EXPORT-LED GROWTH FOR A REGIONAL ECONOMY: A CGE ANALYSIS OF A SOUTH AUSTRALIAN EXPORT PROJECT

Peter B. Dixon[1]
Centre of Policy Studies, Monash University, Clayton, Victoria, Australia.

Matthew W. Peter
Centre of Policy Studies, Monash University, Clayton, Victoria, Australia.

ABSTRACT It is a policy of State governments in Australia to encourage export-oriented activities in their jurisdictions. The most popular method of quantifying the effects of such policies is regional input-output (IO) analysis. Here we use an 8-region-12-sector computable general equilibrium (CGE) model to look at the effects of new export activities in South Australia. Relative to the IO approach, we find that CGE modelling adds interesting insights concerning likely price-induced effects. These include: export expansion and import replacement arising from enhanced competitiveness associated with scale economies; crowding out of traditional export activities associated with exchange rate appreciation; and changes in inter-regional factor flows associated with changes in inter-regional factor returns.

1. INTRODUCTION

Two complementary theories of regional development are the export-base theory and the theory of cumulative causation. In the export-base theory[2], growth in a subnational region depends primarily on growth in external demands for the region's products. External demand growth can come from other regions in the nation or from other nations. A key assumption of the export-base theory is that there is sufficient intra-national factor mobility that subnational regional growth is unconstrained from the supply side. Then, with an increase in the export demand for its products, a region can expand its output and employment by attracting factors of production from other regions. This allows regional expansion without regional price increases.

A quantitative representation of the export-base theory is provided by the single-region input-output model. In this model, regional output expansion is not constrained by resource scarcities and does not generate price movements. The only source of regional growth in the IO model is exogenous increases in final demands for the region's products. In some variants of the model (with regional consumption

---

[1] The authors thank Guy West and an anonymous referee for helpful comments on an earlier version of this paper.

[2] See Nijkamp, Rietveld and Snickers (1986) and Armstrong and Taylor (1993) for expositions of the export-base theory. A current Australian regional model which gives exports a key explanatory role in regional development is West (1994).

and population linked to regional income; with regional investment linked to regional growth; and with regional imports linked to regional outputs)[3], export expansion is the only avenue of exogenous increase in regional final demand. Consistent with the export-base theory of regional development, these variants of the IO model identify export demand as the dominant source of regional growth.

The cumulative-causation theory of regional development emphasises the role of economies of scale[4]. In this theory, an expansion in regional output (initiated, say, by an increase in the region's exports), leads to agglomeration economies as new firms and labour are attracted to the region[5]. The resulting exploitation of external and internal economies of scale reduces costs in the regional economy and enhances the competitiveness of its traded-goods sectors. This generates another round of expansion in the region's economy by allowing the region to make further increases in its exports and to replace imports.

Because the cumulative causation theory gives a central role to competitiveness effects (price changes), it is not well encapsulated by the IO framework. What is required is a model in which regional exports and imports are price sensitive.

An approach which emphasises competitiveness effects is computable general equilibrium (CGE) modelling. In CGE models, price sensitivity is built in via utility-maximising specifications of consumer behaviour and profit-maximising specifications of producer behaviour. At the same time, CGE modelling retains the most attractive feature of IO modelling, namely its ability to quantify linkages between industries arising from their roles as customers for each others products.

In this paper, we provide an illustration of how a CGE model can be used to analyse a regional development strategy involving both export growth and agglomeration economies. We apply MMRF[6], an 8-region, 12-sector CGE model[7], in a comparative-static analysis of the long-run effects on the South Australian and other State and Territory economies of (i) an increase in South Australia's international exports of Manufactures and Professional Services, and (ii) an increase in productivity in the South Australian manufacturing sector linked to the sector's growth in output. This example arose in recent work designed to assist the South

---

[3] Links such as these can be built into the IO model in a variety of ways. See, for example, West (1994 and 1995).

[4] See Richardson and Townroe (1986) and Armstrong and Taylor (1993) for expositions of the cumulative-causation theory.

[5] For an Australian discussion of agglomeration or cluster effects see Bureau of Industry Economics (1994, chapters 2 and 3).

[6] The full name for the MMRF model is the MONASH Multi-Regional Forecasting model. Complete technical documentation is given in Naqvi and Peter (1995).

[7] This level of disaggregation makes MMRF a relatively detailed multi-regional CGE model. Other models in this class include: Liew's (1981) 30 good, 6 region model of Australia; Ko and Hewings' (1986) 5 good, 5 region model of South Korea; Harrigan and McGregor's (1988) 1 good, 2 region model of Malaysia; Mutti, Morgan and Partridge's (1989) 5 good, 6 region model of the U.S.; Madden's (1990) 9 good, 2 region model of Australia; and Wigle's (1992) 13 good, 6 region model of Canada.

Australian government to assess various proposals by multinational corporations to establish export-oriented activities in the State.

We find that MMRF generates employment and output multipliers for South Australia with respect to SA export growth similar to those that could be obtained from a single-region IO model. For regional economies, MMRF implies that there can be a considerable percentage increase in economic activity arising from a demand-side shock with little effect on factor prices. Thus, in simulating the effects on South Australia of an exogenous outward movement in the demand curves for SA exports, MMRF behaves much like an IO model. However, MMRF takes us beyond IO analysis in two directions. First, being a multi-regional model, it allows us to look at the effects of SA export expansion on the rest of Australia. Second, being a CGE model, it allows us to analyse supply-side and price-induced effects, especially those associated with agglomeration economies.

The paper is organised as follows. In section 2 we provide an overview of MMRF. Section 3 discusses the main assumptions underlying the present application of the model. Section 4 explains the results. Concluding remarks are in section 5.

2. OVERVIEW OF MMRF

MMRF divides Australia into the six States and two Territories. There are five types of agents in the model: industrial sectors, capital creators, households, governments, and foreigners. In each region, there are twelve sectors and twelve capital creators. The twelve sectors each produce a single commodity and the twelve capital creators each produce units of capital for a single regional sector. Hence MMRF recognises 96 industrial sectors, 96 commodities and 96 types of capital. Each region in MMRF has a single household and a regional government. There is also a Federal government. Finally, there are foreigners, whose behaviour is summarised by export demand curves for the products of each region and by supply curves for international imports to each region.

MMRF determines regional supplies and demands of commodities through optimising behaviour of agents in competitive markets. Optimising behaviour also determines industry demands for labour and capital. Labour supply at the national level is determined by demographic factors, while national capital supply responds to rates of return. Labour and capital can cross regional borders so that each region's endowment of productive resources reflects regional employment opportunities and relative rates of return.

The specifications of supply and demand behaviour coordinated through market clearing equations, comprise the CGE core of the model. In the version of MMRF used in this paper, there are two blocks of equations in addition to the core[8]. They describe (i) regional and Federal government finances, and (ii) regional labour

---

[8] In forecasting versions of the model there is a further block of equations describing accumulation relations between: capital and investment; population and population growth; and foreign debt and the national balance of trade. However, in the comparative-static version of MMRF used here, these accumulation equations are redundant.

markets. In the remainder of this section, we provide further details on MMRF, starting with the CGE core, followed by comments on the additional two blocks of equations, on data requirements and on the computational technique.

2.1. The CGE Core

The CGE core is based on ORANI, a single-regional model of Australia (Dixon, Parmenter, Sutton and Vincent, 1982). Each regional economy in MMRF looks like an ORANI model. However, unlike the single-region ORANI model, MMRF includes inter-regional linkages. In MMRF, changes in economic conditions in any one regional economy affect the other seven via inter-regional flows of commodities and factors of production. The basic theoretical assumptions made in the CGE core of MMRF are as follows.

The Nature of Markets

The 96 commodity markets in MMRF are assumed to be competitive, implying equality between the producer's price and marginal cost in each regional sector[9]. Demand is assumed to equal supply in all markets other than the labour market (where excess supply conditions can hold). The government intervenes in markets by imposing *ad valorem* sales taxes on commodities. This places wedges between the prices paid by purchasers and prices received by the producers. The model recognises two margin commodities (Domestic Trade and Transport & Communication) which are required for each market transaction (the movement of a commodity from the producer to the purchaser). The costs of the margins are included in purchasers' prices.

