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AUSTRALIAN MINING AND THE ECONOMY:

A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

by

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ABSTRACT

The impact on the domestic mining sector of a range of economic shocks is quantified in this study. These results are based on simulations with ORANI, a computable general equilibrium (CGE) model of the Australian economy. The following economic shocks are examined in detail: a change in the real wage rate as a cost to employers; an expansion in real absorption (i.e., the sum of real household consumption, real private investment and real government spending); protection for manufacturing industries; a change in the tax mix in favour of indirect taxation; additional foreign exchange earnings from, say, an expansion in the agricultural sector or from new mining developments; and a movement in the exchange rate.

Contents

AUSTRALIAN MINING AND THE ECONOMY:
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1. INTRODUCTION

The impact of a range of economic shocks on the mining sector is quantified in this study. To analyse these shocks requires an economic model that captures:

(i) the larger economic environment within which the Australian mining sector operates;

and

(ii) the vulnerability of the mining sector to competition on world markets.

The ORANI computable general equilibrium (CGE) model of the Australian economy (developed by Dixon, Parmenter, Sutton and Vincent, hereafter DPSV (1982)) is ideally suited for such an analysis.

The economic shocks in question are (i) real wages as a cost to employers; (ii) aggregate demand management; (iii) tariff policy; (iv) a possible change in Austalia's tax mix in favour of indirect taxation; (v) foreign exchange earnings from an expansion in, say, the domestic agricultural sector or from new mining developments; and (vi) the recent depreciation of the Australian dollar. First discussed in each case are the short-run (2-year) macroeconomic impacts. These are interesting in their own right, and impinge directly and indirectly on the mining sector in important ways. The short-run effects on mining industry outputs and mineral exports are also discussed. Finally, the short-run effects on real net returns to the mining sector are examined.

The remainder of this paper is organized as follows. In section 2 we define a standard short-run macroeconomic environment for an ORANI simulation. The results are presented in section 3. In section 4 some concluding remarks are offered. Finally, an Appendix explains how the results may be recomputed by the reader under a range of different wage indexation assumptions.

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2. THE STANDARD SHORT-RUN MACROECONOMIC ENVIRONMENT

In this section we define a standard short-run macroeconomic environment for an ORANI simulation. A macroeconomic environment consists of the list of macro variables contained in the user-specified set of exogenous variables chosen to close the model. Rather than analyse in detail all the elements of the standard short-run closure[1] we concentrate here on its four most important features. Three of these can best be explained in terms of choices about the environment which must be made by the user, who must routinely assign to the exogenous set:

> "(i) one of the price level or the exchange rate (as numeraire);
>
> (ii) one of the real wage or the aggregate level of employment;
>
> (iii) one of real absorption or the balance of trade surplus" (Powell, Cooper and McLaren (1983)).

Users must make these choices because there are no mechanisms in ORANI suitable for determining:

> "(I) the extent to which induced changes in the real exchange rate will be realized as changes in the domestic inflation rate relative to the foreign rate or as changes in the nominal exchange rate;

(II) the extent to which induced changes in the buoyancy of the labour market will be realized as changes in real wages or as changes in employment;

(III) the extent to which induced changes in national income will be realized as changes in aggregate absorption or as changes in the balance of trade" (ibid.).

In the standard short-run macroeconomic environment, the choices made are:

(1) the nominal exchange rate is the numeraire. Hence, changes in domestic price indexes can be interpreted as changes in domestic relative to world prices. We do not claim to be able to distinguish between changes in the relative prices of traded and non-traded goods brought about on the one hand by a change in the nominal exchange rate or on the other hand by a change in the domestic price level.

(2) the labour market is slack. There are assumed to be no shortages of labour at the going real wage rates. Thus changes in the labour market show up as changes in employment (which is demand-determined in this closure). This means that the labour supply curves are horizontal. It is then asked of the ORANI model: what real wage is consistent with the employment of this amount of labour?

12 The effective tax rate is the ratio of income tax collected to income.

13 For an analysis of the imposition of a new consumption tax under alternative assumptions with respect to the distribution of the offsetting tax cuts given to labour and capital income see Higgs (1986, Chapter 8).

14 Alternatively the size of the direct tax cut may be chosen so as to leave the public sector borrowing requirement unchanged. Different choices will have different implications for the size of the direct tax cut made possible by the given increase in sales tax. The implications of these different choices are studied in Meagher and Parmenter (1985).

15 Note that this result is not listed in Table 3.1. In the other simulations reported here the percentage change in the CPI is a good proxy for the percentage change in the prices received by producers.

16 The figure of an 18 per cent real depreciation of the Australian dollar was calculated as follows. In the period January 1985 to June 1985 the trade-weighted index of the average value of the Autralian dollar vis-a-vis the currencies of Australia's trading partners (as reported in Reserve Bank of Australia (1985, p.s46)) fell from 80.8 to 65.0 (i.e., a fall of 19.55 per cent). The CPI over the same period increased in Australia by 3.49 per cent whilst the average movement in the CPI of Australia's trading partners was a 2.07 per cent increase (the individual CPI projections were obtained from the worksheets of the Lim and Parmenter (1985) study: these were then weighted according to the trade weights reported in Reserve Bank of Australia (1984, p.231)). Thus the Australian dollar depreciated by approximately 18 per cent in real terms (i.e., 19.55 + 2.07 - 3.49).

17 Note that nominal wage rates are held constant here.

NOTES

* This paper was prepared with financial support from the Australian Mining Industry Council. Comments by Alan Powell and Tony Lawson are acknowledged with thanks.

1 These are listed in Higgs (1986, Appendix A.1, Table A1.1).

2 Note that documentation sufficient to reproduce the simulations reported here is contained in Higgs (1986, Appendix A.1).

3 Note that the foreign elasticity of demand for ferrous metal ores is modelled as -10.0.

4 The Services to Mining nec industry in the original input-output data presented some anomalies, including a negative gross operating surplus. The latter was eliminated in the standard ORANI data base by the artificial device of attributing sales (fictitious, as far as the original data go) to investment. The justifications for this procedure are (i) that it cannot be true that an industry typically makes a negative return on capital and (ii) that exploration and proving, which are important elements of Services to Mining nec, clearly are investment services.

5 The percentage change in the hourly wage rate is assumed to be the same across industries, hence the lack of an industry specific subscript on w.

6 The derivation of equation (3.2) can be found in Higgs (1986, Appendix A.4).

7 Wages are assumed to be 100 per cent indexed to the CPI here. Note that this assumption may be relaxed by the reader -- see Appendix for further details.

8 Note that quantitative restrictions are expressed in terms of tariff equivalents.

9 For a discussion on linearization errors see Dixon, Parmenter, Sutton and Vincent (1982, pp. 326 - 333).

10 See Treasury (1985).

11 An alternative response is one where pre-tax wage rates are fully indexed to consumer prices. See, for example, Dixon (1985) for a study of the effects of the imposition of new consumption tax which would raise purchasers' prices by 5 per cent with pre-tax wage rates fully indexed to the CPI. Note however that Dixon (1985, p. 54) concludes that "the results are so bad I don't think we could get a change in the tax mix without labour market reform."

(3) real domestic absorption is exogenous and set to zero change. An equation implicitly contained in the ORANI model is the Gross Domestic product (hereafter GDP) identity:

$$GDP \equiv (C + I + G) + (X - M) \quad , \qquad (2.1)$$

where C refers to household consumption, I to private investment, G to government spending, X to exports and M to imports. As we have seen, users of ORANI must choose between setting either real domestic absorption (i.e., (C + I + G), deflated by the appropriate price indices) or the balance of trade (i.e., (X - M), measured in foreign currency) exogenously. When real domestic absorption is set to zero change, as in the standard short-run macroeconomic environment, the ORANI model indicates the change in the balance of trade which would need to accompany a tariff cut, say, in order to maintain a given level of real domestic absorption.

