APPLIED GENERAL EQUILIBRIUM MODELLING AND LABOUR MARKET FORECASTING

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ABSTRACT

This paper describes the application of the *MONASH* CGE model to labour market forecasting in Australia. The method consists of solving a top-down sequence of models that proceeds from a macro scenario to the CGE model to various labour market extensions. The extensions involve *ex post* processing of the *MONASH* results based on employment data from the census and a number of large sample surveys. Their purpose is to greatly increase the amount of information furnished by the simulations at modest additional cost, and hence to support the use of the system for analysing the efficient allocation of training resources.

1. Introduction

In his recent review of Hertel's *Global Trade Analysis*, Rauscher (1999) began with the following observation:

> To many economists, computable general equilibrium (CGE) models are a bit dubious. They are huge, they are complex, and they appear to be large black boxes that produce results that cannot be traced to an accessibly small set of simple assumptions or axioms.

This paper describes the application of the *MONASH* CGE model to labour market forecasting in Australia, an application which supports a commercially viable briefing service for policy analysts and for which Rauscher's cautionary observation is both particularly relevant and specifically addressed.

The demand for labour depends on many factors. It depends on the state of macroeconomic health of the domestic economy and of the economies of trading partners. It depends on the amount of capital investment and on its allocation between industries. It depends on the pace of technical change and on changes in government policy. Moreover all these factors are interconnected. Developments in one industry

(the introduction of computers in the service sector, for example) affect the demand for labour in other industries (in this case, in the manufacturing industry that produces computers). The *MONASH* forecasting system incorporates all these factors in a set of formal economy-wide forecasts for labour demand.

For the purpose of policy analysis, the forecasts must ideally satisfy four main requirements: they must be detailed, transparent, accessible and reliable. The broad methodology for producing the forecasts using *MONASH* is now well established (see Adams *et al.* (1994) and Meagher (1997), for example). It consists of solving a top-down sequence of models that proceeds from a macro scenario to a CGE model to various labour market extensions. The labour market extensions involve *ex post* processing of the applied general equilibrium results based on data from the census and a number of large sample surveys conducted by the Australian Bureau of Statistics. Their purpose is to greatly increase the amount of policy-relevant information furnished by the *MONASH* simulations at modest additional cost (i.e., to account for the requirement of *detail*). The forecasting system is described in Section 2.

For each of the many thousands of labour market variables identified, the chain of causality driving the forecast is well defined and can be elucidated by suitable interrogation of the *MONASH* forecasting system. Hence the requirements of *transparency* and *accessibility* are treated via user-friendly software that allows subscribers to the briefing service to interrogate the system independently. The software and its operation are described in section 3.

The requirement of *reliability* is fundamental for the policy analyst. However, given the present state of economic knowledge, it is clear that any attempt at disaggregated medium-term economic forecasting will result in mixed success. Whatever measure of accuracy is chosen, the forecasts for some variables will turn out to be "highly" accurate and the forecasts for others will not. The issues associated with assessing the forecasts are canvassed in Section 4.

The final section, Section 5, contains some concluding remarks.

2. The *MONASH* Forecasting System

The elements of the *MONASH* system are set out in Figure 1. As a formally specified system, its first role is to supply a framework for incorporating relevant data into the forecasting process. Published data accessed by *MONASH* includes the national

