehicle output (i.e., the default rule (1) was adopted) and a second in which it was assumed that the reform led to a consolidation of motor-vehicle output into Victoria.

Table 2.1 National and local industries

<i>National Industry</i>	
1 Pastoral Zone	70 Trains
2 Wheat-Sheep Zone	71 Aircraft
3 High-Rainfall Zone	72 Scientific Equipment
4 Northern Beef	73 Electronic Equipment
5 Milk Cattle	74 Household Appliances
6 Other Farming Export	75 Electrical Equipment
7 Other Farming Imp. Ctg	76 Agricultural Machinery
8 Poultry	77 Construction Machinery
10 Forestry	78 Manufacturing Machinery
11 Fishing	79 Leather Products
12 Iron Ore	80 Rubber Products
13 Non-Ferrous Ores	81 Plastic Products
14 Black Coal	82 Signs
15 Oil and Gas	83 Sports Equipment
16 Other Minerals	85 Gas
17 Services to Mining	94 Rail Transport
18 Meat Cattle	95 Water Transport
19 Dairy Products	96 Air Transport
20 Fruit and Veg. Products	97 Services to Transport
21 Oils and Fats	105 Public Administration
22 Flourmill Products	106 Defence
24 Confectionery	113 Other Services
25 Seafood and Sugar	
28 Other Alcoholic Drinks	
29 Tobacco Products	
30 Fibre Processing	
31 Synthetic Yarn	
32 Cotton Yarn	
33 Wool Yarn	
34 Textile Finishing	
35 Carpets	
36 Canvas Products	
37 Knitting Mills	
38 Clothing	
39 Footwear	
40 Sawmill Products	
41 Panels and Veneers	
42 Fittings	
43 Furniture	
44 Pulp and Paper	
45 Bags and Boxes	
46 Sanitary Products	
47 Newspapers and Books	
48 Commercial Printing	
49 Fertiliser	
50 Basic Chemicals	
51 Paints	
52 Pharmaceuticals	
53 Soaps and Detergents	
54 Cosmetics	
55 Explosives	
56 Petrol	
57 Glass	
61 Pipes	
62 Plaster Products	
63 Iron and Steel	
64 Non-Ferrous Metals	
65 Structural Metal	
66 Sheet Metal	
67 Wire Products	
68 Motor Vehicles	
69 Ships and Boats	

Local Industry

9 Services to Agriculture
23 Bakery Products
26 Soft Drinks
27 Beer
60 Readymix Concrete
84 Electricity
86 Water
87 Residential Building
88 Other Building
89 Wholesale Trade
90 Retail Trade
91 Mechanical Repairs
92 Other Repairs
93 Road Transport
98 Communication
99 Banking
100 Non-Bank Finance
101 Investment Services
102 Insurance
103 Other Financial Services
104 Ownership of Dwellings
107 Health
108 Education
109 Welfare
110 Entertainment
111 Hotels and Clubs
112 Personal Services

Table 4.1 **Macro results from MONASH historical simulation,
1986-87 to 1993-94**

<i>Variable</i>	<i>Aggregate percentage change</i>	<i>Average annual percentage growth rate</i>
Real GDP	19.72	2.61
Real Consumption	24.81	3.22
Real Investment	5.05	0.71
Real Government spending	20.99	2.76
Volume of exports	62.74	7.20
Volume of imports	59.01	6.85
Terms of trade	5.40	0.75

Table 4.2 Industry output results from MONASH historical simulation, 1986-87 to 1993-94, average annual percentage growth rates

<i>Industry</i>	<i>Growth rate</i>	<i>Industry</i>	<i>Growth rate</i>
1 Pastoral Zone	-1.1	58 Clay Products	0.8
2 Wheat-Sheep Zone	1.9	59 Cement	-0.8
3 High-Rainfall Zone	1.0	60 Readymix Concrete	0.9
4 Northern Beef	-0.2	61 Pipes	1.6
5 Milk Cattle	3.4	62 Plaster Products	4.7
6 Other Farming Export	1.6	63 Iron and Steel	1.3
7 Other Farming Imp. Ctg	3.1	64 Non-Ferrous Metals	5.0
8 Poultry	3.8	65 Structural Metal	1.7
9 Services to Agriculture	1.2	66 Sheet Metal	1.0
10 Forestry	-0.1	67 Wire Products	1.4
11 Fishing	3.6	68 Motor Vehicles	2.0
12 Iron Ore	3.7	69 Ships and Boats	3.1
13 Non-Ferrous Ores	10.3	70 Trains	-7.1
14 Black Coal	2.6	71 Aircraft	3.6
15 Oil and Gas	4.5	72 Scientific Equipment	4.8
16 Other Minerals	3.4	73 Electronic Equipment	12.5
17 Services to Mining	0.3	74 Household Appliances	1.8
18 Meat Cattle	3.5	75 Electrical Equipment	-0.2
19 Dairy Products	3.3	76 Agricultural Machinery	-1.1
20 Fruit and Veg. Products	4.9	77 Construction Machinery	-23.1
21 Oils and Fats	-6.3	78 Manufacturing Machinery	1.8
22 Flourmill Products	4.1	79 Leather Products	-1.9
23 Bakery Products	-0.8	80 Rubber Products	1.6
24 Confectionery	-1.1	81 Plastic Products	0.6
25 Seafood and Sugar	3.1	82 Signs	-0.2
26 Soft Drinks	2.9	83 Sports Equipment	-2.1
27 Beer	-0.7	84 Electricity	3.7
28 Other Alcoholic Drinks	4.6	85 Gas	3.3
29 Tobacco Products	-2.6	86 Water	1.8
30 Fibre Processing	6.2	87 Residential Building	4.8
31 Synthetic Yarn	-0.7	88 Other Building	0.0
32 Cotton Yarn	0.4	89 Wholesale Trade	2.1
33 Wool Yarn	-5.5	90 Retail Trade	2.5
34 Textile Finishing	-0.8	91 Mechanical Repairs	0.0
35 Carpets	-3.7	92 Other Repairs	0.0
36 Canvas Products	0.0	93 Road Transport	3.0
37 Knitting Mills	-6.1	94 Rail Transport	2.7
38 Clothing	-2.0	95 Water Transport	2.7
39 Footwear	-6.3	96 Air Transport	7.5
40 Sawmill Products	-2.0	97 Services to Transport	3.3
41 Panels and Veneers	3.4	98 Communication	9.1
42 Fittings	0.3	99 Banking	8.4
43 Furniture	1.6	100 Non-Bank Finance	9.0
44 Pulp and Paper	1.7	101 Investment Services	9.3
45 Bags and Boxes	1.3	102 Insurance	13.2
46 Sanitary Products	1.0	103 Other Financial Services	3.3
47 Newspapers and Books	-0.3	104 Ownership of Dwellings	3.1
48 Commercial Printing	4.0	105 Public Administration	3.3
49 Fertiliser	-4.2	106 Defence	1.2
50 Basic Chemicals	3.2	107 Health	3.1
51 Paints	2.3	108 Education	3.4
52 Pharmaceuticals	7.3	109 Welfare	5.6
53 Soaps and Detergents	-3.3	110 Entertainment	3.5
54 Cosmetics	-1.5	111 Hotels and Clubs	2.9
55 Explosives	5.3	112 Personal Services	2.1
56 Petrol	3.0	113 Other Services	0.1
57 Glass	1.7		

Table 4.3. Shocks to regional macro variables in simulations 2-4

<i>Region</i>	-----VARIABLE-----		
	<i>Percentage change in share of real government final consumption^(a) (fffreq5)</i>	<i>Percentage change in population^(b) (q_reg)</i>	<i>Percentage change in share of real aggregate investment^(c) (fff_y_reg)</i>
New South Wales	-0.86	8.21	0.25
Victoria	-9.47	7.03	-10.08
Queensland	5.01	18.83	19.85
South Australia	-2.13	5.49	-14.83
Western Australia	0.01	14.36	8.03
Tasmania	-0.90	5.45	-13.24
Australian Capital Territory	34.49	14.33	-8.45
Northern Territory	0.69	10.41	-20.21
<i>Australia</i>	<i>n.a.</i>	<i>10.00</i>	<i>n.a.</i>

Notes:

Calculated from ABS Catalogue No. 5220, Table 6.

Calculated from ABS Catalogue No. 5220, Table 1 and 2.

Calculated from ABS Catalogue No. 5220, Table 6.

