THE EFFECTS OF MINING EXPANSION ON REGIONAL ECONOMIES IN AUSTRALIA

Glyn Wittwer
South Australian Centre for Economic Studies, Adelaide and Flinders Universities, Adelaide, SA, Australia

Melissa Bright[1]
South Australian Centre for Economic Studies, Adelaide and Flinders Universities, Adelaide, SA, Australia

ABSTRACT The performance of the South Australian economy over the past decade has suffered in comparison with the rest of Australia. Analysts have attributed this to a number of causes. These include difficulties in adjusting away from heavily protected manufacturing with tariff reform, the State Bank collapse and the relatively low growth in tourism. The State's heavy reliance on the agricultural sector during some difficult times on world markets exacerbated the problems. This paper analyses the effect that the mining boom in Western Australia had on the economic performance of the South Australian economy. Projections from a computable general equilibrium model of the South Australian and Australian economies, FEDERAL-SA, indicate that the mining boom may have accounted for a significant proportion of the net migration out of South Australia over the past decade. The investment and operational phases of one recently announced mining project this.

1. INTRODUCTION

South Australia's contribution to national GDP declined from 8.1 per cent in 1985 to 7.4 per cent in 1995 (ABS, 1996a). Analysts have attributed this relative decline of the South Australian economy to a number of causes. The State had a significant share of the nation's formerly heavily protected manufacturing industries and tariff and quota reforms may have affected the output and employment of these industries. In addition, the State Bank collapse has damaged confidence in the State's economy and tourism growth appears to have been lower than in the rest of Australia. The State's total exports are also heavily reliant on the agricultural sector which has faced some difficult times on world markets

Our premise is that one important factor has been overlooked in the

---

1 The authors wish to acknowledge the helpful comments of two anonymous referees as well as Per Fredriksson, University of Adelaide, and Doug Young, South Australian Centre for Economic Studies, on earlier versions of the paper. The authors are indebted to Mines and Energy South for background information. Sallie James provided invaluable assistance compiling data.

performance of the South Australian economy in this period. Falling mining output in the state combined with a mining boom in Western Australia might have been a significant factor. Mining's contribution to Western Australia's gross state product (GSP) increased from 10.5 per cent in 1984-85 to 15.3 per cent in 1994-95. In this time, the State's share of national GDP increased from 9.4 per cent to 10.5 per cent (ABS, 1996a). Its relative rapid economic growth contrasts with that of South Australia. Within a general equilibrium framework, rapid economic growth in one region may slow down economic growth in other regions, as discussed in subsequent sections of this paper. South Australia is just one of the states or territories that may have been adversely affected by the mining boom in Western Australia (Figure 1).

South Australia's mining sector appears proportionally smaller than that of all other regions except New South Wales and the A.C.T. (ABS, 1996a). Mining accounts for about 2 per cent of the State's GSP, with downstream processing of mining products accounting for a further 3 per cent of GSP (ABS, 1996b). Nationally, mining's gross product comprised 4.2 per cent of GDP in 1995-96 (ABS, 1996a).

This paper uses a computable general equilibrium (CGE) model, FEDERAL-SA, to examine three different scenarios concerning the mining industry. FEDERAL-SA includes two regions, South Australia and a composite region covering the rest of Australia, of which Western Australia is a sub-region. A historical scenario examines the effects that Western Australia's mining expansion in the decade 1985 to 1995 had on the South Australian economy. A second scenario projects the economy-wide effects of the construction phase of a proposed expansion to the existing mine at Olympic Dam. This massive ore body containing copper, uranium and gold is located in outback South Australia, approximately 500 kilometres north of Adelaide. A final scenario projects the effects of the operational phase of the Olympic Dam expansion.

2. SOUTH AUSTRALIA'S MINING SECTOR IN THE DECADE TO 1995

South Australia's mining sector shrank in real terms from 1985 to 1995 (Table 1). There was an increase in production of non-ferrous metal ores in this time due to production commencing at Olympic Dam in 1988. This was, however, more than offset by a decline in quantity of crude oil and other products extracted from Cooper Basin in the far north of the State. Output fell by around 40 per cent in the decade to 1995, while real prices declined (Mines and Energy South Australia, 1996a; ABARE, 1996). This was due to resource depletion associated with low levels of exploration. The decline in the value of output of crude oil and other energy minerals accounts for most of the decline in South Australia's mining output since the mid-1980s.