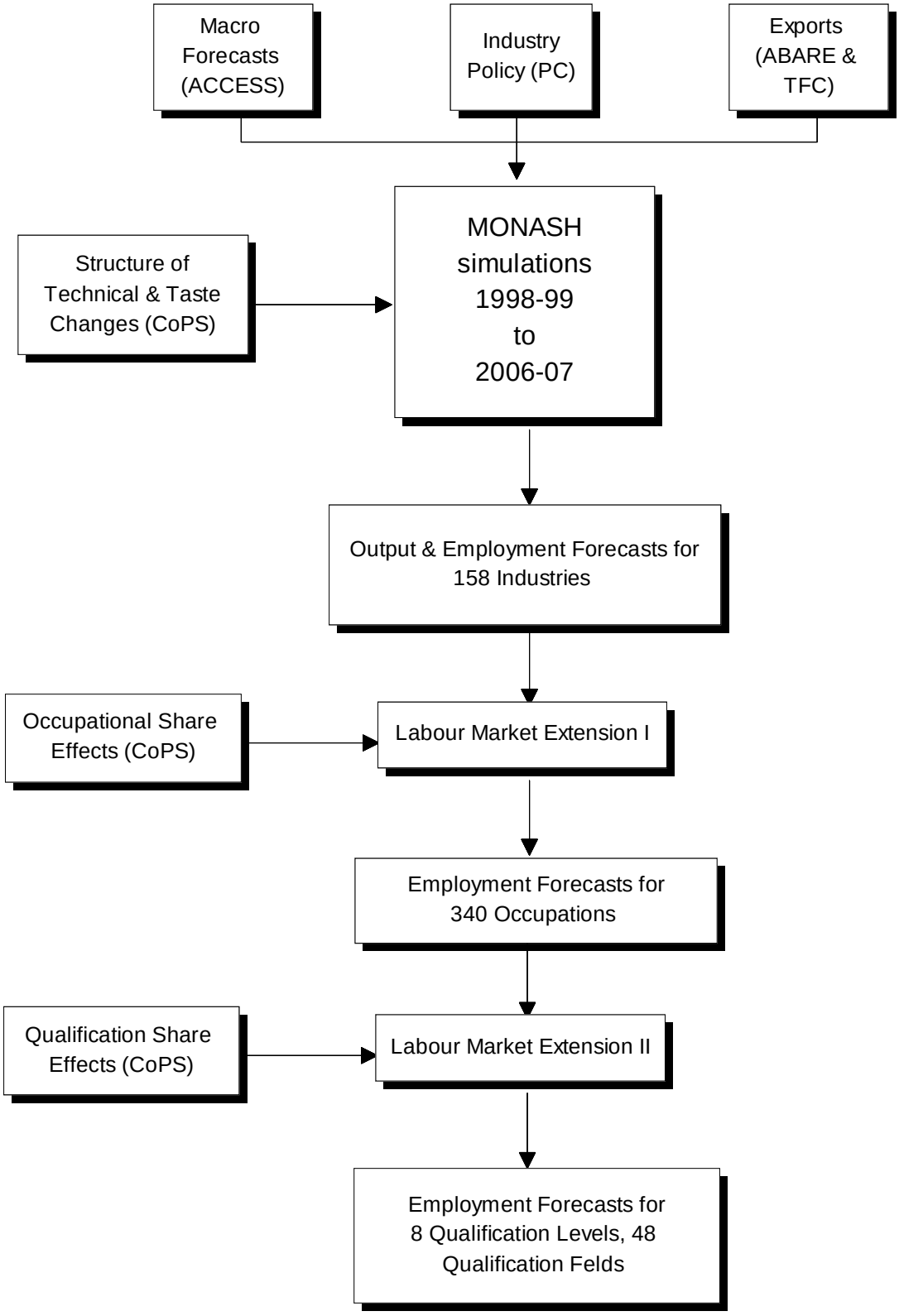

Figure 1. The MONASH Forecasting System

accounts, input-output tables, State accounts, population censuses, foreign trade statistics, capital stock statistics, and income and expenditure surveys. Additional unpublished material is prepared by the Australian Bureau of Statistics especially for the system. Moreover, *MONASH* requires all its data to be consistent. If any inconsistencies do exist in the primary sources, they must be reconciled before the data can be included. This consistency requirement makes the system especially powerful as a framework for organising data.

As well as data about the past, formal or model-based forecasts must rest upon informed opinion about future changes in variables that are *exogenous to* (i.e., determined outside) the system. *MONASH* is quite adaptable in this regard. It already incorporates the views of many expert bodies and can accommodate more detailed exogenous forecasts as they become available. The sources of exogenous forecasts identified in Figure 1 are:

- the commercial forecasting agency, Access Economics (which contributes information about the future state of the macro economy),
- the Australian Bureau of Agricultural and Resource Economics (export prices and volumes for primary products),
- the Tourism Forecasting Council (prospects for tourism),
- the Productivity Commission (changes in protection implied by government industry policy), and
- the Centre of Policy Studies (changes in technology and consumer tastes).