Demands for Inputs to be Used in the Production of Commodities

MMRF recognises two broad categories of inputs: intermediate inputs and primary factors. Firms in each regional sector are assumed to choose the mix of inputs which minimises the costs of production for their level of output. They are constrained in their choice of inputs by a three-level nested production technology (Figure 1). At the first level, intermediate-input bundles and primary-factor bundles are used in fixed proportions to output. These bundles are formed at the second level. Intermediate input bundles are CES combinations of international imported goods

---

[9] There are several CGE models incorporating imperfect competition in commodity markets. Examples are Harris and Cox (1983), Horridge (1987) and Norman (1990). An overview of this work is given by Dixon and Parmenter (1996). At this stage, the literature does not provide an alternative to the competitive paradigm which generates results that are superior on either formal statistical criteria or on an informal plausibility basis. The biases in the results produced by a competitive model in a situation in which competitive assumptions are inappropriate are likely to vary between applications. The current literature does not give us any guidance as to the biases that may affect the present study.

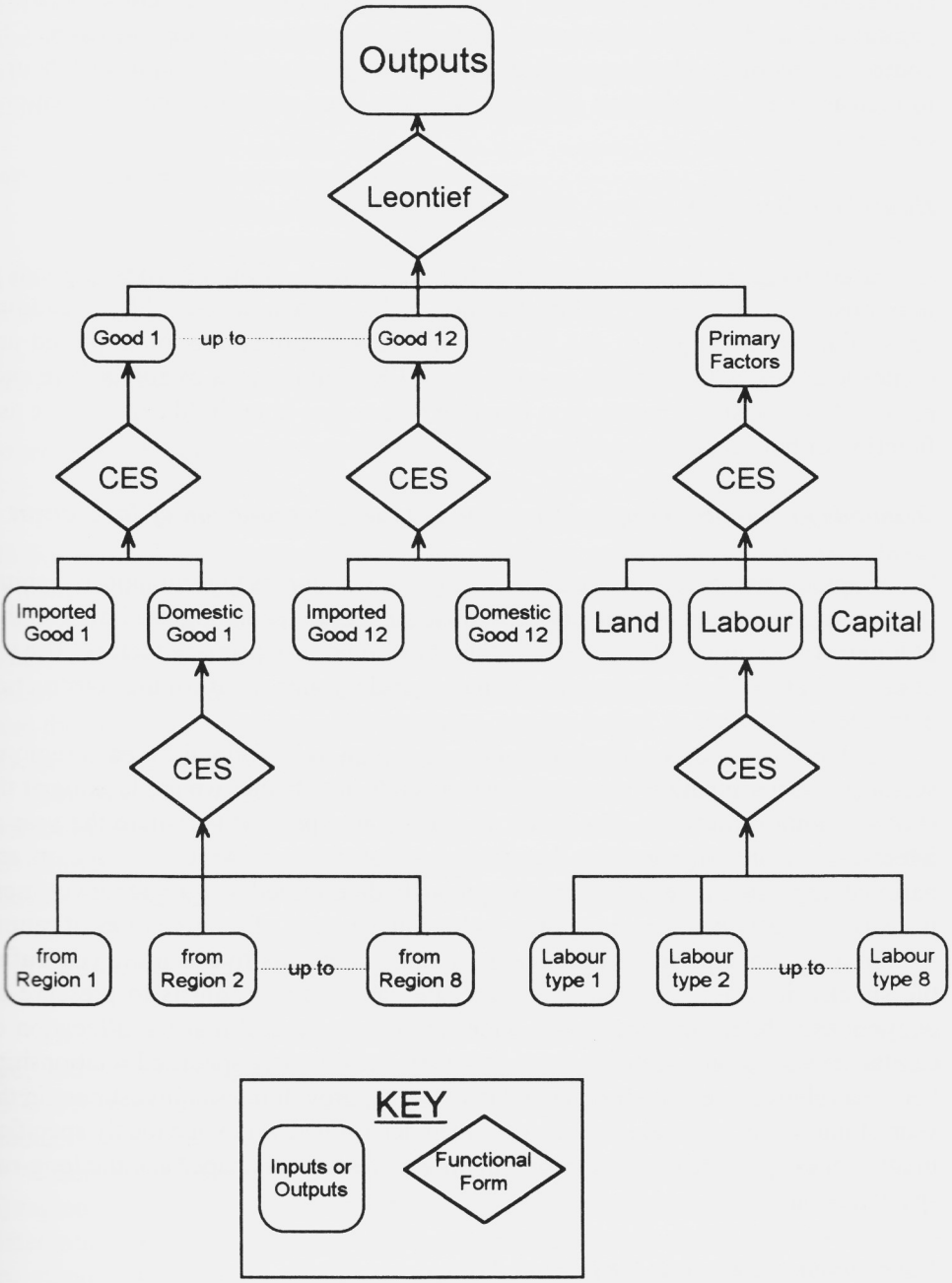

Figure 1. Production Technology for a Regional Sector in MMRF

and domestic goods. The primary-factor bundle is a CES combination of labour, capital and land. At the third level, inputs of domestic goods are formed as CES combinations of goods from each of the eight regions, and the input of labour is formed as a CES combination of inputs of labour from eight different occupational categories.

Household Demands

In each region, the household buys bundles of each of the 12 types of goods to maximise a Stone-Geary utility function subject to a household expenditure constraint. As in Figure 1, the bundles are CES combinations of imported and domestic goods, with domestic goods being CES combinations of goods from each region. A Keynesian consumption function determines household expenditure as a function of household disposable income.

Demands for Inputs to Capital Creation and the Determination of Investment

Capital creators for each regional sector combine inputs to form units of capital. In choosing these inputs, they cost minimise subject to technologies similar to that in Figure 1; the only difference being that they do not use primary factors. The use of primary factors in capital creation is recognised through inputs of the construction commodity (service).

Determination of the number of units of capital to be formed for each regional sector (i.e., determination of investment), depends on whether we are looking at the short- or long-run effects of a shock. In short-run experiments (where the year of interest is one or two years after the shock), capital stocks in the regional sectors and national aggregate investment are exogenously determined. Aggregate investment is distributed between the 96 regional sectors on the basis of relative rates of return.

In long-run experiments (where the year of interest is five or more years after the shock), it is assumed that the aggregate capital stock adjusts to preserve an exogenously determined economy-wide rate of return, and that the allocation of capital across regional sectors adjusts to satisfy exogenously specified relationships between relative rates of return and relative capital growth rates[10]. Investment in the year of interest in each regional sector is then determined via exogenously specified investment/capital ratios. The experiments reported in this paper use the long-run specification.

Governments' Demands for Commodities

Commodities are demanded from each region by regional governments and by the Federal government. In MMRF there are several ways of handling these

---

[10] We assume that if a shock increases the growth rate in capital of a regional sector relative to that of other regional sectors, then it will also increase the sector's rate of return relative to that of other sectors.

demands, including: (i) endogenously, by a rule such as moving government expenditures with household consumption expenditure or with domestic absorption; (ii) endogenously, as an instrument which varies to accommodate an exogenously determined target such as a required level of foreign debt; (iii) exogenously.

Foreign Demand (International Exports)

MMRF is similar to single-region models in its specification of foreign demand. In each region, the export-oriented sectors face downwardly-sloping demand curves for their commodities on international markets.

2.2. Additional Blocks of Equations

Government Finances

For each of the eight regional governments and for the Federal government, MMRF includes revenue equations for income taxes, sales taxes, excise taxes, taxes on international trade and for receipts from government-owned assets. As described already, the model accounts for public expenditures on commodities (or services). It also contains outlay equations for each government for transfer payments to households (e.g., pensions, sickness benefits and unemployment benefits). Transfers from the Federal to the regional governments are modelled, appearing on the outlay side of the Federal budget and on the revenue sides of the regional budgets.

The specification in MMRF of government finances makes the model a suitable tool for (a) analysing the effects of changes in the fiscal policies of both the Federal government and of the regional governments, and (b) analysing the impact on the budgetary situation of the nine governments of a wide range of shocks.[11]

Regional Labour Markets

This block of equations relates: regional population and population of working age; and regional population of working age and regional labour supply. It also defines regional unemployment rates in terms of regional demands and supplies of labour.