Rapid mining growth in Western Australia may also have contributed to a decline in mining in South Australia. Initially, the geology of mineral deposits in Western Australia played a part in the growth of the State's mining sector in the

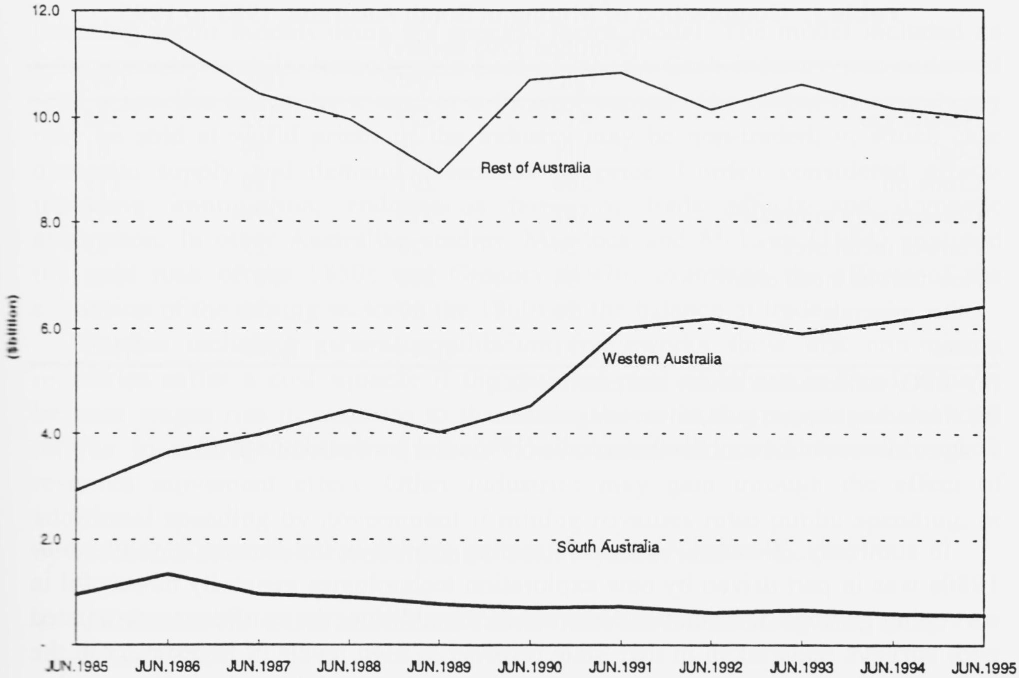

Figure 1. Gross Mining Product, 1995-96 dollars
Source: ABS (1996) Catalogue 5220.0

mid-1980s.[2] Notably, rocky outcrops tend to mark locations where airborne surveys indicated promising deposits. This contrasts with South Australia, for example, where deep sedimentary covers mask mineral deposits. Consequently, mining companies in Western Australia proceeded with drilling and mine construction on the basis of geomagnetic surveys, confident that surveys indicated viable finds. Hence, the technology used to discover ore bodies in Western Australia in the 1980s was not readily applicable in other regions of Australia. The notable exception in South Australia was Olympic Dam (Mines and Energy South Australia, 1996b).[3]

Because of the high costs and long lags associated with developing a mine, many companies have opted to explore for deposits and construct mines in regions where other mines are already established. In remote areas, the existing infrastructure may contribute to substantial economies of scale. Such agglomerations of mining activity have resulted in rapid growth of the sector in Western Australia.

---

2 Mines and Energy South Australia provided this information.

3 Geologists acted on a theory that significant copper deposits were to be found west of the Flinders Ranges in South Australia. Drilling in 1975 near Olympic Dam revealed significant copper deposits at a depth of 350 metres. Further drilling revealed a massive low grade ore body (Morgan, 1996). Political considerations, resulting from the presence of uranium in the ore body, delayed until 1988 the first shipment from the mine.

Table 1. Composition of Mining in South Australia, 1985 to 1995
($ million 1995 dollars)

	1985	1990	1992	1995
Natural gas	417	427	392	345
Coal	111	76	89	61
Crude oil	566	291	189	119
Other energy minerals[(a)]	582	219	274	195
Ferrous metal ores	26	28	23	25
Non-ferrous metal ores[(b)]	34	206	307	342
Other minerals	36	37	32	39
Total	1,771	1,284	1,305	1,126

(a) LPG, condensates, ethane and caroline CO_2
(b) Including copper, gold, silver and uranium.
Source: Mines and Energy South Australia (1996a and previous issues).