The system can also produce alternative forecasts corresponding to competing views about the future. Just as for historical data, all opinions formally incorporated in a particular forecast must be consistent with each other. A forecaster using *MONASH* must either seek a consensus between the expert bodies involved in forecasting the exogenous variables or impose his/her own judgement to resolve any outstanding differences before the forecast can proceed. In other words, the *MONASH* system provides a framework for coordinating both historical data and expert opinion about the future that bear on the demand for labour.

A *MONASH* forecast of the demand for labour proceeds in five stages. It begins with a macroeconomic scenario derived from the Five Year Business Outlook published quarterly by Access Economics[1]. Table 1 compares the current (as at the beginning of the year 2000) scenario with recent history for a selection of macro variables. A key feature of Australia's economic performance has been the rapid expansion of its

[1] The forecasts presented in the paper are based on Access Economics (1999).

participation in international trade, an expansion that has underpinned a sustained period of economic growth at historically high levels. Within the export sector, tourism and non-traditional export commodities (including elaborately transformed manufactures and services such as education) have been increasing their share at the expense of the more customary agricultural and mining commodities. During the forecast period (1998-99 to 2006-07), Access expects this relative trend to continue but within the context of a general slow down, especially in private investment. Hence GDP growth is expected to be reduced by about one percentage point below the 3.8 per cent per annum achieved during the preceding five years.

Table 1. Average Annual Growth Rates, Selected Macro Variables, Australia, Per Cent Per Annum

	Variable	Historical Data 1993-94 to 1998-99	Forecast 1998-99 to 2006-07
1	Private consumption	4.10	3.00
2	Private dwelling construction	3.00	3.50
3	Public investment	4.70	2.20
4	Total investment	6.90	2.60
5	Public consumption	2.80	2.10
6	Exports - agriculture, forestry, fishing	2.50	2.90
7	Exports - mining	5.40	4.00
8	Exports - tourism	6.40	6.00
9	Exports - non-traditional	7.80	6.90
10	Total exports	6.20	5.70
11	Imports	8.90	5.50
12	Gross domestic product	3.80	2.80

The second stage in the process is to convert the forecasts for GDP and its components into forecasts of output and employment[2] by industry. The structural forecasts supplied by the expert bodies indicated in Figure 1 are incorporated at this stage. In particular, the array of exogenous information is treated as a set of

[2] In what follows we shall implicitly assume that employment is demand determined and refer to employment when, strictly speaking, we mean labour demand.

constraints which governs a simulation using the *MONASH* CGE model in forecast mode. Results of the simulation for 21 industries presented in Table 2. Among the industries with the good output growth prospects, *Communication*, *Other machinery* (which includes electronic equipment), *Metallic mineral products* and *Finance, property and business services* are all favoured by forecast changes in technology which result in their outputs being used more intensively by other industries. The poor growth prospects for *Textiles, clothing and footwear* and *Transport equipment* (which includes automobiles) reflect the strong import competition experienced by these industries.

The output and employment forecasts are related by production functions which determine the increase in output associated with given increases in inputs (capital and labour) and a given rate of primary factor saving technical change. The influence of capital growth and technical change can produce quite different output and employment forecasts for some industries. The change in capital inputs depends critically on whether an industry was under- of over-capitalised in the base period of the forecast (i.e., on whether the rate of return in the industry was above or below the average across industries). An industry with a relatively high rate of return attracts investment and enjoys a relatively high rate of capital growth. For a given rate of output growth and technical change, this implies a relatively low rate of employment growth. Similarly, an industry with a relatively rapid rate of technical change will tend to have a relatively low rate of growth in employment. Thus *Communications*, which has the best prospects for output growth, has poor employment prospects because it is expected to experience particularly rapid growth in labour productivity.

At the third stage, the national forecasts for output and employment are converted into regional forecasts using the *MONASH* regional equation system (MRES), a derivative of the ORANI regional equation system (Dixon et al., 1982, Chapter 6). The regionalisation process takes account of:

- differences in industrial structures,
- region-specific industry effects, such as mine closures,
- population movements,
- expected expenditures by regional governments, and
- local multipliers.

Regional forecasts are produced at two levels of aggregation, namely, eight States and Territories and 56 Statistical Divisions.