Table 5.1 Average annual percentage changes in Gross Regional Product, 1986-87 to 1993-94

<i>Sector</i>	----- MONASH-RES simulations ^a -----							<i>Scaled ABS^c</i>	<i>ABS^b</i>
	<i>Sim 1</i>	<i>Sim 2</i>	<i>Sim 3</i>	<i>Sim 4</i>	<i>Sim 5</i>	<i>Sim 6</i>	<i>Sim 7</i>		
New South Wales	3.31	3.30	3.17	3.19	3.28	3.32	3.42	3.15	2.78
Victoria	3.03	2.77	2.76	2.65	2.64	2.28	2.31	2.20	1.94
Queensland	3.39	3.56	4.00	4.17	3.98	4.41	4.56	5.03	4.43
South Australia	3.11	3.07	2.91	2.74	2.63	2.54	2.47	2.51	2.21
Western Australia	4.00	4.01	4.07	4.13	4.44	4.79	4.44	4.78	4.21
Tasmania	3.55	3.54	3.15	3.02	2.99	2.20	2.01	1.71	1.51
Australian Capital Territory	3.04	3.98	3.91	3.71	3.63	3.65	3.36	5.05	4.45
Northern Territory	4.40	4.43	4.13	3.78	2.57	2.20	1.68	1.94	1.71
<i>Australia</i>	<i>3.29</i>	<i>3.29</i>	<i>3.29</i>	<i>3.29</i>	<i>3.29</i>	<i>3.29</i>	<i>3.29</i>	3.29	2.90

Notes.

a For details of the simulations, see Section 3, especially Figure 3.1.

b Calculated as average annual percentage change in nominal GSP at factor cost by region deflated by national GDP price deflator.

c ABS data scaled to annual average change in GDP from Monash model (3.29 per cent).

Table 5.2 Percentage point deviation of average annual per cent changes in Gross Regional Product from the average annual per cent change in GDP, 1986/87 to 1993/94

<i>Sector</i>	----- MONASH-RES simulations -----							<i>Scaled ABS</i>
	<i>Sim 1</i>	<i>Sim 2</i>	<i>Sim 3</i>	<i>Sim 4</i>	<i>Sim 5</i>	<i>Sim 6</i>	<i>Sim 7</i>	
New South Wales	0.02	0.01	-0.12	-0.10	-0.01	0.03	0.13	-0.14
Victoria	-0.26	-0.52	-0.53	-0.64	-0.65	-1.01	-0.98	-1.09
Queensland	0.10	0.27	0.71	0.88	0.69	1.12	1.27	1.74
South Australia	-0.18	-0.22	-0.38	-0.55	-0.66	-0.75	-0.82	-0.78
Western Australia	0.71	0.72	0.78	0.84	1.15	1.50	1.15	1.49
Tasmania	0.26	0.25	-0.14	-0.27	-0.30	-1.09	-1.28	-1.58
Australian Capital Territory	-0.25	0.69	0.62	0.42	0.34	0.36	0.07	1.76
Northern Territory	1.11	1.14	0.84	0.49	-0.72	-1.09	-1.61	-1.35
<i>Mean absolute deviation</i>	<i>0.36</i>	<i>0.48</i>	<i>0.52</i>	<i>0.52</i>	<i>0.57</i>	<i>0.87</i>	<i>0.91</i>	1.24

Source: Calculated from Table 5.1.

Table 5.3 Percentage point deviations of GRP results in Simulations 1-7 from scaled ABS observations

<i>Sector</i>	----- MONASH-RES simulations -----							<i>Scaled ABS</i>
	<i>Sim 1</i>	<i>Sim 2</i>	<i>Sim 3</i>	<i>Sim 4</i>	<i>Sim 5</i>	<i>Sim 6</i>	<i>Sim 7</i>	
New South Wales	0.16	0.15	0.02	0.04	0.13	0.17	0.27	0
Victoria	0.83	0.57	0.56	0.45	0.44	0.08	0.11	0
Queensland	-1.64	-1.47	-1.03	-0.86	-1.05	-0.62	-0.47	0
South Australia	0.60	0.56	0.40	0.23	0.12	0.03	-0.04	0
Western Australia	-0.78	-0.77	-0.71	-0.65	-0.34	0.01	-0.34	0
Tasmania	1.84	1.83	1.44	1.31	1.28	0.49	0.30	0
Australian Capital Territory	-2.01	-1.07	-1.14	-1.34	-1.42	-1.40	-1.69	0
Northern Territory	2.46	2.49	2.19	1.84	0.63	0.26	-0.26	0
<i>Mean absolute deviation</i>	<i>1.29</i>	<i>1.11</i>	<i>0.94</i>	<i>0.84</i>	<i>0.68</i>	<i>0.38</i>	<i>0.44</i>	0

Source: Calculated from Table 5.1.

**Table 5.4 Contributions to deviations in GSP growth rates in Simulation 7:
fast growing regions**

<i>Sector</i>	<i>Qld</i>	<i>WA</i>	<i>NSW</i>	<i>ACT</i>
Agriculture and Forestry	-0.06	-0.08	0.07	-0.08
Mining	-0.12	0.42	-0.01	-0.05
Food	-0.02	-0.06	0.03	0.04
TCF	0.05	0.05	0.01	0.05
Wood-related	0.05	-0.02	0.00	-0.09
Paper-related	0.01	0.03	0.00	0.05
Chemical/Oil	0.03	0.04	-0.01	0.00
Nonmetal	0.04	0.02	0.00	0.01
Metal	0.13	0.03	-0.04	0.03
Transport Equipment	-0.02	0.02	-0.01	-0.00
Other Machinery	0.02	0.01	-0.00	-0.04
Other Manufacturing	0.03	-0.01	-0.00	0.00
Utilities	0.01	0.04	0.02	0.11
Construction	0.31	0.24	0.07	-0.45
Trade related	0.20	-0.05	-0.10	0.25
Transport & Storage	0.05	0.12	0.00	-0.07
Communications	-0.01	-0.02	0.02	0.08
Finance related	0.16	0.15	0.00	-0.13
Dwelling ownership	0.10	0.04	-0.03	0.05
Public administration	0.03	0.11	0.05	0.08
Community Services	0.21	0.00	0.04	0.15
Recreation	0.04	0.02	-0.01	0.06
<i>Growth deviation: (GSP growth - Aust. growth)</i>	<i>+1.23</i>	<i>+1.11</i>	<i>+0.12</i>	<i>+0.06</i>

**Table 5.5 Contributions to deviations in GSP growth rates in Simulation 7:
slow growing regions**

<i>Sector</i>	<i>SA</i>	<i>VIC</i>	<i>TAS</i>	<i>NT</i>
Agriculture and Forestry	0.01	0.00	0.10	-0.60
Mining	-0.08	-0.04	-0.03	-0.00
Food	0.01	0.01	-0.19	0.02
TCF	-0.03	-0.06	0.03	0.05
Wood-related	0.02	-0.01	-0.15	-0.01
Paper-related	-0.02	-0.02	-0.06	0.01
Chemical/Oil	-0.01	-0.00	-0.18	0.00
Nonmetal	-0.02	-0.01	-0.09	-0.06
Metal	0.01	-0.03	-0.15	-0.09
Transport Equipment	0.04	-0.01	0.10	0.04
Other Machinery	0.03	-0.02	0.05	-0.04
Other Manufacturing	-0.02	-0.00	-0.00	0.01
Utilities	-0.03	-0.05	-0.05	0.16
Construction	-0.29	-0.24	0.07	-0.39
Trade related	-0.02	0.03	-0.29	-0.01
Transport & Storage	0.04	-0.08	-0.12	-0.03
Communications	-0.06	0.00	-0.03	0.01
Finance related	-0.15	-0.08	-0.04	-0.57
Dwelling ownership	-0.04	-0.03	-0.05	0.00
Public administration	-0.09	-0.13	0.16	0.10
Community Services	-0.04	-0.17	-0.23	0.04
Recreation	-0.05	0.00	-0.08	-0.22
<i>Growth deviation: (GSP growth - Aust. growth)</i>	<i>-0.80</i>	<i>-0.96</i>	<i>-1.25</i>	<i>-1.58</i>

