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THE SENSITIVITY OF ORANI 78 PROJECTIONS TO THE DATABASE USED

by

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ABSTRACT

ORANI simulations of the short run effects of a 5.0 per cent increase in Aggregate Employment and a 5.3 per cent increase in the Balance of Trade are reported using 1968-69, 1974-75 and 1977-78 databases. The results are in general very similar within each experiment. Differences between the results reflect both changes in the Australian economy and developments in database methodology. An attempt is made to isolate the major elements of the dissimilarities.

6. In Table 7, 75 per cent of Construction Machinery sales were to capital creation in 1968-69, which suggests that the Construction Machinery industry's output change should have been negative. In fact the change was +0.76 per cent. The anomaly can be explained by noting that the weighted average rate of return of the principal industries (whose investment was endogenously determined) which bought Construction Machinery in the 1968-69 simulation for capital creation was +19.4 per cent, which exceeded the change in the economy-wide rate of return of +16.6 per cent. In contrast, in the 1977-78 simulation, the corresponding figures were +7.6 and +19.8 per cent, respectively. These differences drove the ORANI investment allocation mechanism [equations (19.2) and (19.8) in Dixon et al. (1982)] to increase purchases of Construction Machinery for capital creation in the 1968-69 simulation but to decrease them in the 1977-78 simulation.

7. See equation (16.2) in Dixon et al. (1982).

8. See equations (14.21) and (14.24) in Dixon et al. (1982).

FOOTNOTES

* A draft version of this paper was presented at the Economic Society of Australia's Fourteenth Conference of Economists, held at the University of New South Wales in May 1985. The paper has benefitted from the comments of Peter Higgs, Mike Kenderes, Tony Lawson, Tony Meagher, Brian Parmenter and (especially) Alan Powell. The author is grateful to these people and claims full property rights to remaining errors.

1. The ORANI computable general equilibrium model of the Australian economy is described in Dixon, Parmenter, Sutton and Vincent (1982).

2. The Melbourne ORANI 78 code was used, employing CSIRONET's CYBER 76 mainframe computer under the SCOPE operating system.

3. Throughout this paper the convention has been used of assigning capital letters to the names of variables which enter the ORANI equations explicitly.

4. Of course, ORANI could be used to find the set of relativities which would be consistent with absorbing any given hypothetical occupational mix.

5. Although Sheep-meat is defined to be an endogenous export commodity on pp. 38-39 of Bruce (1985), it was dropped from the default list of such commodities for the standard 1977-78 database shortly after the simulations reported here were undertaken.

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I INTRODUCTION

Since it became operational in 1977, the ORANI[1] computable general equilibrium model of the Australian economy has been used in a wide range of economic policy analyses (for an overview, see Parmenter and Meagher (1985)). More recently, ORANI has been used for short-term economic forecasting (Dixon, McDonald and Meagher (1984)). ORANI relies heavily on a set of national input-output tables for the bulk of its data requirements. At the time of writing, three sets of input-output accounts have been used for ORANI projections (ABS (1977), (1980), (1983)). It is natural to ask what effect a change from one of these databases to another has on projections made with ORANI? If there is a substantial effect, especially on macro results, then there may be a case for reworking major analyses with newer databases. On the other hand, if the macro results vary only minutely with a change in database, then existing analyses can be allowed to stand and one must then consider whether it is worth committing substantial resources to the construction of new ORANI databases each time a new set of input-output accounts is published. The ABS plans to publish input-output tables for each year from 1977-78 and has already released the 1978-79 tables (ABS (1984)), which are currently being used by the

Industries Assistance Commission to create a new ORANI database.

The aim of this paper is to highlight changes in the Australian economy and in the standard ORANI databases for 1968-69, 1974-75 and 1977-78. More recent input-output tables may enable ORANI users to identify more accurately the economic consequences of policy and other changes for the present Australian economy if it is more closely portrayed by such data – except for industries whose experience is abnormal in the most recently collected data. The gain in accuracy stems from the many industry technologies and sales shares which are updated when a new set of input-output tables is used. In consequence, it seems obvious that the Australian economy represented in the 1977-78 ORANI database is far more like the present economy than either of the previous databases.

In addition to the use of newly released input-output tables, considerable work has been done at each update to improve the database in other ways; e.g., re-specification of the agricultural sector, re-estimation of the household expenditure elasticities and the adoption of an extra occupational class.

For the above reasons one should not be surprised if, for a given economic environment and exogenous shock, the ORANI model were to yield moderately different numerical results with different databases. In general, however, one would expect qualitatively similar results, especially for changes in the macroeconomic variables. What follows provides a partial validation for such expectations. This paper complements Bruce (1985), which describes the construction of the 1977-78

Parmenter, B.R. and G.A. Meagher (1985). Policy Analysis Using a Computable General Equilibrium Model: A Review of Experience at the IMPACT Project. Australian Economic Review 69:3-15.

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Norman, N.R. (1981). The IMPACT Macrofix: An Exposition. Australian Economic Papers 20:183-185.

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ORANI database. The principal new features of the latter are the incorporation of data for the agricultural sector in a typical year and the balancing of total costs and sales values.

The method adopted is described in Part II, and the results obtained are presented in Part III. Finally, the implications for future interpretations of ORANI analyses and the construction of subsequent databases are discussed.

II METHOD

The method of analysis adopted here is to compare the ORANI databases which have been used as representations of the Australian economy and its behaviour by members of the IMPACT Project, and others, and which have been regarded by them as sufficiently accurate for their purposes. The paper differs from the work of Dixon, Parmenter and Rimmer (1984), who partitioned the differences between the results of projections using the 1968-69 and 1974-75 databases into a number of effects using the tools of sensitivity analysis. Rather, by exposing the salient differences between the 1977-78 database and the others, this paper points to the parts of the ORANI databases which are candidates for such analyses.

The Economic Environment

ORANI was run[2] using the Johansen solution method in a short-run closure with each of the three databases to be scrutinised: 1968-69, 1974-75 and 1977-78. Variables which were set exogenous in order to close the model are listed in Table 1, from which it should be noted that domestic consumption was allowed to vary and the Balance of Trade[3] set exogenously. The reasons for this do not relate to the databases, but rather to a desire to allow the simulation of increased prosperity generated in the export sector to feed into consumption. The same closure was used in the case of the employment shock to facilitate comparison. Other ORANI studies in which the Balance of Trade has been set exogenous are Bonnell (1984), and Dixon, Powell and Parmenter (1979).

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commodities to exports and to capital creation. It may be that the variability of industry investment between the three databases obscures more logical underlying trends. If so, there is a prima facie case for the IMPACT team to consider the incorporation of typical year industry investment shares into future databases.

The usual assumption of an exogenous Aggregate Wage Rate was replaced in favour of making Aggregate Labour Employment exogenous so that it could be shocked to gauge the effects on real wages and other macro variables of increasing the size of the employed workforce. Admittedly, ORANI as used here cannot tell a complete story for, even though absorption is endogenous, there is no explicit linkage between household expenditure and household income (Challen (1984), pp. 21-22).

Lastly, Aggregate Real Investment was set exogenous and the Ratio of Real Aggregate Consumption to Real Aggregate Investment allowed to vary. It follows from the GDP identity that the full manifestation of changes in real GDP will be as changes in Aggregate Real Consumption. In all other respects, the closure was standard: all indexing parameters were set to unity; Other Final Demand (government consumption) was indexed to Aggregate (household) Consumption; and default sets of endogenous export commodities, and industries for which the ORANI rate-of-return investment theory is inoperative, were used (both sets vary somewhat among the three databases).

