ANNEXURE 6 – REPORT OF ACCESS ECONOMICS

ACCESS ECONOMICS Pty Limited

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Commercial-in-Confidence

Report by Access Economics Pty Limited for

Rio Tinto

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1. INTRODUCTION

Access Economics was commissioned by Rio Tinto Iron Ore to undertake applied computable general equilibrium (CGE) modelling analysis of a number of scenarios that resulted in reductions in iron ore exports from Western Australia. The aim was to assess the impacts of a specified reduction in iron ore exports on key macroeconomic variables including gross domestic and state product, the value of overall exports from Australia and Western Australia, the impact on the output from other sectors in the economy and the impact on employment.

The model used is a variant of Access Economics' in-house CGE model called AE-RGEM. This model identifies the Western Australia economy explicitly, and was extended for the purposes of this study to include a representation of the iron ore sector. The model and the analytical framework are set out in section 2.

In conducting the type of assessment set out here it is necessary to construct both a reference case – a description of what the world, the Australian and the Western Australian economies would have looked like in the absence of the policy shocks modelled – and a set of policy scenarios that describe the impacts that are required to be assessed. A description of the reference case is set out in section 3. The reference case iron ore prices and iron ore production and trade projections by country were provided to Access Economics by Port Jackson Partners. These data were taken as model input without change.

The specifications of the policy scenarios were provided to Access Economics by Port Jackson Partners and are set out in section 4. The results of the analysis are presented in section 5.

2. ANALYTICAL FRAMEWORK

The quantitative analysis undertaken in this report is based on Access Economics' in house general equilibrium model called AE-RGEM (Access Economics Regional General Equilibrium Model). General equilibrium models like AE-RGEM are a widely accepted tool for estimating the direct and indirect impacts of large-scale changes in economic conditions, such as the emergence of supply constraints, at the economy-wide level.

AE-RGEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as GDP (or GSP at the State level), employment, export volumes, investment and private consumption that are estimated to arise from a given policy change. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The model is based on Access Economics' more general model of the global economy that only details national regions, that is, AE-GEM. AE-RGEM replaces the treatment of Australia as a single region with multiple regions representing the States and Territories. As such, each Australian sub-region is treated as a separate economy but operates within national constraints.

BASE DATA

The base data of the model is derived from the Global Trade Analysis Project (GTAP)[1], which is based in Purdue University in the United States. GTAP produces a global database for general equilibrium modelling used by over 700 researchers worldwide. The database produced by the GTAP describes bilateral trade patterns, production, consumption and intermediate use of commodities and services and it represents the most detailed and comprehensive database of its type in the world. The Australian component of the database is provided by the Productivity Commission, and is based on Australian input-output tables produced by the Australian Bureau of Statistics.

The model is primarily based on input-output or social accounting matrices, as a means of describing how economies are linked through production, consumption, trade and investment flows. The model incorporates:

- Direct linkages between industries and countries through purchases and sales of each other's goods and services.
- Indirect linkages through mechanisms such as the collective competition for available resources, such as labour, that operates in an economy-wide or global context.

AE-RGEM is based on Version 6.0 of the GTAP database. This has a 2001 base year covering 87 countries and 57 industry sectors. Not all regions and sectors are relevant to this study, so the database is aggregated to the 23 sectors and 19 countries/regions shown in Table 1. The Australian economy is split into Western Australia and the Rest of Australia.

[1] Key references are: Hertel, T.W. (1997) *The Global Trade Analysis: Modeling and Applications;* Dimaranan, B.V. and McDougall, R.A (2005) *Global Trade, Assistance and Production: The GTAP 6 Data Base* and **www.gtap.agecon.purdue.edu**.

AE-RGEM uses the 2000-01 input-output, state and national accounts data from the ABS to calibrate the State-based components of the model. Consistent with the national accounts, the model is commodity or industry based rather than being a firm level model. That is, the commodities and industries represent state-wide aggregates, or the accumulation of individual firms, rather than firm specific data. In other words, a production function is specified for each sector, rather than representing each or any particular firm's operations in detail.

In the original GTAP database iron ore is aggregated into the sector 'Other minerals'. For the purposes of this study iron ore is specified as a separate industry. Further data are sourced from the MMRF-NRA model used by the Productivity Commission in the *National Reform Agenda* report.[2]

TABLE 1: SECTORS AND REGIONS IN AE-RGEM

Number	Sectors	Number	Regions
1	Primary and processed agriculture	1	Western Australia
2	Coal	2	Rest of Australia
3	Oil	3	China (incl. Hong Kong)
4	Gas	4	Japan
5	Iron ore	5	South Korea
6	Other minerals	6	Taiwan
7	Light manufacturing	7	India
8	Petroleum and coal products	8	Rest of Asia
9	Chemicals, rubber and plastics	9	Canada
10	Other non-metallic mineral products	10	United States
11	Iron and steel	11	Venezuela
12	Non-ferrous metals	12	Brazil
13	Fabricated metal products	13	Rest of South America
14	Motor vehicles and parts	14	European Union
15	Other transport equipment	15	Russian Federation
16	Other machinery and equipment	16	Rest of the Former Soviet Union
17	Other manufacturing	17	South Africa
18	Electricity[a]	18	Rest of Africa
19	Gas and water	19	Rest of the World
20	Construction		
21	Sea and air transport		
22	Road and rail transport		
23	Other services		

[a] Electricity is generated using brown coal, black coal, gas, oil-fired, nuclear, hydropower and other renewables.