Table 2. Industry Forecasts, 1998-99 to 2006-07, Australia, Per Cent Per Annum

	Industry	Labour Inputs	Capital Inputs	Factor Inputs	Output	Labour Productivity	Total factor Productivity
1	Agriculture, forestry and fishing	0.09	-1.44	-0.02	2.74	2.65	2.76
2	Mining	-3.25	2.51	1.58	2.67	5.92	1.09
3	Food, beverages and tobacco	1.99	1.96	1.98	2.83	0.84	0.85
4	Textiles, clothing and footwear	-2.75	2.56	-1.78	0.90	3.65	2.68
5	Wood, wood products and furniture	1.62	0.70	1.52	1.40	-0.23	-0.12
6	Paper, paper products, printing, publishing	-2.29	5.38	1.01	2.62	4.91	1.61
7	Chemical, petroleum and coal products	1.56	3.11	2.17	3.27	1.71	1.11
8	Non-metallic mineral products	0.58	0.07	0.44	1.82	1.23	1.38
9	Metallic mineral products	1.04	-0.50	0.81	3.83	2.79	3.02
10	Transport equipment	-3.36	2.43	-2.23	1.80	5.16	4.03
11	Other machinery	-0.67	0.62	-0.55	5.19	5.86	5.75
12	Other manufacturing	3.15	1.12	2.86	2.58	-0.57	-0.29
13	Utilities	-4.74	0.78	0.06	3.00	7.75	2.95
14	Construction	1.74	3.74	2.10	2.33	0.59	0.23
15	Wholesale and retail trade	2.33	4.38	2.79	3.24	0.91	0.46
16	Transport and storage	0.40	5.51	2.84	3.69	3.29	0.85
17	Communication	-3.37	2.71	-0.04	6.44	9.81	6.48
18	Finance, property and business services	2.15	3.43	3.03	3.90	1.76	0.88
19	Public administration and defence	1.20	0.54	1.17	1.92	0.72	0.75
20	Community services	2.89	0.92	2.70	2.72	-0.17	0.01
21	Recreation and personal services	0.45	4.80	1.41	2.54	2.09	1.13
	All industries	1.43	3.30	2.17	2.80	1.37	0.63

At the fourth stage, the employment forecasts are converted from an industry basis to an occupational basis. National results for nine occupations are reported in Table 3. As the table indicates, employment growth (measured in persons) for a particular occupation can be decomposed into:

- a component due to the growth in aggregate employment (measured in hours),
- a component (the *industry share effect*) due to changes in the distribution of employment across industries,
- a component (the *occupational share effect*) due to changes in the distribution of employment across occupations within industries, and
- a component due to changes in the number of hours per worker.

The forecast for aggregate employment in hours is already known from Table 2 as 1.43 per cent per annum. The industry share effects are computed from the growth rates in employment by industry using an industry by occupation employment matrix derived from the Population Census. The occupational share effects are treated as a type of technical change and are forecast by extrapolating historical trends in the occupational mix in each industry. The method is described in detail in Meagher (1997). Changes in the number of hours per worker in an occupation are also derived by extrapolating past trends.

Table 3. Contributions to Employment Growth, Australia
ASCO Major Groups, 1998-99 to 2006-07, Per Cent Per Annum

Code	Occupation	Growth Effect (hours)	Industry Share Effect	Occupat-ional Share Effect	Hours Effect	Total Growth (persons)
1	Managers and administrators	1.43	–0.45	0.13	–0.01	1.10
2	Professionals	1.43	0.76	0.59	–0.16	2.61
3	Associate professionals	1.43	0.01	–0.15	0.09	1.38
4	Tradespersons and related workers	1.43	–0.57	–0.03	–0.10	0.72
5	Advanced clerical and service workers	1.43	0.00	–2.26	–0.21	–1.04
6	Intermediate clerical, sales and service workers	1.43	0.07	0.34	0.08	1.92
7	Intermediate production and transport workers	1.43	–0.61	0.18	–0.02	0.97
8	Elementary clerical, sales and service workers	1.43	0.35	–1.43	0.24	0.59
9	Labourers and related workers	1.43	0.02	–0.02	–0.15	1.27
	All occupations	1.43	0.00	0.00	–0.06	1.37

At the final stage, the forecasts for employment by occupation in persons are used to determine the employment outlook for workers identified by age, sex, qualifications and hours worked per week. The methodology is analogous to that used to determine the occupational forecasts from the industry forecasts.