The final feature is a standard analytical device for defining the short run; namely the assumption that:

(4) plant and equipment in use in every industry do not change (from the levels they otherwise would have reached) due to the shock under analysis (i.e., fixed industry capital stocks). It is assumed that in the

short run the industry rates of return on current capital adjust to reflect any change in its scarcity value. Thus if any industry expands its output in the short run the rental rate on its fixed capital will increase.

Notice that, in interpreting (4), the time period allowed is long enough to allow revisions in all industries' investment plans, for orders for capital goods to be placed and met, for the new plant and equipment to be installed (but not yet switched on). The length of the standard short run in ORANI has been estimated by Cooper (1983) as a 7.9 quarters. In policy work 'about two years' is the appropriate level of precision for describing the ORANI short run.

APPENDIX TABLE A.2: FACTORS UNDERLYING THE RESPONSE OF SERVICES TO MINING NEC TO A ONE PER CENT INCREASE IN REAL ABSORPTION

ORANI Industry	Responses of (a) Mining Industries				Other demand for 17.
	Output		Investment		
12. Ferrous Metal Ores	-1.61	(.003)	-2.02	(.061)	
13. Non-Ferrous Metal Ores	-2.22	(.033)	-1.04	(.094)	
14. Black Coal	-2.78	(.019)	-2.50	(.098)	
15. Oil, Gas & Brown Coal	-0.20	(.177)	0.76	(.109)	
16. Other Minerals	0.11	(.003)	3.12	(.029)	
Totals(b) [e] + [f] = (0.658)	-0.166	(.235)[e]	-0.296	(.391)[f]	
17. Services to Mining nec	-0.61	(.324)	1.00(c)	(zero)	1.00(d) (.049)

(a) The share of the output of Services to Mining nec sold to each category is shown in parenthesis.

(b) The numbers in the output and investment columns are share weighted sums.

(c) This is an exogenous investment category. The one per cent exogenous expansion in real absorption shows up as a one per cent expansion in real investment in each industry for which investment is treated exogenously.

(d) Other demand for Services to Mining nec (like all Other demand) is set exogenously to 1 per cent increase.

within-industry-17 sales, the sales shares to current output and investment of this industry are

$$\text{(current ouput):} \quad \sum_{j=12}^{16} S_{1,17,j} \; / \; (1 - S_{1,17,17})$$

and

$$\text{(capital creation):} \quad \sum_{j=12}^{16} S_{2,17,j} \; / \; (1 - S_{1,17,17}) \; ;$$

namely, 0.35 (=0.235/0.676) and 0.58 (=0.391/0.676) respectively. The corresponding share of Other demand is 0.07 (=0.049/0.676). Then the approximate output response z_{17} is 0.35 x 0.73 + 0.58 x 0.66 + 0.07 x 0.0 = 0.64 per cent, as shown in the text.

The details relevant to the one per cent expansion in real absorption are shown in Table A.2. Proceeding as above, the average output and investment responses in mining industries other than industry 17 are -0.71 (= -0.166/0.235) and -0.76 (=-0.296/0.391) per cent respectively. In addition, the Other demands facing industry 17, which is indexed to real absorption, increases by 1 per cent. Weighting these as before, the output response of Services to Mining nec, z_{17}, should be about -0.62 (i.e., 0.35 x (-0.71) + 0.58 x (-0.76) + 0.07 x (1.00)). This is in close agreement with the actual ORANI projection of -0.61 per cent.

3. RESULTS

The specific economic shocks examined are: a one per cent cut in the real wage rate as a cost to employers; a one per cent increase in real absorption; a 25 per cent across-the-board tariff cut; the imposition of a new consumption tax which would increase purchasers' prices by 5 per cent accompanied by compensating cuts in direct taxes; additional foreign exchange earnings equivalent to one per cent of GNP; and an 18 per cent depreciation of the Australian dollar with full discounting of wages for the inflationary impact of the depreciation. Also contained in this section is a discussion of the magnitudes of these shocks calibrated such that each shock would cause a 5 per cent decline in the short-run real net returns to the mining sector.

The standard short-run macroeconomic environment, as discussed in section 2, was assumed for most of the simulation presented here. Any deviations from this environment will be noted below.[2]

3.1 Real Wages

By the real wage is meant the money wage deflated by some index of the general level of prices. For our purpose, the consumer price index (CPI) will serve as deflator. We need to distinguish between real wages as a cost to employers of labour, and real wages as take-home pay (i.e., as disposable income). The real wage as a cost to employers includes the gross wage, payroll taxes and other costs of employing labour such as superannuation contributions, etc.

The short-run macroeconomic projections of a one per cent cut in the real wage rate as a cost are given in Table 3.1, column [I]. It can be seen from the table that a cut in the real wage rate as a cost to employers is projected to increase employment by 0.87 per cent. A real wage cut is deflationary. The CPI is projected to fall by 1.73 per cent due to the one per cent real wage cut. Note that a 1.73 per cent decrease in the CPI means that after about 2 years we would expect the CPI (with a base of 100.0) to be about 1.73 percentage points lower as a result of the real wage cut than it would otherwise have been. As domestic costs fall, the international competitiveness of the traded sectors improves. This leads to an increase in exports of 2.39 per cent and a decline in imports of 0.85 per cent. The net result is an improvement in the balance of trade of $0.47 billion (1977-78 prices).

Real wages represent a major cost to the mining sector, both directly through hired labour and indirectly through commodity inputs. A sustained one per cent economy-wide decrease in the real wage rate as a cost commencing today is projected to cause a 2.21 per cent increase in the output of the mining sector after about 2 years -- see Table 3.2, column [I].

The distribution of the benefits of the real wage cut are not uniform across the mining sector. This is due to the different cost

$$z_{17} \equiv \sum_{j=12}^{17} [S_{1,17,j}\, z_j + S_{2,17,j}\, y_j] + S_{3,17}\, x_{17} \quad ; \qquad (A.6)$$

where $S_{1,17,j}$, $S_{2,17,j}$ and $S_{3,17}$ respectively are the shares of total sales of industry 17 to current production by industry j, to capital creation by industry j, and to Other demand. Since $S_{2,17,17} = 0$ in the data base, we have:

$$z_{17} \equiv S_{1,17,17}\, z_{17} + \sum_{j=12}^{16} S_{1,17,j}\, z_j + \sum_{j=12}^{16} S_{2,17,j}\, y_j + S_{3,17}\, x_{17} \quad . \qquad (A.7)$$

Solving for z_{17}, we obtain

$$z_{17} \equiv \left[\sum_{j=12}^{16} (S_{1,17,j}\, z_j + S_{2,17,j}\, y_j) + S_{3,17} x_{17}\right] / (1 - S_{1,17,17}) \; . \qquad (A.8)$$

According to Table A.1, under a one per cent reduction in the real wage as a cost, the right of (A.8) is

$$\text{RHS(A.8)} \equiv [0.172 + 0.258 + 0]/(0.676) = 0.64 \text{ per cent} \; . \qquad (A.9)$$

Within the limit of accuracy of our hand computations, this agrees with the figure projected by ORANI (0.63 per cent -- see last row of Table A.1). Notice that this result could also have been obtained as follows: from row 6 of Table A.1 the average output and investment responses in other mining industries (nos 12 - 16) could be calculated as 0.73 (= 0.172/0.235) and 0.66 per cent (= 0.258/0.391) respectively. Net of

APPENDIX TABLE A.1: FACTORS UNDERLYING THE RESPONSE OF SERVICES TO MINING NEC TO A ONE PER CENT REDUCTION IN THE REAL WAGE RATE AS A COST

ORANI Industry	Responses of (a)				Other demand for 17.
	Mining Industries				
	Output		Investment		
12. Ferrous Metal Ores	1.62	(.003)	1.73	(.061)	
13. Non-Ferrous Metal Ores	2.23	(.033)	0.89	(.094)	
14. Black Coal	2.76	(.019)	2.21	(.098)	
15. Oil, Gas & Brown Coal	0.22	(.177)	-0.87	(.109)	
16. Other Minerals	0.58	(.003)	-1.89	(.029)	
Totals(b) [e] + [f] = (0.658)	0.172	(.235)[e]	0.258	(.391)[f]	
17. Services to Mining nec	0.63	(.324)	zero(c)	(zero)	zero(d) (.049)

(a) The share of the output of Services to Mining nec sold to each category is shown in parentheses.