In summary, Western Australia's mining growth in the decade from the mid-1980s was in part driven by new exploration technologies generally not useful in surveying geological formations elsewhere. In addition, the confidence associated with surveys undertaken in that State resulted in high levels of investment in the industry, diverting productive resources from other activities, including mining interstate, with resulting economies of scale in Western Australia. This is an example of cumulative causation (discussed in Armstrong and Taylor, 1993), with rapid growth in mining in Western Australia and a decline in mining output in the rest of the nation in real dollar terms.

3. PREVIOUS STUDIES OF THE IMPACT OF MINING ON THE AUSTRALIAN ECONOMY

Blainey (1993) undertook a systematic study of the history of Australian mining. The study emphasised the role of mining in the nation's economic development. For example, the profits of mining companies played an important role in founding a number of manufacturing industries in Australia. The fourth edition of this study covers the changes that occurred in the industry between the early 1970s and the early 1990s. These include tapping of natural gas on the North-West Shelf, the discovery and establishment of the Olympic Dam field, the revival of gold mining, particularly in Western Australia, and the return of the mining industry to the prominent role it held in the economy at the turn of the century.[4]

The distribution of gains and losses from mining booms has been the subject of previous general equilibrium studies. Corden (1984) consolidated the studies of

[4] Butlin (1962) estimates that mining's share of Australia's GDP was 4.2 per cent in 1890, but grew steadily in the following years to 9.8 per cent by 1900 (table 269). In 1963, mining's share of GDP was only 1.8 per cent. It peaked in 1986 at 5.3 per cent (ABS, 1996).

booming sector models using the specific-factor model. The model included an intersectorally mobile, homogenous pool of labour. Each industry was endowed with a specific factor, be it land or a form of capital. The output of an industry may be sold at world prices or the industry may be non-traded, in which case domestic supply and demand determine its price. Corden considered effects including immigration, endogenous terms of trade effects and domestic absorption. In other Australian studies, Maddock and McLean (1984) analysed the gold rush of the 1850s and Gregory (1976) examined the effects of the expansion of the mining sector in the 1960s on the balance of trade.

Studies including general equilibrium frameworks show that non-mining industries suffer a cost squeeze if the national pool of labour is fixed. This is because wages rise in response to the mining boom as mining output and total returns to mining increase. Further, non-booming industries lose through a resource movement effect. Other industries may gain through the effect of additional spending by government if mining royalties raise public spending, or by additional household consumption if such royalties lead to tax cuts.

4. THE USE OF CGE MODELS TO ANALYSE BOOMING SECTOR EFFECTS

Since Corden's work, economists have increasingly used CGE models to compare the effects of particular shocks with a base case scenario. Dixon *et al.* (1982) used ORANI, the single region multisectoral model of the Australian economy, to examine the effects of a mining boom between the mid-1960s and mid-1970s. In addition, they simulated movements in world commodity prices to depict the increase in raw material prices between 1968 and 1975 relative to manufacturing prices.

CGE models allow analysts to predict more about the overall impact that technological changes in one group of industries in mining, for example, may have on industries in other sectors, namely manufacturing, agriculture and services. Such models take account of the differing cost structures of individual industries. The Corden analysis, for example, assumes that industries use only primary factors in production. CGE models also include intermediate input usage and primary factors are substitutable in response to changes in factor price ratios. These additions to the model tend to spread the effects of a particular shock widely across other industries.

What if changes at the regional level as well as the national level are of interest to the modeller? CGE modellers have used two different approaches to analyse the impacts of economic shocks on regions. This first is the 'top down' approach. ORANI, the first large-scale CGE model of the Australian economy, contained a regional equation system (Dixon, *et al.*, 1982). This entails the use of a single national database, while capturing regional effects on the basis of exogenous regional shares. This restricts the ability of the modeller to depict region-specific shocks.

This paper discusses the application of FEDERAL-SA, a 'bottoms-up' two-region model, to analyse the effects across regions and sectors of technological gains in the mining sector in Australia.[5] The 'bottom-up' approach uses separate databases and separate equations for different regions in the model. This allows each region to have a particular structure in a given industry. Each region also has its own pattern of sales, rather than being constrained by an exogenous share of the national total as in a 'tops-down' model. The databases are linked by inter-regional trade flows while the theory of the model captures changes in flows between regions. The two regions within FEDERAL-SA are South Australia and a composite region comprising of the rest of Australia (Madden, 1990; Wittwer and Bright, 1996).[6] Other regional models include other versions of FEDERAL (Madden, 1990) and MONASH-MRF, developed by the Centre of Policy Studies (Naqvi and Peter, 1995). MONASH-MRF contains a greater regional disaggregation of the Australian economy than the FEDERAL models, with an eight region model of the Australian economy.