There are three main possible treatments in MMRF for regional labour markets: (i) regional labour supply and unemployment rates are exogenous and regional wage differentials are endogenous, (ii) regional wage differentials and unemployment rates are exogenous and regional labour supply is endogenous or (iii) regional labour supply and wage differentials are exogenous and regional unemployment rates are endogenous.

---

[11] Papers which draw on the fiscal specifications in MMRF include Meagher and Parmenter (1993), Madden (1995) and Crowe (1995).

2.3. Data Requirements

The CGE core of MMRF requires a multi-regional input-output table together with values for the elasticities of substitution in the CES nests of the specifications of technologies and preferences. The government finance block requires data on regional and Federal government revenues and outlays. The regional labour market block requires regional demographic, employment and labour force data.

Suitable regional data for the government finance and labour market blocks are published by the Australian Bureau of Statistics (ABS), see Peter (1994). However, the ABS do not compile multi-regional IO tables. IO data for the MMRF core was created by disaggregating the national IO table used in the national CGE model, MONASH (see Dixon and McDonald (1992) for a description of the MONASH IO data). The regional disaggregation of the national IO table involved three steps: (i) splitting of columns using regional proportions of industry outputs and final demands; (ii) splitting of rows using inter-regional trade data available from Quinlan (1991); and (iii) application of RAS procedures to ensure equality in the multi-regional input-output table between the outputs and sales of regional sectors. Details of these steps are in Han (1992) and Han and Peter (1994).

For values of primary-factor and domestic-import substitution elasticities, MMRF relies on the ORANI national database (Kenderes, 1995). We have no estimates of substitution elasticities between domestic products from different regional sources. We assume that high numbers are appropriate, five times the values for domestic/import substitution elasticities. That is, we assume that different domestic varieties of good i are closer substitutes than are domestic and imported varieties.

2.4. Computing Solutions for MMRF

MMRF is a system of non-linear equations. These are solved using GEMPACK,[12] a suite of general-purpose programs for implementing and solving economic models. A linear, differential version of the MMRF equation system is specified in a syntax similar to ordinary algebra. GEMPACK then solves the system of non-linear equations as an Initial Value problem, using a standard method, such as Euler or midpoint, (see for example, Press *et al.* 1986). For details of the algorithms available in GEMPACK, see Pearson (1991).

In the simulations reported in this paper, we used the Euler multi-step algorithm to generate solutions to the non-linear equation system of MMRF. We also generated solutions to the linearised version of the model. Comparing the results from the linear and non-linear solutions, we found the linearisation errors to be negligible.[13]

---

[12] See Harrison and Pearson (1994).

[13] We define the relative error (re_i) as $re_i = |100(yl_i - ynl_i)/ynl_i|$, where yl_i is the percentage change in the ith endogenous variable in the linear solution and ynl_i is the percentage change in the non-linear solution. In the simulation reported in section 4.1, for example, the average value of re_i (for all variables for which ynl_i is non-negligible) is 0.02, ranging from 0 to 0.8.

In this paper, we report results of the linear version of the model because this facilitates sensitivity analysis by ignoring second- and higher-order derivatives of the endogenous variables with respect to the exogenous variables.

3. MAIN ASSUMPTIONS

For the present study, we conduct three MMRF simulations, giving the effects of:

(i) a $100 million stimulation of manufacturing exports from South Australia;
(ii) a $100 million stimulation of professional-service exports from South Australia; and
(iii) a one per cent improvement in total factor productivity[14] in South Australian manufacturing.

Results are reported separately in Tables 1 to 3 for these three simulations. By separating our results, we allow the reader to perform sensitivity analysis.[15] For example, a central case in our work presented to the South Australian government was a package consisting of an $80 million stimulation of SA manufacturing exports plus a $20 million stimulation of SA professional-service exports plus a 0.11 per cent improvement in SA manufacturing productivity. To calculate the effects of this package, we combine results from the three Tables as follows:

Result for variable z in package =
0.80×result for z in Table 1+0.20×result for z in Table 2+0.11×result for z in Table 3.

If z is employment in South Australia, then:

Result for variable z in package
$= 0.80 \times 0.353 + 0.20 \times 0.478 + 0.11 \times 0.829$
= 0.47 per cent,

i.e., the package increases SA employment by 0.47 per cent, or about 3410 jobs.

In the analysis presented to the South Australian government of the implications of possible export packages, the roles of simulations (i) and (ii) were to represent the effects of exports of machinery and of engineering design services. The third simulation was used to represent agglomeration effects.

All three simulations represent long-run, comparative-static effects (effects after 5 or more years of sustained application of the shocks), and in all three cases, the results are for deviations from a base case forecast for the year 2000. In row 2 of Table 1-part A, for example, the result in column 5 means that if SA's manufactured exports were $100 million above their base case forecast in each of the years 1996 to 2000, then in 2000, SA employment would be 0.353 per cent above its base case

---

The smallness of the linearisation errors in all simulations in this paper, reflects the relatively small size of the shocks imposed.

[14] This is a one per cent reduction in labour and capital per unit of output in SA manufacturing.

[15] As explained in section 2.4, our results are computed by a linear method making possible the sensitivity approach described here.

forecast.

In generating the numbers in Tables 1 to 3, we imposed the following assumptions.

Labour Market

We assume that additional export activities in South Australia do not affect aggregate employment in Australia. In the long run, aggregate employment is determined by demographic variables, participation rates and the natural rate of unemployment.[16] These variables are unrelated to SA exports. In our simulations, productivity enhancing activities (including possibly extra exporting from South Australia) increase the real wage rate at which the exogenously given level of Australia-wide employment is achieved.

Although in our simulations extra SA exporting does not affect Australia-wide employment, it does affect the regional distribution of employment. SA export activities draw labour and capital into South Australia, away from the other States.

We assume that wage rates in Australia are set at the national level. Consequently, in our simulations, productivity increases in South Australia beyond those in other States give South Australia a cost advantage. This allows South Australian products to replace those from other States in national and international markets.

Capital Formation

Because we are concerned with the long run, we allow for capital reallocation effects in our simulations. For example, in simulating the effects on South Australian manufacturing of increased exports, we allow the SA manufacturing capital stock to deviate from its base case level. We assume that in the long run, average rates of return on capital over all regional sectors will be the same with and without extra SA exports. Initially, these exports may increase rates of return in SA firms. We assume that this draws capital to SA, thereby driving rates of return back towards their initial levels. We do, however, allow increased rates of return to persist in regional sectors experiencing rapid growth relative to those in industries experiencing slow growth (see footnote 10).

Demand Aggregates

With increased exports and manufacturing productivity in SA, our simulations indicate that there will be an increase in the State's capital stock. We assume that in a typical long run year, (i.e., after the shocks have been sustained for 5 or more

---

[16] The assumption that, in the long run, the national employment level is determined by population growth, labour force participation rates and the natural rate of unemployment, is the standard steady-state (i.e., long-run) assumption of most modern macroeconometric models (see Powell and Murphy, 1995).

years) investment in South Australia will deviate from the base case in line with the deviation in the State's capital stock. Similarly, for the other States, we assume that deviations in investment are in line with their capital stock deviations.

We assume that the ratio of State-government public consumption to private consumption is unchanged by our shocks. Similarly, for the Federal government, we assume that the deviation in their expenditure from the base case is in line with the Australia-wide deviation in private consumption expenditure.

To tie down the long run deviations in consumption (private and public) from their base case levels, we assume that our shocks have no long-run effects on the trade balances of Australia and of the States and Territories. That is, we assume that national and regional expansions in income are matched by national and regional expansions in absorption.

4. DETAILED RESULTS

As explained in section 3, the effects of a development package can be calculated in MMRF as a weighted sum of the effects of its components. In the present example, the components are: an increase in SA manufacturing exports; an increase in SA service exports; and an increase in SA manufacturing productivity. To understand the effects of any package consisting of these three components, all that is required is an understanding of the effects of each component separately.