Table 5.6 Contributions to deviations in GSP growth rates – Queensland

<i>Sector</i>	<i>Simulations</i>						
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
Agriculture and Forestry	-0.04	-0.04	-0.04	-0.04	-0.07	-0.07	-0.06
Mining	-0.01	-0.01	-0.01	-0.01	-0.12	-0.12	-0.12
Food	0.00	0.00	0.01	0.01	0.01	-0.01	-0.02
TCF	0.03	0.03	0.03	0.03	0.03	0.05	0.05
Wood-related	0.00	0.00	0.00	0.00	0.00	0.05	0.05
Paper-related	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Chemical/Oil	0.00	0.00	0.00	0.00	0.00	0.03	0.03
Nonmetal	0.00	0.00	0.00	0.00	0.01	0.04	0.04
Metal	0.02	0.02	0.02	0.02	0.02	0.13	0.13
Transport Equipment	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02
Other Machinery	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Other Manufacturing	0.01	0.01	0.01	0.01	0.01	0.03	0.03
Utilities	0.01	0.01	0.03	0.03	0.03	0.04	0.01
Construction	0.04	0.05	0.08	0.18	0.18	0.18	0.31
Trade related	0.01	0.03	0.12	0.15	0.14	0.17	0.20
Transport & Storage	-0.01	-0.00	0.01	0.01	0.01	0.03	0.05
Communications	0.02	0.02	0.04	0.04	0.04	0.04	-0.01
Finance related	0.02	0.04	0.11	0.13	0.12	0.17	0.16
Dwelling ownership	-0.01	0.01	0.12	0.12	0.12	0.12	0.10
Public administration	0.01	0.01	0.01	0.01	0.01	0.03	0.03
Community Services	-0.01	0.07	0.11	0.11	0.11	0.11	0.21
Recreation	0.00	0.01	0.04	0.04	0.04	0.04	0.04
<i>Growth deviation: (GSP growth – Aust. growth)</i>	<i>0.09</i>	<i>0.26</i>	<i>0.68</i>	<i>0.85</i>	<i>0.67</i>	<i>1.08</i>	<i>1.23</i>

Table 5.7 Contributions to deviations in GSP growth rates – Tasmania

<i>Sector</i>	<i>Simulations</i>						
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
Agriculture and Forestry	0.02	0.02	0.02	0.02	0.11	0.11	0.10
Mining	0.05	0.05	0.05	0.05	-0.03	-0.03	-0.03
Food	0.03	0.03	0.03	0.03	0.03	-0.20	-0.19
TCF	0.01	0.01	0.01	0.01	0.01	0.03	0.03
Wood-related	-0.06	-0.06	-0.06	-0.06	-0.06	-0.15	-0.15
Paper-related	-0.03	-0.03	-0.03	-0.03	-0.03	-0.06	-0.06
Chemical/Oil	-0.03	-0.03	-0.03	-0.03	-0.03	-0.18	-0.18
Nonmetal	-0.03	-0.03	-0.03	-0.03	-0.03	-0.09	-0.09
Metal	0.06	0.06	0.06	0.06	0.06	-0.15	-0.15
Transport Equipment	0.02	0.02	0.02	0.02	0.02	0.10	0.10
Other Machinery	0.01	0.01	0.01	0.01	0.01	0.05	0.05
Other Manufacturing	0.01	0.01	0.01	0.01	0.01	-0.00	-0.00
Utilities	0.02	0.02	0.01	0.00	-0.00	-0.05	-0.05
Construction	0.02	0.02	-0.01	-0.09	-0.09	-0.10	0.07
Trade related	0.02	0.02	-0.06	-0.08	-0.08	-0.17	-0.29
Transport & Storage	-0.02	-0.02	-0.03	-0.03	-0.04	-0.07	-0.12
Communications	0.01	0.01	-0.00	-0.01	-0.01	-0.01	-0.03
Finance related	0.01	0.01	-0.05	-0.06	-0.08	-0.13	-0.04
Dwelling ownership	0.03	0.03	-0.05	-0.05	-0.05	-0.05	-0.05
Public administration	0.03	0.03	0.03	0.03	0.03	0.16	0.16
Community Services	0.03	0.02	-0.03	-0.03	-0.03	-0.04	-0.23
Recreation	0.01	0.01	-0.02	-0.02	-0.02	-0.02	-0.08
<i>Growth deviation: (GSP growth - Aust. growth)</i>	<i>0.25</i>	<i>0.24</i>	<i>-0.14</i>	<i>-0.27</i>	<i>-0.30</i>	<i>-1.07</i>	<i>-1.25</i>

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Appendix 1. REGTOP.TAB: A TABLO input file for a stand-alone implementation of the RES using economy-wide results from MONASH

! Section 1 Files !

File

FID # Main file of updatable data #;
PARAMS # Main file of non-updatable data #;
EXTRA # Capital accumulation and rates of return data #;
SETINFO # Set information (for current aggregation) #;

(New,Text) WRITFILE # Text output file for examining database values #;

! Section 2 Sets and subsets !

Set COM # Commodities # Maximum Size 115 !26 for MONAGG!
Read Elements from file SETINFO Header "COM ";

Set COM_JP # Commodities produced by joint-product industries #
Maximum Size 9 !3 for MONAGG!
Read Elements from file SETINFO Header "COMJ";

Set COM_UP # Commodities produced by unique-product industries #
Maximum Size 106 !23 for MONAGG!
Read Elements from file SETINFO Header "COMU";

Set FAC # Primary Factors # (labour,capital,land);

Set IND # Industries # Maximum Size 113 !25 for MONAGG!
Read Elements from file SETINFO Header "IND ";

Set IND_JP # Joint-production industries # Maximum Size 7 !2 for MONAGG!
Read Elements from file SETINFO Header "INDJ";

Set IND_UP # Unique-product industries # Maximum Size 106 !23 for MONAGG!
Read Elements from file SETINFO Header "INDU";

Set MARGCOM # Margin Commodities # Maximum Size 9 !2 for MONAGG!
Read Elements from file SETINFO Header "MARC";
! The margin commodities in MARGCOM are :

91 - Wholesale trade
92 - Retail trade
95 - Road transport
96 - Rail and other transport
97 - Water transport
98 - Air transport
99 - Services to transport
104 - Insurance and services
113 - Restaurants, hotels !

Set NONMARGCOM # Non-Margin Commodities # Maximum Size 106 !24 for MONAGG!
Read Elements from file SETINFO Header "NONM";

Set OCC # Broad occupations # (OCC1 - OCC8);
! they are
1 MANAGERS AND ADMINISTRATORS
2 PROFESSIONALS
3 PARA PROFESSIONALS

```

4   TRADESPERSONS
5   CLERKS
6   SALES AND PERSONAL SERVICE
7   PLANT & MACHINE OPERATORS
8   LABOURERS

```

```
Set SOURCE # Domestic/Imported # ( dom,imp);
```

```
Subset COM_JP is subset OF COM;
! It is the complement of COM_UP !
```

```
Subset COM_UP is subset OF COM;
! It is the complement of COM_JP !
```

```
Subset IND_JP is subset OF IND;
! It is the complement of IND_UP !
```

```
Subset IND_UP is subset OF IND;
! It is the complement of IND_JP !
```

```
Subset MARGCOM is subset of COM;
! It is the complement of NONMARGCOM !
```

```
Subset NONMARGCOM is subset of COM;
! It is the complement of MARGCOM !
```

```
! Section 3 Coefficient declaration listed alphabetically !
```

```
Coefficient
```

```
TINY;
```

```

      (All,i,COM)(All,j,IND)
BOCI(i,j) # Share of ind. j in the output of comm. i Fc#;
      (All,i,COM)(All,s,SOURCE)(All,j,IND)
BAS1(i,s,j) # Basic-value flows of commodities: current production RU#;
      (All,i,COM)(All,s,SOURCE)(All,j,IND)
BAS2(i,s,j) # Basic-value flows of commodities: industry investment RU#;
      (All,i,COM)(All,s,SOURCE)
BAS3(i,s) # Basic-value flows of commodities: private consumption RU#;
      (All,i,COM)
BAS4(i) # Basic-value flows of commodities: exports RU#;
      (All,i,COM)(All,s,SOURCE)
BAS5(i,s) # Basic-value flows of commodities: government demand RU#;
      (All,j,IND)
CAPITAL(j) # Returns to capital by industry RU#;
      (All,j,IND)
COSTS(j) # Total cost in each industry Fj#;
      (All,i,COM)(All,j,IND)
H0CI(i,j) # Share of commodity i in total revenue of industry j Fc#;
      (All,j,IND)
LABIND_J(j) # Total wage bill in industry j Fi#;
      (All,m,OCC)(All,j,IND)
LABOCCIND(m,j) # Wage bill for occupation m in industry j RU#;
      (All,j,IND)
LAND(j) # Total rental value of land used in industry j RU#;
      (All,i,COM)(All,j,IND)
MAKE(i,j) # Production of commodity i by industry j RU#;
      (All,j,IND)
MAKE_COSTS(j) # Production by industry j: column sums of make matrix Fc#;
      (All,i,COM)