(b) The numbers shown in the output and investment columns are share weighted sums.

(c) Investment in Services to Mining nec is set exogenously to zero change.

(d) Other demand for Services to Mining nec (like all Other demand) is set exogenously to zero change.

TABLE 3.1 : THE SHORT-RUN MACROECONOMIC PROJECTIONS*

Variable	A Cut in the Real Wage Rate[a] as a Cost of	An Increase in Real Absorption[b] of	An Across-the-Board Tariff Cut[c] of	The Imposition of a Consumption Tax Which Would Raise Purchasers' Prices by 5 per cent Accompanied by Compensating Cuts[d] in Income Taxes	Additional Foreign Exchange Earnings Equivalent to	A Depreciation of the Australian Dollar with Full Discounting of Wages[e] of
	1 per cent [I]	1 per cent [II]	25 per cent [III]	[IV]	1 per cent of GNP [V]	18 per cent [VI]
Consumer Price Index	-1.73	2.34	-2.33	5.49	3.16	6.59
Aggregate Exports (foreign currency value)	2.39	-2.56	2.61	-0.84	-3.46[g]	15.75
Aggregate Imports (foreign currency value)	-0.85	1.97	1.54	0.26	2.66	-5.60
Balance of Trade	0.47	-0.66	0.16	-0.16	-0.89[h]	3.10
Real Gross Domestic Product	0.59	0.19	0.17	-0.20	0.26	3.89
Aggregate Employment[f]	0.87	0.20	0.28	-0.30	0.27	5.74

* All projections, with the exception of the balance of trade, are percentage deviations from the value the variable in question would have taken in the absence of the shock at the head of the column. The balance of trade, while also a deviation from control, has the units billion of 1977-78 Australian dollars (GDP in the base period was $94.737 billion ($1 billion = $1,000 million) in 1977-78 prices). As the ORANI model is solved using a linear solution algorithm, to find the effects of, say, a 2 per cent cut in the real wage rate, simply multiply the projections listed in column [I] by 2. The effects of, say, a real wage increase of 1 per cent are obtained by reversing the signs in column [I]. For a discussion on linearization errors see OPSV (1982, pp. 326 - 333). Note that the length of the short run in ORANI has been estimated by Cooper (1983) as 7.9 quarters. In policy work 'about 2 years' is the appropriate level of precision for describing the ORANI short run.

a The real wage rate is defined here as the nominal wage rate deflated by the consumer price index.

b Absorption is defined as the sum of household consumption, private investment and government spending.

c Quantitative restrictions are expressed in terms of tariff equivalents.

d Post-tax wage rates are 100 per cent indexed to the consumer price index and the direct tax cuts (comprising equal percentage cuts in the effective tax rates on labour and capital incomes) are calculated to hold constant private disposable income deflated by a private absorption deflator.

e That is, no flow-on into wages of the inflationary effects of the depreciation.

f Aggregate employment is calculated using persons weights. The seasonally adjusted number of persons employed in June 1985 was 6,637,900 -- ABS (1985). Therefore an increase of, say, 0.87 per cent is equivalent to the addition of 57,750 people in the total number of people employed.

g This projection refers to traditional exports (i.e., it does not include the additional foreign exchange earnings at the head of the column).

h This projection refers to a balance of trade which excludes the additional foreign exchange earnings at the head of the column.

TABLE 3.2 : THE SHORT-RUN OUTPUT PROJECTIONS FOR MINING INDUSTRIES*

ORANI Industry[a]	A Cut in the Real Wage Rate[b] as a Cost of	An Increase in Real Absorption[c] of	An Across-the-Board Tariff Cut[d] of	The Imposition of a Consumption Tax Which Would Raise Purchasers' Prices by 5 per cent Accompanied by Compensating Cuts[e] in Income Taxes	Additional Foreign Exchange Earnings Equivalent to	A Depreciation of the Australian Dollar with Full Discounting of Wages[f] of
	1 per cent [I]	1 per cent [II]	25 per cent [III]	[IV]	1 per cent of GNP [V]	18 per cent [VI]
12. Ferrous Metal Ores	1.62	-1.61	1.75	-0.57	-2.17	10.69
13. Non-Ferrous Metal Ores	2.23	-2.22	2.32	-0.76	-2.99	14.72
14. Black Coal	2.76	-2.78	2.88	-1.34	-3.75	18.22
16. Other Minerals	0.58	0.11	0.33	-0.20	0.15	3.83
17. Services to Mining nec	0.63	-0.61	0.69	-0.30	-0.82	4.16
64. Non-Ferrous Metals	2.65	-2.61	2.73	-0.89	-3.53	17.49
Mining[g]	2.21	-2.15	2.28	-0.84	-2.90	14.55

* All projections are percentage deviations from what the industry outputs would have been in the absence of the shock at the head of the column.

a ORANI industries 12, 13, 16, 17 and 64 correspond to the industrial classifications 11.01, 11.02, 14.00, 16.00 and 29.02, respectively, as used in the 1977-78 input-output tables -- see ABS (1983). A description of the mapping between the ORANI industry 14 and the input-output classification 12.00 is contained in Bruce (1985).

b The real wage rate is defined here as the nominal wage rate deflated by the consumer price index.

c Absorption is defined as the sum of household consumption, private investment and government spending.

d Quantitative restrictions are expressed in terms of tariff equivalents.

e Post-tax wage rates are 100 per cent indexed to the consumer price index and the direct tax cuts (comprising equal percentage cuts in the effective tax rates on labour and capital incomes) are calculated to hold constant private disposable income deflated by a private absorption deflator.

f That is, no flow-on into wages of the inflationary effects of the depreciation.

g The effect on the Mining sector's output is calculated by weighting the effects on industry output by the industry-output shares in the total output for all of mining. These shares are 0.1293, 0.1783, 0.2238, 0.0639, 0.0640 and 0.3407, respectively, for industries 12, 13, 14, 16, 17 and 64.

(A.5), readers would find that $y_{75} = 0.0 + (-2.21) \times (75/100 - 1) \times 12.57 = 6.94$ per cent. To take one more example, suppose readers would like to know the effect on exports of ferrous metal ores of a 25 per cent across-the-board tariff increase with only 50 per cent wage indexation. First they must compute the effect on the CPI of the tariff increase under 50 per cent wage indexation. If they substituted $\xi_{100} = 2.33$ (see Table 3.1, column [III], and note the sign reversal), $\eta_{\xi W_R} = 1.73$ and $\chi = 50$ into equation (A.4), they would find that $\xi_{50} = 2.33/(1 - 1.73 \times (50/100 - 1)) = 1.25$ per cent. Then they could substitute $y_{100} = -1.92$ (see Table 3.3, column [III], and note the sign reversal), $\eta_{yw_R} = -1.69$ (see Table 3.3, column [I], and note the sign reversal), $\chi = 50$ and $\xi_{50} = 1.25$ into equation (A.5), and solve for $y_{50} = -1.92 + (-1.69) \times (50/100 - 1) \times 1.25 = -0.86$ per cent.