4.1. The Effects of a $100 million Increase in SA Exports of Manufactured Products (Table 1)

In Table 1-part A, we see that the Australia-wide effects are negligible. By assumption, there is no effect on Australia-wide employment (row 2, column 1, Table 1-A). Because manufacturing is less capital intensive than overall productive activity, stimulation of manufacturing with fixed aggregate employment reduces the economy's capital stock (row 3, column 1, Table 1-A). This explains the slight reduction in real GDP (row 1, column 1, Table 1-A).

With Australia's trade balance held constant, additional manufacturing exports crowd-out traditional rural and mining exports. The mechanism is exchange-rate movement. Additional manufacturing exports strengthen the exchange rate, reducing the competitiveness of Australia's other export products. This explains the negative results in column 1 of Table 1-B&C for output and employment in the rural and mining sectors, and in the closely related transport sector. Output and employment in manufacturing, on the other hand, increases. The adverse competitiveness effects from the exchange rate are outweighed by the imposed increase in manufactured exports.

At the regional level, SA gains strongly from the assumed stimulation of its manufactured exports. In our deviation year (the year 2000), the base case forecast for the gross state product (GSP) of SA is $51 billion. Thus, our shock of $100 million to SA manufactured exports is worth 0.196 per cent of SA GSP. As can be seen from row 1, column 5 of Table 1-A, the application of this 0.196 per cent shock

Table 1. Effects of a $100m Increase in SA Manufacturing Exports (% Deviation from Basecase)

	Aust (1)	NSW (2)	Vic (3)	Qld (4)	SA (5)	WA (6)	Tas (7)	NT (8)	ACT (9)
A Macro Variables									
1 Real GDP, GSP	-0.001	-0.022	-0.001	-0.044	0.364	-0.110	-0.024	-0.100	0.001
2 Employment	0.000	-0.023	-0.002	-0.043	0.353	-0.108	-0.026	-0.098	0.001
3 Capital Stock	-0.004	-0.021	-0.001	-0.045	0.376	-0.115	-0.021	-0.104	0.001
B Sectoral Outputs									
1 Rural	-0.011	-0.012	-0.009	-0.020	0.070	-0.047	-0.019	-0.013	-0.008
2 Mining	-0.063	-0.065	-0.015	-0.063	0.315	-0.118	-0.095	-0.106	-0.030
3 Manufacturing	0.020	-0.022	0.002	-0.040	0.437	-0.078	-0.025	-0.047	-0.002
4 Public Utilities	0.001	-0.021	0.019	-0.044	0.325	-0.115	-0.024	-0.105	0.001
5 Construction	-0.001	-0.020	0.000	-0.043	0.364	-0.117	-0.020	-0.101	0.002
6 Domestic Trade	0.005	-0.023	-0.005	-0.045	0.479	-0.114	-0.025	-0.106	0.002
7 Transport and Communication	-0.018	-0.028	-0.009	-0.049	0.246	-0.110	-0.032	-0.110	-0.005
8 Professional Services	-0.001	-0.022	-0.002	-0.045	0.380	-0.111	-0.025	-0.100	0.000
9 Housing	0.002	-0.021	-0.001	-0.047	0.402	-0.134	-0.021	-0.123	0.002
10 Public Services	0.003	-0.011	0.000	-0.027	0.208	-0.079	-0.014	-0.080	0.001
11 Community Services	0.006	-0.020	0.000	-0.044	0.373	-0.131	-0.021	-0.115	0.001
12 Personal Services	-0.007	-0.016	0.008	-0.035	0.199	-0.108	-0.001	-0.062	-0.003
C Sectoral Employment									
1 Rural	-0.018	-0.016	-0.016	-0.028	0.070	-0.058	-0.027	-0.011	-0.012
2 Mining	-0.074	-0.075	-0.031	-0.073	0.272	-0.121	-0.101	-0.110	-0.035
3 Manufacturing	0.021	-0.022	0.002	-0.040	0.444	-0.073	-0.025	-0.041	-0.003
4 Public Utilities	0.005	-0.021	0.024	-0.045	0.309	-0.115	-0.026	-0.106	0.000
5 Construction	-0.001	-0.020	-0.001	-0.043	0.363	-0.117	-0.020	-0.101	0.001
6 Domestic Trade	0.005	-0.024	-0.005	-0.045	0.495	-0.114	-0.027	-0.107	0.002
7 Transport and Communication	-0.019	-0.030	-0.011	-0.051	0.226	-0.110	-0.035	-0.112	-0.007
8 Professional Services	-0.003	-0.022	-0.003	-0.046	0.382	-0.110	-0.027	-0.098	-0.002
9 Housing	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10 Public Services	0.002	-0.010	0.000	-0.026	0.198	-0.078	-0.014	-0.079	0.001
11 Community Services	0.005	-0.020	0.000	-0.004	0.373	-0.131	-0.021	-0.115	0.001
12 Personal Services	-0.009	-0.015	0.010	-0.033	0.153	-0.106	0.005	-0.051	-0.004

produces an increase in SA GSP of 0.364 per cent. Hence, the multiplier for the SA economy on stimulation of manufactured exports is 1.86 (=0.364/0.196).[17]

The $100 million increase in SA manufactured exports represents a 0.461 per cent increase in the sector's sales.[18] In row 3, column 5 of Table 1-B, the increase in the sector's output is only 0.437 per cent. With expansion of SA manufacturing there is, in our simulation, an increase in the user costs of manufacturing-specific capital. Put another way, our simulation allows SA manufacturing firms to respond to an increase in the demand for their products by not only increasing output, but by also increasing their profit margins. The increase in their profit margins reduces their competitiveness in domestic markets, leaving the increase in SA manufacturing output (0.437 per cent)
a little below the initial impact effect of the increase in exports.

All other SA sectors are stimulated by increases in demands for their products in the expanded SA economy. The most trade-exposed sector in the SA economy, and the one relying least on SA for absorption of its product, is rural. Consequently, this is the SA sector with least gain in output and employment from the stimulation of SA manufactured exports. The sector with the least international exposure is domestic trade (wholesale and retail trade). This is the sector with the largest percentage gains in output and employment. Domestic trade in SA is stimulated not only by increases in SA output and employment, but also by strong growth in SA's interstate and international trade.

Unlike the situation in the other States, the SA mining sector relies relatively little on international exports. Most of its production is absorbed in SA. Consequently, this sector is among those strongly stimulated by growth in the SA economy arising from additional manufactured exports.

In the rest of Table 1, we see slightly adverse effects on the other States and Territories of SA's success in manufacturing exports. These effects arise from exchange rate appreciation and loss of labour and capital to the relatively buoyant SA economy. Only the ACT, which depends almost entirely on Federal government expenditures, is shown in Table 1-A with non-negative effects on output, employment and capital. The ACT affects are, however, negligible.

---

[17] It is interesting to compare this multiplier with those obtained by West (1995, Table 6, p. 222) in five different regional modelling frameworks. Our multiplier is close to West's IOE long-term multiplier. The assumptions underlying the IOE-long-term model are similar to those made in the present application of MMRF. In both cases, the calculations refer to the effects of a sustained increase in final demand for a region's products after a sufficient elapse of time to allow factors of production to be drawn into the region and for the induced rounds of income/expenditure increases to have been fully worked out.

[18] In our typical year database, SA manufacturing sales (excluding intra-industry sales) are $21.7 billion. To some readers, this may seem high in relation to SA GSP of $51 billion. However, readers should not confuse sales with value added. Value added in SA manufacturing is only about $7.3 billion, implying that the manufacturing share in SA GSP is about 14 per cent. Sales include not only value added, but also intermediate inputs. In manufacturing industries, the value of intermediate inputs is, on average, about twice that of value added.

The States worst affected by SA manufactured exports are WA, NT and Queensland. These are the States relying most on traditional exports. The State suffering the smallest adverse effect is Victoria. This is the State with the smallest reliance on traditional exports. It is also the State with the heaviest reliance on SA for the absorption of its products.

4.2. The Effects of a $100 million Increase in SA Exports of Professional Services (Table 2)

As in the previous simulation, the Australia-wide macroeconomic effects (Table 2-A, column 1) are negligible. However, because professional services is more capital intensive than overall productive activity, the stimulation of this sector, with fixed aggregate employment, increases the economy's capital stock (row 3, column 1, Table 2-A). This gives a slight increase in real GDP (row 1, column 1, Table 2-A).