Both regions in this version of FEDERAL-SA include 65 industries, each producing a single commodity. Sixty five capital creators produce units of capital for each industry in a single region. Therefore the model includes 130 industries, 130 commodities and 130 types of capital. Each region has a single consumer and a regional government. In addition, the model includes the Commonwealth government. The rest of the world is exogenous. Export demand curves depict the demands of foreigners for the outputs of each region, while foreign supply curves apply to the imports of each region.

In each of the three scenarios discussed in this paper, it is assumed that labour is exogenous at the national level, but that it moves between regions in response to regional differences in economic outcomes. This accords with available evidence that wage differentials (Figure 2) and unemployment differentials (Figure 3) have varied little between regions since 1985. State or territory shares of the national population, however, have changed significantly in this period. For example, Western Australia's share of the national population grew from 9.0 per cent in 1985 to 9.6 per cent in 1995, while South Australia's share shrunk in the corresponding period from 8.7 per cent to 8.2 per cent (ABS, 1996c). Interstate migration has been the main cause of change. Over this period, around 2,400 people annually have moved interstate from South Australia, although in both 1994 and 1995 migration was in excess of 5,000 (ABS 1996d).

The modelling results presented here entail comparative-static analysis. The first and third scenarios involve a long-run setting in which capital stocks adjust to equalise rates of return across all industries. In the second scenario, depicting the construction phase of the planned Olympic Dam expansion, capital stocks are exogenous and rates of return endogenous, but the labour market setting is the same as in the other scenarios.

---

[5] Clements, *et al.* (1996) analyse the regional boom in Western Australia using a single region CGE model of the Western Australian economy.

[6] Wittwer (1997) outlines the compilation of the database of FEDERAL-SA.

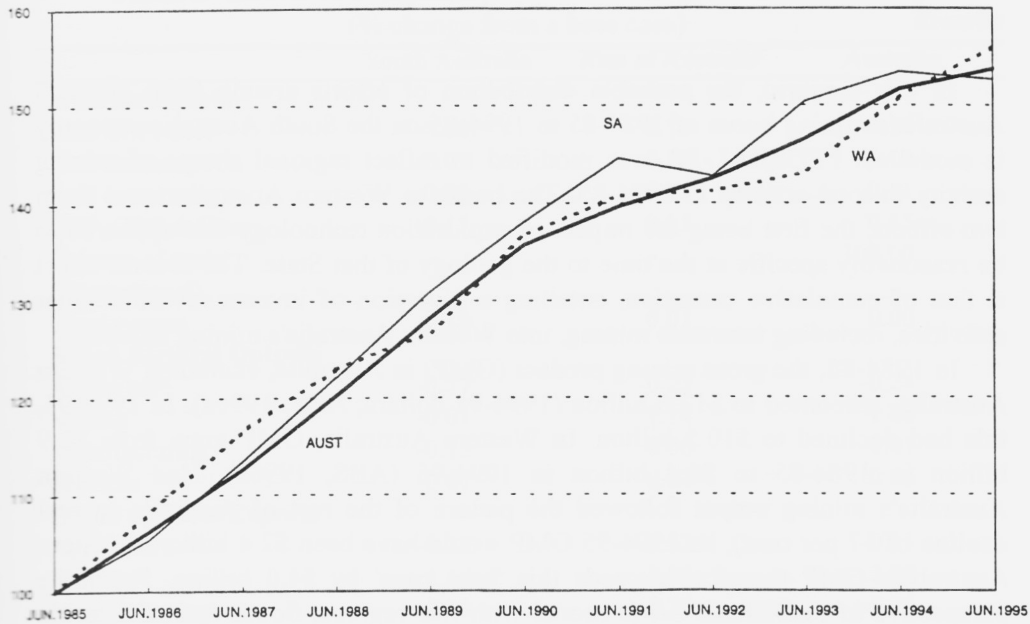

Figure 2. Index of Average Weekly Earnings for South Australia, Western Australia and Australia, 1985 = 100