DYNAMICS

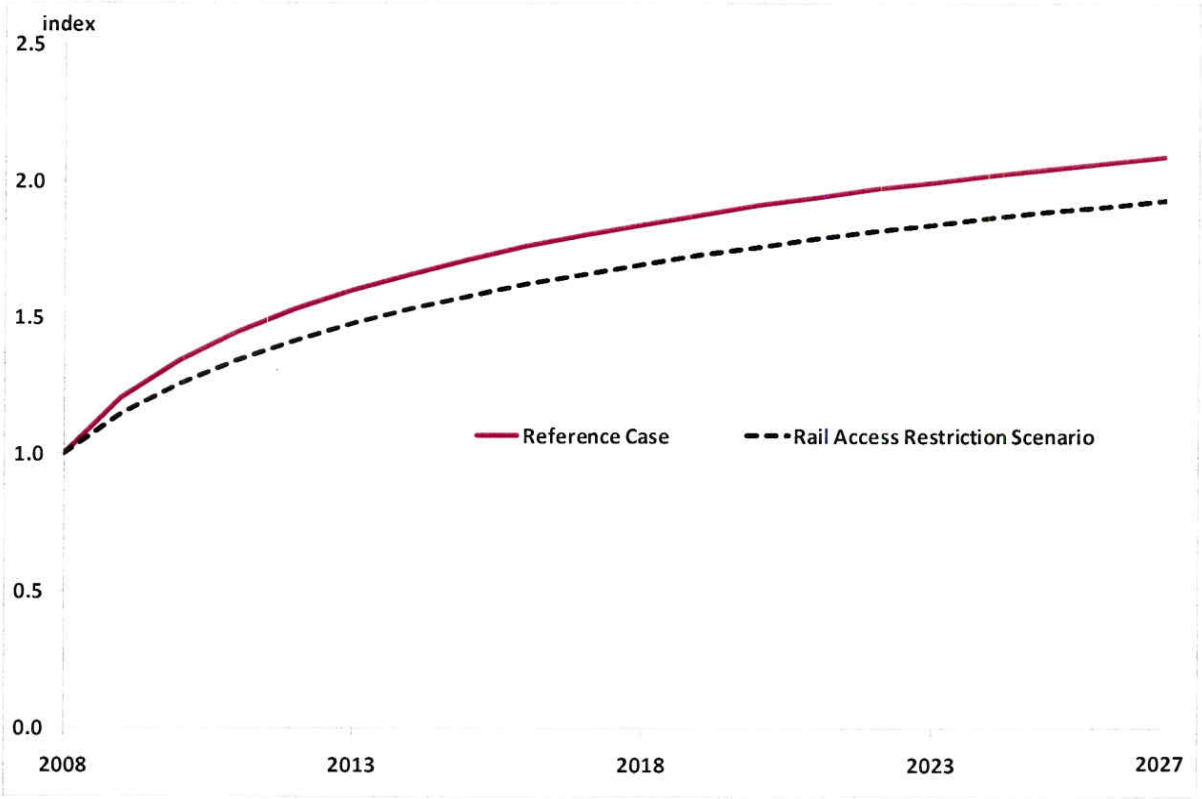
AE-RGEM is a recursive dynamic model that solves year-on-year over a specified timeframe. The model is then used to project the relationship between variables under different scenarios, over a predefined period. The first step in any analysis is to generate a reference

[2] Productivity Commission, 2006, Supplement to *Potential Benefits of the National Reform Agenda*, Productivity Commission Research Paper, December, Canberra.

case. The reference case represents the model projections assuming that all policies remain at their current setting. For example, for the purpose of the analysis conducted here it is assumed that rail access is not a factor that inhibits iron ore exports in the reference case. For the purposes of the chosen policy case the impact of rail access on exports is then determined by comparing the output from the model for the reference case with that for the policy case. This is illustrated conceptually in Figure 1. The model is solved year-by-year from time 0, which reflects the base year of the model (2001), to a predetermined end year (in this case 2027).

The variable represented on the vertical axis of Figure 1 could be one of the hundreds of thousands represented in the model ranging from macroeconomic indicators such as real GDP to sectoral variables such as the exports of iron ore. In the figure, the percentage changes in the variables have been converted to an index (= 1.0 in 2008) and are projected to increase by 2027. The differences between the reference case and policy intervention scenario are tracked over the entire timeframe of the simulation and the impact of the modelled policy intervention can be assessed at any point in time or for the entire projection period.

FIGURE 1: DYNAMIC SIMULATION USING AE-RGEM



3. REFERENCE CASE PROJECTIONS

As described above, AE-RGEM requires a reference case projection against which to compare the various scenarios representing the loss of iron ore sales on the export market. The reference case scenario is based on a set of input assumptions made about:

- economic growth;
- population and employment growth; and
- developments in the iron ore market.

In terms of the input assumptions, the reference case runs over the period 2001 to 2027.

Key macroeconomic assumptions are shown in Table 2, including assumed regional output growth, population and employment growth. These are consistent with Access Economics' March 2007 Business Outlook publication.

TABLE 2: KEY MACROECONOMIC REFERENCE CASE INPUT ASSUMPTIONS (AVERAGE ANNUAL GROWTH, 2008-2027)

Region	Regional output	Population	Employment
	%	%	%
Western Australia	3.73	1.57	1.06
Rest of Australia	3.08	1.18	0.56
Australia	3.17	1.22	0.61
China (incl. Hong Kong)	5.19	0.46	0.30
Japan	0.92	-0.34	-0.87
South Korea	3.94	0.28	0.23
Taiwan	3.76	0.28	0.31
India	6.00	1.12	1.44
Rest of Asia	5.01	1.25	1.64
Canada	2.65	0.72	0.37
United States	2.71	0.82	0.43
Venezuela	2.54	1.19	1.66
Brazil	3.34	1.04	1.15
Rest of South America	3.49	1.01	1.32
European Union	2.08	0.07	0.14
Russian Federation	2.99	-0.26	-1.32
Rest of the former Soviet Union	4.55	-0.21	0.27
South Africa	1.74	-1.07	-0.58
Rest of Africa	5.24	1.78	2.01
Rest of the World	3.82	1.56	1.58