Table 1: VARIABLES SET EXOGENOUSLY IN THE REPORTED SIMULATIONS

Variable[a]	No. of components[b]
Exogenous commodity exports	g-G
Powers of exogenous *ad valorem* export subsidies	G
Import prices (foreign currency)	g
Ad valorem tariff rates	g
Nominal exchange rate ($A/$US)	1
Base period capital stocks by industry	h
Employment of agricultural land	7
Balance of trade ($A x 10^9)	1
Aggregate real investment	1
Aggregate labour employment (persons)[c]	1
Number of households	1
Shift term for exports	g
Shift term for occupation wage rates	M
Shift term for industry wage rates	h
Shift term for other costs	h
Shift term for exogenous investment	h-J*
Shift term for other usage (domestic)	g
Shift term for other usage (imports)	g
Composite variables b_1 in cost of capital equation	h
Composite variables b_2 in price equation	h
Composite variables b_3 in domestic consumption equation	g
Composite variables b_4 in import consumption equation	g
Composite variables b_5 in labour demand equation	M
Composite variables b_6 in capital demand equation	h
Composite variables b_7 in land demand equation	7
Composite variables b_8 in domestic market clearing equation	g
Composite variables b_9 in imports market clearing equation	g
Composite variables b_{10} in import price equation	g
Composite variables b_{11} in export cost equation	g
Composite variable b_{12} in CPI equation	1
Composite variables b_{13} in CRETH equation	9

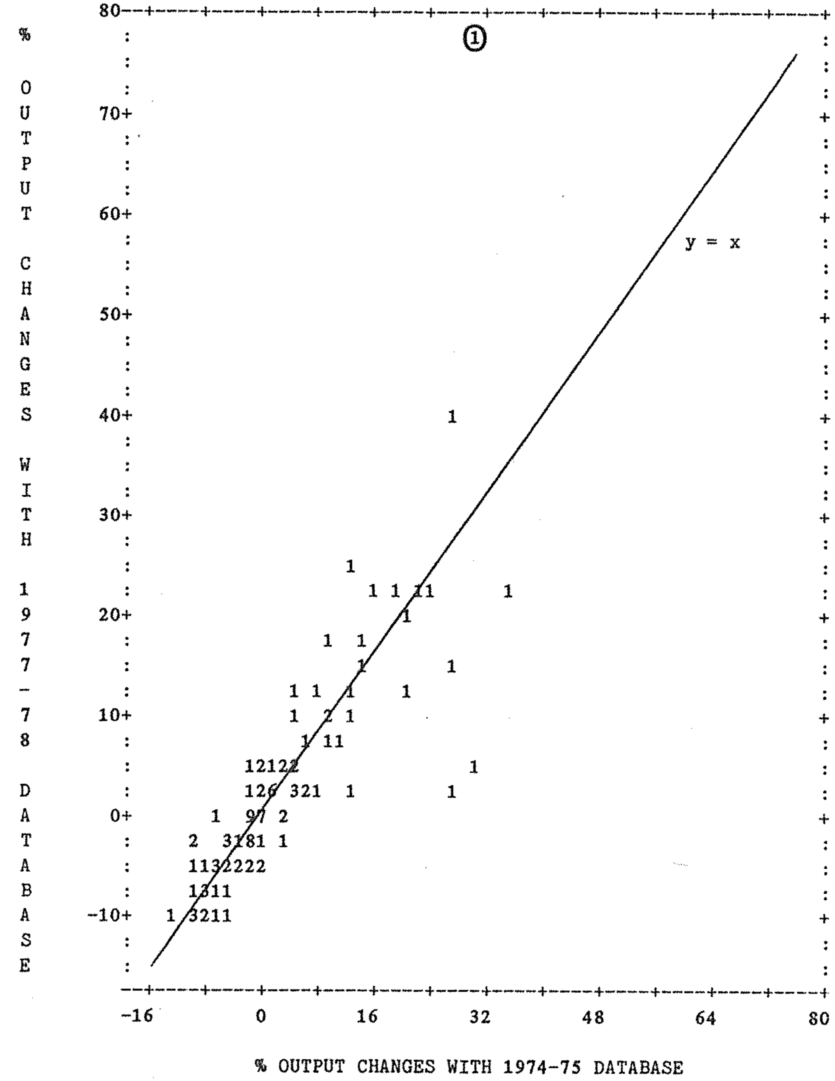
a These variables are explained in Table III.2 of Higgs and Parmenter (1982).
b For the 1968-69 and 1974-75 databases, g = 115, G = 13, h = 113, J* = 101 and M = 9. For 1977-78, g = 114, G = 12, h = 112, J* = 99 and M = 10.
c This is the variable with mnemonic U2 in Higgs and Parmenter (1982).

IV CONCLUDING COMMENTS

Each of the databases used in this paper have been used in a wide range of ORANI simulations, which in turn have often been inputs to important government decisions. The users of the ORANI model have in general used the database which provided the most recent information on the structure of the Australian economy. The results of the experiments reported in this paper do not challenge the logic of that approach. However, for the analysis of macro level disturbances, the evidence is that ORANI projections are remarkably consistent between databases. Further, the variations which **do** occur between runs with different databases overwhelmingly appear to be the result of changes in the input-output part of the database rather than changes in the parameter files. This evidence is supported by the stability of the IMPACT "Macrofix" package under a change in database [compare Norman (1981) with Parmenter (1983)]. These conclusions are encouraging, given the emphasis which is placed on macro effects in most interpretations of ORANI for alternative policy shocks, be the shocks specific to some industry, commodity or occupation, or economy-wide.

It has been difficult to explain a few of the variations in industry output responses. Further work using a formal sensitivity analysis in which only one feature of a database at a time is changed may be necessary to provide convincing explanations. Such research may also reveal counterbalancing effects of changes in the databases which were not obvious in the experiments reported here. Prime candidates for sensitivity analyses of the differences between the 1974-75 and 1977-78 databases are the primary factor shares of total industry costs and the sales shares of

Figure 5: **BALANCE OF TRADE SHOCK EXPERIMENT: SCATTERGRAM OF ORANI INDUSTRY OUTPUT CHANGES USING THE 1974-75 DATABASE AGAINST CORRESPONDING CHANGES USING THE 1977-78 DATABASE[a]**



a See note to Figure 2.

The Exogenous Shocks

The present exercise required general, rather than industry-specific, shocks. Specific shocks usually have only tiny effects outside the industry on which they directly impact. Comparisons of such very small magnitudes between databases are not of interest. Two separate shocks were imposed: one to the supply side of the economy and one to the demand side. The first shock was a 5.0 per cent increase in Aggregate Employment and the second was a 5.3 per cent increase in the Balance of Trade as a proportion of GDP. The latter shock corresponds to a real rise of five billion in 1977-78 dollars in the Balance of Trade (see Table 2).

In the former case, the aim was to find the change in the level of real wages which would follow an artificial boost in employment. Wage relativities between industries and occupations were fixed because, given the willingness of Australian trade unions to tolerate unemployment, the ORANI theory has nothing to say about which occupations will succeed in increasing/preserving their relativities.[4]

The Balance of Trade shock serves as an additional comparative experiment which highlights the relatively small effects of the employment shock. The Balance of Trade variable plays a specific role in ORANI which it will be helpful to describe here. Like all general equilibrium models of national economies, the GDP identity holds (implicitly) in ORANI:

GDP = Aggregate absorption + Balance of Trade

= (C + I + G) + BT,

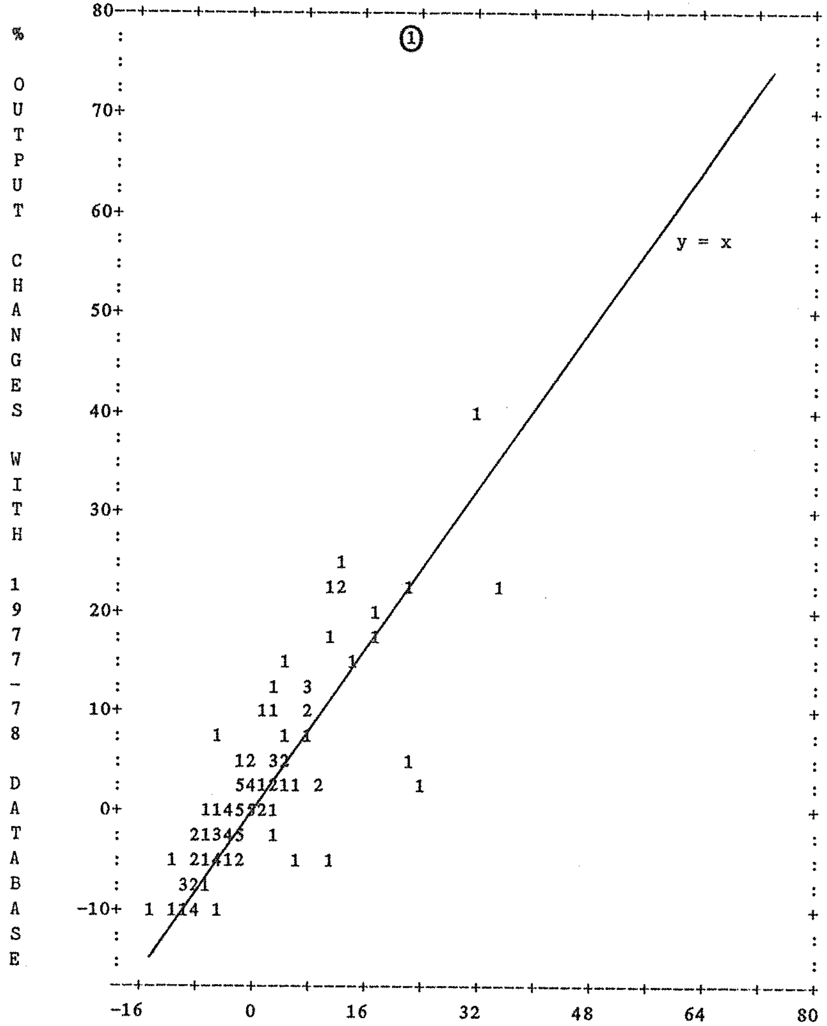
where aggregate absorption is the sum of Aggregate Household Consumption, Aggregate Private Investment and aggregate government expenditure (Other Final Demand in ORANI); and the Balance of Trade is equal to Aggregate Exports (at foreign currency prices), less Aggregate Imports (also at foreign prices). In order to preserve this identity, it follows that setting the Balance of Trade exogenously will necessarily lead the user of the ORANI model to ensure that some or all components of real aggregate absorption are made endogenous. Increasing the Balance of Trade will drive ORANI to indicate the combination of changes in real absorption and the real exchange rate which is required to accomodate the nominated addition to foreign exchange receipts.

Table 2: SELECTED MACRO AGGREGATES IN THE THREE DATABASES

Macroeconomic Aggregate	Unit	Database 1968-69	1974-75	1977-78
Aggregate Exports (f.o.b.)	$A x 10^9 nominal	3.707	9.515	14.477
Aggregate Imports (c.i.f.)	$A x 10^9 nominal	4.053	9.463	14.546
Balance of Trade	$A x 10^9 nominal	-0.345	+0.053	-0.068
Gross Domestic Product (GDP)	$A x 10^9 nominal	27.574	60.831	94.738
Balance of Trade as a Percentage of GDP	%	-1.253	+0.086	-0.072
Shock as a Percentage of GDP[a]	%	5.3	5.3	5.3

a The Balance of Trade shock is equal to $5 billion for the run using the 1977-78 database.

Figure 4: BALANCE OF TRADE SHOCK EXPERIMENT: SCATTERGRAM OF ORANI INDUSTRY OUTPUT CHANGES USING THE 1968-69 DATABASE AGAINST CORRESPONDING CHANGES USING THE 1977-78 DATABASE[a]



a See note to Figure 2.

Table 14: MAJOR BUYERS OF THE WHOLESALE TRADE MARKUP COMMODITY

Industry	1968-69 Share of Total Purchases[a]	1968-69 Output Change	1974-75 Share of Total Purchases[a]	1974-75 Output Change	1977-78 Share of Total Purchases[a]	1977-78 Output Change
		%		%		%
87 Residential Construction	0.168	-2.82	0.133	-2.21	0.086	-0.76
88 Other Construction	0.098	0.00	0.066	0.00	0.064	0.00
93 Road Transport	0.039	3.70	0.056	2.19	0.054	2.54
Totals[b]	0.305	-0.33	0.255	-0.17	0.204	0.07

a Share of total sales of the Wholesale Trade markup commodity represented by purchases of the industries shown.
b Weighted averages in the output change columns.

For Other Building and Construction, the picture is less clear and a similar exercise using investment change weights is not nearly so helpful. This part of the results would benefit from a sensitivity analysis of the industry investment section of the ORANI database.

Scattergrams of 1977-78 industry output changes against 1968-69 and 1974-75 output responses reveal the results to be distributed very close to the 45^{0} line in each case: in Figure 4, the regression slope is 0.99 and in Figure 5, 0.92. The outlier circled in Figures 4 and 5 represent the Agricultural Machinery industry – the explanation for this is essentially the same as in the employment shock experiment. Briefly, most of the commodity is sold for capital creation purposes, especially in the 1977-78 database (see Table 8), to industries which experienced relatively high rates of return on their fixed capital in response to the shock.

III RESULTS

Employment Shock

The key results of the employment increase experiment are shown in Tables 3 and 4. Table 3 shows that an increase in national labour employment of 5.0 per cent is associated with a fall in the real wage rate of 5-6 per cent when short-run equilibrium is attained. Other real macro effects are a negligible change in the inflation rate and a GDP rise of 2.6-2.9 per cent – as mentioned previously, this effect consists entirely of the change in real consumption, since both Aggregate Real Investment and the Balance of Trade are exogenous in the closure used.

Table 3: ORANI PROJECTIONS OF THE SHORT-RUN MACROECONOMIC EFFECTS OF A 5 PER CENT INCREASE IN AGGREGATE EMPLOYMENT

Variable	Database 1968-69	Database 1974-75	Database 1977-78
	%	%	%
Consumer Price Index	-0.34	0.36	0.38
Aggregate Real Consumption	4.41	4.78	4.58
Real Gross Domestic Product	2.61	2.88	2.77
Average Real Wage Rate	-6.30	-5.39	-5.66
Investment Price Index	-2.63	-2.00	-2.22
Employment by Occupation:			
1. Professional	5.59	5.33	5.34
2. Para-professional white collar	}5.37	}5.40	5.80
3. Skilled white collar			4.98
4. Semi and unskilled white collar	5.48	5.74	5.54
5. Skilled blue collar (metal + elect.)	4.72	4.75	4.69
6. Skilled blue collar (building)	2.15	2.96	3.07
7. Skilled blue collar (other)	4.71	5.16	5.18
8. Semi and unskilled blue collar	4.67	4.39	4.43
9. Rural workers	6.00	5.39	5.39
10. Armed services	4.27	4.69	4.53

Table 4: ORANI PROJECTIONS OF THE SHORT-RUN EFFECTS ON THE OUTPUT LEVELS OF SELECTED INDUSTRIES OF ACCOMODATING A 5 PER CENT INCREASE IN AGGREGATE EMPLOYMENT

Industry	Database 1968-69	1974-75	1977-78
	%	%	%
(i) Import Competing Sector			
31 Man-made Fibres, Yarns	4.76	5.31	7.72
32 Cotton, Silk, Flax	4.91	4.97	5.91
37 Knitting Mills	2.46	3.85	2.89
39 Footwear	3.56	5.08	5.51
68 Motor Vehicles and Parts	3.91	5.82	6.30
73 Electronic Equipment	5.90	5.61	6.09
74 Household Appliances	5.29	6.31	6.03
(ii) Export Sector			
3 High Rainfall Zone	3.08	6.05	3.32
13 Other Metallic Minerals	3.55	2.54	3.03
14 Coal	7.20	3.05	3.63
18 Meat Products	2.62	5.30	4.66
25 Food Products n.e.c.	5.04	4.64	7.20
63 Basic Iron and Steel	5.04	6.12	2.31
64 Other Basic Metals	3.96	3.78	3.56
(iii) Non-trading Sector			
84 Electricity	3.71	4.60	4.28
88 Other Building and Construction	0.88	0.65	0.67
89 Wholesale Trade	3.04	3.72	3.45
107 Education, Libraries, etc.	5.26	5.14	5.03
(iv) Summary[a]			
Range high	7.67	7.74	8.33
Range low	0.00	-0.80	-0.78
Spearman's rank correlation coefficient against: 1968-69		0.80	0.71
1974-75			0.81

a These statistics refer to all the industries for which ORANI projections are generated, excluding the Business Expenses industry in 1968-69 and 1974-75.

per cent (see Table 12).