Source: ABS (1996) Catalogue 6302.0

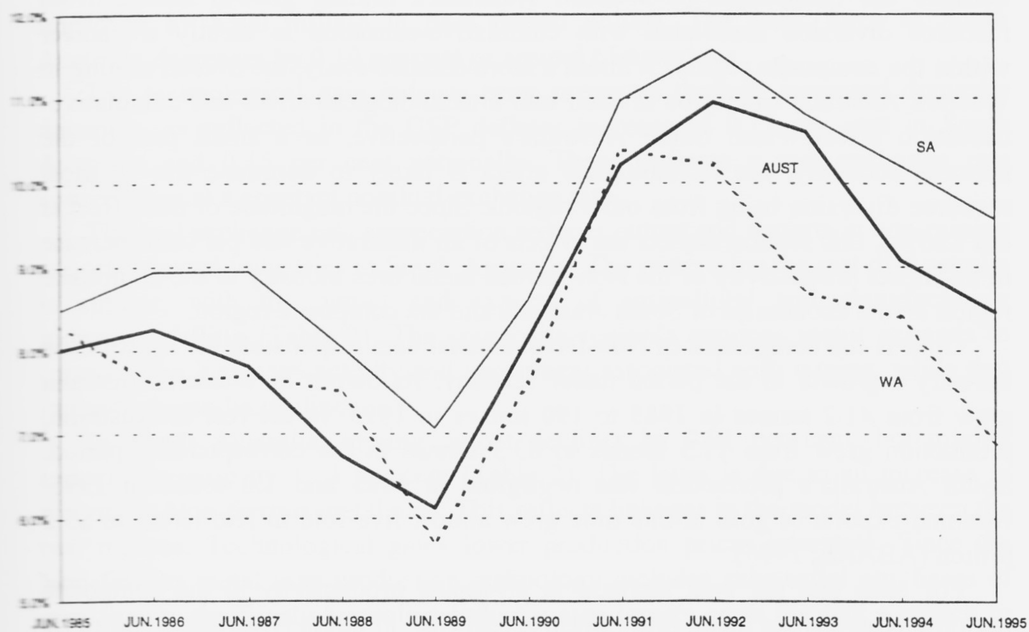

Figure 3. Unemployment Rate

Source: ABS (1996) Catalogue 6202.0

Scenario 1: The Impact of An Illustrative Region-specific Technological Growth

In this scenario, the probable distribution of effects arising from Western Australia's mining boom of 1984-85 to 1994-95 on the South Australia economy is modelled. FEDERAL-SA was modified to reflect regional shares of mining activity in total activity in 1984-85. The boom in Western Australia arose from two effects, the first being the impact of exploration technology that appeared to be reasonably specific at the time to the geology of that State. The second effect is that of cumulative causation, entailing a diversion of investment from other activities, including interstate mining, into Western Australia's mining industry.

In 1984-85, the gross mining product (GMP) in Australia, excluding Western Australia, amounted to $12.6 billion (1994-95 dollars; ABS, 1996a). In 1994-95, this had declined to $10.5 billion. In Western Australia, GMP grew from $2.9 billion in 1984-85 to $6.4 billion in 1994-95 (ABS, 1996a). Had Western Australia's mining output followed the pattern of the rest of Australia (a real decline of 17 per cent), its 1994-95 GMP would have been $2.4 billion. Western Australia's GMP therefore exceeds this 'base case' by $4.0 billion. From the perspective of FEDERAL-SA (a model with two regions; South Australia and a composite region of which Western Australia is a sub-region), mining growth in the composite region exceeded the base case by $4.4 billion or 32 per cent during the period between 1984-85 and 1994-95.

By ignoring the cumulative-causation effect, the difference between actual and 'base case' mining growth in the composite region is exaggerated. This is because the component of Western Australia's mining growth arising from resource diversion associated with cumulative-causation is mostly a transfer within the composite region. Without a more detailed study, the overall mining in Western Australia cannot be divided into a technological effect and cumulative-causation effect. From South Australia's perspective, as a small part of the national economy, the technological effect is likely to dominate due to most resource diversion being from other regions. Since the magnitude of this effect is not known, this section depicts the effects of an illustrative one per cent increase in all-inputs productivity of the Non-ferrous metal ores industry in the composite region on the economies of South Australia and the composite region.

Gold is the component of Non-ferrous metal ores responsible for most of the industry's growth in the period under scrutiny. Its output in Western Australia grew from 41.2 tonnes in 1985 to 190 tonnes in 1995. In the rest of Australia, production grew from 17.3 tonnes to 63.3 tonnes in the corresponding period. South Australia's production was negligible in 1985 and 1.0 tonne in 1995. National exports of gold in this time grew almost five-fold in real terms to $5.2 billion (ABARE, 1996).