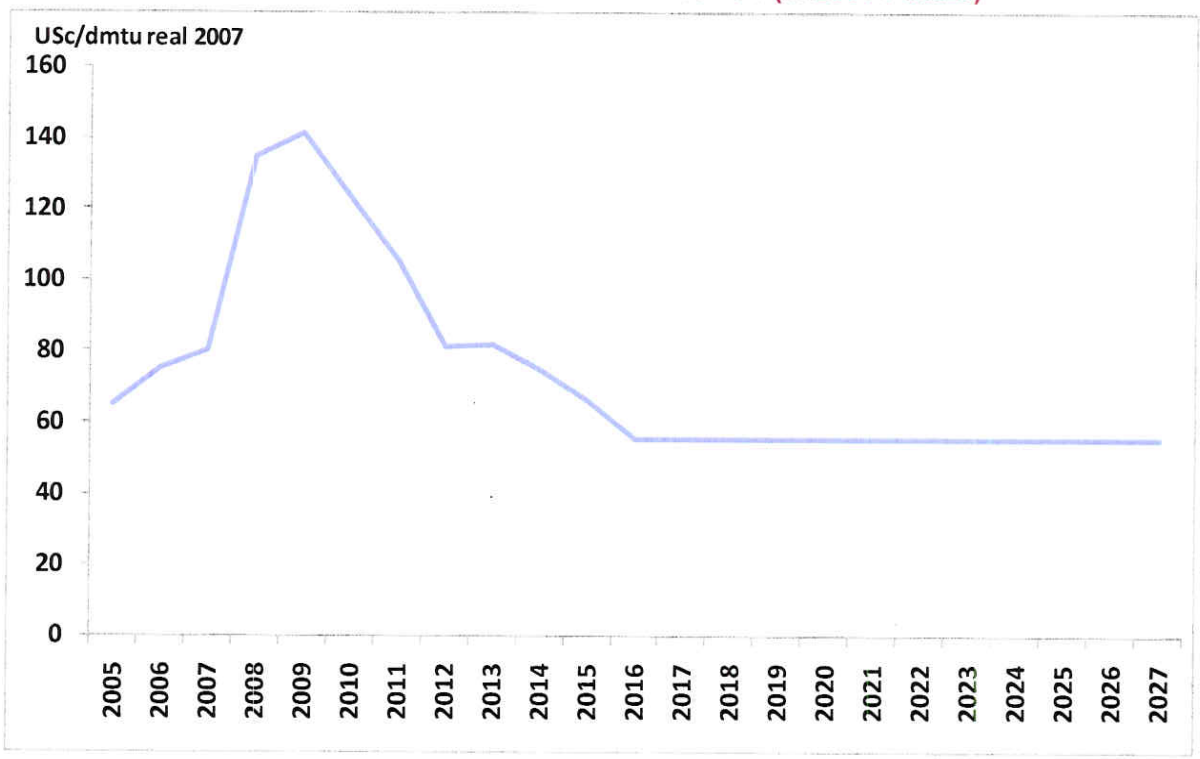
Source: Access Economics forecasts

3.1.1 KEY ASSUMPTIONS ABOUT THE IRON ORE MARKET

In terms of the key assumptions for this modelling, the first is the world iron ore price assumptions provided by Port Jackson Partners, summarised in Figure 2. These prices have

been assumed to prevail in the global iron ore market over the reference case period, and are maintained in each scenario. Reference case production of iron ore is also set to be consistent with that used in the Port Jackson Partners' modelling (discussed below). The projections of iron ore production, consumption and trade by country/region for the reference case were produced in collaboration by Port Jackson Partners and were adopted in the modelling without change.

FIGURE 2: PRICE ON IRON ORE PRODUCTION (IN 2007 PRICES)



Source: Port Jackson Partners

4. SCENARIO DESIGN

In this study, four alternative scenarios are considered as discussed above. The specifications of these scenarios were supplied by Port Jackson Partners and have been implemented without change.

The base policy scenarios are designed to illustrate the impact on exports of iron ore by Rio Tinto as a consequence of delays to expansion resulting from delays 'occasioned as a result of the multi-user status of its rail facilities'.[3] In addition to assessing the impact of delays on exports an additional scenario (2B) was designed to illustrate the impact of delays in development together with the impact of a loss in efficiency in operating the railway system itself.

The policy scenarios are set out below.

- Scenario 1: Every 2-year expansion takes 3.5 years to complete; third parties in Australia capture 20 per cent of Rio Tinto's loss of exports while the remainder is captured by Brazil.[4]
- Scenario 2A: Every 2-year expansion takes 3 years to complete; third parties in Australia capture 20 per cent of Rio Tinto's loss of exports while the remainder is captured by Brazil.
- Scenario 2B: Same assumptions as scenario 2A together with the additional impact of a 15 per cent efficiency loss in the operation of the rail system. For the additional loss in exports 20 per cent is captured by third parties in Australia and the remainder is captured by Brazil.
- Scenario 3: Every 2-year expansion takes 2.5 years to complete; third parties in Australia capture 20 per cent of Rio Tinto's loss of exports while the remainder is captured by Brazil.
- Scenario 4: Same assumptions as scenario 3 on effects of delay; third parties in Australia capture 50 per cent Rio Tinto's loss of exports and the remainder is captured by Brazil.

The export assumptions for Rio Tinto are summarised in Table 3. Each scenario assumes a reduction in iron ore exports from Western Australia, based on a reduction in Rio Tinto's production ranging from 20 to 43 per cent. The scenarios assume that Rio Tinto's exports fall, with third party producers in Australia capturing a proportion of this loss as outlined above. The reductions in iron ore output represented by each scenario have no impact on world prices because it is assumed that Brazilian producers anticipate the fall in Australian output and increase their own production to offset the reduction in Australian exports, thus holding world supply at reference case levels. For the purpose of the analysis it is assumed that aggregate global demand for iron ore does not vary from reference case levels and therefore iron ore prices follow the same path in each policy scenario as that set for the reference case.

[3] Port Jackson Partners (2008), 'Economic evaluation of the impact of lost iron ore production and share', Submission to the National Competition Council.

[4] For the purposes of the modelling it was assumed that any exports lost to Australia would be supplied by Brazil. For the purposes of calculating the impacts on Australia it will make no material difference which competitor gains the displaced tonnes.

TABLE 3: RIO TINTO EXPORTS OF IRON ORE NET OF AUSTRALIAN THIRD PARTY CAPTURE (MT)

Year	Reference case	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3	Scenario 4
2008	201.0	189.0	191.4	167.2	195.4	197.5
2009	210.0	194.9	198.0	172.5	203.0	205.6
2010	224.0	204.1	208.3	180.7	214.7	218.2
2011	253.0	223.2	229.5	197.7	239.1	244.3
2012	299.0	253.4	263.3	224.7	277.7	285.7
2013	320.0	267.2	278.7	236.5	295.4	304.6
2014	341.0	281.0	294.1	248.8	313.0	323.5
2015	355.0	290.2	304.3	257.2	324.8	336.1
2016	369.0	299.4	314.6	265.2	336.5	348.7
2017	385.0	309.9	326.3	274.4	350.0	363.1
2018	399.0	319.1	336.6	282.9	361.7	375.7
2019	412.0	327.7	346.1	290.4	372.6	387.4
2020	426.0	336.9	356.4	298.4	384.4	400.0
2021	439.0	345.4	365.9	306.0	395.3	411.7
2022	452.0	353.9	375.5	313.6	406.2	423.4
2023	467.0	363.8	386.5	322.6	418.8	436.9
2024	481.0	373.0	396.7	331.0	430.6	449.5
2025	498.0	384.2	409.2	340.7	444.9	464.8
2026	512.0	393.4	419.5	348.8	456.6	477.4
2027	526.0	402.6	429.7	357.5	468.4	490.0