The Australia-wide sectoral effects in column 1 of Table 2-B&C are similar to those in column 1 of Table 1-B&C. The main difference is that in Table 2, professional services replaces manufacturing as a principal gaining sector. In both tables, the rural and mining sectors suffer crowding-out via exchange rate appreciation.

In column 5 of Table 2-A, we find that SA benefits strongly from stimulation of its professional service exports. As in the previous simulation, the shock ($100 million) is worth 0.196 per cent of SA GSP. This generates an eventual increase in SA GSP of 0.531 per cent, giving a multiplier on professional service exports of 2.71 (=0.531/0.196).

The multiplier on SA professional service exports is considerably higher than on SA manufactured exports. This is because SA manufactured exports rely heavily on intermediate inputs sourced from outside the State. In the production of professional services, there is comparatively little use of externally sourced intermediate inputs.

Reflecting this lack of linkage between the SA professional services industry and industries outside SA, the other States and Territories generally do worse in Table 2 than in Table 1. There is, however, one exception, the ACT. It does slightly better in Table 2 than in Table 1. This is because the slightly better Australia-wide outcome allows Federal government expenditure to be higher in Table 2 than in Table 1.

At the SA sectoral level, the results in Table 2-B&C are similar to the corresponding results in Table 1-B&C. The most obvious difference is the replacement of manufacturing with professional services as a major gaining sector.

The $100 million increase in professional-service exports represents an impact on the SA sector's sales of about 1.2 per cent. The bulk of the sector's sales are to the SA economy. With the increase in SA GSP of 0.531 per cent (row 1, column 4, Table 2-A), the professional services sector gains additional sales giving it a total increase in output of 1.521 per cent (row 8, column 5, Table 2-B).

As in Table 1-B&C, in Table 2-B&C, the trade-exposed SA rural sector gains least, while non-trade exposed sectors, such as construction, public utilities and

Table 2. Effects of a $100m Increase in SA Professional Service Exports (% Deviation from Basecase)

	Aust (1)	NSW (2)	Vic (3)	Qld (4)	SA (5)	WA (6)	Tas (7)	NT (8)	ACT (9)
A Macro Variables									
1 Real GDP, GSP	0.002	-0.029	-0.007	-0.053	0.531	-0.141	-0.030	-0.135	0.003
2 Employment	0.000	-0.030	-0.007	-0.053	0.478	-0.138	-0.032	-0.131	0.002
3 Capital Stock	0.017	-0.028	-0.007	-0.055	0.806	-0.147	-0.027	-0.140	0.005
B Sectoral Outputs									
1 Rural	-0.021	-0.026	-0.017	-0.029	0.074	-0.060	-0.029	-0.032	-0.017
2 Mining	-0.074	-0.078	-0.026	-0.075	0.558	-0.151	-0.113	-0.143	-0.033
3 Manufacturing	-0.022	-0.030	-0.007	-0.050	0.073	-0.105	-0.032	-0.078	-0.001
4 Public Utilities	0.001	-0.027	0.020	-0.054	0.436	-0.147	-0.031	-0.142	0.003
5 Construction	0.015	-0.027	-0.005	-0.052	0.692	-0.149	-0.025	-0.135	0.005
6 Domestic Trade	-0.008	-0.031	-0.011	-0.055	0.421	-0.145	-0.032	-0.142	0.005
7 Transport and Communication	-0.026	-0.034	-0.012	-0.058	0.238	-0.135	-0.037	-0.132	-0.002
8 Professional Services	0.063	-0.028	-0.006	-0.055	1.521	-0.142	-0.031	-0.133	0.003
9 Housing	0.012	-0.028	-0.006	-0.056	0.676	-0.171	-0.026	-0.166	0.005
10 Public Services	0.004	-0.014	-0.002	-0.032	0.269	-0.101	-0.018	-0.107	0.002
11 Community Services	0.008	-0.027	-0.006	-0.053	0.504	-0.167	-0.027	-0.155	0.003
12 Personal Services	-0.007	-0.020	0.009	-0.042	0.279	-0.137	0.001	-0.082	-0.002
C Sectoral Employment									
1 Rural	-0.035	-0.036	-0.028	-0.042	0.039	-0.074	-0.042	-0.041	-0.025
2 Mining	-0.090	-0.090	-0.049	-0.087	0.394	-0.156	-0.121	-0.149	-0.039
3 Manufacturing	-0.030	-0.031	-0.007	-0.049	-0.018	-0.099	-0.033	-0.072	-0.002
4 Public Utilities	0.000	-0.028	0.026	-0.055	0.321	-0.148	-0.033	-0.143	0.002
5 Construction	0.014	-0.027	-0.005	-0.052	0.684	-0.150	-0.025	-0.135	0.004
6 Domestic Trade	-0.014	-0.031	-0.012	-0.055	0.362	-0.145	-0.033	-0.143	0.005
7 Transport and Communication	-0.031	-0.035	-0.014	-0.060	0.156	-0.133	-0.039	-0.131	-0.005
8 Professional Services	0.076	-0.029	-0.006	-0.055	1.920	-0.140	-0.034	-0.130	0.001
9 Housing	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10 Public Services	0.001	-0.014	-0.002	-0.031	0.237	-0.099	-0.017	-0.107	0.002
11 Community Services	0.006	-0.027	-0.006	-0.053	0.488	-0.168	-0.027	-0.155	0.003
12 Personal Services	-0.013	-0.018	0.012	-0.038	0.147	-0.134	0.009	-0.067	-0.003

domestic trade, are major winners.

4.3. The Effects of a 1.0 per cent Improvement in Total Factor Productivity in SA Manufacturing (Table 3)

In Tables 1 and 2, the Australia-wide effects were small. An expansion in the demand for exports has little effect on GDP if it is unaccompanied by either an increase in employment or productivity. As we saw, there were minor effects on GDP due to changes in the availability of capital. In Table 3, productivity growth allows a significant increase in GDP.

In row 1, column 1 of Table 3-A, Australia's GDP increases by 0.014 per cent. In our base case forecasts for 2000, value added in SA manufacturing is about 0.8 per cent of Australia's GDP. Consequently, a one per cent improvement in total factor productivity in SA manufacturing has an impact effect on Australia's GDP of about 0.008 per cent. Thus the multiplier for the national economy on manufacturing productivity growth is 1.75 (=0.014/0.008). This multiplier arises from capital growth. In our simulation, total factor productivity growth encourages investment and thereby generates extra capital (row 3, column 1) allowing GDP expansion beyond the initial impact effect.

As in the previous two simulations, the sectoral results for Australia reflect crowding-out of rural and mining. With lower costs in manufacturing, this sector increases its exports and replaces imports, thus strengthening the exchange rate. This harms the other trade-exposed industries where there is no assumed productivity growth.

Despite strong growth in Australia's manufacturing output (row 3, column 1, Table 3-B), manufacturing employment declines (row 3, column 1, Table 3-C). The labour-saving effects of productivity growth outweigh the employment-creating effects of output expansion.

Value added in SA manufacturing is about 14 per cent of SA GSP. The impact effect on SA GSP of a one per cent improvement in total factor productivity growth in SA manufacturing is, therefore, 0.14 per cent. As can be seen from row 1, column 5 of Table 3-A, our simulation gives a GSP increase for SA of 1.016 per cent. Thus the multiplier for the SA economy on total factor productivity growth in manufacturing is 7.3 (=1.016/0.140).