For each one per cent increase in all-inputs productivity in the composite region's Non-ferrous metal ores industry, real GSP in South Australia declines by 0.08 per cent ($25 million) (Table 2). Conversely, there is an increase in national real GDP of 0.11 per cent ($450 million). Real consumption and investment both

Table 2. Effects of a Region-Specific Technological Gain in Mining (% change from a base case)

	South Australia	Rest of Australia	Australia
Macroeconomic			
Real GSP, GDP	-0.08	0.11	0.10
Real consumption	-0.05	0.12	0.10
Real investment	-0.05	0.11	0.11
GSP, GDP deflator	0.17	0.15	0.15
Balance of trade (international)	-	-	300.00
Employment	-0.10	0.01	0.00
Broad Sectoral Outputs			
Agriculture	-0.27	-0.23	-0.24
Mining	-0.01	1.14	1.06
Manufacturing	-0.15	0.00	-0.01
Services	-0.07	0.07	0.06
Broad Sectoral Exports			
Agriculture	-0.23	-0.32	-0.31
Mining	1.14	2.93	2.90
Manufacturing	0.00	-0.25	-0.23
Services	0.07	0.00	0.00

Source: FEDERAL-SA projections.

decrease by 0.05 per cent in South Australia, and increase by 0.12 per cent and 0.11 per cent respectively in the composite region. The national balance of trade improves by $300 million in base period dollars. The work force in South Australia decreases by 0.10 per cent or around 650 workers.

The technological gain induces price pressures through increased domestic demands, as reflected in the GSP deflator increase of 0.17 per cent in South Australia and 0.15 per cent nationally. These indicate a real exchange rate appreciation at a constant nominal exchange rate.

The real exchange rate appreciation reduces output and exports in non-mining export-oriented industries in South Australia. The pattern for the rest of Australia is similar, with the output and exports of agricultural and manufacturing industries falling (Table 2). The composite region's services sector expands to cater for the increased activity and investment associated with mining, while that in South Australia declines.

In South Australia, mining output declines by 0.01 per cent, but mining exports increase by 1.14 per cent (Table 2). The latter is due to an increase in activity in Non-ferrous metal ores. This reflects linkages in the model between the two regions. Technological gains lower production prices interstate. Since the Non-ferrous metal ores production technology includes substantial purchases of own inputs, the South Australian industry also lowers costs through a switch to interstate purchases. This allows the industry to increases its output. This appears to be an artefact of commodity classification that might only be resolved by further disaggregation of the model beyond the standard national classification published by ABS in its input-output tables. Despite the cumulative-causation effect not being modelled in the historical scenario, the projection using FEDERAL-SA indicates that a part of the state's declining fortunes over the past decade appear to have been a consequence of the mining boom in Western Australia.

Scenario 2: The Effects of the Construction Phase of the Olympic Dam Expansion[7]

At the time the expansion to the Olympic Dam mine site was announced in July 1996, annual extraction included 85 kt of copper ore and 1.5 kt of uranium ore. This scenario models the economic impacts of expanding the capacity of the Olympic Dam site to extract and refine 200 kt of copper ore and 3.7 kt or uranium ore.

The proposed average annual expenditure at the Olympic Dam site is $590 million over a period of up to two and a half years. In a two-region or multi-regional model, construction phases tend to follow a zero-sum game. Essentially, a level of construction that is above a region's usual share of investment activity is modelled. The region where additional activity takes place experiences increases in real income and employment. Other regions lose out because construction activity in a CGE framework entails a diversion of resources from other activities, while the effect nationally approximates zero.

The closure used approximates a medium run of two to five years. Capital stocks do not adjust in this time to equalise rates of return across all industries. As in the long-run setting of the historical simulations, the labour market adjusts through interstate migration rather than changes in regional unemployment levels.

At the macroeconomic level, the investment phase draws labour into South Australia. The state's work force increased for the duration of construction by 0.26 per cent or around 1,750 workers (Table 3), of which 1,300 jobs are created directly. Real GSP in South Australia increases by 0.39 per cent, or about $130 million, with negligible change in real GDP at the national level. South Australia's real GSP gain is smaller than the proposed annual expenditure, representing mainly the direct value-added component of this.

The construction phase benefits the South Australian economy through the direct investment expenditure with the services sector gains occurring through additional non-residential construction. Indirectly, the additional places in the work force provide some stimulus to housing, so that residential construction also increases. Export-oriented industries in agriculture, mining and manufacturing lose slightly from the real exchange rate effect associated with the additional demands of construction.

---

7 The second and third modelling scenarios draw on a study undertaken by the authors for an environmental impact statement prepared for the Olympic Dam project.