The Coal industry output increase of 35 per cent was the largest output rise with the 1968-69 database attached. This response was larger than in the runs with the other databases mainly because of the movement in the fixed factor intensity of the industry (see Table 6), as can be seen by applying Equation (1) with the assumption that p_{O14} is zero in each run.

As in the employment shock experiment, the Basic Iron and Steel industry shows a markedly smaller output response in the 1977-78 run. The cause is again that, in the 1977-78 simulation, the change in exports of Basic Iron and Steel was exogenous.

Among the industries which make non-traded goods [part (iii) of Table 13], Other Building and Construction and Wholesale Trade exhibit large movements in output responses between databases. The sales of the commodities produced by each industry are heavily concentrated into particular areas: into capital creation in the case of Other Building and Construction (94 per cent in 1977-78) and into margins for Wholesale Trade (95 per cent in 1977-78). Most of the changes in output responses should be explained by changes in the compositions of the purchasing shares of the major industries buying each commodity in each case. Table 14 shows the principal buyers of Wholesale Trade as a margin commodity and their output changes. The weighted average changes clearly establish the ranking and change in sign of the Wholesale Trade industry output responses in Table 13. The main influences are seen from Table 14 to be the falling share of the Other Building and Construction industry in margin purchases of Wholesale Trade, and the rise in output changes of that industry.

Exporting industries all show significant output increases, as would be expected. Movements in the non-traded sector are generally fairly small, except for the Education, Libraries etc. industry, which moves with GDP. As in the employment shock experiment, the rank correlation coefficients are high, but less than unity. Part (iv) of Table 13 also gives evidence that, using the rank correlation coefficient criterion, it would be slightly more appropriate to simulate the effects of the shock on the Australian economy as it was in 1974-75 using the 1968-69 database rather than its 1977-78 counterpart.

There are several seemingly anomalous fluctuations in the output responses reported in Table 13. In part (i) of the table, industries 31 and 32 have exceptionally high changes in 1977-78 and industries 37 and 39 have low changes in 1968-69. The high changes of the former pair can be explained by the fact that their Armington import substitution elasticities were almost doubled in 1977-78 to 4.7 (previously 2.4). The latter pair had much lower import market shares in 1968-69 than in the subsequent databases: for Knitting Mills the import share of apparent absorption was only 4.7 per cent in 1968-69, rising to 35.6 per cent in 1974-75 and 20.5 per cent in 1977-78. In 1968-69 the negative output response came from reduced domestic demand not being offset by substitution away from imports.

We now consider anomalies among the export industry responses [part (ii) of Table 13]. While the output fluctuations of the High Rainfall Zone industry partly reflected changes in the mix of the commodities that it produced, the major influence causing the doubling of the output change from 1968-69 to 1974-75 was the movement in Wool exports from 7.7 to 17.6

Opposing forces which worked to keep the change in the CPI small are the increased goods demand, resulting from increased consumption, and the prevailing decreases in basic values prices in consequence of the effective fall in unit labour costs. The reversal in sign of the CPI change between the 1968-69 run and the others can be understood with the aid of Figure 1, which depicts the outward shift in the aggregate supply curve of the economy induced by the shock. Since the only component of aggregate demand which is free to move is Aggregate Real Consumption (private and public), the shock indirectly induces an outward shift in the aggregate demand curve. It is clear that, while GDP is stimulated from both sides, the change in the price level is ambiguous. The direction of movement of the CPI depends on the slopes of the aggregate demand and supply curves and on the ratio of the vertical shifts of the two (α/β in Figure 1). All these determining factors are affected by the database, the closure, and the shock.

Figure 1: A HEURISTIC DIAGRAM OF THE EFFECTS OF THE EMPLOYMENT SHOCK UPON GROSS DOMESTIC PRODUCT AND THE CONSUMER PRICE INDEX

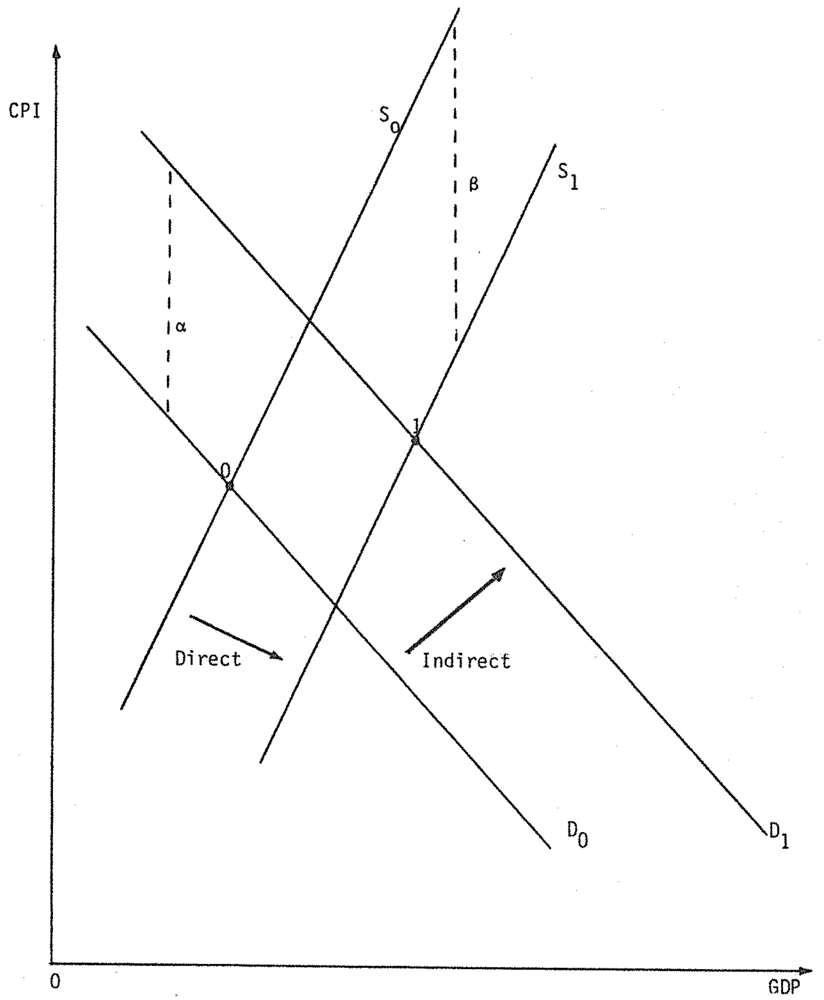


Table 13: ORANI PROJECTIONS OF THE SHORT-RUN EFFECTS ON THE OUTPUT LEVELS OF SELECTED INDUSTRIES OF AN INCREASE IN THE BALANCE OF TRADE EQUAL TO 5.3 PER CENT OF GDP