(3) Explanation of the output responses of Services to Mining nec

Virtually all (94.9 per cent) of the output of Services to Mining nec is sold within the mining sector. A further 4.9 per cent is sold to Other demand (government consumption). In Table A.1 the numbers in parentheses represent the sales pattern of Services to Mining nec in the ORANI data base (see end note 4). Letting z_j and y_j respectively represent the changes in output and investment by industry j, and letting x_{17} represent the change in Other demand for the output of industry 17, the output of industry 17 is a weighted sum of the demands made by production and investment requirements in all the relevant (i.e., mining) industries, and of Other demand:

The second and final step to compute the results for an ORANI simulation under χ per cent wage indexation is that having obtained ξ_χ, further results under χ per cent wage indexation are computed as:

$$y_\chi = y_{100} + \eta_{yw_R} (\chi/100 - 1)\xi_\chi \quad ; \qquad (A.5)$$

where $y\chi$ and y_{100} refer to ORANI results for any variable y under χ per cent and 100 per cent wage indexation, respectively (note that in the case of an 18 per cent depreciation in the exchange rate with 100 per cent wage indexation, all endogenous price variables and real variables are projected to increase by 18 per cent and zero per cent, respectively); and η_{yw_R} is the elasticity of variable y with respect to a change in the real wage rate. These elasticities, with the opposite sign, are listed in column [I] of the tables.

Thus it is possible to compute using a hand calculator the results presented here under a range of alternative wage indexation assumptions. For example, suppose readers would like to know the effect on the output of the Mining sector of the 18 per cent depreciation with only 75 per cent flow-on into wages of the inflationary impact of the depreciation. First they must compute the effect on the CPI of the depreciation under 75 per cent wage indexation. If the substituted $\xi_{100} = 18$, $\eta_{\xi w_R} = 1.73$ and $\chi = 75$ into equation (A.4), they would find that $\xi_{75} = 18/(1 - 1.73 \times (75/100 - 1)) = 12.57$ per cent. Having estimated ξ_{75}, they can then use equation (A.5) to calculate the effect on the output of the Mining sector under 75 per cent wage indexation. If the substituted $y_{100} = 0.0$, $\eta_{yw_R} = -2.21$ (see Table 3.2, column [I], and note the sign reversal), $\chi = 75$ and $\xi_{75} = 12.57$ into equation

structures and sales patterns of the mining industries. The Ferrous Metal Ores, Non-Ferrous Metal Ores, Black Coal and Non-Ferrous Metals industries all directly export a significant portion of their output. Due to the competitive pressures on world markets, the exports of these industries will expand if there is a cut in the real wage rate as a cost -- see Table 3.3, column [I].

Among the mining industries Black Coal is projected to benefit the most from the real wage cut. This is due to a number of factors. The Black Coal industry exports a relatively high percentage of its output (approximately 70 per cent in the base period) which means that its total output is largely determined by what happens to its exports. Furthermore, the foreign demand curve for Australian black coal, whilst being downward sloping, is not particularly steep. The foreign elasticity of demand for black coal is modelled as -20.0. This means that a one per cent fall in the foreign currency at-port export price would result in an increase in foreign demand for Australian black coal of 20 per cent.

The Non-Ferrous Metals industry is also projected to benefit significantly from the real wage cut. This industry does not expand to quite the same extent from the real wage cut as the Black Coal industry. This is because the Non-Ferrous Metals industry exports a slightly lower percentage of its output (approximately 55 per cent in the base period) and the foreign elasticity of demand for non-ferrous metals is modelled as -10.0. However, the Non-Ferrous Metals industry is slightly more labour

TABLE 3.3 : THE SHORT-RUN EFFECTS ON MINERAL EXPORTS*

Endogenous Export Commodity	A Cut in the Real Wage Rate[a] as a Cost of 1 per cent [I]	An Increase in Real Absorption[b] of 1 per cent [II]	An Across-the-Board Tariff Cut[c] of 25 per cent [III]	The Imposition of a Consumption Tax Which Would Raise Purchasers' Prices by 5 per cent Accompanied by Compensating Cuts[d] in Income Taxes [IV]	Additional Foreign Exchange Earnings Equivalent to 1 per cent of GNP [V]	A Depreciation of the Australian Dollar with Full Discounting of Wages[e] of 18 per cent [VI]
12. Ferrous Metal Ores	1.69	-1.72	1.92	-0.59	-2.33	11.15
13. Non-Ferrous Metal Ores	1.64	-1.72	1.79	-0.57	-2.32	10.82
14. Black Coal	3.54	-3.85	3.97	-1.76	-5.20	23.36
64. Non-Ferrous Metals	3.75	-4.20	4.77	-1.26	-5.68	24.75
Mineral Exports[f]	2.94	-3.21	3.50	-1.16	-4.34	19.43

* All projections are percentage deviations from the values that the export volumes would have taken in the absence of the shock at the head of the column.

a The real wage rate is defined here as the nominal wage rate deflated by the consumer price index.

b Absorption is defined as the sum of household consumption, private investment and government spending.

c Quantitative restrictions are expressed in terms of tariff equivalents.

d Post-tax wage rates are 100 per cent indexed to the consumer price index and the direct tax cuts (comprising equal percentage cuts in the effective tax rates on labour and capital incomes) are calculated to hold constant private disposable income deflated by the private absorption deflator.

e That is, no flow-on into wages of the inflationary effects of the depreciation.

f The effect on mineral exports is calculated by weighting the effects on individual mineral exports by their shares in total mineral exports. These shares are 0.2070, 0.1252, 0.2954, 0.0142, 0.0000 and 0.3582, respectively, for commodities 12, 13, 14, 16, 17 and 64. Note that exports of commodities 16 and 17 are exogenous and set to zero change in these simulations.

must compute the effect on the CPI under χ per cent wage indexation, ξ_χ:

$$\xi_\chi = \xi_{100} + \eta_{\xi w_R} (\chi/100 - 1)\xi_\chi \quad ; \tag{A.1}$$

where ξ_{100} is the effect on the CPI under 100 per cent wage indexation (these are listed in the first row of Table 3.1 for simulations [I], [II], [III] and [V], and for simulations [VI] the effect on the CPI under 100 per cent wage indexation is 18 per cent); and $\eta_{\xi w_R}$ is elasticity of the CPI with respect to the real wage (i.e., 1.73 -- see Table 3.1, column [1] and note the sign reversal as the elasticity is defined with respect to a one per cent increase in the real wage). Equation (A.1) says that the effect on the CPI under χ per cent wage indexation consists of two parts, the effect under fixed real wages and the effect of reduction in the real wage (i.e., $(\chi/100 - 1)\xi_\chi$). Note that the percentage change in the real wage, w_R, is given by:

$$w_R = w - \xi_\chi \quad ; \tag{A.2}$$

where w is the percentage change in the nominal wage rate; and ξ_χ is as defined above. If wages are χ per cent indexed to the CPI then w is equal to $(\chi/100)\xi_\chi$. Thus we can write:

$$w_R = (\chi/100)\xi_\chi - \xi_\chi = (\chi/100 - 1)\xi_\chi \quad . \tag{A.3}$$

The percentage change in the CPI under χ per cent wage indexation can be solved from (A.1):

$$\xi_\chi = \xi_{100}/(1 - \eta_{\xi w_R} (\chi/100 - 1)) \quad . \tag{A.4}$$

APPENDIX

In this Appendix we: (1) define the concept of wage indexation used here; and (2) explain how the reader can compute the results under alternative wage indexation assumptions, with the exception of simulation [IV]. This exception is due to the complex nature of the wage bargain involved in the sales/income tax package.