It is not surprising that the SA multiplier (7.3) is larger than the Australian multiplier (1.75). This simply reflects the ability of the now relatively more efficient SA economy to attract capital and labour from the rest of Australia. However, what may seem puzzling is the large size of the SA multiplier. This reflects the smallness of the SA economy (about 7.5 per cent of Australian GDP). A one per cent productivity shock restricted to manufacturing in SA has relatively little effect on wage rates, which are nationally determined. This means that in an MMRF simulation of an improvement in SA manufacturing productivity, SA attracts capital and labour from the rest of Australia without a significant accompanying deterioration in its international competitiveness. In MMRF simulations of the effects of a one per cent productivity improvement in the manufacturing sectors of

Table 3. Effects of a 1% Improvement in Total Factor Productivity in SA Manufacturing (% Deviation from Basecase)

	Aust (1)	NSW (2)	Vic (3)	Qld (4)	SA (5)	WA (6)	Tas (7)	NT (8)	ACT (9)
A Macro Variables									
1 Real GDP, GSP	0.014	-0.077	-0.055	-0.080	1.016	-0.101	-0.072	0.265	0.012
2 Employment	0.000	-0.078	-0.057	-0.080	0.829	-0.102	-0.074	0.250	0.011
3 Capital Stock	0.013	-0.071	-0.046	-0.078	0.972	-0.098	-0.066	0.288	0.021
B Sectoral Outputs									
1 Rural	-0.006	-0.019	-0.025	-0.044	0.260	-0.040	-0.042	0.087	-0.018
2 Mining	-0.031	-0.097	-0.064	-0.088	0.888	-0.095	-0.123	0.291	-0.023
3 Manufacturing	0.024	-0.144	-0.126	-0.132	1.671	-0.156	-0.141	-0.028	-0.038
4 Public Utilities	0.014	-0.079	-0.004	-0.085	0.957	-0.109	-0.077	0.277	0.011
5 Construction	0.018	-0.067	-0.044	-0.073	0.950	-0.098	-0.058	0.282	0.016
6 Domestic Trade	0.010	-0.076	-0.056	-0.082	1.038	-0.105	-0.074	0.271	0.009
7 Transport and Communication	0.015	-0.057	-0.029	-0.063	0.816	-0.071	-0.046	0.242	0.005
8 Professional Services	0.011	-0.074	-0.038	-0.081	1.056	-0.100	-0.074	0.245	0.027
9 Housing	0.013	-0.073	-0.053	-0.080	1.041	-0.112	-0.064	0.351	0.014
10 Public Services	0.022	-0.036	-0.027	-0.044	0.556	-0.066	-0.041	0.223	0.012
11 Community Services	0.030	-0.071	-0.055	-0.077	0.951	-0.112	-0.063	0.318	0.011
12 Personal Services	0.008	-0.044	-0.007	-0.049	0.578	-0.079	0.000	0.193	-0.005
C Sectoral Employment									
1 Rural	-0.012	-0.023	-0.037	-0.062	0.293	-0.050	-0.057	0.114	-0.027
2 Mining	-0.064	-0.104	-0.088	-0.096	0.820	-0.098	-0.129	0.274	-0.030
3 Manufacturing	-0.081	-0.152	-0.135	-0.141	0.568	-0.167	-0.151	-0.066	-0.044
4 Public Utilities	0.020	-0.084	0.006	-0.092	0.944	-0.118	-0.083	0.266	0.007
5 Construction	0.018	-0.067	-0.045	-0.073	0.946	-0.099	-0.058	0.280	0.015
6 Domestic Trade	0.007	-0.077	-0.058	-0.083	1.046	-0.107	-0.076	0.266	0.007
7 Transport and Communication	0.017	-0.056	-0.028	-0.061	0.789	-0.068	-0.043	0.223	0.000
8 Professional Services	0.001	-0.077	-0.037	-0.085	1.094	-0.107	-0.080	0.209	0.029
9 Housing	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10 Public Services	0.021	-0.034	-0.026	-0.043	0.530	-0.065	-0.040	0.222	0.012
11 Community Services	0.028	-0.071	-0.056	-0.077	0.949	-0.113	-0.063	0.318	0.011
12 Personal Services	0.007	-0.039	0.002	-0.043	0.474	-0.075	0.017	0.163	-0.010

larger regions (or of Australia as a whole), increases in wage rates reduce international competitiveness, thereby reducing these regions' output expansions and their regional multipliers.

In column 5 of Table 3-B&C, all SA sectors are shown as gaining strongly from the imposed improvement in total factor productivity in SA's manufacturing sector. The SA sector with the largest percentage gain in output is manufacturing (row 3, column 5, Table 3-B). Its output gain is sufficient to generate employment growth (row 3, column 5, Table 3-C) despite the productivity increase. As in the earlier simulations, the SA sector with the smallest output gain is the trade-exposed rural sector.

Consistent with our discussion of the SA productivity multiplier, the effects of total factor productivity growth in SA manufacturing on the other States are generally small and negative. With Australia-wide employment fixed and with wage rates determined nationally, real wage rates rise in all states. Only SA has compensating productivity growth Thus, most States lose small percentages of their resources to SA. The Northern Territory, which relies comparatively heavily on SA manufactured goods, benefits from reductions in their costs. This enables NT export-oriented sectors to expand (rows 1&2, column 8, Table 3-B&C).

4.4. The Effects of SA Export/Productivity Packages (Tables 4 and 5)

In Table 4 we present the effects of an $80 million increase in SA manufactured exports combined with a $20 million increase in SA exports of professional services. An 80:20 split is typical of the composition of the additional exports associated with projects considered by the South Australia government. The figures in Table 4 were calculated by adding 0.80 times Table 1 to 0.20 times Table 2.

Given the 80 to 20 weighting on Table 1 relative to Table 2, the results in Table 4 are close to those in Table 1. However, relative to the pure manufacturing case (Table 1), the results for the mixed manufacturing/ professional services case (Table 4) are a little more favourable to the SA economy. In Table 4, the increases in SA GSP and employment are 0.397 and 0.378 per cent whereas in Table 1 they are 0.364 and 0.353 per cent. As explained in section 4.2, professional-service exports have a higher multiplier effect for SA than exports of manufactures.

In Table 5, we continue to assume that there are increases of $80 million in SA manufactured exports and $20 million in SA professional-service exports. We also assume that this extra export activity improves total factor productivity in SA manufacturing by 0.11 per cent. Thus, we calculate Table 5 by adding 0.11 times Table 3 to Table 4.

We chose 0.11 after a little experimentation. With this value, we find in Table 5, that the percentage improvement in total factor productivity is 0.2 times the percentage increase in SA manufacturing output (0.537 per cent, see row 3, column 5, Table 5-B). We think that 0.2 times the increase in manufacturing output is a reasonable upper bound on the likely gain in SA manufacturing productivity arising from export stimulation. We base this on evidence from the literature on scale economies. For broad sectors, estimates from this literature would not support our

Table 4. Effects of an $80m Increase in SA Manufacturing Exports and a $20m Increase in SA Professional Service Exports (% Deviation from Basecase)