Industry		Database 1968-69	1974-75	1977-78
		%	%	%
(i)	Import Competing Sector			
31	Man-made Fibres, Yarns	12.69	12.57	25.15
32	Cotton, Silk, Flax	10.57	10.09	18.65
37	Knitting Mills	-1.23	7.65	1.58
39	Footwear	4.55	14.25	15.30
68	Motor Vehicles and Parts	8.09	8.05	11.66
73	Electronic Equipment	-2.62	-1.59	-1.85
74	Household Appliances	-11	-9.0	-5.72
(ii)	Export Sector			
3	High Rainfall Zone	13.74	27.41	14.99
13	Other Metallic Minerals	18.01	14.18	18.14
14	Coal	34.9	15.58	22.68
18	Meat Products	12.20	24.58	21.46
25	Food Products n.e.c.	32.0	27.17	41.24
63	Basic Iron and Steel	23.18	29.78	3.82
64	Other Basic Metals	22.79	22.07	21.65
(iii)	Non-trading Sector			
84	Electricity	-2.09	-2.11	-2.76
88	Other Building and Construction	-2.82	-2.21	-0.76
89	Wholesale Trade	-1.03	-0.48	1.52
107	Education, Libraries, etc.	-9.6	-9.0	-8.85
(iv)	Summary[a]			
	Range high	34.9	35.52	76.91
	Range low	-15	-13	-11
	Spearman's rank correlation coefficient			
	against: 1968-69		0.93	0.85
	1974-75			0.91

a These statistics refer to all the industries for which ORANI projections are generated, excluding the Business Expenses industry in 1968-69 and 1974-75.

technically they are regarded as being import competing, these industries behave in the present experiment as though they produce non-traded goods.

A similar pattern of sales shares and household demand characteristics is shared by the Motor Vehicles and Parts industry, which however has positive output changes in all three runs. Whilst the contraction of the domestic market reduced the demand for Motor Vehicles and Parts from all sources, this negative influence was more than offset by substitution away from imports and towards the domestic product. The substitution effect is much stronger for Motor Vehicles and Parts than for Electronic Equipment and Household Appliances primarily because of the differences between their import substitution elasticities, which were set at around five for Motor Vehicles and Parts and about two for the other commodities.

A back of the envelope explanation of the change in sign of the CPI variable from 1968-69 to 1974-75, which relies on shifts in the slope of the aggregate supply curve, is as follows. It is assumed that slope of the aggregate demand curve and the share of primary factors in total costs are invariant across the three runs. We use the identity equation (45.21) of Dixon et al. (1982), in which the output change of an industry (j) is:

$$z_j = \frac{\sigma(1 - S_{Kj})}{S_{Kj}} \left[\frac{p_{Oj}}{S_{Vj}} - p_{Ij}\left(\frac{1}{S_{Vj}} - 1\right) - w\right] , \qquad (1)$$

where z_j is the percentage change in the output of industry j;

σ is the capital-labour substitution elasticity (0.5 in all cases here);

S_{Kj} is the share of fixed factor(s) in industry j's total primary factor costs;

p_{Oj} is the percentage change in output price (expected to be small);

S_{Vj} is the share of primary inputs in j's total costs;

p_{Ij} is the average percentage change in the price of intermediate inputs to the industry; and

w is the percentage change in wages (given in Table 3).

Changes in the slope of the aggregate supply function can be related to changes in:

$$\gamma = [(1-S_K)/S_K],$$

where S_K is the share of fixed factors in total primary factor costs throughout the economy. S_K is simply $(1-S_L)$, where S_L is the share of labour in aggregate primary factor costs, values for which are shown in

Table 5. This gives estimates of γ of 2.9, 3.7 and 3.6 for the databases in chronological order. Consequently, the aggregate supply curve is flattest in the 1968-69 run and the possibility of a negative CPI change is strongest in that case. As the explanation does not hold for the small difference between the 1974-75 and 1977-78 CPI changes, one or more of the above assumptions is violated in that comparison.

Table 5: SECTORAL WEIGHTED AVERAGE EMPLOYMENT INTENSITIES AS PERCENTAGES OF VALUE ADDED IN THE THREE DATABASES

Sector	Database 1968-69	1974-75	1977-78
	%	%	%
Non-traded Industries[a]	75.52	78.24	77.79
Traded Industries[b]	73.29	79.96	78.99
Whole Economy	74.63	78.76	78.16

a For the 1968-69 database, there were 39 non-traded industries, as defined in Table 45.4 of Dixon et al. (1982). For the 1974-75 database, industries 7, 15, 17 and 22 were dropped, and 16, 42, 43, 45, 48, 53, 65, 66 and 70 were added to the the 1968-69 list. For the 1977-78 database, industries 16 and 100 were dropped from the 1974-75 list (and Business Expenses, which does not appear in the 1977-78 database), and none were added. These changes reflect more recent characteristics and interpretations (including the author's), of the industries concerned – see, for example, Table A.1 of Bruce (1985).

b Traded industries comprise all industries which do not appear in the non-traded industry list. Consequently, it includes export related, exporting and import-competing industries as well as the dummy industry, Noncompeting Imports.

Sources: ORANI 78 databases (Melbourne CYBER 76 versions).

The investment price index falls 2-3 per cent as the result of the lowering of the real unit cost of labour. Since the real volume of

Table 12: CONTRIBUTIONS OF EXPORT CHANGES TO OUTPUT FLUCTUATIONS AMONG SELECTED ENDOGENOUS EXPORT COMMODITIES

Commodity	1968-69 Export Change (1)	Export Share (a) (2)	Contribution to Output Change (b) (3)	1974-75[c] (1)	(2)	(3)	1977-78[c] (1)	(2)	(3)
	%		%	%		%	%		%
A1 Wool	7.67	0.88	6.78	17.59	0.88	15.46	10.41	0.88	9.13
A2 Sheep							2.62	0.40	1.06
A3 Wheat	9.79	0.69	6.72	13.44	0.80	10.75	11.77	0.76	8.93
A4 Barley	17.93	0.29	5.16	17.26	0.70	11.90	9.24	0.83	7.67
A5 Other Grains	-29.10	0.22	-6.31	-2.10	0.51	-1.07	-3.46	0.39	-1.34
14 Coal	93.14	0.28	26.23	17.31	0.66	11.46	30.83	0.69	21.37
18 Meat Products	58.21	0.27	15.83	89.89	0.28	25.17	72.70	0.31	22.83
25 Food Products n.e.c.	110.60	0.24	26.84	56.94	0.43	24.63	140.00	0.28	39.48

a Share of export sales in total basic values sales of the commodity.
b Elements in this column are the product of the corresponding elements in the two previous columns.
c The abbreviated column headings can be interpreted by reference to their 1968-69 counterparts at left.

Turning now to Table 13, the general movement in import competing industries is for output rises, which is intuitively obvious for industries which are sensitive to import competition and do not themselves depend heavily on imported inputs. The industries which show negative output responses throughout, Electronic Equipment and Household Appliances, sell substantial proportions of their outputs to households, which have relatively elastic demands for those commodities. The negative income effect on households, shown by the decline in Aggregate Real Consumption (see Table 9), exceeds the positive substitution effect towards domestically produced Electronic Equipment and Household Appliances. So, while

Table 11: INDUSTRIES EMPLOYING SUBSTANTIAL SHARES OF SKILLED BLUE COLLAR (OTHER) LABOUR, AND THEIR OUTPUT CHANGES IN THE BALANCE OF TRADE SHOCK EXPERIMENT

Industry No. Name	1968-69 Employment Share(a)	1968-69 Output Change	1974-75 Employment Share(a)	1974-75 Output Change	1977-78 Employment Share(a)	1977-78 Output Change
	%	%	%	%	%	%
18 Meat Products	15.77	12.20	18.79	24.58	21.74	21.46
23 Bread, Cakes and Biscuits	10.71	-1.29	11.05	-1.23	9.94	-1.04
38 Clothing	8.10	-1.12	5.36	0.05	4.50	1.50
47 Publishing, Printing	5.56	-2.91	4.78	-1.44	4.78	-0.11
48 Paper Stationery, Printing, etc.	9.40	-3.20	9.44	-2.10	7.97	-2.23
90 Retail Trade	14.75	-9.02	14.96	-8.99	14.82	-7.85
106 Health	2.74	-10.77	4.78	-10.27	5.23	-11.00
110 Restaurants, Hotels and Clubs	9.41	-7.57	12.63	-7.71	11.62	-8.81
Sub-totals(b)	76.44	-1.45	81.79	1.73	80.60	2.09
Other industries	23.56		18.21		19.40	
TOTALS	100.00		100.00		100.00	

a Share in the database of total employment of Skilled Blue Collar (Other) labour accounted for by each industry.

b Weighted averages in the output change columns.

aggregate investment is exogenous, there are no demand-side effects on this total. The distribution of the economy-wide investment budget among investing industries, however, follows the pattern of changes in rates of return to their fixed capital.