Source: Port Jackson Partners

5. RESULTS

An economic cost is imposed on Western Australia, and Australia broadly, under each policy scenario. Table 4 shows the net present value of the projected loss in Western Australian real GSP and real exports over the period 2008 to 2027 (in 2008 dollars using a 7 per cent real discount rate). The projected size of the economic impacts is directly related to the assumed reduction in iron ore exports. For example, Scenario 1 assumes an 18 month delay in every two year expansion or a 43 per cent reduction in output, which is projected to reduce Western Australia real GSP by just under $17 billion over the period compared with what it otherwise would have been.

The largest economic impact is projected for Scenario 2B.

The economic impacts on Australia as a whole are slightly higher than those projected for Western Australia. For example, under Scenario 1 the net present value of the projected loss in Australian GDP is just under $17.5 billion. This is mainly due to the fact that a decline in activity in Western Australia has adverse impacts on producers in the eastern States who supply goods and services to the Western Australia market. This results in a reduction in demand for inter-state exports from the eastern States to Western Australia, lowering economic activity.

The projected impacts on Australian exports are similar to that projected for Western Australia, albeit slightly lower. This is because the reduction in activity in Western Australia results in a movement of labour to the eastern States. This also reduces the growth in wages in the eastern States which adversely affects consumption, and is another contributing factor to the decline in Australian output. This is discussed in more detail below.

The projected reduction in real exports is significantly higher than the real GSP impacts. For example, under Scenario 1 the $17 billion reduction in real GSP is accompanied by a $23 billion reduction in real exports in net present value terms compared with what would have occurred otherwise. This is because the reduction in exports is accompanied by a reallocation of resources out of the iron ore sector, into other sectors of the economy which produce lower returns at the margin. This is discussed in more detail below.

TABLE 4: NET PRESENT VALUE OF THE LOSS OF GSP/GDP AND EXPORTS FOR THE PERIOD 2008 TO 2027 (RELATIVE TO REFERENCE CASE) (IN 2008 DOLLARS)

Indicator	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3	Scenario 4
West Australia					
Real GSP (A$million)	-16,930	-13,384	-28,877	-8,088	-5,042
Real exports (A$million)	-23,014	-18,504	-37,312	-11,446	-7,182
Australia					
Real GDP (A$million)	-17,478	-14,107	-29,569	-8,453	-5,606
Real exports (A$million)	-21,551	-17,671	-33,615	-11,082	-7,084

Source: AE-RGEM; 7 per cent real discount rate

5.1.1 DETAILED RESULTS FOR WESTERN AUSTRALIA

A summary of the projected macroeconomic impacts of each scenario on the Western Australian economy is shown in Table 5. The analysis shows that a decrease in iron ore exports results in a decrease in economic output (real GSP) and economic welfare (measured by real household consumption) relative to the reference case at 2027 (the year on year results are presented in Appendix 2).

In terms of reduced economic growth rates, the average annual growth in Western Australian GSP is projected to be 0.11 percentage points lower over the period 2008-2027 under Scenario 2B compared with reference case growth. Under Scenario 4, Western Australia GSP is projected to be 0.04 percentage points lower. In 2027, the projected reduction in GSP growth in Western Australia is 0.10 percentage points under scenario 2B. In other words, Western Australia economic growth in the reference case was 3.70 per cent compared with a forecast growth rate of 3.60 in the year 2027 under Scenario 2B.

The primary driver of the economic costs is the assumed reduction in iron ore exports which reduces aggregate demand in the Western Australian economy. This manifests itself in lower employment and investment relative to the reference case. The loss in iron ore exports reflects a loss of efficiency across the economy as resources are forced to reallocate from iron ore production to other sectors. One of the key mechanisms driving this reallocation of resources is the reduction in real wages driven by lower demand for labour which, in turn, acts to reduce real consumption.

TABLE 5: PROJECTED MACROECONOMIC IMPACTS ON THE WESTERN AUSTRALIA ECONOMY OF EACH SCENARIO AT 2027 (RELATIVE TO REFERENCE CASE)

Variable	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3	Scenario 4
% deviation from reference case					
Real GSP	-1.411	-1.116	-2.014	-0.679	-0.426
Employment	-0.501	-0.396	-0.701	-0.242	-0.151
Real Household Consumption	-1.230	-0.961	-1.942	-0.574	-0.357
Real Exports	-3.588	-2.913	-4.757	-1.830	-1.164
Real Imports	-1.799	-1.388	-2.872	-0.826	-0.507
Real Wages	-1.392	-1.099	-2.165	-0.665	-0.415
Value change from reference case					
Real GSP ($Am)	-4,149	-3,280	-5,920	-1,996	-1,251
Employment (FTE)[a]	-5,906	-4,670	-8,268	-2,861	-1,778
Real Household Consumption ($Am)	-1,504	-1,175	-2,375	-702	-436
Real Exports ($Am)	-5,256	-4,267	-6,967	-2,680	-1,704
Real Imports ($Am)	-1,008	-778	-1,609	-463	-284

[a] Full time equivalent workers

Source: AE-RGEM, 2008 prices

The projected changes in output of each sector in Western Australia at 2027 are shown in Table 6. As the iron ore sector is assumed to be directly affected by a reduction in export volumes, output is thus projected to fall relative to the reference case. The projected reductions in iron ore output range from just over 28 per cent under Scenario 2B to 6 per cent under Scenario 3 compared with what otherwise would have occurred.

Some other sectors of the Western Australia economy experience increases in output relative to the reference case as a result of the contraction of iron ore production. For example, agricultural production and, notably, non-ferrous metals production are projected to both expand output compared with the reference case. These increases in output are a result of the reallocation of resources from the iron ore sector to other sectors of the economy. This works to the advantage of, particularly, trade exposed sectors who now gain a competitive advantage as key input costs fall. The main example of this is the fall in real wages.