	Aust (1)	NSW (2)	Vic (3)	Qld (4)	SA (5)	WA (6)	Tas (7)	NT (8)	ACT (9)
A Macro Variables									
1 Real GDP, GSP	-0.001	-0.024	-0.003	-0.045	0.397	-0.116	-0.025	-0.107	0.001
2 Employment	0.000	-0.024	-0.003	-0.045	0.378	-0.114	-0.027	-0.104	0.001
3 Capital Stock	0.001	-0.022	-0.002	-0.047	0.462	-0.121	-0.022	-0.111	0.002
B Sectoral Outputs									
1 Rural	-0.013	-0.014	-0.011	-0.022	0.071	-0.049	-0.021	-0.017	-0.010
2 Mining	-0.065	-0.068	-0.017	-0.065	0.364	-0.124	-0.099	-0.113	-0.031
3 Manufacturing	0.012	-0.023	0.000	-0.042	0.364	-0.083	-0.026	-0.053	-0.002
4 Public Utilities	0.001	-0.002	0.019	-0.046	0.347	-0.121	-0.025	-0.112	0.002
5 Construction	0.002	-0.021	-0.001	-0.045	0.429	-0.123	-0.021	-0.108	0.002
6 Domestic Trade	0.002	-0.025	-0.006	-0.047	0.467	-0.120	-0.027	-0.114	0.003
7 Transport and Communication	-0.019	-0.029	-0.010	-0.051	0.244	-0.115	-0.033	-0.114	-0.004
8 Professional Services	0.012	-0.023	-0.003	-0.047	0.608	-0.118	-0.026	-0.106	0.001
9 Housing	0.004	-0.023	-0.002	-0.049	0.457	-0.142	-0.022	-0.132	0.003
10 Public Services	0.003	-0.012	0.000	-0.028	0.220	-0.084	-0.015	-0.085	0.001
11 Community Services	0.006	-0.022	-0.002	-0.045	0.399	-0.138	-0.022	-0.123	0.002
12 Personal Services	-0.007	-0.017	0.008	-0.036	0.215	-0.114	0.000	-0.066	-0.003
C Sectoral Employment									
1 Rural	-0.021	-0.020	-0.018	-0.031	0.064	-0.061	-0.030	-0.017	-0.015
2 Mining	-0.077	-0.078	-0.035	-0.076	0.297	-0.128	-0.105	-0.118	-0.036
3 Manufacturing	0.011	-0.024	0.000	-0.041	0.352	-0.078	-0.027	-0.047	-0.003
4 Public Utilities	0.004	-0.023	0.024	-0.047	0.311	-0.122	-0.027	-0.113	0.001
5 Construction	0.002	-0.022	-0.002	-0.045	0.427	-0.124	-0.021	-0.108	0.002
6 Domestic Trade	0.001	-0.025	-0.007	-0.047	0.468	-0.120	-0.028	-0.114	0.003
7 Transport and Communication	-0.021	-0.031	-0.011	-0.053	0.212	-0.115	-0.036	-0.115	-0.006
8 Professional Services	0.012	-0.024	-0.003	-0.048	0.689	-0.116	-0.028	-0.104	-0.002
9 Housing	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10 Public Services	0.002	-0.011	0.000	-0.027	0.206	-0.082	-0.015	-0.085	0.001
11 Community Services	0.006	-0.022	-0.002	-0.045	0.396	-0.139	-0.022	-0.123	0.002
12 Personal Services	-0.010	-0.016	0.010	-0.034	0.152	-0.112	0.006	-0.054	-0.004

Table 5. Effects of an $80m Increase in SA Manufacturing Exports, a $20m Increase in SA Professional Service Exports and a 0.11% Increase in Total Factor Productivity in SA Manufacturing (% Deviation from Basecase)

	Aust (1)	NSW (2)	Vic (3)	Qld (4)	SA (5)	WA (6)	Tas (7)	NT (8)	ACT (9)
A Macro Variables									
1 Real GDP, GSP	0.001	-0.032	-0.008	-0.054	0.506	-0.127	-0.033	-0.079	0.003
2 Employment	0.000	-0.032	-0.009	-0.054	0.467	-0.125	-0.035	-0.077	0.002
3 Capital Stock	0.002	-0.030	-0.007	-0.056	0.566	-0.132	-0.029	-0.080	0.004
B Sectoral Outputs									
1 Rural	-0.014	-0.016	-0.013	-0.027	0.099	-0.053	-0.026	-0.008	-0.012
2 Mining	-0.068	-0.078	-0.024	-0.075	0.459	-0.134	-0.112	-0.082	-0.033
3 Manufacturing	0.014	-0.039	-0.013	-0.056	0.537	-0.100	-0.041	-0.056	-0.006
4 Public Utilities	0.003	-0.030	0.018	-0.055	0.450	-0.133	-0.034	-0.083	0.003
5 Construction	0.004	-0.029	-0.006	-0.053	0.531	-0.134	-0.027	-0.077	0.004
6 Domestic Trade	0.003	-0.033	-0.012	-0.056	0.578	-0.131	-0.035	-0.084	0.004
7 Transport and Communication	-0.018	-0.035	-0.013	-0.058	0.331	-0.123	-0.038	-0.088	-0.004
8 Professional Services	0.013	-0.031	-0.007	-0.056	0.721	-0.128	-0.034	-0.080	0.003
9 Housing	0.005	-0.030	-0.007	-0.057	0.568	-0.154	-0.029	-0.094	0.004
10 Public Services	0.006	-0.015	-0.003	-0.032	0.280	-0.091	-0.019	-0.061	0.003
11 Community Services	0.010	-0.029	-0.007	-0.054	0.501	-0.150	-0.029	-0.089	0.003
12 Personal Services	-0.006	-0.022	0.007	-0.042	0.277	-0.122	0.000	-0.045	-0.003
C Sectoral Employment									
1 Rural	-0.022	-0.022	-0.022	-0.037	0.095	-0.066	-0.036	-0.005	-0.018
2 Mining	-0.084	-0.089	-0.044	-0.086	0.385	-0.138	-0.119	-0.088	-0.039
3 Manufacturing	0.002	-0.040	-0.014	-0.057	0.412	-0.096	-0.043	-0.054	-0.007
4 Public Utilities	0.007	-0.032	0.025	-0.057	0.412	-0.134	-0.036	-0.084	0.002
5 Construction	0.004	-0.029	-0.006	-0.053	0.528	-0.134	-0.027	-0.078	0.004
6 Domestic Trade	0.002	-0.034	-0.013	-0.056	0.580	-0.131	-0.036	-0.086	0.004
7 Transport and Communication	-0.020	-0.037	-0.014	-0.059	0.297	-0.122	-0.040	-0.092	-0.006
8 Professional Services	0.013	-0.032	-0.007	-0.057	0.807	-0.127	-0.037	-0.082	0.001
9 Housing	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10 Public Services	0.004	-0.015	-0.003	-0.031	0.262	-0.089	-0.019	-0.061	0.003
11 Community Services	0.009	-0.029	-0.007	-0.054	0.498	-0.151	-0.029	-0.089	0.003
12 Personal Services	-0.009	-0.020	0.011	-0.038	0.203	-0.120	0.008	-0.037	-0.005

use of a number higher than 0.2.[19]

As noted in section 4.3., total factor productivity growth in SA manufacturing has very beneficial effects on the SA economy. In Table 5, with the productivity increase set at 0.11 per cent, the SA GSP and employment deviations associated with additional exports of $100 million are 0.506 and 0.467 per cent. In Table 4, without the productivity increase, these deviations were 0.397 and 0.378 per cent. Because, in Table 4, output and employment in all SA sectors are increased by productivity improvements in manufacturing, all output and employment results for SA sectors are higher in Table 5 than in Table 4.

5. CONCLUDING REMARKS

Economic models such as MMRF are complex. Most users of analyses based on an economic model do not have the time or inclination to understand in any depth the model's equations or database. Controversial assumptions contained in the equations and database often have a crucial influence on results derived from a model. Results may also depend on simplifications made by the analyst in trying to mould the issue at hand into a form suitable for model simulation.

In these circumstances, it is incumbent on analysts presenting model results to put considerable effort into explaining them. They have an obligation to identify the mechanisms of their model and the components of its database which play the key roles in determining their conclusions. Only by providing full explanations can analysts give their clients the opportunity to make informed decisions as to how model-based conclusions should be used.

In this paper we have provided an explanation of MMRF results on the effects of a $100 million expansion of SA exports, composed of manufactures and professional services. We have identified the roles of critical elements in our database, e.g., the size of the SA manufacturing sector in relation to the SA economy; the size of the SA economy in relation to the Australian economy; the linkages between the SA manufacturing sector and the rest of Australia; and the trade-exposure of different sectors. We have also identified critical mechanisms in our model (e.g., crowding-out effects associated with exchange rate movements) and listed what we believe are our most controversial assumptions (e.g., that additional SA export activities will not affect Australia-wide employment). Finally, by providing component tables (Tables 1 to 3), we have given readers considerable scope for conducting their own sensitivity analyses. For example, readers can generate new results based on different assumptions concerning the size and composition of the additional exports from SA and the cost-reducing effects of agglomeration.

Among the results generated by us, the most striking are (i) that SA experiences an increase in its GSP far greater than the initial impacts of export and productivity changes (i.e., SA experiences large positive multipliers) and, (ii) that extra growth in SA has negative effects on growth in the other States.

---

[19] See for example, Pratten (1989).