(1) Concept of wage indexation

It is important to define the concept of wage indexation used here. Wages are said to be χ per cent indexed to the CPI if per unit costs of labour actually rose by $(\chi y/100)$ per cent, where y is the percentage increase in the CPI. For example, assume that in the base period the per unit cost of labour was \$20,000. As the result of some shock, say an across-the-board tariff increase, the CPI is projected to increase 5 per cent (i.e., $y = 5$). If wages are 70 per cent (i.e., $\chi = 70$) indexed to the CPI, then the per unit cost of labour will increase to \$20,700 (i.e., \$20,000 x (1 + (70 x 5/100)/100)). This represents an increase in per unit labour costs of 3.5 per cent (i.e., 100 x (\$20,700 - \$20,000)/\$20,000 = $\chi y/100$ = 70 x 5/100).

(2) The computation of results under alternative wage indexation assumptions

If the results are required for an ORANI simulation under χ per cent wage indexation, as opposed to 100 per cent wage indexation, then (following Dixon (1978)) they can be calculated as follows. First we

intensive in its use of primary factors than is the case for the Black Coal industry and for the Mining sector as a whole. As labour is modelled as the only variable primary factor in the short run (see feature (4) of the standard short-run macroeconomic environment as described in section 2 above), a labour intensive industry tends to be more responsive.

The next mining industry to benefit from the real wage cut is Non-Ferrous Metal Ores. This industry exported directly only approximately 40 per cent of its output in the base period and the foreign elasticity of demand for its output is modelled as only -8.0. Therefore, the increase in direct exports is just part of the explanation of why this industry benefitted from the cut in the real wage rate as a cost. The other part of the explanation is that nearly all of the remaining output of non-ferrous metal ores is sold to the Non-Ferrous Metals industry. As discussed above, this processing industry does relatively well from the real wage cut. As the Non-Ferrous Metals industry expands its output it also increases its demand for non-ferrous metal ores.

Among the mining industries which export a significant amount of their output, the least responsive is the Ferrous Metal Ores industry. This is due to the relatively large fixed factor intensity in this industry (or the relatively low labour intensity in its use of primary factors). The relatively large fixed factor intensity restricts the responsiveness of the industry even though it exports quite a large share of its output (approximately 85 per cent in the base period).[3]

On a net basis (i.e., excluding sales to itself), the Services to Mining nec industry sells 35 per cent of its output to current production in other mining industries, and 58 per cent to capital creation by them.[4] After taking into account a rather disparate pattern of responses within the mining sector, from the viewpoint of demands placed on Services to Mining nec the appropriate average responses of output and investment in other mining industries are 0.73 and 0.66 per cent respectively (see Appendix, note 3). On this basis, the output response of Services to Mining nec should be about 0.64 per cent (i.e., 0.35 x 0.73 + 0.58 x 0.66), which is quite close to the actual projection (0.63 per cent).

The final mining industry to be discussed is the Other Minerals industry. The sales of 'other minerals' are generally more diverse than those of the other mineral products. At least half of this industry's output, however, is sold to construction industries in the base period. Thus the response of the Other Minerals industry is linked to changes in the distribution of investment across industries. As a very rough rule, the percentage change in real GDP (see Table 3.1, column [I]) is a proxy in the simulations presented here, for the percentage change in the demand for 'other minerals'.

The effects of a cut in the real wage rate as a cost are presented in Table 3.4, column [I]. The size of the cut is chosen so as to cause a 5 per cent decline in the short-run real net returns to the Mining

(v) additional foreign exchange earnings, generated outside the existing mining sector, equivalent to six-tenths of one per cent of GNP;

and

(vi) an appreciation of the Australian dollar of about 2.7 per cent under conditions in which nominal wage rates remained unaffected by this development.

About two years after their imposition, each of these shocks could be expected to cause real net returns in the Mining sector to be about five per cent less than would otherwise have been the case.

For future research, the long-run (say at about ten years) effects of these economic shocks should also be studied. The modelling of the response of mining industries in long-run ORANI simulations is currently under investigation at the IMPACT Project -- see Blampied, Horridge and Powell (1985).

4. CONCLUSION

In this study we have sought to quantify the short-run (about two years) effects of a range of economic shocks on the domestic Mining sector. The key finding is that the fortunes of the Australian Mining sector are highly dependent upon Australia's international competitiveness in general. In terms of their seriousness as measured by their capacity to depress pre-tax real net returns to mining, the following shocks are equally deleterious:

(i) a one per cent increase in the real wage rate as a cost to employers;

(ii) an eight-tenths of one per cent increase in real aggregate demand;

(iii) an across-the-board increase of one-fifth of the ad valorem values of tariffs (and the tariff equivalents of other protective measures);

(iv) a sales/income tax package which increases purchasers' prices by three and a half per cent while granting equal relief to effective income tax rates on capital and labour (with the size of the income tax cuts calibrated to keep real personal disposable income constant);

sector. There are two features of projections obtained from the ORANI model which should be explained at this point. The first is that these projections are deviations from the value real net returns would have taken in about 2 years time in the absence of the economic shock under focus -- in this case a 0.98 per cent increase today in the real wage rate as a cost. The second is the linear nature of the projections. This means that the effects of a one per cent increase in the real wage rate as a cost can be obtained by dividing the projections listed in Table 3.4, column [I], by 0.98. Also, if the reader were really interested in projections for a one per cent real wage cut, then these could be obtained by first dividing the projections listed in Table 3.4, column [I], by 0.98 and then reversing the sign. For example, a one per cent cut today in the real wage rate as a cost would increase the real net returns in the Mining sector by 5.10 per cent (i.e., -(-5.00/0.98)) in about 2 years.

The real net return to industry j is defined as the earnings of labour and capital in that industry both deflated by the CPI:

$$(nr_j - \varepsilon) = S_{Lj}(\ell_j + w - \varepsilon) + S_{Kj}(k_j + q_j - \varepsilon) \quad ; \qquad (3.1)$$

where $(nr_j - \varepsilon)$ is the percentage change in real net returns in industry j; S_{Lj} and S_{Kj} are respectively the shares of returns to labour and

TABLE 3.4 : THE SHORT-RUN EFFECTS ON REAL NET RETURNS TO MINING INDUSTRIES*

ORANI Industry	An Increase in the Real Wage Rate[a] as a Cost of 0.98 per cent [I]	An Increase in Real Absorption[b] of 0.84 per cent [II]	An Across-the-Board Tariff Increase[c] of 19.75 per cent [III]	The Imposition of a Consumption Tax Which Would Raise Purchasers' Prices by 3.51 per cent Accompanied by Compensating Cuts[d] in Income Taxes [IV]	Additional Foreign Exchange Earnings Equivalent to 0.63 per cent of GNP [V]	An Appreciation of the Australian Dollar with Full Discounting of Wages[e] of 2.67 per cent [VI]
12. Ferrous Metal Ores	-5.24	-5.32	-5.42	-4.86	-5.32	-5.24
13. Non-Ferrous Metal Ores	-5.36	-5.44	-5.33	-4.87	-5.44	-5.36
14. Black Coal	-6.49	-6.49	-6.29	-5.90	-6.49	-6.49
16. Other Minerals	-0.78	0.30	-0.81	-3.74	0.30	-0.78
17. Services to Mining nec	0.24	-0.60	-0.64	-3.56	-0.60	0.24
64. Non-Ferrous Metals	-5.33	-5.36	-5.25	-4.82	-5.36	-5.33
Mining[f]	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00

* All projections are percentage deviations from what real net returns in each industry would have been in the absence of the shock at the head of the column. Real net returns is the earnings of capital and labour deflated for increases in the consumer price index.

a The real wage rate is defined here as the nominal wage rate deflated by the consumer price index.

b Absorption is defined as the sum of household consumption, private investment and government spending.

c Quantitative restrictions are expressed in terms of tariff equivalents.

d Post-tax wage rates are 100 per cent indexed to the consumer price index and the direct tax cuts (comprising equal percentage cuts in the effective tax rates on labour and capital incomes) are calculated to hold constant private disposable income deflated by a private absorption deflator.

e That is, no flow-on into wages of the inflationary effects of the depreciation.

f The effect on real net returns for the Mining sector is calculated by weighting the effects on industry real net returns by each industry's share of primary factors (returns to capital and labour) in the total input of primary factors for all of mining. These shares are 0.1468, 0.2346, 0.2950, 0.0766, 0.0572 and 0.1898, respectively, for industries 12, 13, 14, 16, 17 and 64.

presented in column [VI] of Table 3.4. It can be seen from the table that a 2.67 per cent appreciation with full discounting of wages would cause a 5 per cent decline in real net returns to the Mining sector. The pattern of industry real net return projections follow from the industry output projections -- see section 3.1 for further discussion on this point and note that the real wage (i.e., $w - \xi$) is projected to fall by 6.59 per cent here.

traded sector would improve dramatically. Exports are projected to increase by 15.75 per cent and imports are projected to decline by 5.60 per cent -- see Table 3.1, column [VI]. The net result is an improvement in the balance of trade of $3.10 billion (1977-78 prices). Aggregate Employment and Real GDP are projected to increase due to the depreciation if there is full discounting of wages. Note that it is possible for the reader to recompute the results for an environment of partial wage indexation. This is explained in the Appendix.