```

```

MAKE_SALES(i) # Total production of good i: row sums of make matrix Fc#;
              (All,i,COM)(All,s,SOURCE)(All,j,IND)(All,r,MARGCOM)
MAR1(i,s,j,r) # Basic values of margins on intermediate inputs RU#;
              (All,i,COM)(All,s,SOURCE)(All,j,IND)(All,r,MARGCOM)
MAR2(i,s,j,r) # Basic values of margins on inputs to capital creation RU#;
              (All,i,COM)(All,s,SOURCE)(All,r,MARGCOM)
MAR3(i,s,r) # Basic values of margins on flows to consumption RU#;
              (All,i,COM)(All,r,MARGCOM)
MAR4(i,r) # Basic values of margins on exports RU#;
           (All,i,COM)(All,s,SOURCE)(All,r,MARGCOM)
MAR5(i,s,r) # Basic values of margins on flows to government RU#;
           (All,j,IND)
OTHCOST(j) # Cost of other cost tickets to industry j RFibU#;
           (All,j,IND)
P1OCT(j) # Price of other cost tickets RU#;
          (All,i,COM)(All,s,SOURCE)(All,j,IND)
PURCHVAL1(i,s,j) # Purchasers' values of intermediate inputs Fd#;
                (All,j,IND)
ROTHCOST(j) # Quantity of other costs Fl#;
            (All,i,COM)(All,s,SOURCE)(All,j,IND)
TAX1(i,s,j) # Total tax collection on intermediate use of (i,s) by ind j
            Fd#;
            (All,i,COM)(All,s,SOURCE)(All,j,IND)
TAX1F(i,s,j) # Phantom tax collection on intermed. use of (i,s) by ind j
            RFibU#;
            (All,i,COM)(All,s,SOURCE)(All,j,IND)
TAX1G(i,s,j) # Genuine tax collection on intermediate use of (i,s) by ind j
            RU#;
            (All,j,IND)
TAX0(j) # Collection of production taxes Fd#;
        (All,j,IND)
TAX0F(j) # Collection of phantom production taxes RU #;
        (All,j,IND)
TAX0G(j) # Collection of genuine production taxes RU #;
        (All,j,IND)
TOTFACIND(j) # Total primary factor payments in industry j Fi#;
             (All,i,COM)(All,j,IND)
TPURCHVAL1(i,j) # Purchasers' value of intermediate use of good i by ind j
            Fd#;
            (All,j,IND)
NUMCOM # Number of commodities Fa#;
NUMIND # Number of industries Fa#;

```

! Section 4 Read instructions for coefficients listed alphabetically !

Read

```

              (All,i,COM)(All,j,IND)
BAS1(i,"dom",j) from file FID Header "F001";
              (All,i,COM)(All,j,IND)
BAS1(i,"imp",j) from file FID Header "F002";
              (All,i,COM)(All,j,IND)
BAS2(i,"dom",j) from file FID Header "F003";
              (All,i,COM)(All,j,IND)
BAS2(i,"imp",j) from file FID Header "F004";
              (All,i,COM)
BAS3(i,"dom") from file FID Header "F005";
              (All,i,COM)
BAS3(i,"imp") from file FID Header "F006";

```

```

BAS4          from file FID Header "F007";
              (All,i,COM)
BAS5(i,"dom") from file FID Header "F008";
              (All,i,COM)
BAS5(i,"imp") from file FID Header "F009";
CAPITAL       from file FID Header "F011";
LABOCCIND     from file FID Header "F010";
LAND          from file FID Header "F012";
MAKE          from file FID Header "Y ";
              (All,i,COM)(All,j,IND)(All,r,MARGCOM)
MAR1(i,"dom",j,r) from file FID Header "FC55";
              (All,i,COM)(All,j,IND)(All,r,MARGCOM)
MAR1(i,"imp",j,r) from file FID Header "FC56";
              (All,i,COM)(All,j,IND)(All,r,MARGCOM)
MAR2(i,"dom",j,r) from file FID Header "FC57";
              (All,i,COM)(All,j,IND)(All,r,MARGCOM)
MAR2(i,"imp",j,r) from file FID Header "FC58";
              (All,i,COM)(All,r,MARGCOM)
MAR3(i,"dom",r)  from file FID Header "F019";
              (All,i,COM)(All,r,MARGCOM)
MAR3(i,"imp",r)  from file FID Header "F020";
MAR4           from file FID Header "F023";
              (All,i,COM)(All,r,MARGCOM)
MAR5(i,"dom",r)  from file FID Header "F025";
              (All,i,COM)(All,r,MARGCOM)
MAR5(i,"imp",r)  from file FID Header "F026";
OTHCOST       from file FID Header "F013";
P1OCT         from file EXTRA Header "POTH";
              (All,i,COM)(All,j,IND)
TAX1F(i,"dom",j) from file FID Header "F51F";
              (All,i,COM)(All,j,IND)
TAX1F(i,"imp",j) from file FID Header "F52F";
              (All,i,COM)(All,j,IND)
TAX1G(i,"dom",j) from file FID Header "F51G";
              (All,i,COM)(All,j,IND)
TAX1G(i,"imp",j) from file FID Header "F52G";
TAX0G         from file FID Header "FT0G";
TAX0F         from file FID Header "FT0F";

```

! Section 5 Formulas in thematic groups !

! Subsection 5a Default shares, binary dummies and miscellaneous scalar parameters !

! Subsection 5b Correction to initial IO data to eliminate phantom taxes !

! The formulas in this section eliminate the phantom taxes (recorded in the matrices TAX1F, TAX2F, TAX3F, TAX4F, TAX5F and TAX0F). Balancing adjustments are made to other costs leaving us with a balanced phantom-free IO database as a starting point for our simulation for year t. !

Formula

```

TINY = 0.000000000001;
NUMCOM = 1.0/Sum(i,COM,1);

```

```

NUMIND = 1.0/Sum(j,IND,1);

      (Initial)(All,i,COM)(All,s,SOURCE)(All,j,IND)
TAX1F(i,s,j) = 0.0;
      (Initial)(All,j,IND)
TAX0F(j) = 0.0;

! in start***** 17/4/99 *****!

      (Initial)(All,j,IND)
OTHCOST(j) = Sum(i,COM,MAKE(i,j)) - TAX0G(j) -
{Sum[i,COM,Sum{s,SOURCE,BAS1(i,s,j)+TAX1G(i,s,j)+Sum(r,MARGCOM,MAR1(i,s,j,r
))}]
+ Sum(m,OCC,LABOCCIND(m,j)) + CAPITAL(j) +LAND(j)};
! in end ***** 17/4/99 *****!

! Subsection 5c MAKE shares and joint production coefficients !

Formula
      (All,i,COM)
MAKE_SALES(i) = Sum(k,IND,MAKE(i,k));
      (All,j,IND)
MAKE_COSTS(j) = Sum(i,COM,MAKE(i,j));

      Zerodivide Default NUMCOM;
      Formula
      (All,i,COM)(All,j,IND)
H0CI(i,j) = MAKE(i,j)/MAKE_COSTS(j);
      Zerodivide off;

      Zerodivide Default NUMIND;
      Formula
      (All,i,COM)(All,j,IND)
B0CI(i,j) = MAKE(i,j)/MAKE_SALES(i);
      Zerodivide off;

Formula
      (All,i,COM)(All,s,SOURCE)(All,j,IND)
TAX1(i,s,j) = TAX1G(i,s,j) + TAX1F(i,s,j);

      (All,j,IND)
TAX0(j) = TAX0G(j) + TAX0F(j);

      (All,i,COM)(All,s,SOURCE)(All,j,IND)
PURCHVAL1(i,s,j) = BAS1(i,s,j) + TAX1(i,s,j) +
Sum(r,MARGCOM,MAR1(i,s,j,r));

      (All,i,COM)(All,j,IND)
TPURCHVAL1(i,j) = Sum(s,SOURCE,PURCHVAL1(i,s,j));

      (All,j,IND)
LABIND_J(j) = Sum(m,OCC,LABOCCIND(m,j));

      (All,j,IND)
TOTFACIND(j) = LABIND_J(j) + CAPITAL(j) + LAND(j);

      (All,j,IND)
ROTHCOST(j) = OTHCOST(j)/P1OCT(j);