TABLE 6: PROJECTED WESTERN AUSTRALIA SECTORAL IMPACTS OF EACH SCENARIO AT 2027 (% DEVIATION FROM REFERENCE CASE)

Sectors	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3	Scenario 4
Primary and processed agriculture	2.16	1.67	3.56	0.98	0.60
Coal	1.33	1.01	2.29	0.58	0.35
Oil	2.37	1.84	3.88	1.08	0.69
Gas	1.86	1.43	3.07	0.84	0.52
Iron ore	-19.29	-15.41	-28.53	-9.50	-6.02
Other minerals	2.66	2.06	4.31	1.22	0.77
Light manufacturing	2.36	1.83	3.86	1.08	0.67
Petroleum and coal products	-0.69	-0.58	-0.84	-0.38	-0.25
Chemicals, rubber and plastics	3.05	2.34	5.12	1.36	0.82
Other non-metallic mineral products	1.73	1.38	2.69	0.84	0.53
Iron and steel	3.03	2.34	5.06	1.38	0.83
Non-ferrous metals	7.07	5.44	11.69	3.18	1.95
Fabricated metal products	0.37	0.29	0.66	0.17	0.10
Motor vehicles and parts	1.48	1.17	2.27	0.72	0.44
Other transport equipment	2.99	2.33	4.87	1.37	0.84
Other machinery and equipment	2.72	2.12	4.47	1.25	0.77
Other manufacturing	1.91	1.50	3.08	0.89	0.55
Electricity	0.72	0.49	1.57	0.23	0.11
Gas and water	-0.30	-0.24	-0.41	-0.15	-0.10
Construction	-0.25	-0.09	-0.84	0.01	0.03
Sea and air transport	0.29	0.21	0.62	0.11	0.05
Road and rail transport	-0.06	-0.06	0.00	-0.05	-0.03
Other services	-0.88	-0.69	-1.35	-0.41	-0.26

Source: AE-RGEM

5.1.2 DETAILED RESULTS FOR AUSTRALIA

A summary of the projected macroeconomic impacts of each scenario on the Australian economy is shown in Table 7. The results show that a decrease in iron ore exports results in a decrease in economic output (real GDP) and economic welfare (measured by real household consumption) relative to the reference case at 2027. These losses are projected to be greater, the higher the assumed loss of iron ore trade from Western Australia.

In terms of reduced economic growth rates, the average annual growth in Australian GDP is projected to be 0.04 percentage points lower over the period 2008-2027 under Scenario 2B compared with reference case growth. In 2027, the projected reduction in GDP growth in

Australia is 0.04 percentage points. In other words, Australia economic growth in the reference case was 3.19 per cent compared with a forecast growth rate of 3.15 under Scenario 2B.

The impacts on Australia are mitigated to some extent by a reallocation of resources, notably labour, to the eastern states. As wages in Western Australia fall, due to a reduction in economic activity in that State, the migration of labour toward Western Australia is slowed. In the eastern states, this results in a moderate mitigation of the Australia-wide economic impacts over time. For example, the projected reduction in Australian employment at 2027 under Scenario 1 is 3,352 full time equivalent (FTE) workers. The reduction in Western Australia employment is just under 6,000 FTE for the same scenario. The reduction in Western Australia employment, therefore, is a combination of lower employment within the State, as well as a reduction in worker migration from the eastern States.

TABLE 7: PROJECTED MACROECONOMIC IMPACTS ON THE AUSTRALIAN ECONOMY OF EACH SCENARIO AT 2027 (RELATIVE TO REFERENCE CASE)

Variable	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3	Scenario 4
% deviation from reference case					
Real GDP	-0.201	-0.163	-0.292	-0.102	-0.058
Employment	-0.033	-0.041	-0.069	-0.029	-0.007
Real Household Consumption	-0.140	-0.113	-0.230	-0.070	-0.034
Real Exports	-0.821	-0.673	-1.075	-0.407	-0.244
Real Imports	-0.293	-0.228	-0.466	-0.140	-0.079
Real Wages	-0.245	-0.193	-0.366	-0.121	-0.080
Value change from reference case					
Real GSP ($Am)	-3,923	-3,186	-5,712	-1,986	-1,133
Employment (FTE)[a]	-3,352	-3,151	-7,062	-3,002	-739
Real Household Consumption ($Am)	-2,043	-1,648	-3,359	-1,028	-505
Real Exports ($Am)	-5,109	-4,049	-4,069	-2,140	-1,122
Real Imports ($Am)	-1,270	-989	-2,023	-609	-343

[a] Full time equivalent workers

Source: AE-RGEM, 2008 prices

Projected changes in Australian output at 2027 are shown in Table 8. The results for the iron ore sector are dominated by Western Australia. The results for other sectors are broadly similar to those discussed above, due to the reallocation of resources from the iron ore sector to other sectors of the economy both across Western Australia, and Australia-wide.

TABLE 8: PROJECTED SECTORAL IMPACTS OF EACH SCENARIO AT 2027 (%DEVIATION FROM REFERENCE CASE)

Sectors	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3	Scenario 4
Primary and processed agriculture	0.27	0.20	0.43	0.13	0.09
Coal	0.11	0.08	0.19	0.05	0.03
Oil	1.12	0.86	1.83	0.50	0.32
Gas	1.10	0.85	1.83	0.50	0.31
Iron ore	-18.72	-14.95	-27.70	-9.21	-5.84
Other minerals	1.63	1.26	2.64	0.75	0.47
Light manufacturing	0.18	0.13	0.27	0.08	0.07
Petroleum and coal products	-0.07	-0.07	-0.08	-0.04	-0.02
Chemicals, rubber and plastics	0.33	0.24	0.53	0.15	0.11
Other non-metallic mineral products	0.34	0.26	0.51	0.15	0.11
Iron and steel	0.25	0.18	0.42	0.11	0.08
Non-ferrous metals	3.27	2.52	5.36	1.50	0.93
Fabricated metal products	0.06	0.04	0.08	0.02	0.03
Motor vehicles and parts	0.10	0.07	0.14	0.04	0.04
Other transport equipment	0.23	0.18	0.35	0.12	0.09
Other machinery and equipment	0.23	0.17	0.35	0.11	0.08
Other manufacturing	0.28	0.22	0.44	0.13	0.10
Electricity	0.22	0.15	0.43	0.08	0.05
Gas and water	-0.03	-0.03	-0.05	-0.02	-0.01
Construction	-0.04	-0.01	-0.13	-0.02	-0.01
Sea and air transport	0.01	0.00	0.02	0.00	0.01
Road and rail transport	0.01	0.00	0.02	0.00	0.01
Other services	-0.11	-0.09	-0.18	-0.06	-0.03