The Mining sector as a whole is projected to expand due to the depreciation, assuming full discounting of wages for the inflationary impact of the depreciation -- see Table 3.2, column [VI]. The distribution of benefits is not uniform across the sector. The export-oriented mining industries are projected to experience relatively large increases in output. Exports of ferrous metal ores, non-ferrous metal ores, black coal and non-ferrous metals are all projected to increase due to the depreciation with full discounting of wages -- see Table 3.3, column [VI]. The Services to Mining nec industry is projected to follow the output response of the Mining sector -- see, for example, section 3.1 for further discussion on this point. The Other Minerals industry is projected to experience a relatively small increase in output. This is due to increased sales to the domestic construction industries which are projected to expand as a result of the depreciation with full wage discounting (cf. the real GDP projection listed in Table 3.1, column [VI]).

The effects of an appreciation in the exchange rate, with full discounting of wages, on real net returns to the Mining sector are

capital in primary factors in industry j; ℓ_j and k_j are the percentage changes in the employment levels of labour and capital in industry j; w is the percentage change in the nominal wage rate[5]; q_j is the percentage change in the rental on capital in industry j; and ξ is the percentage change in the CPI. Recall from section 2 that labour is a variable input in the standard short-run macroeconomic environment; therefore, its earnings can increase both through an increase in the amount of labour used and through an increase in real wages. Since real wages are set to fall by one per cent in this simulation (i.e., $w - \xi = -1$), any increase in real returns to labour will be due to increased employment. On the other hand, capital is fixed in the standard short-run macroeconomic environment (i.e., $k_j = 0$). Therefore its earnings can only increase through an increase in the real rental rate on capital (i.e., via $q_j - \xi$). The rental rate on capital in industry j will rise as the ratio of labour to capital in use in the industry increases (i.e., as the industry's output increases). In fact the percentage change in real net returns to industry j can be written:[6]

$$(nr_j - \xi) = z_j \pi_j + w - \xi \quad ; \tag{3.2}$$

where

$$\pi_j = 1 + S_{Kj}/(\sigma S_{Lj}) \quad . \tag{3.3}$$

According to equation (3.2) the percentage change in real net returns in industry j depends upon; z_j, the percentage change in the output of industry j, multiplied by π_j (which is a function of S_{Kj} and S_{Lj}, as defined above, and σ, the elasticity of substitution between primary factors (set equal to 0.5 for all industries in the short run)); and

$(w - \xi)$, the percentage change in the real wage. If there is full wage indexation (i.e., $w = \xi$) then the percentage change in real net returns $(nr_j - \xi)$ is equal to $z_{j\,j}$. Furthermore, if the only primary factor is labour (i.e., $\pi_j = 1$), to take an extreme case, then the percentage change in real net returns will equal the percentage change in industry output (which in turn equals the percentage change in the size of the workforce employed in the industry). However, as the share of fixed factors (i.e., capital) increases, the percentage change in real net returns increases by more than the percentage change in output. The π_j can be calculated from the ORANI data base and they are equal to 3.9140, 2.9063, 2.7658, 3.0950, 1.1782 and 2.4323 respectively for industries 12, 13, 14, 16, 17 and 64. To take the Ferrous Metal Ores industry as an example, a one per cent cut in the real wage rate as a cost is projected to cause this industry's output to increase by 1.62 per cent -- see Table 3.2, column [I]. Thus a 0.98 per cent increase in the real wage rate as a cost would cause a 1.59 per cent (i.e., -0.98 x 1.62) decrease in this industry's output. Therefore according to equation (3.2), a 0.98 per cent increase in the real wage rate as a cost would cause real net returns to the Ferrous Metal Ores industry to decline by 5.24 per cent (i.e., -1.59 x 3.9140 + 0.98). The other real net return projections can be deduced by a similar chain of effects. Of note perhaps is the small increase of 0.25 per cent in the real net returns to the Services to Mining nec industry that is projected to occur if there were a 0.98 per cent increase in the real wage rate as a cost. This is due to the relatively high share of labour in primary factors in this industry. Even though the output of this industry is projected to decline if there were an increase in the real wage as a cost,

projections -- see, for example, section 3.2 for further discussion on this point.

3.6 A Movement in the Exchange Rate

The final external economic shock to be considered is a movement in the Australian exchange rate. Here we examine the depreciation over the first half of 1985 of the Australian dollar relative to the currencies of Australia's major trading partners. On average the Australian dollar can be seen to have depreciated 18 per cent in real terms (i.e., after taking into account movements in the Australian versus rest of world inflation rates).[16] This has produced an immediate improvement in the competitiveness of the export and import-competing sectors. Whether or not this improved competitveness is retained depends on the response of the labour movement. In terms of the popular nomenclature, if there is no discounting of wages (i.e., if wages are fully indexed to consumer prices) then the improved competitiveness will be lost. If, however, there is full discounting of wages (i.e., wages are not adjusted to compensate for price changes due to currency movements), the whole competitive advantage will be retained. In Table 3.1, column [VI], we can see the potency of changes in the overseas value of the Australian dollar when wages are fully discounted. According to ORANI, if wages are held constant in nominal terms, an 18 per cent depreciation of the Australian dollar would cause the CPI to increase by only 6.59 per cent. Since the selling price in Australian dollars of traded goods would have increased by around 18 per cent but domestic costs would have only increased by less 6.59 per cent[17] the international competitiveness of the

Aggregate employment and real GDP are projected to increase due to the additional foreign exchange earnings. Note that since the increase in foreign exchange is accommodated by an increase in absorption, the results for an increase in real absorption are similar to those discussed here (compare columns [II] and [V] of Table 3.1).

The traditional Mining sector as a whole is projected to decline due to the additional foreign exchange -- see Table 3.2, column [V]. The distribution of the costs of the additional foreign exchange is not uniform across the sector. The traditional export-oriented mining industries are projected to experience relatively large declines in output. Exports of ferrous metal ores, non-ferrous metal ores, black coal and non-ferrous metals are all projected to decline due to the additional foreign exchange -- see Table 3.3, column [V]. The Services to Mining nec industry is projected to follow the output response of the Mining sector -- see, for example, section 3.1 for further discussion in this point. The Other Minerals industry is projected to experience a small increase in output due to increased sales to domestic construction industries which are projected to expand as a result of the additional foreign exchange (cf. the real GDP projection listed in Table 3.1, column [V]).

The effects of additional foreign exchange earnings on real net returns to the traditional Mining sector are presented in column [V] of Table 3.4. It can be seen from the table that additional foreign exchange earnings equivalent to 0.63 per cent of GNP would cause a 5 per cent decline in real net returns to the traditional Mining sector. The pattern of industry real net return projections follow from the industry output

the increased return to those workers still employed in the industry after the wage rise is sufficient to more than offset the effects on real net returns of the now smaller workforce employed in that industry.