```

```

      (All,j,IND)
COSTS(j) = Sum(i,COM, TPURCHVAL1(i,j)) + TOTFACIND(j) + OTHCOST(j)
+ TAX0(j);

```

! Section 6 Variable declarations in alphabetical order !

```

Variable
      (All,j,IND)
cap_at_t(j) # Capital stock at t (start of forecast year) #;
      (Change)(All,j,IND)
del_ploct(j) # Change in price of other cost tickets #;
      (Change)(All,i,COM)(All,s,SOURCE)(All,j,IND)
del_tax1g(i,s,j) # Rev from genuine taxes on intermediate input flows #;
      (Change)(All,i,COM)(All,s,SOURCE)(All,j,IND)
del_tax1ph(i,s,j) # Rev from phantom taxes on intermediate input flows #;
      (Change)(All,j,IND)
del_tax0ph(j) # Rev from phantom production taxes #;
      (Change)(All,j,IND)
del_tax0g(j) # Rev from genuine production taxes #;
gdpreal # Real GDP from the expenditure side #;
      (All,j,IND)
labind(j) # Employment by industry #;
      (All,j,IND)
n(j) # Use of land #;
      (All,i,COM)(All,s,SOURCE)
p0(i,s) # Basic price of good i, source s #;
      (All,i,COM)
p0dom(i) # Basic price of domestic goods #;
      (All,j,IND)
plcap(j) # Rental price of capital #;
      (All,j,IND)(All,m,OCC)
p1laboi(m,j) # Cost of a unit of labour of occupation m in industry j #;
      (All,j,IND)
p1land(j) # Rental price of land #;
q # Number of households #;
      (All,i,COM_JP)(All,j,IND_JP)
x0ci(i,j) # Supply of commodity i produced by industry j #;
      (All,i,COM)
x0dom(i) # Total supplies of domestic goods #;
      (All,j,IND)
x0ind(j);
      (All,i,COM)(All,s,SOURCE)(All,j,IND)
x1csi(i,s,j) # Demands for inputs for current production #;
      (All,j,IND)(All,m,OCC)
x1laboi(m,j) # Employment of occupation type m in industry j #;
      (All,i,COM)(All,s,SOURCE)(All,j,IND)(All,r,MARGCOM)
x1marg(i,s,j,r) # Margins - production #;
      (All,j,IND)
x1oct(j) # Demand for other cost tickets #;
      (All,i,COM)(All,s,SOURCE)(All,j,IND)
x2csi(i,s,j) # Demands for inputs for capital creation #;
      (All,i,COM)(All,s,SOURCE)(All,j,IND)(All,r,MARGCOM)
x2marg(i,s,j,r) # Margins - capital creation #;
      (All,i,COM)(All,s,SOURCE)
x3cs(i,s) # Household demand for goods #;
      (All,i,COM)(All,s,SOURCE)(All,r,MARGCOM)
x3marg(i,s,r) # Margins - households #;
      (All,i,COM)
x4(i) # Export volumes #;

```

```

      (All,i,COM)(All,r,MARGCOM)
x4marg(i,r) # Margins - exports #;
      (All,i,COM)(All,s,SOURCE)
x5cs(i,s) # Demands for inputs for government demands #;
      (All,i,COM)(All,s,SOURCE)(All,r,MARGCOM)
x5marg(i,s,r) # Margins, government #;
      (All,j,IND)
y(j) # Capital creation by using industry #;

```

! Section 7 Updates in alphabetical order !

Update

```

      (Change)(All,i,COM)(All,s,SOURCE)(All,j,IND: BAS1(i,s,j) ne 0)
BAS1(i,s,j) = [BAS1(i,s,j)/100]*[p0(i,s) + x1csi(i,s,j)];
      (Change)(All,i,COM)(All,s,SOURCE)(All,j,IND: BAS2(i,s,j) ne 0)
BAS2(i,s,j) = [BAS2(i,s,j)/100]*[p0(i,s) + x2csi(i,s,j)];
      (Change)(All,i,COM)(All,s,SOURCE)
BAS3(i,s) = [BAS3(i,s)/100]*[p0(i,s) + x3cs(i,s)];
      (Change)(All,i,COM: BAS4(i) ne 0)
BAS4(i) = [BAS4(i)/100]*[p0(i,"dom") + x4(i)];
      (Change)(All,i,COM)(All,s,SOURCE: BAS5(i,s) ne 0)
BAS5(i,s) = [BAS5(i,s)/100]*[p0(i,s) + x5cs(i,s)];
      (All,j,IND)
CAPITAL(j) = plcap(j)*cap_at_t(j);
      (All,m,OCC)(All,j,IND)
LABOCCIND(m,j) = pllaboi(m,j)*x1laboi(m,j);
      (All,j,IND)
LAND(j) = plland(j)*n(j);
      (Change)(All,i,COM_JP)(All,j,IND_JP : MAKE(i,j) ne 0)
MAKE(i,j) = [MAKE(i,j)/100]*[p0dom(i) + x0ci(i,j)];
      (Change)(All,i,COM_UP)(All,j,IND_UP: MAKE(i,j) ne 0)
MAKE(i,j) = [MAKE(i,j)/100]*[p0dom(i) + x0dom(i)];
      (Change)(All,i,COM)(All,s,SOURCE)(All,j,IND)
      (All,r,MARGCOM: MAR1(i,s,j,r) ne 0)
MAR1(i,s,j,r) = [MAR1(i,s,j,r)/100]*[p0dom(r) + x1marg(i,s,j,r)];
      (Change)(All,i,COM)(All,s,SOURCE)(All,j,IND)
      (All,r,MARGCOM: MAR2(i,s,j,r) ne 0)
MAR2(i,s,j,r) = [MAR2(i,s,j,r)/100]*[p0dom(r) + x2marg(i,s,j,r)];
      (Change)(All,i,COM)(All,s,SOURCE)(All,r,MARGCOM: MAR3(i,s,r) ne 0)
MAR3(i,s,r) = [MAR3(i,s,r)/100]*[p0dom(r) + x3marg(i,s,r)];
      (Change)(All,i,COM)(All,r,MARGCOM: MAR4(i,r) ne 0)
MAR4(i,r) = [MAR4(i,r)/100]*[p0dom(r) + x4marg(i,r)];
      (Change)(All,i,COM)(All,s,SOURCE)(All,r,MARGCOM: MAR5(i,s,r) ne 0)
MAR5(i,s,r) = [MAR5(i,s,r)/100]*[p0dom(r) + x5marg(i,s,r)];
      (Change)(All,j,IND)
OTHCOST(j) = [OTHCOST(j)/100]*x1loct(j) + ROTHCOST(j)*del_ploct(j);
      (Change)(All,i,COM)(All,s,SOURCE)(All,j,IND)
TAX1F(i,s,j) = del_tax1ph(i,s,j);
      (Change)(All,i,COM)(All,s,SOURCE)(All,j,IND)
TAX1G(i,s,j) = del_tax1g(i,s,j);
      (Change)(All,j,IND)
TAX0F(j) = del_tax0ph(j);
      (Change)(All,j,IND)
TAX0G(j) = del_tax0g(j);

```

! This part disaggregates Australia-wide results down to the State level.

The disaggregation is in the spirit of Green Book ORES, but more general.
! Section 8.1: States sets !

File SETREG # States set information #;

Set NATCOM # National commodities # Maximum Size 88 !20 for MONAGG!
Read Elements from file SETREG Header "NATC";
Subset NATCOM is subset of COM;
! In MONASH the national commodities are:
(C1-C10,C12-C24,C26-C27,C30-C61,C63-C85, C87,C96-C99,C107-C108,C115)
In MONAGG the national commodities are: (C1-C16, C20-C22, C24)
Note we have put C100=AGGc21(communication) and
C101-C105 (Banking etc)=AGGc22 as NATIONAL commodities in MONAGG even
though
the corresponding commodities are local commodities in MONASH. !

Set LOCCOM # Local commodities # Maximum Size 27 !6 for MONAGG !
Read Elements from file SETREG Header "LOCC";
Subset LOCCOM is subset of COM;
! Local commodities must be produced in region of use
or, for exports to ROW, in source region. In MONASH LOCCOM contains:
(C11,C25,C28-C29,C62,C86, C88-C95,C100-C106,C109-C114).
In MONAGG LOCCOM contains: (C17-C19, C23, C25, C26). !