Source: AE-RGEM

APPENDIX 1: SOME DETAIL ABOUT AE-RGEM

AE-RGEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as GDP (or GSP at the State level), employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The model is based upon a set of key underlying relationships between the various *components* of the model, each which represent a different group of agents in the economy. These relationships are solved simultaneously, and so there is no logical start or end point for describing how the model actually works. Figure 3 shows the key components of the model for an individual region (say, Queensland). The components include a representative household, producers, investors and international (or linkages with the other regions in the model, including other Australian States and foreign regions). Below is a description of each component of the model and key linkages between components. Some additional, somewhat technical, detail is also provided.

AE-RGEM is based on a substantial body of accepted microeconomic theory. Key assumptions underpinning the model are:

- The model contains a 'regional consumer' that receives all income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).
- Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas (C-D) utility function.
- Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In the Australian regions, households can also source goods from interstate. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption for composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via a C-D utility function.
- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a CES production function.
- Producers are cost minimisers, and in doing so choose between domestic, imported and interstate intermediate inputs via a CRESH production function.

- The model contains a more detailed treatment of the electricity sector that is based on the 'technology bundle' approach for general equilibrium modelling developed by ABARE (1996).[5]

- The supply of labour is positively influenced by movements in the real wage rate governed by an elasticity of supply (assumed to be 0.2).
- Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return. Once the aggregate investment has been determined for Australia, aggregate investment in each Australian sub-region is determined by an Australian investor based on: Australian investment and rates of return in a given sub-region compared with the national rate of return.
- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.
- Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other Australian regions (interstate exports).
- For internationally-traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But in relative terms imported goods from different regions are treated as closer substitutes than domestically-produced goods and imported composites. Goods traded interstate within the Australian regions are assumed to be closer substitutes again.
- The model accounts for greenhouse gas emissions from fossil fuel combustion. Taxes can be applied to emissions, which are converted to good-specific sales taxes that impact on demand. Emission quotas can be set by region and these can be traded, at a value equal to the carbon tax avoided, where a region's emissions fall below or exceed their quota.

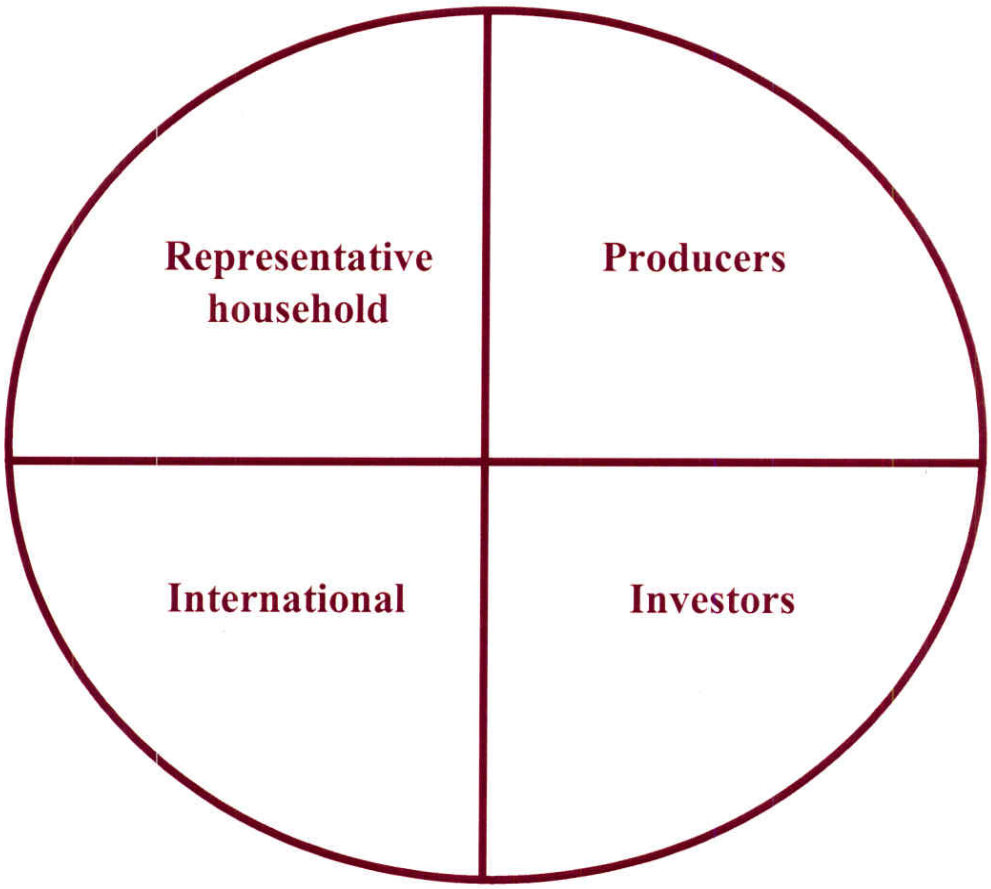
THE REPRESENTATIVE HOUSEHOLD

Each region in the model has a so-called *representative household* that receives and spends all income. The *representative household* allocates income across three different *expenditure* areas: private household consumption; government consumption; and savings.

Going clockwise around Figure 3, the representative household interacts with producers in two ways. First, in allocating expenditure across household and government consumption, this sustains demand for production. Second, the representative household owns and receives all income from factor payments (labour, capital, land and natural resources) as well as net taxes. Factors of production are used by producers as *inputs into production* along with intermediate inputs. The level of production, as well as supply of factors, determines the amount of income generated in each region.

[5] Australian Bureau of Agricultural and Resource Economics (ABARE), 1996, *MEGABARE: Interim Documentation*, Canberra.

FIGURE 3: KEY COMPONENTS OF AE-RGEM



The *representative household's* relationship with investors is through the supply of investable funds – savings. The relationship between the *representative household* and the international sector is twofold. First, importers compete with domestic producers in consumption markets. Second, other regions in the model can lend (borrow) money from each other.