Except for the Skilled Blue Collar (Building) occupation, changes in employment by occupation are generally close to the national average of 5.0 per cent. The exception occurs because, in each of the databases, a significant proportion of the Skilled Blue Collar (Building) workforce is concentrated in the Residential Building Construction and Other Construction industries: 67, 47 and 43 per cent in chronological order. Substantial portions of the outputs of these industries are bought for capital creation by industries for which investment has been set exogenously to zero in the simulations. In particular, 90-100 per cent of sales of the Residential Building Construction commodity are bought by Ownership of Dwellings for capital creation in each database. Further, in the case of the 1977-78 database, 43 per cent of the basic value of sales the Other Construction commodity were purchased by exogenous investment industries for capital creation. Consequently, the increase in demand for Skilled Blue Collar (Building) workers was not as high as for the other occupations.

Industry output changes broadly show the expected pattern of results: mainly fairly similar across the three databases with some exceptions which can be attributed chiefly to changes in the input-output shares (see Table 4). As reported in Table 4, the rank correlation coefficients between industry output vectors from the three simulations are high, but less than unity as would be expected. The use of Spearman's rank correlation coefficient rather than the "ordinary" correlation coefficient is based on the frequent practice of examining the rankings of industry output changes when scrutinising ORANI results. The pattern of the coefficients in Table 4 could be interpreted as providing some empirical support for the popular notion that newer databases give more relevant results. For example, there would be an obvious gain in using the 1974-75 database instead of the 1968-69 version to simulate the present experiment for the Australian economy in 1977-78. However, suppose one wished to show the effects of the shock on the economy as it was in 1974-75 but only the 1968-69 and 1977-78 databases were available. Many users would employ the 1977-78 database, it being the closer in time to 1974-75. On the criterion of ranked industry output responses, such a decision is shown in Table 4 to be marginal.

Six of the output responses in Table 4 might be regarded as showing exceptional fluctuations between databases: industries 31, 68, 3, 14, 25 and 63. Each will be briefly discussed.

Industry 31, Man-made Fibres and Yarns, shows increases in output changes from 1968-69 through 1974-75 to 1977-78. The first rise is attributed to the movement in the base-year import share of apparent consumption of the Man-made Fibres and Yarns commodity from 40.8 per cent in 1968-69 to 43.8 per cent in 1974-75. A higher base year import share gives the Australian producer a greater gain in domestic market share when his operating conditions become more internationally competitive. The import share rose again in 1977-78 to 54.2 per cent and this, together with

the ORANI solutions. The pertinent information is presented in Table 11. The change in sign of the occupation response from 1968-69 to 1974-75 is mainly due to the doubling of the Meat Products industry output change. This can in turn be mainly attributed to the fluctuations in Meat Products exports (see Table 12). The question of the cause of the export change differences is difficult to resolve and there is a case for a sensitivity analysis of export sales shares and/or commodity contributions to aggregate exports. In contrast, the rise in the employment change from 1974-75 to 1977-78 is due to diffuse changes in both the base years' employment distributions and the employer industry output changes.

Table 10: SECTORAL WEIGHTED AVERAGES OF ORANI PROJECTIONS OF THE SHORT-RUN OUTPUT EFFECTS IN THE TWO EXPERIMENTS

Experiment	Industry Sector	Database 1968-69	1974-75	1977-78
		%	%	%
Employment up 5%	Non-traded[a]	3.16	3.47	3.45
	Traded[b]	3.39	3.98	3.70
	Whole Economy	3.26	3.66	3.55
Balance of Trade up 5.3% of GDP	Non-traded[a]	-4.11	-3.70	-3.92
	Traded[b]	6.81	9.58	8.68
	Whole Economy	0.62	1.20	0.98

a,b See corresponding notes to Table 5.

Most of the employment by occupation changes, also shown in Table 9, vary moderately when different databases are used. This reflects the diffuse linkages which most of the recognised occupations have with the exporting, import-competing and non-traded goods sectors of the Australian economy. Armed Services employment changes move closely with Aggregate Real Consumption, as occurred in the employment shock experiment. This is so because all workers in this occupation are employed in the Defence industry, the output of which is constrained to move with real government spending, which in turn is fully indexed to Aggregate Real Consumption in these simulations.

Employment changes in the Skilled Blue Collar (Other) occupation reverse sign in moving from the 1968-69 simulation to the 1974-75 run, and increase substantially from the 1974-75 response when the 1977-78 database is used. These variations are due to the combined effects of shifts in the base year distribution of employment in this occupation among the relevant ORANI industries and changes in the output responses of those industries in

an increase in the Import Substitution Elasticity (σ_{31}) for Man-made Fibres and Yarns from 2.4 to 4.7 in the 1977-78 database, explains the second rise in output. The change in σ_{31} had the effect of making domestically produced and imported Man-made Fibres and Yarns into closer substitutes for most domestic purchasers.

Changes in the Motor Vehicle and Parts industry output responses occurred for similar reasons to those just described. From 1968-69 to 1974-75 the base import share rose from 22.2 per cent to 30.5 per cent with σ_{68} unaltered. From 1974-75 to 1977-78 the import share scarcely changed but σ_{68} was increased from 5.0 to 5.2.

The High Rainfall Zone is a multiproduct industry which contributed to the national outputs of Wool, Sheep-meat, Wheat, Barley, Other Grains, Meat Cattle, Milk Cattle and Pigs and Other Farming Export (Other Agriculture - Sugar Cane, Fruits and Nuts in 1977-78) in each database. Endogenous export commodities made by the High Rainfall Zone industry and common to all three databases were Wool, Wheat, Barley and Other Grains. The High Rainfall Zone's principal outputs were Wool and Meat Cattle in each year, although Sheep-meat also became an important output in the 1977-78 database, reflecting the development of the live sheep export market to the Middle East. There were no changes in the export demand elasticities for these three commodities across the three databases, but Sheep-meat was declared to be a commodity for which ORANI would endogenously determine exports in the 1977-78 database[5]. On this basis, we may have expected the 1977-78 output change to have been rather different from the others but, as Table 4 shows, the 1974-75 change of 6 per cent is clearly the anomaly. The main part of the explanation lies with the input mix to the High Rainfall Zone. The proportions of labour costs in total industry costs were 22.5, 42.1 and 37.0 per cent, respectively, in the 1968-69, 1974-75 and 1977-78 databases. It follows that the industry benefitted most from the real wage cut in 1974-75 and least in 1968-69. The 1977-78 output response would probably have been closer to 6 per cent had the share of labour in value added of the industry been the same in both cases (c.f. 0.75 in 1974-75 with 0.64 in 1977-78).