Set MARLOCCOM # Local margin commodities # Maximum Size 5 !1 for MONAGG !
Read Elements from file SETREG Header "LOMC";
Subset MARLOCCOM is subset of MARGCOM;
Subset MARLOCCOM is subset of LOCCOM;
! Margin local commodities must be produced in region of use
of underlying basic flow. In MONASH MARLOCCOM
contains:(C91,C92,C95,C104,C113)
and in MONAGG it contains: C19. !

Set NONMARLOCCOM # Local non-margin commodities # Maximum Size 22 !5 for
MCA!
Read Elements from file SETREG Header "NMLC";
Subset NONMARLOCCOM is subset of NONMARGCOM;
Subset NONMARLOCCOM is subset of LOCCOM;
! In MONASH NONMARLOCCOM contains:
(C11,C25,C28-C29,C62,C86,C88-C90,C93-C94,C100-C103,C105-C106,C109-
C112,C114).
In MONAGG NONMARLOCCOM contains (C17-C18, C23, C25, C26). !

Set NATIND # National industries # Maximum Size 86 !19 for MCA!
Read Elements from file SETREG Header "NATI";
Subset NATIND is subset of IND;
! In MONASH NATIND contains:
(I1-I8,I10-I22,I24-I25,I28-I59,I61-I83, I85,I94-I97,I105-I106,I113).
In MONAGG NATIND contains: (I1-I15, I19-I21, I23);!

Set REGION # Regions # Maximum Size 8 !6 for MONAGG!
Read Elements from file SETREG Header "REGS";
! In MONASH this is (NSW, VIC, QLD, SA, WA, TAS, ACT, NT).
In MONAGG this is (NSW, VIC, QLD, SA, WA, TAS). !

Set SEC18 # 18 sector industry aggregation # Maximum Size 20
Read Elements from file SETREG Header "SC18";

! Section 8.2: States variables !


```

VARIABLE
!      (All,i,COM)
ac(i) # Commodity-using technical and taste change #;!

      (All,i,LOCCOM)(All,r,REGION)
x0_reg(i,r)      # Output of state commodities #;
      (All,j,IND)(All,r,REGION)
z_reg(j,r)      # Output of state industries #;
      (All,r,REGION)
labrev_reg(r)      # Wage bills by state #;
      (All,i,LOCCOM)(All,s,SOURCE)(All,j,IND)(All,r,REGION)
x1csi_reg(i,s,j,r) # State demands for intermediate inputs #;
      (All,i,LOCCOM)(All,s,SOURCE)(All,j,IND)(All,r,REGION)
x2csi_reg(i,s,j,r) # State demands for inputs for investment #;
      (All,i,LOCCOM)(All,s,SOURCE)(All,r,REGION)
x3cs_reg(i,s,r)      # State household demand for goods #;
      (All,i,LOCCOM)(All,r,REGION)
x4_reg(i,r)      # Foreign exports by state #;
      (All,i,LOCCOM)(All,s,SOURCE)(All,r,REGION)
x5cs_reg(i,s,r)      # State "other" demands #;
      (All,i,COM)(All,s,SOURCE)(All,j,IND)(All,m,MARLOCCOM)(All,r,REGION)
x1marg_reg(i,s,j,m,r)# Usage of margins on production by state #;
      (All,i,COM)(All,s,SOURCE)(All,j,IND)(All,m,MARLOCCOM)(All,r,REGION)
x2marg_reg(i,s,j,m,r)# Usage of margins on investment by state #;
      (All,i,COM)(All,s,SOURCE)(All,m,MARLOCCOM)(All,r,REGION)
x3marg_reg(i,s,m,r) # Usage of margins on private consumption by state #;
      (All,i,COM)(All,m,MARLOCCOM)(All,r,REGION)
x4marg_reg(i,m,r)      # Usage of margins on foreign exports by state #;
      (All,i,COM)(All,s,SOURCE)(All,m,MARLOCCOM)(All,r,REGION)
x5marg_reg(i,s,m,r) # Usage of margins on "other" demands by state #;
      (All,j,IND)
rsum1(j)      # Sum of state shares in Australia-wide ind.
production #;
      (All,j,IND)
rsum2(j)      # Sum of state shares in Australia-wide ind.
investment #;
      (All,i,COM)
rsum3(i)      # Sum of state shares in Australia-wide consumption #;
      (All,i,COM)
rsum4(i)      # Sum of state shares in Australia-wide foreign
exports #;
      (All,i,COM)
rsum5(i)      # Sum of state shares in Australia-wide other demands
#;
      (All,j,NATIND)
rsum_nat(j) # Sum of state shares in Australia-wide production of nat.
inds.#;
      (All,j,IND)
rsumy(j)      # Sum of state shares in Australia-wide investment of nat.
inds.#;
      (All,j,IND)
ffreg2(j)      # State-uniform shifts in rgshr2(j,r) from rgshr1(j,r)
#;
      (All,i,COM)
ffreg3(i)      # State-uniform shifts in rgshr3(i,r) #;
      (All,i,COM)
ffreg4(i)      # State-uniform shifts in rgshr4(i,r) #;
      (All,i,COM)
ffreg5(i)      # State-uniform shifts in rgshr5(i,r) #;

```

```

      (All,r,REGION)
fffreg5(r)          # State-specific shifts in rgshr5(i,r) #;
      (All,j,IND)(All,r,REGION)
freg2(j,r)          # Commodity-specific complement of ffreg2 #;
      (All,i,COM)(All,r,REGION)
freg3(i,r)          # Commodity-specific complement of ffreg3 #;
      (All,i,COM)(All,r,REGION)
freg4(i,r)          # Commodity-specific complement of ffreg4 #;
      (All,i,COM)(All,r,REGION)
freg5(i,r)          # Commodity-specific complement of ffreg5 #;
      (All,j,IND)(All,r,REGION)
rgshr1(j,r)         # State shares in Australia-wide industry production
#;
      (All,j,IND)(All,r,REGION)
rgshr2(j,r)         # State shares in Australia-wide industry investment
#;
      (All,i,COM)(All,r,REGION)
rgshr3(i,r)         # State shares in Australia-wide private consumption
#;
      (All,i,COM)(All,r,REGION)
rgshr4(i,r)         # State shares in Australia-wide foreign exports
#;
      (All,i,COM)(All,r,REGION)
rgshr5(i,r)         # State shares in Australia-wide "other" demands
#;
      (All,j,NATIND)(All,r,REGION)
f_z_reg(j,r)        # State-specific deviations from normal nat.ind. rule
#;
      (All,j,NATIND)
ff_z_reg(j)         # State-uniform deviations from normal nat.ind. rule
#;
      (All,j,IND)(All,r,REGION)
zcon_reg(j,r)       # Contributions to deviations in total state outputs from national GDP #;
      (All,r,REGION)
q_reg(r)            # Population by state #;
      (All,r,REGION)
ner(r)              # Retired-age component of q_reg #;
un                  # Unemployed (but not retired-age) component of q_reg
#;
f_q                 # Slack in E_q #;
      (All,j,IND)(All,r,REGION)
labind_reg(j,r);
      (All,r,REGION)
labindtot_reg(r);
      (All,r,REGION)
gspreal(r)          # Real Gross State Products (GSP)#;
gdpreal_fc          # Real GDP at factor cost (GSP)#;
      (All,j,IND)(All,r,REGION)
y_reg(j,r)          # Investment by regional industry #;
      (All,j,IND)(All,r,REGION)
f_y_reg(j,r)        # Region- and industry-specific investment shifter #;
      (All,j,IND)
ff_y_reg(j)         # Industry-specific investment shifter #;
      (All,r,REGION)
fff_y_reg(r)        # Region-specific investment shifter #;

```

! Section 8.3: States data !

File REGDATA # States data file #;
! The following shares are read in and updated. !

Coefficient

(All,j,IND)(All,r,REGION) REGSHR1(j,r) # State output shares #;
(All,j,IND)(All,r,REGION) REGSHR2(j,r) # State investment shares #;
(All,i,COM)(All,r,REGION) REGSHR3(i,r) # State consumption shares #;
(All,i,COM)(All,r,REGION) REGSHR4(i,r) # State export shares #;
(All,i,COM)(All,r,REGION) REGSHR5(i,r) # State 'other' shares #;

Read

REGSHR1 from file REGDATA Header "R001";
REGSHR2 from file REGDATA Header "R002";
REGSHR4 from file REGDATA Header "R004";
REGSHR5 from file REGDATA Header "R005";

Update

(All,j,IND)(All,r,REGION) REGSHR1(j,r) = rgshr1(j,r);
(All,j,IND)(All,r,REGION) REGSHR2(j,r) = rgshr2(j,r);
(All,i,COM)(All,r,REGION) REGSHR4(i,r) = rgshr4(i,r);
(All,i,COM)(All,r,REGION) REGSHR5(i,r) = rgshr5(i,r);

! Section 8.4: States coefficients and formulae !