Table 3. Effects of the Construction Phase of the Olympic Dam Expansion (% change from a base case)

	South Australia	Rest of Australia	Australia
Macroeconomic			
Real GSP, GDP	0.39	-0.03	0.00
Real consumption	0.14	0.04	0.05
Real investment	3.23	0.20	0.44
GSP, GDP deflator	0.61	0.44	0.45
Balance of trade (international)	-	-	-326.00
Employment	0.26	-0.02	0.00
Broad Sectoral Outputs			
Agriculture	-0.43	-0.30	-0.31
Mining	-0.34	-0.23	-0.24
Manufacturing	-0.07	-0.07	-0.07
Services	0.23	0.02	0.04
Broad Sectoral Exports			
Agriculture	-0.64	-0.53	-0.54
Mining	-0.65	-0.35	-0.36
Manufacturing	-0.98	-0.71	-0.73
Services	0.00	0.00	0.00

Source: FEDERAL-SA projections.

Table 4. Effects of the Operational Phase of the Olympic Dam Expansion (% change from a base case)

	South Australia	Rest of Australia	Australia
Macroeconomic			
Real GSP, GDP	0.37	0.06	0.08
Real consumption	0.33	0.07	0.09
Real investment	0.58	0.06	0.10
GSP, GDP deflator	0.12	0.17	0.16
Balance of trade (international)	-	-	96.00
Employment	0.17	-0.01	0.00
Broad Sectoral Outputs			
Agriculture	-0.26	-0.26	-0.26
Mining	2.43	-0.55	-0.30
Manufacturing	0.64	0.19	0.23
Services	0.22	0.04	0.05
Broad Sectoral Exports			
Agriculture	-0.46	-0.73	-0.73
Mining	3.21	-0.41	0.01
Manufacturing	1.94	1.31	1.37
Services	0.00	0.00	0.00

Source: FEDERAL-SA projections.

Scenario 3: The Operational Phase of Olympic Dam

The extension to Olympic Dam will be operating at planned capacity by 2001. Information provided by the industry was used to model the operational phase. This phase directly affects the output of two industries, Non-ferrous metal ores and Non-ferrous metal products. The mining operation at Olympic Dam includes processing that will require additional water and electricity inputs.

With the expanded mine fully operational, South Australia's real GSP increases by 0.37 per cent ($120 million), with an increase of 0.06 per cent ($250 million) interstate. National real GDP increases by 0.08 per cent ($370 million) and the balance of trade improves by $96 million (Table 4). The total impact on the work force is smaller than that of the construction phase. The operational phase will employ 200 workers directly, compared with 1000 during construction. FEDERAL-SA projects total net migration into South Australia of 0.17 per cent of the State's existing workforce, equivalent to 1,100 workers.

At the sectoral level, agriculture loses slightly in both regions through the real appreciation effect. While the output and exports of mining in South Australia increase, the sector experiences losses interstate. The impacts of an expanded Olympic Dam are modelled in isolation, without taking account of projects interstate that may increase mining output. The operational phase induces an increase in demand for services in South Australia (Table 4).

The outputs of most South Australian industries increase. Some lose through the real exchange rate appreciation, as in agriculture, whilst others gain either through the population inflow or the increased demands arising from increased production of Non-ferrous metal ores and Non-ferrous metal products. The Coal, oil and gas industry provides a key input into electricity and experiences an increase in output due to the increased electricity requirements of the operational phase (Table 5). It must be noted that the constant-cost assumption of the model overstates the actual resource cost of electricity as Olympic Dam, due to its constant demand, is certain to utilise off-peak electricity. Total usage at the site will increase from 40 MW to 140 MW. The increased demand is approximately equal to the capacity of a cogeneration plant at Port Adelaide that is entering the interstate electricity grid. To the extent that the resource cost of electricity is overstated in the model, the output and export gains at the industry level plus real GSP and GDP gains will be understated.

Apart from possibly overstating the resource costs of additional electricity demands, the model does not consider the possibility that the infrastructure associated with Olympic Dam, including a water pipeline and roads, could lower the development costs of relatively adjacent potential mine sites. Mines and Energy South Australia commenced an exploration initiative in 1992 that has produced high-resolution geomagnetic surveys of the Gawler Craton, a large geological formation to the west of Olympic Dam. There is considerable optimism that the Gawler Craton could be the source of a mining boom in South Australia. If this did eventuate, the infrastructure associated with Olympic Dam may lower the costs of further developments in the vicinity.

Table 5. Industry Level Effects of the Operational Phase of the Olympic Dam Expansion

Industry: South Australia	Output	Producer price	Export volume (overseas)	Capital stock	Employment
Non-ferrous metal ores	14.5	-9.7	22.3	3.1	3.0
Coal, oil & gas	1.4	0.2	-2.7	1.4	1.4
Non-ferrous metal products	25.1	-15.4	46.5	14.6	14.6
Electricity	4.5	0.2	0.0	4.5	4.5

Source: FEDERAL-SA projections.