A key assumption underlying the first of these results is that SA can meet increased export demands without cost increases. As mentioned in the introduction, the original purpose of our study was to assist the SA government in assessing proposals from multinational corporations. Specifically, we were concerned with responses to the SA government's call for proposals from multinational corporations to operate Adelaide's water and sewerage system while, at the same time, sourcing inputs (e.g., equipment and design services) from SA for use in their operations in the rest of the world. Because multinational corporations face no barriers to sourcing inputs from SA, our initial suspicion was that *extra* exports from SA would be achieved only via cross-subsidisation. We suspected that in their proposals multinational corporations would quote higher charges for running Adelaide's water services than they would have in the absence of the requirement to generate exports. Thus, our initial inclination was to include an allowance for increased SA water costs in our simulations of the effects of increased SA exports. The inclusion of such cost increases would have reduced the simulated benefits to SA of the government's policy of linking export performance with the provision of water services.

However, the multinational corporation which made the successful proposal assured the SA government that extra exports would be achieved without cross-subsidisation. This corporation conducted a survey of SA engineering and design firms, and concluded that SA was capable of producing a range of inputs for the corporation's overseas operations at costs no higher than those of current suppliers. Although this survey was extensive and detailed, the cost of conducting it was negligible in comparison with the costs of providing Adelaide's water services. Given the results of the survey and the relative smallness of its costs, our suspicions of cross-subsidisation were allayed and we felt justified in simulating export increases without increases in water costs.

A possible interpretation of the SA government's export-linking policy is as an effective approach to overcoming a market failure caused by inadequacy of corporate awareness of the potential performance of SA industry. An alternative response to such information deficiencies is to rely on publicly funded export-marketing organizations. The SA government's strategy has the advantage of encouraging prospective corporate customers for SA products to seek their own information. We think that self-generated information is likely to be more influential in corporate purchasing decisions than information provided by a public authority. However, research well beyond the scope of this paper would be required to assess the advantages of the SA approach to stimulating exports relative to other possibilities.

Our second main result (that other States experience losses from expansion in the SA economy) raises the possibility of retaliation. In our simulations, we neglected this possibility and assumed that the policies of other States are independent of those of South Australia. This assumption is probably justified by the smallness of the SA economy and the consequent smallness of the impact of SA policies on the rest of Australia. In future studies using MMRF, it may be possible to build in reaction functions which relate each State's policies to those of other States. The inclusion of such functions might be important in simulating export-promotion policies by the larger States.

REFERENCES

Armstrong, H. and Taylor, J. (1993) *Regional Economics and Policy.* Harvester Wheatsheaf: New York.

Bureau of Industry Economics (1994) *Regional Development: Patterns and Policy Implications.* AGPS: Canberra.

Crowe, M. (1995) An application of the MONASH multi-regional model: the economic impacts of improving the productivity of government trading enterprises (GTEs) in New South Wales. A paper presented to the *24th Conference of Economists*: Adelaide, 30 pp.

Dixon, P.B. and McDonald, D. (1992) Creating 1990-91 input-output tables for Australia by ORANI simulations. A paper presented at the *16th Annual Conference of the Australian and New Zealand Regional Science Association*, Ballarat University College: December.

Dixon, P.B. and Parmenter, B.R. (1996) Computable general equilibrium modelling for policy analysis and forecasting. Chapter 1 in H. Amman, D. Kendrick and J. Rust (eds.), *Handbook of Computational Economics.* North-Holland: Amsterdam, (forthcoming).

Dixon, P.B., Parmenter, B.R., Sutton, J. and Vincent, D.P. (1982) *ORANI: A Multisectoral Model of the Australian Economy*. North-Holland: Amsterdam.

Han, S.H. (1992) A multi-regional input-output data base for the Australian economy 1986-87. *COPS Discussion paper No. D161*, Centre of Policy Studies. Monash University: Clayton, 60 pp.

Han, S.H. and Peter, M.W. (1994) A thirteen-sector aggregation of the 1990/91 MONASH input/output table. *COPS and IMPACT Project Research Memorandum No. 94-03*. Monash University: Clayton 28 pp.

Harrigan, F. and McGregor, P. (1988) Price and quantity interaction in regional economic models: the importance of "openness" and "closures". *London Papers in Regional Science*, (19), pp. 178-207.

Harris, R.G. and Cox, D. (1983) *Trade, Industrial Policy and Canadian Manufacturing*. Ontario Economic Council: Ontario.

Harrison, J., and Pearson, K. (1994) Computing solutions for large scale general equilibrium models using GEMPACK. *COPS and IMPACT Project Preliminary Working Paper No. IP-64*. Monash University: Clayton, 55 pp.

Horridge, J.M. (1987) *The Long-term Costs of Protection: Experimental Analysis with Different Closures of an Australian Computable General Equilibrium Model*. Ph.D. Thesis. Melbourne University: Melbourne.

Kenderes, M. (1995) Updating of the ORANI database to 1989-90. *ORANI Research Memorandum No. OA-634*. Industry Commission: Canberra.

Ko, S. and G. Hewings (1986) A regional computable general equilibrium model for Korea. *Korean Journal of Regional Science*, (2) pp. 45-57.

Liew, L. (1981) *A Multi-regional, Multi-sectoral General Equilibrium Model of the Australian Economy.* Ph.D. thesis. Monash University: Clayton, Victoria.

Madden, J. (1990) *FEDERAL: A Two-Region Mulitsectoral Model of the Australian Economy*, Ph.D. thesis. University of Tasmania: Hobart.

Madden, J. (1995) Implementing the Hilmer reforms: the effects on the national and State economies, *Business Council Bulletin,* Competition Policy Supplement, pp. 14-24.

Meagher, G.A. and. Parmenter, B.R (1993) MONASH-MR: A multiregional CGE model of Australia. A paper presented to the *Workshop on Transportation and Spatial CGE Models*: Venice, 24 pp.

Mutti, J., Morgan, W. and Partridge, M. (1989) The incidence of regional taxes in a general equilibrium framework. *Journal of Public Economics*, 39, pp. 83-107.

Naqvi, F. and Peter, M.W. (1995) Notes on the implementation of MONASH-MRF: a multiregional model of Australia. *Centre of Policy Studies and Impact Project Working Paper No. OP-82.* Monash University: Clayton, i+14+A58 pp.

Nijkamp, P., Rietveld, P. and Snickers, F. (1986) Regional and multiregional models: a survey. Chapter 7 in P. Nijkamp (ed) *Handbook of Regional and Urban Economics*, *Vol. 1.* North Holland: Amsterdam.

Norman, V.D. (1990) A comparison of alternative approaches to CGE modeling with imperfect competition. *European Economic Review*, 34(4), pp. 725-751.

Pearson, K. (1991) Solving nonlinear economic models accurately via a linear representation. *IMPACT Project Working Paper No. IP-55*, 39 pp.

Peter, M.W. (1994) A report on the development of MONASH-MRF: a multiregional CGE model of the Australian economy. A paper presented at the *CSIRO International Seminar on Transportation and Policy in a Network and Price Equilibrium Framework.* Highett, 26 pp.

Powell, A.A. and Murphy, C.W. (1995) *Inside a Modern Macroeconometric Model.* Springer-Verlag: Heidelberg.

Pratten, C. (1989) A survey of the economies of scale. Chapter 2 in Commission of the European Communities, *Research on the Costs of Non-Europe. Basic Findings. Vol. 2.* Luxembourg.

Press, W.H., Flannery, B.P., Teukolsky, S.A. and Vetterling, W.T. (1986) *Numerical Recipes: The Art of Scientific Computing.* Cambridge University Press.

Quinlan, H. (1991) *Australia's Domestic Freight, 1986-87.* Centre for Transportation Policy Analysis. Wollongong University: Wollongong.

Richardson, H.W. and Townroe, P.M. (1986) Regional policies in developing countries. Chapter 16 in P. Nijkamp (ed) *Handbook of Regional and Urban Economics*, *Vol. 1.* North Holland: Amsterdam.

West, Guy, R. (1994) Queensland state impact and projection model: the household sector. *Economic Systems Research*, 6(4), pp. 363-383.

West, Guy, R. (1995) Comparison of input-output, input-output+econometric and computable general equilibrium models at the regional level. *Economic Systems Research*, 7(2), pp. 209-227.

Wigle, R. (1992) Transportation costs in regional models of foreign trade: an application to Canada-U.S. trade. *Journal of Regional Science,* 32, pp. 185-207.