The Coal industry (Black Coal in 1977-78) had endogenously determined exports and the same export demand elasticity in all three databases. Consequently, we look to the input-output part of each database to explain the far greater output response when the 1968-69 database is attached. Equation (1) above is useful in this context. For an endogenous export commodity with a high export demand elasticity it is usually reasonable to set p_{0j} to zero in the equation (in fact, the values of p_{014} were 0.28, 0.30 and 0.34). While S_{V14} did not vary much across the databases (see Table 6), S_{K14} was substantially lower in the first database. As shown in Table 6, these variations are sufficient to explain most of the differences in Coal industry outputs.

line of Table 10 , from which the ranking of Average Real Wage Rate changes in Table 9 is clearly established. The traded and non-traded sector output changes are also shown in Table 10, revealing that the responsiveness of the traded goods sector was much smaller with the 1968-69 database attached than with the others. This lower responsiveness can be explained using Equation (1) as being mainly due to the lower labour intensity of the traded sector in 1968-69 (see Table 5), given that the share of value added in total costs for the traded sector was virtually constant (0.37, 0.38, 0.37) and assuming zero output price changes for traded goods.

Corresponding sectoral output changes for the employment shock experiment are also given in Table 10. These show why the Average Real Wage Rate exhibited such a small range of responses in that experiment (see Table 3). Labour intensities in value added of the sectors of Table 9 are provided in Table 5, illustrating that the 1968-69 database is again the anomalous one (in a relative sense). On the basis of Table 5, we might expect that, in standard closures involving endogenous total employment, a shock which stimulated the traded sector and depressed the non-traded sector would lead ORANI to project the change in labour demand to be smallest when run with the 1968-69 database.

Table 9: ORANI PROJECTIONS OF THE SHORT-RUN MACROECONOMIC EFFECTS OF PRODUCING AN INCREASE IN THE BALANCE OF TRADE EQUAL TO 5.3 PER CENT OF GDP

Variable	Database 1968-69	1974-75	1977-78
	%	%	%
Consumer Price Index	-22	-19	-19
Aggregate Real Consumption	-9.0	-9.0	-8.51
Average Real Wage Rate	-1.78	0.20	-0.15
Investment Price Index	-17	-13	-14
Aggregate Exports (foreign currency)	23.68	21.81	20.63
Aggregate Imports (foreign currency)	-14	-12	-14
Employment by Occupation:			
1. Professional	-4.9	-4.87	-5.57
2. Para-professional white collar	}-3.8	}-3.85	-6.41
3. Skilled white collar			-2.01
4. Semi and unskilled white collar	-4.7	-4.34	-4.41
5. Skilled blue collar (metal + elect.)	2.9	2.97	2.04
6. Skilled blue collar (building)	-1.53	-1.38	-1.18
7. Skilled blue collar (other)	-1.23	1.77	2.59
8. Semi and unskilled blue collar	2.15	1.82	1.59
9. Rural workers	19.39	18.59	17.81
10. Armed services	-8.7	-8.3	-8.41

In contrast to the other macro responses, the Average Real Wage Rate declines by 1.8 per cent when the 1968-69 database is used, but experiences negligible change in simulations with the other databases attached. Why is it that when about 9 per cent of Aggregate Real Consumption is diverted to the Balance of Trade surplus (viz., a change in the pattern of aggregate demand in the economy), that the marginal productivity of labour rises for 1974-75 but declines in the other runs? This pattern can be related to both variations in the weighted averages of changes in outputs of all the industries in each database and movements in the labour intensity of Australian production. The output changes were calculated using base year industry cost weights and are shown in the last

Table 6: ANALYSIS OF ANOMALOUS RESULTS FOR THE EXPORT INDUSTRIES IN THE EMPLOYMENT SHOCK EXPERIMENT

Industry	Database	Fixed Factor Intensity (s_{Kj})	Value Added Share (s_{Vj})	Change in Input Price (p_{Ij})	Change in Output Price (p_{Oj})	Estimated Output Change[a]	Actual Output Change
				%	%	%	%
14 Coal	1968-69	0.38	0.56	-0.34[b]	0.00[d]	5.32	7.20
	1974-75	0.51	0.57	0.36[b]	0.00[d]	2.43	3.05
	1977-78	0.47	0.50	0.38[b]	0.00[d]	2.99	3.63
25 Food Products n.e.c.	1968-69	0.32	0.17	0.28[c]	-0.14	4.37	5.04
	1974-75	0.39	0.18	-0.19[c]	-0.15	4.27	4.64
	1977-78	0.28	0.14	-0.63[c]	-0.74	5.41	7.20

a Estimated with Equation (1).
b Percentage change in the Consumer Price Index.
c Percentage change in the Basic Price of the Other Farming - Export commodity, which was the major intermediate input to the Food Products n.e.c. industry in each database.
d By assumption.

There were no relevant parameter changes to the Food Products n.e.c. industry in the databases: its output was an endogenous export commodity throughout. The higher output response with the 1977-78 database attached is due in large measure to the changes in the fixed factor intensity of the industry (see Table 6). Using Equation (1) with the assumption of a zero export price change is sufficient to explain the differences in output changes. However, the estimated output change of 12.3 per cent in the 1977-78 run using that approach was rather high and Table 6 shows the results of the calculations with the actual p_{O25}s. The residual output differential is far more difficult to explain and is attributed here to second order effects. The determinants of the residual may become obvious in a sensitivity analysis of primary factor shares along the lines of Dixon, Parmenter and Rimmer (1984).

Exports of the Basic Iron and Steel commodity are endogenously determined in the 1968-69 and 1974-75 default settings but not in 1977-78. Consequently, the commodity experienced no change in exports in the 1977-78 run and its output change there was lower than in the other cases.

The presence of some negative industry output changes (see Table 7) in the newer databases is puzzling at first. All four industries with such changes sell significant proportions of their outputs to capital creation, and these sales are dampened by falls in the investment demands of their principal customers.[6]

Table 7: SHARES OF SALES TO CAPITAL CREATION IN TOTAL SALES OF COMMODITIES PRODUCED BY INDUSTRIES EXHIBITING NEGATIVE OUTPUT CHANGES IN THE EMPLOYMENT SHOCK EXPERIMENT

Database	Commodity Name	Output Change %	Capital Creation Sales Share 1968-69	1974-75	1977-78
1974-75	Ship and Boat Building	-0.80	0.292	0.413	0.313
1977-78	Forestry and Logging	-0.43	0	0.125	0.250
	Services to Mining	-0.78	0	0	0.391
	Construction Machinery	-0.51	0.745	0.647	0.683

Figure 2 shows the scatter distribution of industry output changes

Balance of Trade Shock

An increase in the Balance of Trade equal to 5.3 per cent of GDP is imposed on the model in this experiment. As suggested previously, the motivation here is to shock the demand side of the economy for the purpose of comparison with the effects of the supply side shock reported above. The experiment may be viewed as an attempt to stimulate the effects of action required to overcome a deficit in the Balance of Trade. This is achieved by reducing the overall level of domestic demand, which has the direct effects of reducing the demand for imports and lowering the prices of domestically produced goods and services. The falls in domestic prices trigger indirect effects, particularly the substitution of demand away from imports and the stimulation of exports.

The macro results of the experiment are shown in Table 9. As expected, exports rise and imports and Aggregate Real Consumption fall. Real consumption falls because of large falls in Aggregate Nominal Consumption which are only partly offset by the deflation[7]. These falls in Aggregate Nominal Consumption are in turn associated with reduced household demands for most of the 230-odd commodities recognised in ORANI[8].

In tandem with the decline in Aggregate Real Consumption, there is a real exchange rate depreciation, manifested by a significant fall in the CPI (see Table 9). This is so because the Nominal Exchange Rate is held constant in the experiment (see Table 1), and because the ORANI theory has no mechanism explaining how changes in the ratio of the domestic price level to the foreign currency price of traded goods are apportioned between changes in the domestic inflation rate and changes in the nominal exchange rate.