Some detail

- The representative household allocates income across three different expenditure areas – private household consumption; government consumption; and savings – to maximise a Cobb-Douglas utility function.
- Private household consumption on composite goods is determined by minimising a CDE (Constant Differences of Elasticities) expenditure function. Private household consumption on composite goods from different sources is determined is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption on composite goods, and composite goods from different sources, is determined by maximising a Cobb-Douglas utility function.
- All savings generated in each region is used to purchase bonds whose price movements reflect movements in the price of generating capital.

PRODUCERS

Apart from selling goods and services to households and government, producers sell products to each other (intermediate usage) and to investors. Intermediate usage is where one producer supplies inputs to another's production. For example, coal producers supply inputs to the electricity sector.

Capital is an input into production. Investors react to the conditions facing producers in a region to determine the amount of investment. Generally, increases in production are accompanied by increased investment. In addition, the production of machinery, construction of buildings and the like that forms the basis of a region's capital stock, is undertaken by producers. In other words, investment demand adds to household and government expenditure from the representative household, to determine the demand for goods and services in a region.

Producers interact with international markets in two main ways. First they compete with producers in overseas regions for export markets, as well as in their own region. Second, they use inputs from overseas in their production.

Some detail

- Sectoral output equals the amount demanded by consumers (households and government) and intermediate users (firms and investors) as well as exports.
- Intermediate inputs are assumed to be combined in fixed proportions at the composite level. As mentioned above, the exception to this is the electricity sector that is able to substitute different technologies (brown coal, black coal, oil, gas, hydropower and other renewables) using the 'technology bundle' approach developed by ABARE (1996).
- To minimise costs, producers substitute between domestic and imported intermediate inputs is governed by the Armington assumption as well as between primary factors of production (through a CES aggregator). Substitution between skilled and unskilled labour is also allowed (again via a CES function).
- The supply of labour is positively influenced by movements in the wage rate governed by an elasticity of supply is (assumed to be 0.2). This implies that changes influencing the demand for labour, positively or negatively, will impact both the level of employment and the wage rate. This is a typical labour market specification for a dynamic model such as AE-RGEM. There are other labour market 'settings' that can be used. First, the labour market could take on long-run characteristics with aggregate employment being fixed and any changes to labour demand changes being absorbed through movements in the wage rate. Second, the labour market could take on short-run characteristics with fixed wages and flexible employment levels.

INVESTORS

Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. The global investor ranks countries as investment destination based on two factors: current economic growth and rates of return in a given region compared with global rates of return.

Some detail

- Once aggregate investment is determined in each region, the regional investor is constructs capital goods by combining composite investment goods in fixed

proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.

INTERNATIONAL

Each of the components outlined above operate, simultaneously, in each region of the model. That is, for any simulation the model forecasts changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. Of course, this implies some global conditions must be met such as global exports and global imports are the same and that global debt repayments equals global debt receipts each year.

APPENDIX 2: YEAR-ON-YEAR RESULTS

TABLE 9: PROJECTED MACROECONOMIC IMPACTS OF SCENARIO 1 (RELATIVE TO REFERENCE CASE)

	West Australia				Australia			
Variable	**2008**	**2015**	**2020**	**2027**	**2008**	**2015**	**2020**	**2027**
% deviation from reference case								
Real GNP	-0.179	-0.488	-0.748	-1.345	-0.028	-0.078	-0.117	-0.203
Real GDP	-0.257	-0.708	-0.940	-1.411	-0.038	-0.107	-0.142	-0.201
Employment	-0.181	-0.235	-0.302	-0.501	-0.022	-0.027	-0.032	-0.033
Real Household Consumption	-0.171	-0.459	-0.692	-1.230	-0.021	-0.059	-0.085	-0.140
Real Exports	-0.560	-1.991	-2.541	-3.588	-0.112	-0.428	-0.572	-0.821
Real Imports	-0.223	-0.598	-0.995	-1.799	-0.037	-0.110	-0.170	-0.293
Real Wage	-0.054	-0.443	-0.755	-1.392	-0.009	-0.077	-0.129	-0.245
CPI	-0.074	-0.461	-0.827	-1.597	-0.012	-0.066	-0.108	-0.218
Value change from reference case (A$million)								
Real GNP	-267	-927	-1,705	-3,954	-304	-1,041	-1,842	-3,964
Real GDP	-384	-1,346	-2,144	-4,149	-412	-1,437	-2,227	-3,923
Employment (FTE)[a]	-1,777	-2,576	-3,422	-5,906	-2,038	-2,644	-3,235	-3,352
Real Household Consumption	-103	-354	-645	-1,504	-170	-585	-989	-2,043
Real Exports	-397	-1,940	-2,971	-5,256	-355	-1,753	-2,705	-5,109
Real Imports	-62	-204	-410	-1,008	-85	-308	-561	-1,270

[a] Full time equivalent workers

Source: AE-RGEM, 2008 prices

TABLE 10: PROJECTED MACROECONOMIC IMPACTS OF SCENARIO 2A (RELATIVE TO REFERENCE CASE)

	West Australia				Australia			
Variable	**2008**	**2015**	**2020**	**2027**	**2008**	**2015**	**2020**	**2027**
% deviation from reference case								
Real GNP	-0.142	-0.382	-0.586	-1.050	-0.022	-0.062	-0.094	-0.162
Real GDP	-0.205	-0.559	-0.745	-1.116	-0.030	-0.085	-0.114	-0.163
Employment	-0.144	-0.185	-0.242	-0.396	-0.018	-0.022	-0.028	-0.041
Real Household Consumption	-0.136	-0.359	-0.543	-0.961	-0.017	-0.047	-0.069	-0.113
Real Exports	-0.451	-1.595	-2.041	-2.913	-0.090	-0.343	-0.458	-0.673
Real Imports	-0.176	-0.459	-0.775	-1.388	-0.029	-0.087	-0.136	-0.228
Real Wage	-0.043	-0.348	-0.594	-1.099	-0.008	-0.061	-0.103	-0.193
CPI	-0.058	-0.358	-0.646	-1.036	-0.009	-0.052	-0.086	-0.164
Value change from reference case (A$million)								
Real GNP	-212	-726	-1,336	-3,086	-243	-827	-1,474	-3,170
Real GDP	-306	-1,063	-1,697	-3,280	-332	-1,145	-1,789	-3,186
Employment (FTE)[a]	-1,414	-2,035	-2,736	-4,670	-1,644	-2,186	-2,767	-3,151
Real Household Consumption	-82	-277	-505	-1,175	-137	-466	-797	-1,648
Real Exports	-319	-1,554	-2,386	-4,267	-304	-1,003	-2,224	-4,049
Real Imports	-49	-156	-319	-778	-68	-243	-449	-989