3.2 Aggregate Demand Management

The Mining sector is not only sensitive to wages but also to aggregate demand management policy. An increase in domestic demand, say through increased government spending, would stimulate the non-traded sector of the economy. However, it would also tend to increase domestic costs and thus reduce the competitiveness of domestic export and import-competing industries. It can be seen from column [II] of Table 3.1 that a one per cent increase in real absorption (i.e., the sum of real household consumption, real private investment and real government spending) is projected to cause the CPI to increase by 2.34 per cent. As domestic costs increase, the international competitiveness of the traded sectors worsens. Exports are projected to decline by 2.56 per cent and imports are projected to increase by 1.97 per cent; the net result is a deterioration of the balance of trade of $0.66 billion (1977-78 prices). Aggregate employment and real GDP are projected to increase due to the expansion in domestic demand.

The Mining sector as a whole is projected to decline due to the increase in real absorption -- see Table 3.2, column [II]. The distribution of the costs of the increase in real absorption, however, is not uniform across the sector. The export-oriented mining industries are projected to experience relatively large declines in output. Exports of

ferrous metal ores, non-ferrous metal ores, black coal and non-ferrous metals are all projected to decline due to the increase in real absorption -- see Table 3.3, column [II]. Note that the ranking of the industry output responses for these export-oriented industries is the same here as what it would be for the case of a real wage increase -- for further discussion on this point see section 3.1 above.

Output in the Services to Mining nec industry is projected to decline by 0.61 per cent. About 40 per cent of this decline is due to contractions in current output of other mining industries, and about 60 per cent to contractions in investment in these industries (see Appendix, note 3). The decline would have been larger except for the fact that five percent of the sales of Services to Mining nec are to Other (i.e., government) demand, which expands exogenously by one per cent.

The Other Minerals industry would experience a small increase in output if there were a one per cent increase in real absorption -- see Table 3.2, column [II]. The Other Minerals industry sells about two thirds of its output to the construction industries, and to industries which supply them with cement, glass, products made therefrom, and similar products. In the face of a one per cent exogenous increase in real absorption, these industries expand on average by slightly less than one per cent. This construction-related source of demand would have led, therefore, to an increase in the output of Other Minerals of about 0.6 per cent. Other sources of demand, however, lie predominantly in the export and import-competing sectors, where output contracts, leading finally to a net rise of only 0.11 per cent in the output of Other Minerals.

3.5 Foreign Exchange Earnings from New Exports

The idea that the direct effects of new mining activity have an overall impact on the Australian economy which is small by comparison with the indirect effects of the additional foreign exchange earned was first highlighted by Gregory (1976). Here we analyze the short-run impact on the traditional mining sector of the impact of additional foreign exchange earnings equivalent to one per cent of GNP. The foreign exchange earnings could be derived from new mining or agricultural activities. Note that we are only capturing the indirect effects of the additional foreign exchange and not the direct input-output linkage effects of the new activity. To simulate the effects of a 'free gift' of foreign exchange use was made of the ORANI macro-accounting module as developed by Horridge (1985).

An increase in foreign exchange is accommodated (i.e., spent) by an increase in absorption. This increase in absorption is inflationary -- see Table 3.1, column [V]. As domestic costs increase, the international competitiveness of the traded sector worsens. There is a contraction in traditional (i.e., pre-new-activity) exports and an increase in imports. (Thus the new export-oriented activity can be seen to cause contractions in traditional exports). The balance of trade (excluding the additional foreign exchange equivalent to one per cent of GNP) is projected to deteriorate by $0.89 billion (1977-78 prices). Since GNP in the base period was $91.24 billion (1977-78 prices), the free gift of foreign exchange is equal to $0.91 billion (1977-78 prices). Thus the balance of trade (inclusive of the additional foreign exchange) would increase by $0.02 billion (i.e., ($0.91 - $0.89) billion) in terms of 1977-78 prices.

Real pre-tax net returns are projected to decline most in the export-oriented industries, however in this simulation the distribution of the costs in terms of the real pre-tax net returns to the individual industries is fairly uniform across the sector. This result can be explained with reference to equation (3.2) which says that the percentage change in real net returns can be expressed as a function of the percentage changes in industry output and the real pre-tax wage rate. Recall from above that pre-tax wage rate is projected to increase by 0.77 per cent (i.e., $w = 0.77$) and the CPI is projected to increase by 5.49 per cent (i.e., $\xi = 5.49$). Therefore the real pre-tax wage rate is projected to decrease by 4.72 per cent (i.e., 0.77 - 5.49). If the sales tax was one which would only raise purchasers' prices by 3.51 per cent rather than by 5 per cent, then the real pre-tax wage rate would decrease by 3.31 per cent (i.e., 4.72/5 x 3.51 = 3.31). This relatively large decline in the real pre-tax wage rate tends to dominate the effects on real pre-tax net returns of the individual industry output projections (i.e., the $z_j\pi_j$ effects). For example, the percentage change in real net returns to the Ferrous Metal Ores industry due to the imposition of a sales tax which would raise purchasers' prices by 3.51 per cent is equal to the percentage change in its output (-0.57/5 x 3.51 = -0.40 per cent -- see Table 3.2, column [IV]) times the relevant π_j (3.9140 -- these are listed in section 3.1), which equals -1.55 per cent, plus the change in the real pre-tax wage rate of -3.31 per cent. Thus real net returns to the Ferrous Metal Ores industry is projected to decrease by 4.86 per cent (i.e., -1.55 + (-3.31)). The other pre-tax real net return projections can be deduced by a similar chain of effects.

The effects of an increase in real absorption on real net returns to the Mining sector are presented in column [II] of Table 3.4. It can be seen from the table that a 0.84 per cent increase in real absorption would cause a 5 per cent decline in real net returns to the Mining sector as a whole. The effects on real net returns are not uniform across the sector. This result follows from the pattern of industry output projections. Recall from equation (3.2) that the percentage change in real net returns can be expressed as a function of the percentage changes in industry output and the real wage. In this simulation there is assumed to be no change in the latter(i.e., $w = \xi$); thus, according to equation (3.2) the percentage change in real net returns simply depends on the percentage change in industry output multiplied by the parameter π_j, which reflects the degree of capital intensity in the primary factors employed in the industry. For example, the percentage change in real net returns to the Ferrous Metal Ores industry due to a 0.84 per cent increase in real absorption is equal to the percentage change in its output (-1.61 x 0.84 = -1.35 per cent -- see Table 3.2, column [II]) times the relevant π_j (3.9140 -- these are listed in section 3.1), which equals -5.32 per cent. The other real net return projections can be deduced via a similar chain of effects.

3.3 Protection for Manufacturing Industries

The detrimental effects of Australia's continuing high levels of protection for its manufacturing industries are specifically concentrated on the export sector. This can be explained by examining the effects of a cut in protection of the CPI. The direct impact of such a cut is to cause a reduction in the CPI due to the now cheaper imported consumer goods. In view of the wage indexation assumption, a fall in (or a moderation in the rate of increase of) the CPI7 would lead to lower money wages. The lower

wage demands would feed into domestic prices which in turn would feed back into the CPI, etc. The ORANI model captures these general equilibrium effects and a 25 per cent acros-the-board tariff cut[8] is projected to cause the CPI to be 2.33 per cent lower after about 2 years relative to what it would have been in the absence of the tariff cut -- see Table 3.1, column [III]. As domestic costs fall, the international competitiveness of the traded sectors improves. Exports are projected to increase by 2.61 per cent and imports are projected to increase by 1.54 per cent, the net result being an improvement of the balance of trade of $0.16 billion (1977-78 prices). Aggregate employment and real GDP are also projected to improve from the across-the-board tariff cut.