Coefficient

(All,j,IND)(All,r,REGION) LABINDREG(j,r) # Labour bills by industry and state #;
(All,r,REGION) LABREGTOT(r) # Total labour bill by state #;
(All,j,IND)(All,r,REGION) VALUADD(j,r) # Factor bills by industry and state #;
(All,r,REGION) VALUADDTOT(r) # Total factor bill by state #;

Formula

(All,j,IND)(All,r,REGION) LABINDREG(j,r) = LABIND_J(j)*REGSHR1(j,r);
(All,r,REGION) LABREGTOT(r) = Sum(j,IND, LABINDREG(j,r));
(All,j,IND)(All,r,REGION) VALUADD(j,r) = TOTFACIND(j)*REGSHR1(j,r);
(All,r,REGION) VALUADDTOT(r) = SUM(j,IND, VALUADD(j,r));
(All,i,COM)(All,r,REGION)
REGSHR3(i,r) =
LABREGTOT(r)/Sum(s,REGION,LABREGTOT(s));

Coefficient (All,i,LOCCOM)(All,r,REGION)

TOTSUPREG(i,r) # Supply of local good i in state r #;

Formula (All,i,LOCCOM)(All,r,REGION)

TOTSUPREG(i,r) = SUM(j,IND, H0CI(i,j)*COSTS(j)*REGSHR1(j,r));

Coefficient (All,i,LOCCOM)(All,r,REGION)

TOTDEMREG(i,r) # All basic + margin use of local good i in state r #;

Formula

(All,i,MARLOCCOM)(All,r,REGION)
TOTDEMREG(i,r) =
SUM(j,IND, REGSHR1(j,r)*BAS1(i,"dom",j))
+ SUM(j,IND, REGSHR2(j,r)*BAS2(i,"dom",j))
+ BAS3(i,"dom")*REGSHR3(i,r)
+ BAS4(i)*REGSHR4(i,r)
+ BAS5(i,"dom")*REGSHR5(i,r)
+ SUM(u,COM, (MAR4(u,i)*REGSHR4(u,r))
+ SUM(s,SOURCE, MAR3(u,s,i)*REGSHR3(u,r)
+ MAR5(u,s,i)*REGSHR5(u,r)
+ SUM(j,IND, REGSHR1(j,r)*MAR1(u,s,j,i)
+ REGSHR2(j,r)*MAR2(u,s,j,i)));

Formula

```
(All,i,NONMARLOCCOM)(All,r,REGION)
TOTDEMREG(i,r) =
    SUM(j,IND, REGSHR1(j,r)*BAS1(i,"dom",j))
    + SUM(j,IND, REGSHR2(j,r)*BAS2(i,"dom",j))
    + BAS3(i,"dom")*REGSHR3(i,r)
    + BAS4(i)*REGSHR4(i,r)
    + BAS5(i,"dom")*REGSHR5(i,r);
```

Coefficient (All,i,LOCCOM)(All,r,REGION) TOTCHECK(i,r)

```
# Check for consistency between regional and FID databases #;
! This should be zero if state shares + FID constitute a balanced database
!
```

Formula (All,i,LOCCOM)(All,r,REGION)

```
TOTCHECK(i,r) = TOTDEMREG(i,r) - TOTSUPREG(i,r);
```

```
! Shares of employed, unemployed and retired-age persons in State
population.
```

```
These shares are presently hard-wired and are uniform across all states
```

```
!
```

Coefficient

```
(All,r,REGION) Ser(r) # Share of employed #;
(All,r,REGION) Sner(r) # Share of retired-age persons #;
(All,r,REGION) Sun(r) # Share of unemployed (but not retired-age) persons
#;
```

Formula

```
(All,r,REGION) Ser(r) = 0.79;
(All,r,REGION) Sner(r) = 0.16;
(All,r,REGION) Sun(r) = 0.05;
```

```
! Section 8.5: States equations !
```

```
! Regional outputs !
```

Equation

E_z_reg_B

```
# Output of national industries eq39.2, DPSV P.260 #
(All,j,NATIND)(All,r,REGION)
z_reg(j,r) = x0ind(j) + f_z_reg(j,r) + ff_z_reg(j);
```

E_z_reg_A

```
# Supplies of local commodities related to production of local
industries #
```

```
(All,i,LOCCOM)(All,r,REGION)
x0_reg(i,r) = SUM(j,IND, B0CI(i,j)*z_reg(j,r));
```

E_x0_reg_A

```
# Output of nonmargins local commodities, Green book, eq39.8a #
(All,i,NONMARLOCCOM)(All,r,REGION)
TOTDEMREG(i,r)*x0_reg(i,r)
= SUM(j,IND, REGSHR1(j,r)*BAS1(i,"dom",j)*x1csi_reg(i,"dom",j,r))
+ SUM(j,IND, REGSHR2(j,r)*BAS2(i,"dom",j)*x2csi_reg(i,"dom",j,r))
+ BAS3(i,"dom")*REGSHR3(i,r)*x3cs_reg(i,"dom",r)
+ BAS4(i)*REGSHR4(i,r)*x4_reg(i,r)
+ BAS5(i,"dom")*REGSHR5(i,r)*x5cs_reg(i,"dom",r);
```

E_x0_reg_B

```

# Usage of margins local commodities #
(All,i,MARLOCCOM)(All,r,REGION)
TOTDEMREG(i,r)*x0_reg(i,r)
= SUM(j,IND, REGSHR1(j,r)*BAS1(i,"dom",j)*xlcsi_reg(i,"dom",j,r))
+ SUM(j,IND, REGSHR2(j,r)*BAS2(i,"dom",j)*x2csi_reg(i,"dom",j,r))
+ BAS3(i,"dom")*REGSHR3(i,r)*x3cs_reg(i,"dom",r)
+ BAS4(i)*REGSHR4(i,r)*x4_reg(i,r)
+ BAS5(i,"dom")*REGSHR5(i,r)*x5cs_reg(i,"dom",r)
+ SUM(u,COM, MAR4(u,i)*REGSHR4(u,r)*x4marg_reg(u,i,r)
+ SUM(s,SOURCE, MAR3(u,s,i)*REGSHR3(u,r)*x3marg_reg(u,s,i,r)
+ MAR5(u,s,i)*REGSHR5(u,r)*x5marg_reg(u,s,i,r)
+ SUM(j,IND, REGSHR1(j,r)*MAR1(u,s,j,i)*xlmarg_reg(u,s,j,i,r)
+ REGSHR2(j,r)*MAR2(u,s,j,i)*x2marg_reg(u,s,j,i,r) )));

! Regional demands for local commodities !

E_xlcsi_reg
# Direct intermediate demands by industry and state #
(All,i,LOCCOM)(All,s,SOURCE)(All,j,ind)(All,r,REGION)
xlcsi_reg(i,s,j,r) = xlcsi(i,s,j) + rgshr1(j,r);

E_x2csi_reg
# Direct investment demands by industry and state #
(All,i,LOCCOM)(All,s,SOURCE)(All,j,ind)(All,r,REGION)
x2csi_reg(i,s,j,r) = x2csi(i,s,j) + rgshr2(j,r);

E_x3cs_reg
# Consumption by state #
(All,i,LOCCOM)(All,r,REGION)(All,s,SOURCE)
x3cs_reg(i,s,r) = x3cs(i,s) + rgshr3(i,r);

E_x4_reg
# Foreign exports by state #
(All,i,LOCCOM)(All,r,REGION)
x4_reg(i,r) = x4(i) + rgshr4(i,r);

E_x5cs_reg
# "Other" demands by state #
(All,i,LOCCOM)(All,s,source)(All,r,REGION)
x5cs_reg(i,s,r) = x5cs(i,s) + rgshr5(i,r);

E_xlmarg_reg
# Margin intermediate demands by industry and state #
(All,i,COM)(All,s,SOURCE)(All,j,IND)(All,m,MARLOCCOM)(All,r,REGION)
xlmarg_reg(i,s,j,m,r) = xlmarg(i,s,j,m) + rgshr1(j,r);

E_x2marg_reg
# Margin investment demands by industry and state #
(All,i,COM)(All,s,SOURCE)(All,j,IND)(All,m,MARLOCCOM)(All,r,REGION)
x2marg_reg(i,s,j,m,r) = x2marg(i,s,j,m) + rgshr2(j,r);

E_x3marg_reg
# Margin private consumption by state #
(All,i,COM)(All,s,SOURCE)(All,m,MARLOCCOM)(All,r,REGION)
x3marg_reg(i,s,m,r) = x3marg(i,s,m) + rgshr3(i,r);

E_x4marg_reg
# Margin to foreign export by state #
(All,i,COM)(All,m,MARLOCCOM)(All,r,REGION)