[a] Full time equivalent workers

Source: AE-RGEM, 2008 prices

TABLE 11: PROJECTED MACROECONOMIC IMPACTS OF SCENARIO 2B (RELATIVE TO REFERENCE CASE)

	West Australia				Australia			
Variable	**2008**	**2015**	**2020**	**2027**	**2008**	**2015**	**2020**	**2027**
% deviation from reference case								
Real GNP	-0.630	-0.904	-1.277	-2.123	-0.093	-0.142	-0.198	-0.329
Real GDP	-0.871	-1.230	-1.477	-2.014	-0.123	-0.184	-0.221	-0.292
Employment	-0.632	-0.373	-0.445	-0.701	-0.071	-0.042	-0.047	-0.069
Real Household Consumption	-0.601	-0.848	-1.182	-1.942	-0.069	-0.107	-0.144	-0.230
Real Exports	-1.748	-3.314	-3.795	-4.757	-0.357	-0.714	-0.852	-1.075
Real Imports	-0.828	-1.181	-1.744	-2.872	-0.124	-0.207	-0.290	-0.466
Real Wage	-0.190	-0.859	-1.302	-2.165	-0.032	-0.143	-0.215	-0.366
CPI	-0.289	-0.933	-1.471	-2.550	-0.041	-0.127	-0.188	-0.337
Value change from reference case (A$million)								
Real GNP	-941	-1,718	-2,911	-6,242	-1,013	-1,899	-3,113	-6,435
Real GSP/GDP	-1,300	-2,338	-3,368	-5,920	-1,346	-2,462	-3,460	-5,712
Employment (FTE)[a]	-6,225	-4,097	-5,031	-8,268	-6,561	-4,115	-4,665	-7,062
Real Household Consumption	-362	-655	-1,101	-2,375	-553	-1,056	-1,668	-3,359
Real Exports	-1,238	-3,229	-4,438	-6,967	-810	-2,088	-2,835	-4,069
Real Imports	-229	-402	-719	-1,609	-287	-578	-957	-2,023

[a] Full time equivalent workers

Source: AE-RGEM, 2008 prices

TABLE 12: PROJECTED MACROECONOMIC IMPACTS OF SCENARIO 3 (RELATIVE TO REFERENCE CASE)

	West Australia				Australia			
Variable	**2008**	**2015**	**2020**	**2027**	**2008**	**2015**	**2020**	**2027**
% deviation from reference case								
Real GNP	-0.082	-0.228	-0.351	-0.628	-0.013	-0.037	-0.056	-0.100
Real GDP	-0.119	-0.338	-0.453	-0.679	-0.018	-0.052	-0.069	-0.102
Employment	-0.083	-0.112	-0.150	-0.242	-0.011	-0.013	-0.015	-0.029
Real Household Consumption	-0.078	-0.214	-0.325	-0.574	-0.010	-0.029	-0.040	-0.070
Real Exports	-0.265	-0.984	-1.263	-1.830	-0.053	-0.207	-0.280	-0.407
Real Imports	-0.100	-0.267	-0.462	-0.826	-0.017	-0.054	-0.081	-0.140
Real Wage	-0.025	-0.207	-0.357	-0.665	-0.004	-0.038	-0.065	-0.121
CPI	-0.032	-0.211	-0.384	-0.740	-0.005	-0.032	-0.050	-0.107
Value change from reference case (A$million)								
Real GNP	-122	-433	-801	-1,845	-143	-498	-874	-1,950
Real GDP	-177	-643	-1,033	-1,996	-196	-697	-1,079	-1,986
Employment (FTE)[a]	-815	-1,234	-1,696	-2,861	-991	-1,260	-1,525	-3,002
Real Household Consumption	-47	-165	-303	-702	-81	-283	-468	-1,028
Real Exports	-188	-959	-1,477	-2,680	-119	-905	-1,332	-2,140
Real Imports	-28	-91	-191	-463	-40	-150	-269	-609

[a] Full time equivalent workers

Source: AE-RGEM, 2008 prices

TABLE 13: PROJECTED MACROECONOMIC IMPACTS OF SCENARIO 4 (RELATIVE TO REFERENCE CASE)

	West Australia				Australia			
Variable	**2008**	**2015**	**2020**	**2027**	**2008**	**2015**	**2020**	**2027**
% deviation from reference case								
Real GNP	-0.045	-0.143	-0.223	-0.392	-0.010	-0.023	-0.035	-0.054
Real GDP	-0.068	-0.210	-0.285	-0.426	-0.017	-0.037	-0.047	-0.058
Employment	-0.044	-0.070	-0.096	-0.151	-0.006	-0.006	-0.008	-0.007
Real Household Consumption	-0.041	-0.131	-0.204	-0.357	-0.008	-0.018	-0.025	-0.034
Real Exports	-0.162	-0.615	-0.790	-1.164	-0.027	-0.118	-0.162	-0.244
Real Imports	-0.048	-0.157	-0.287	-0.507	-0.008	-0.032	-0.051	-0.079
Real Wage	-0.013	-0.126	-0.220	-0.415	-0.002	-0.024	-0.042	-0.080
CPI	-0.011	-0.126	-0.237	-0.463	-0.009	-0.028	-0.040	-0.079
Value change from reference case (A$million)								
Real GNP	-68	-271	-507	-1,153	-109	-314	-548	-1,046
Real GDP	-101	-400	-650	-1,251	-181	-490	-736	-1,133
Employment (FTE)[a]	-436	-766	-1,090	-1,778	-566	-614	-827	-739
Real Household Consumption	-25	-101	-190	-436	-67	-176	-285	-505
Real Exports	-115	-599	-923	-1,704	-91	-545	-878	-1,122
Real Imports	-13	-54	-118	-284	-19	-89	-169	-343

[a] Full time equivalent workers

Source: AE-RGEM, 2008 prices