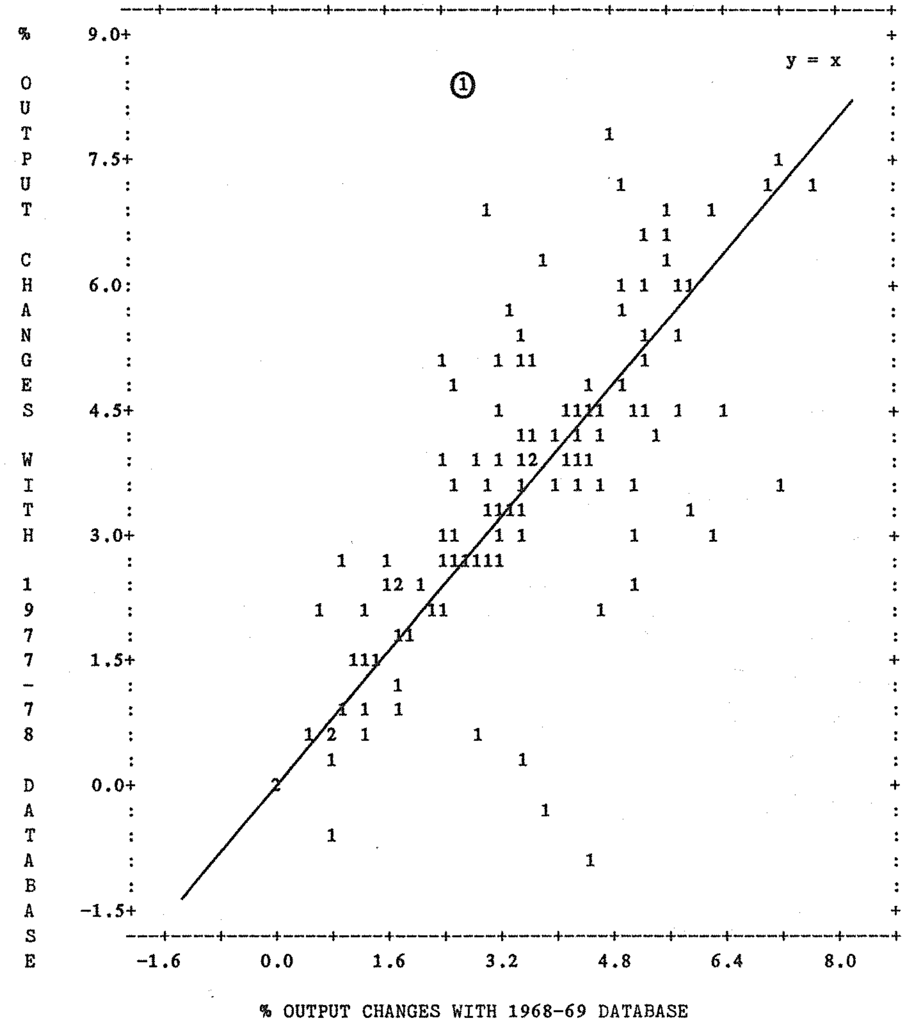
Table 8: BASIC VALUES SALES SHARES OF THE AGRICULTURAL MACHINERY COMMODITY[a]

Destination	1968-69	1974-75	1977-78
Intermediate usage	0.388	0.293	0.277
Capital creation	0.579	0.567	0.647
Household consumption	0.003	0.001	0.001
Exports	0.031	0.139	0.075
TOTAL	1.000	1.000	1.000

a There were no Agricultural Machinery sales to the Other Final Demand category in any of the databases.

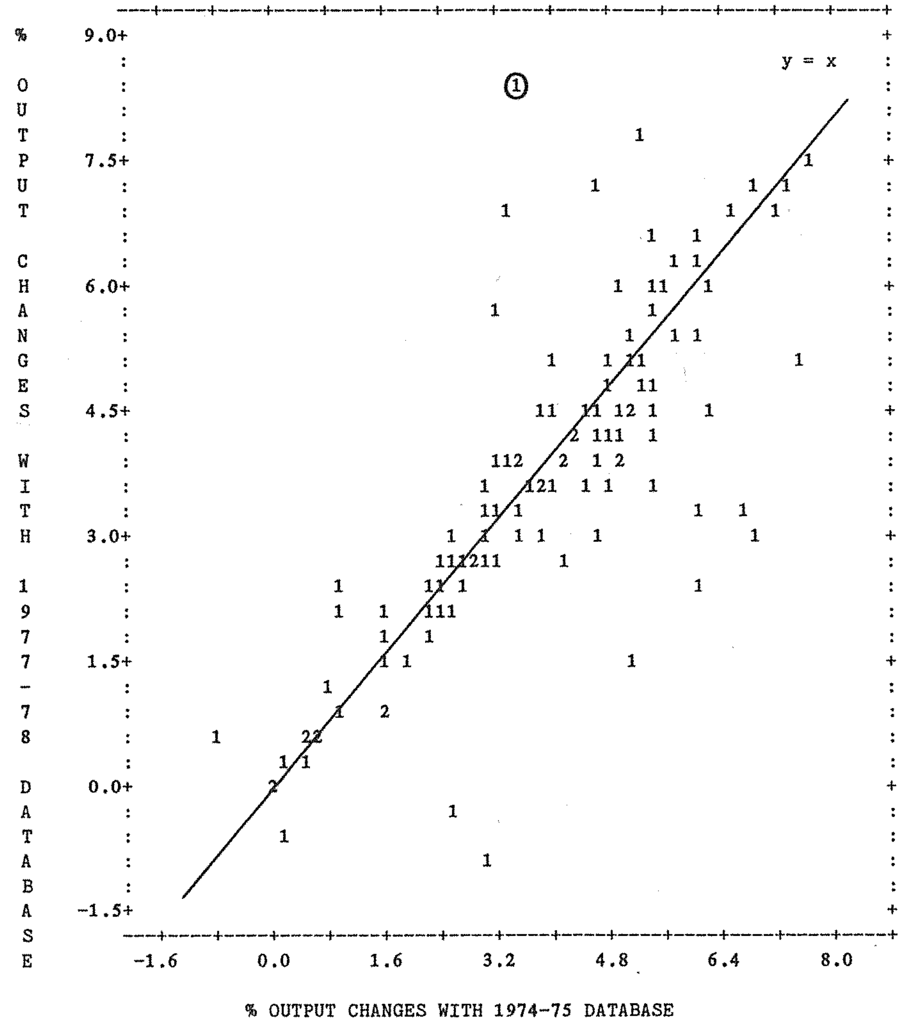
using the 1968-69 results against the 1977-78 results. Had there been no technical changes in the databases and no structural changes in the Australian economy, the distribution would lie along the 45^{o} line through the origin. In fact, this is broadly so, the regression intercept being 0.48 and the slope being 0.80. Figure 3 is a similar scattergram for 1974-75 versus 1977-78. The regression intercept is again 0.48 and the slope 0.82. As an exercise, we may take the furthest outlier from the y = x line in each figure and consider why it is not located closer. In both cases the outlier (circled in the figures) is the Agricultural Machinery industry, the basic values sales shares of the output of which are shown for each database in Table 8. The main feature distinguishing 1977-78 is the increase in the share of sales to capital creation to 65 per cent. These sales are mainly to the agricultural and pastoral industries, which themselves experience large increases in output and rates of return under the shock. Thus the major customers of the Agricultural Machinery industry succeed in capturing a larger share of the (fixed) total investment budget. It follows that the Agricultural Machinery industry enjoys improvements in both demand and supply conditions, and more so on the demand side with the 1977-78 database than in the other cases.

Figure 2: EMPLOYMENT SHOCK EXPERIMENT: SCATTERGRAM OF ORANI INDUSTRY OUTPUT CHANGES USING THE 1968-69 DATABASE AGAINST CORRESPONDING CHANGES USING THE 1977-78 DATABASE[a]



a Each digit in this scattergram, and those that follow, refers to the number of industries located at those particular co-ordinates. The circled digit represents the industry located farthest from the y = x line.

Figure 3: EMPLOYMENT SHOCK EXPERIMENT: SCATTERGRAM OF ORANI INDUSTRY OUTPUT CHANGES USING THE 1974-75 DATABASE AGAINST CORRESPONDING CHANGES USING THE 1977-78 DATABASE[a]



a See note to Figure 2.