5. SUMMARY

Given the structure of South Australia's economy, increased mining activity in the decade to 1995 in Western Australia has adversely affected the state's performance. This is due to the impact of a real exchange rate appreciation on South Australia's export-oriented industries. In addition, a cumulative-causation effect appears to have shifted resources from other regions into Western Australia.

The construction phase of the Olympic Dam expansion will yield significant benefits for South Australia, with a negligible effect nationally. The modelling indicates that this phase, which will employ more than 1,000 workers directly, will increase South Australia's employment by at least 1,750.

While the operational phase of the project will employ only 200 people directly, the projected increase in employment in South Australia will be 1,100 in the long term. The output and employment benefits of this phase will be spread widely over industries other than Non-ferrous metal ores and Non-ferrous metal products, notably in the services sector. The Olympic Dam project may also contribute to lower development costs for other potential mines in the region.

REFERENCES

Australian Bureau of Agricultural and Resource Economics (1995) *Australian Commodity Statistics*. Canberra.

Australian Bureau of Statistics (1996a) *Australian National Accounts: State Accounts*. Catalogue No. 5220.0, Australian Government Publishing Service: Canberra.

Australian Bureau of Statistics (1996b) *Manufacturing Industry, South Australia*. Catalogue No. 8221.4, Australian Government Publishing Service: Canberra.

Australian Bureau of Statistics (1996c) *Australian Demographic Statistics*. Catalogue No. 3101.0, Australian Government Publishing Service: Canberra.

Australian Bureau of Statistics (1996d) *Migration, Australia*. Catalogue No. 3412.0, Australian Government Publishing Service: Canberra.

Armstrong, H. and Taylor, J. (1993) *Regional Economics and Policy*. Harvester

Wheatsheaf: New York.

Blainey, G. (1993) *The Rush That Never Ended, A History of Australian Mining* (4th edition). Melbourne University Press: Melbourne.

Butlin, N. (1962) *Australian Domestic Product, Investment and Foreign Borrowing 1861 - 1938/39*. University Press: Cambridge.

Clements, K., Ahammad, H. and Qiang, Y. (1996) *The Economics and New Mining and Mineral-Processing Projects in WA*. Economic Research Centre, Department of Economics, The University of Western Australia, November.

Corden, W. (1984) Booming sector and Dutch Disease economics: survey and consolidation. *Oxford Economic Papers*, 36(3), pp. 359-380.

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

Dixon, P. and Peter, M. (1996) Export-led growth of a regional economy: a CGE analysis of a South Australian project. *Australasian Journal of Regional Studies*, 2(1), pp. 11-34.

Gregory, R. (1976) Some implications of the growth of the mineral sector. *Australian Journal of Agricultural Economics*, 20(3), pp. 71-91.

Industry Commission (1993) *Impediments to Regional Industry Adjustment*. Report No. 35. Australian Government Publishing Service: Canberra.

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

Madden, J. (1990) *FEDERAL: A Two-region Multisectoral Fiscal Model of the Australian Economy*. Ph.D. thesis, University of Tasmania.

Maddock, R. and McLean, I. (1984) Supply-side shocks: the case of Australian gold. *Journal of Economic History*, 44(4), pp. 1047-67.

Mines and Energy South Australia (1996a) *Annual Report*. Mines and Energy South Australia: Adelaide.

Mines and Energy South Australia (1996b) South Australian exploration initiative. *MESA Journal*, 1, pp. 5-8, March.

Morgan, H. (1996) Mineral development in South Australia: a tale of two metals. Luncheon address at the Trends Business Lunch, Adelaide, July 15.

Naqvi, F. and Peter, M. (1995) Notes on the Implementation of MONASH-MRF. *Working Paper No. OP-82*, Centre of Policy Studies, Monash University, April.

Naqvi, F. (1996) A multiregional, multisectoral model of the Australian economy with an illustrative application. *Australian Economic Papers,* 35(66), pp. 94-113.

Wittwer, G. and Bright, M. (1996) FEDERAL-SA: CGE model of the South Australian and Australian economies. *Working paper*, South Australia Centre for Economic Studies and the Centre for Regional Economic Analysis, October.

Wittwer, G. (1997) Calibrating intra-domestic substitution elasticities in a multiregional model of the Australian economy. *Working paper*, South Australian Centre for Economic Studies, April.