```

```

x4marg_reg(i,m,r) = x4marg(i,m) + rgshr4(i,r);

E_x5marg_reg
# Margins to "other" by state #
(All,i,COM)(All,s,SOURCE)(All,m,MARLOCCOM)(All,r,REGION)
x5marg_reg(i,s,m,r) = x5marg(i,s,m) + rgshr5(i,r);

! Output shares !

E_rgshr1
# State shares of industry production #
(All,j,IND)(All,r,REGION)
rgshr1(j,r) = z_reg(j,r) - x0ind(j);

! Investment shares !

E_rgshr2
! Can be overwritten by E_rgshr2a if freg2(j,r) is endogenous. !
# State shares of industry investment related to State production shares
#
(All,j,IND)(All,r,REGION)
rgshr2(j,r) = rgshr1(j,r) + freg2(j,r)+ ffreg2(j);

! Next two equations facilitate the introduction of regional investment
data
into historicals. These two equations can be used to overwrite E_regshr2.
To do so, set freg2(j,r) as an endogenous variable. If E_regshr2 is to
operate,
set freg2(j,r)exogenous and f_y_reg(j,r) endogenous. !

E_y_reg
# Investment in regional industries #
(All,j,IND)(All,r,REGION)
y_reg(j,r) = y(j) + f_y_reg(j,r) + ff_y_reg(j) + fff_y_reg(r);

E_rgshr2a
# State shares of industry investment #
(All,j,IND)(All,r,REGION)
rgshr2(j,r) = y_reg(j,r) - y(j);

! Household consumption shares !

E_rgshr3
# State shares in private consumption move with State population shares #
(All,i,COM)(All,r,REGION)
rgshr3(i,r) = (q_reg(r) - q) + freg3(i,r)+ ffreg3(i);

E_q_reg
# State population comprises employed, retired and other (ie unemployed)
#
(All,r,REGION)
q_reg(r) = Ser(r)*labindtot_reg(r) + Sner(r)*ner(r) + Sun(r)*un;

E_labind_reg #employment by state and industry#

```

```

(All,j,IND)(All,r,REGION)
labind_reg(j,r) = labind(j) + rgshr1(j,r);

E_labindtot_reg # aggregate state employment#
(All,r,REGION)
LABREGTOT(r)*labindtot_reg(r) =
SUM(j,IND, LABINDREG(j,r)*labind_reg(j,r));

E_q
# Australia-wide population equals sum of state populations #
Sum(r,REGION,LABREGTOT(r))*q = Sum(s,REGION,LABREGTOT(s)*q_reg(s))
+ Sum(r,REGION,LABREGTOT(r))*f_q;

! Export shares !

E_rgshr4
# State shares in foreign exports #
(All,i,COM)(All,r,REGION)
rgshr4(i,r) = freq4(i,r)+ ffreq4(i);

! Government demand shares !

E_rgshr5
# State shares in "other" demands #
(All,i,COM)(All,r,REGION)
rgshr5(i,r) = freq5(i,r)+ ffreq5(i) + fffreq5(r);

! Aggregation checks !

E_rsum1
# For checking purposes: rsum1 should be endogenous and zero #
(All,j,IND)
Sum(r,REGION, REGSHR1(j,r)*rgshr1(j,r)) = rsum1(j);

E_rsum2
# For checking purposes: rsum2 should be endogenous and zero #
(All,j,IND)
Sum(r,REGION, REGSHR2(j,r)*rgshr2(j,r)) = rsum2(j);

E_rsum3
# For checking purposes: rsum3 should be endogenous and zero #
(All,i,COM)
Sum(r,REGION, REGSHR3(i,r)*rgshr3(i,r)) = rsum3(i);

E_rsum4
# For checking purposes: rsum4 should be zero #
(All,i,COM)
Sum(r,REGION, REGSHR4(i,r)*rgshr4(i,r)) = rsum4(i);

E_rsum5
# Used to ensure rsum5 is zero #
(All,i,COM)
Sum(r,REGION, REGSHR5(i,r)*rgshr5(i,r)) = rsum5(i);

```

```

E_rsum_nat
# Adding up rule for national industries: rsum_nat normally end. and zero
#
(All,j,NATIND)
SUM(r,REGION, REGSHR1(j,r)*z_reg(j,r)) = x0ind(j) + rsum_nat(j);

E_rsumy_nat
# Adding up rule for regional investment in national industries #
(All,j,IND)
SUM(r,REGION, REGSHR2(j,r)*y_reg(j,r)) = y(j) + rsumy(j);

! Reporting variables !

E_zcon_reg
# Contributions to deviations in gspreal from national GDP (gdpreal) #
(All,j,IND)(All,r,REGION)
zcon_reg(j,r) = {[VALUADD(j,r)/VALUADDTOT(r)]
- [TOTFACIND(j)/SUM(k,IND, TOTFACIND(k))]}*[z_reg(j,r) -
gdpreal_fc]
+ [TOTFACIND(j)/SUM(k,IND, TOTFACIND(k))] *[z_reg(j,r) -
x0ind(j)];

E_gdpreal_fc
# Real GDP at factor cost #
Sum(j,IND, TOTFACIND(j)) * gdpreal_fc = Sum(k,IND, TOTFACIND(k) *
x0ind(k));

E_gspreal
# Real Gross State Products (primary factor weights) #
(All,r,REGION)
gspreal(r) = gdpreal_fc + SUM(j,IND, zcon_reg(j,r));

E_labrev_reg
# Total wage bills by state #
(All,r,REGION)
LABREGTOT(r)*labrev_reg(r)
= SUM(j,IND, REGSHR1(j,r)*
SUM(m,OCC, LABOCCIND(m,j)*{rgshr1(j,r) + pllabo1(m,j) +
x1labo1(m,j)}));

! Displays !

Display TOTCHECK;
Display LABINDREG;
Display LABREGTOT;
Display VALUADDTOT;_

```


Appendix 2. Status of Variables in the RES Historical Simulations
(See Appendix 1 for definitions of the variables.)

(i) Variables with unchanging status

Exogenous in all simulations	Endogenous in all simulations
<p><i>Regional variables</i></p> <p>ff_y_reg(j) fff_y_reg(r) ffreg2(j) ffreg3(i) ffreg4(i) ffreg5(i) fffreg5(r) freg3(i,r) freg4(i,r) freg5(i,r) f_z_reg(j,r) ff_z_reg(j)</p> <p><i>All MONASH variables listed in Appendix 1</i></p>	<p><i>Regional variables</i></p> <p>x0_reg(i,r) z_reg(j,r) labrev_reg(r) xlcsi_reg(i,s,j,r) x2csi_reg(i,s,j,r) x3cs_reg(i,s,r) x4_reg(i,r) x5cs_reg(i,s,r) x1marg_reg(i,s,j,m,r) x2marg_reg(i,s,j,m,r) x3marg_reg(i,s,m,r) x4marg_reg(i,m,r) x5marg_reg(i,s,m,r) rsum1(j) rsum2(j) rsum3(i) rsum4(i) rsum5(i) rsum_nat(j) rsumy(j) rgshr1(j,r) rgshr2(j,r) rgshr3(i,r) rgshr4(i,r) rgshr5(i,r) zcon_reg(j,r) labind_reg(j,r) labindtot_reg(r) gspreal(r) gdpreal_fc y_reg(j,r)</p>

(ii) Regional variables that are endogenous in some simulations but exogenous in others

Variable	Status in:		
	Simulations 1&2	Simulation 3	Simulations 4-6
q_reg(r)	Endogenous	Exogenous	Exogenous
ner(r)	Exogenous	Endogenous	Endogenous
un	Endogenous	Exogenous	Exogenous
f_q	Exogenous	Endogenous	Endogenous
f_y_reg(j,r)	Endogenous	Endogenous	Exogenous
freg2(j,r)	Exogenous	Exogenous	Endogenous