The Mining sector as a whole is projected to expand due to the tariff cut -- see Table 3.2, column [III]. The distribution of the benefits are not uniform across the sector. The export-oriented mining industries are projected to experience relatively large increases in output. Exports of ferrous metal ores, non-ferrous metal ores, black coal and non-ferrous metals are all projected to increase due to the tariff cut -- see Table 3.3, column [III]. The Services to Mining nec industry is projected to follow the output response of the Mining sector -- see, for example, section 3.1 for further discussion on this point. The Other Minerals industry is projected to experience a relatively small increase in output. This is due to increased sales to domestic construction industries which are projected to expand as a result of the tariff cut (cf. the real GDP projection listed in Table 3.1, column [III]).

The effects of a tariff change on real net returns to the

as seen by a typical Australian producer. Producers in the Mining sector selling to world markets are <u>not</u> typical, however, since inflation in their costs cannot, as a rule, be passed on. On average prices received by mineral producers do not change as a result of the shift towards indirect taxation, so that the rise in pre-tax wages required by the bargain causes the real wage as a cost to mineral producers to increase by 0.77 per cent rather than by 0.29 per cent. As a result the Mining sector is projected to experience a 0.84 per cent decrease in output -- see Table 3.2, column [IV]. The distribution of the costs of the change in the tax mix are not uniform across the sector. The export-oriented mining sectors are projected to experience relatively large decreases in output. Exports of ferrous metal ores, non-ferrous metal ores, black coal and non-ferrous metals are all projected to decline due to the change in the tax mix -- see Table 3.3, column [IV]. The Services to Mining nec industry is projected to follow the output response of the Mining sector -- see, for example, section 3.1 for further discussion on this point. The Other Minerals industry is projected to experience a relatively small decline in output. This is due to decreased sales to domestic construction industries which are projected to contract as a result of the change in the tax mix (cf. the real GDP projection listed in Table 3.1, column [IV]).

The effects of a sales tax on real pre-tax net returns to the Mining sector are presented in column [IV] of Table 3.4. It can be seen from the table that the imposition of new sales tax which would raise purchasers' prices by 3.51 per cent, with rates of take-home pay held constant in real terms and compensating tax cuts, would cause a 5 per cent decline in real net returns to the Mining sector as a whole.

Is the cut in income taxes described above enough to provide in full the $17.22 compensation needed to maintain the purchasing power of our hypothetical worker? If the pre-tax wage stayed put at $400, the tax saving is worth only $14.68 (viz., (0.2173 - 0.1806) x $400). This would leave a gap of $2.54 in the take-home pay. Under the bargain, the employer would have to increase pre-tax wages by $3.09 (i.e., $2.54/(1-0.1806)).

We are now in a position to say what will have happened to the real wage rate as a cost. Nominal wages, as a cost, have increased by $3.09 or 0.77 per cent (i.e., $3.09/$400 x 100). It turns out however that prices received by producers have increased only by 0.48 per cent.[15] Thus the real wage rate as a cost has risen by 0.29 (= 0.77 - 0.48) per cent.

As the change in the tax mix is projected to cause an increase in the real wage rate as a cost, the international competitiveness of the traded sectors declines. Exports are projected to decrease by 0.84 per cent and imports are projected to increase by 0.26 per cent -- see Table 3.1, column [IV]. The net result is a deterioration of the balance of trade of $0.16 billion (1977-78 prices). Aggregate employment and real GDP are projected to decline due to the change in the tax mix. As a final point, note that since the change in the tax mix is projected to cause the real wage rate as a cost to increase by 0.29 per cent we would expect, with the exception of the CPI projection, that the projections in column [IV] of Table 3.1 would be of the opposite sign and roughly one-third of those listed in column [I].

So far the discussion has been cast in terms of real wage costs

Mining sector are presented in column [III] of Table 3.4. It can be seen from the table that a 19.75 per cent across-the-board tariff increase would cause a 5 per cent decline in real net returns to the Mining sector as a whole. The pattern of industry real net return projections follow from the industry output projections -- see, for example, section 3.2 for further discussion on this point.

The results listed in Table 3.4 can be used to estimate the short-run cost to the Mining sector of the protection currently afforded to manufacturing industries. If a 19.75 per cent across-the-board tariff increase would cause real net returns to the Mining sector to decline by 5 per cent, then a 100 per cent across-the-board tariff cut would cause real net returns to the Mining sector to increase in the short-run by approximately 25 per cent (i.e., (-5/19.75) x -100).[9] Note that an identical calculation was made by Parmenter (1985) to estimate the cost of manufacturing protection to farmers. The short-run cost to farmers was estimated to be approximately 17 per cent of real net farm returns, somewhat less than the cost to the Mining sector.

3.4 Change in the Tax Mix in Favour of Indirect Taxation

The next aspect of domestic economic management that is studied here concerns a change in Australia's tax mix in favour of indirect taxation. The Australian tax system is currently under debate, largely due to the growing share of government revenue raised from personal income taxes. In response to this pressure for reform the Australian government called a tax summit in 1985 at which its preferred option (at least prior

to the summit) involved a shift towards indirect taxation with compensating income tax cuts.[10] Here we use the ORANI National and Government Accounts module, NAGA, as developed by Meagher and Parmenter (1985), to analyse the effects of the imposition of a 5 per cent household consumption tax accompanied by compensating cuts in income taxes. A compensating tax cut is defined here to be a tax cut which when combined with the household consumption tax leaves real private absorption (i.e., real household consumption plus real private investment) unchanged.

The outcome of any tax package is going to depend crucially on the response of the labour movement. The response studied here is one where post-tax wage rates (i.e., rates of take-home pay) are fully indexed to consumer prices.[11] The outcome also depends on the distribution of the compensating tax cuts between labour and capital income. Here it is assumed that there are equal percentage cuts in the effective tax rates[12] on labour and capital income.[13] Recall from section 3.1 that it is important to distinguish between wage rates as a cost and wage rates as an income. The wedge between these two is the income tax rate. In the ORANI data base, the initial effective tax rate on labour income is 21.73 per cent. Thus, if the average worker receives a pre-tax wage of $400 (i.e., wages as a cost), he takes home $313.08 (i.e., wages as an income = $400 x (1 - 0.2173)). The imposition of the household consumption tax will increase the CPI by about 5.5 per cent -- see Table 3.1, column [IV]. (The reason that the CPI rises by more than the 5 per cent of the consumer tax is that, as will be seen below, there is some upward pressure on labour costs which feed into prices.) If an agreement is reached with the labour movement to fully index take-home pay, then the latter must increase by

$17.22 (i.e., 0.055 x $313.08). If such a payment is made, then there will have been no change in the purchasing power of an employed worker (i.e., the real wage rate as an income will not have changed). The implicit bargain struck between employers and employees, through the interventions by the government in the tax field, guarantees that such a payment will indeed be made. The bargain thus underwrites the interests of workers who retain employment after the implementation of the package.

The question then is: will the real wage rate as a cost have risen, fallen, or not have changed? This depends on the extent to which the relativity between producers' costs and prices received by them changes in the aftermath of the imposition of the package. If the prices received by producers increased by more than the percentage change in the pre-tax money wage rate, then the real wage rate as a cost will have fallen; in the contrary case, it will have risen.

Our calculations depend on what else is assumed about macro-economic management when the package is implemented. Here it is assumed that the size of the direct tax cuts is chosen in such a way that the sum of take-home labour income and post-tax returns to capital are held steady in real terms.[14] It is further assumed that the average income tax rates actually paid by workers and the owners of capital, each decline by the same proportion. This turns out to imply that the income tax rate paid by workers is reduced to 18.06 per cent. Under these conditions, (as foreshadowed above) the package entails some secondary inflation, leading to a rise in producers' prices of about half of one per cent.