3. Interrogating the Forecasting System

The forecasting system described above generates employment forecasts for:

- the 158 classes (3-digit) of the Australian and New Zealand Standard Industry Classification (ANZSIC),
- the 340 unit groups (4-digit) of the Australian Standard Classification of Occupations (ASCO),
- the 8 educational attainment levels of the Australian Bureau of Statistics Classification of Qualifications (ABSCQ),
- the 47 ABSCQ narrow qualification fields,
- 24 demographic groups differentiated by age and sex, and
- 9 categories of hours worked per week.

Moreover, all the forecasts are generated for the 8 States and Territories and the 56 Statistical Divisions. To render such a large amount of information *accessible* to a policy analyst, it is written onto CD-ROM together with software to facilitate its manipulation. In particular, the forecasts have been provided with a WINDOWS interface which allows the analyst to select, via pull-down menus,:

- the variable of interest from the above list (e.g., employment by occupation),
- the level of aggregation (e.g., the 9 ASCO major groups shown in Table 3),
- the region, and
- the form in which the forecasts are presented (levels or growth rates).

Any table of forecasts generated in this way can then be conveniently transferred, via a Copy button, to an Excel spreadsheet for further processing. One CD-ROM presents national forecasts disaggregated by State and Territory. A second, identical in design to the first, presents the forecasts for a particular State or Territory disaggregated by Statistical Division.

To meet the requirement of *transparency*, the analyst can (in principle, if not yet always in practice) interrogate the system in four ways. First, the CD-ROM includes historical data which can be conveniently compared with the employment forecasts.

That is, any variable that appears in the forecast menu can also be selected from a historical menu which contains data for the period 1990-91 to 1998-99. Drilling on a particular variable produces a graphic which allows for a visual assessment of the deviation of the forecast from the historical record.

Second, the CD-ROM allows for a variety of shift/share analyses in which employment growth for one category of the system is "explained" in terms of employment growth in another category. The range of available pairs is described by the menu:

- industry (158) by occupation (340)
- occupation (340) by hours worked (9)
- hours worked (9) by demographic group (24)
- occupation (340) by qualification field (47)
- occupation (340) by qualification level (8)
- qualification level (8) by qualification field (47)
- occupation by demographic group (47),

where the number in brackets is the maximum level of disaggregation for the category.

Suppose one was interested in knowing how much various industries contribute the employment growth of *Tradespersons and related workers*. From Table 3, employment in this occupation is forecast to grow at an average annual rate of 0.72 per cent or, equivalently, by 5.91 per cent over the whole forecast period (1998-99 to 2006-07). To generate the desired contributions, two choices must be made. First, the pair of categories concerned with industries and occupations (i.e., the first pair) is selected from the shift/share menu. This results in a table describing employment growth by occupation. The occupation of interest is then selected from this table, producing a second table with the format shown in Table 4.

The first column of the table shows how the employment (measured in persons) of *Tradespersons and related workers* was distributed across industries in base period for the forecast, i.e.,1998-99. The second column shows the average annual employment growth rate for each industry over the eight year forecasting period[3], and the third column shows the total growth rate over the same period. The fourth and fifth columns show the corresponding information for the occupational share effect. If the employment share (from the first column) is multiplied by the total growth rate (the sum of the third and fifth columns), one obtains the contribution (in the sixth column)

[3] Note that the employment growth rates by industry in Table 4 (which are measured in persons) are similar to, but not identical to, those in Table 2 (which are measured in hours).

Table 4. Employment Contributions by Industry: Tradespersons and Related Workers, Persons, 1998-9 to 2006-7

Code	Industry	(1) Employment Share	(2) Industry Growth Rate (per cent)	(3)	(4) Occupation Share Effect (per cent)	(5)	(1) * [(3)+(5)] Contribution (percentage points)	Rank
		1998-9	Average Annual	Total	Average Annual	Total		
A00	Agriculture forestry and fishing	0.020	0.23	1.89	0.19	1.56	0.07	14
B00	Mining	0.015	-3.28	-23.44	0.11	0.89	-0.33	9
C00	Manufacturing	0.243	0.11	0.90	-0.09	-0.68	0.05	15
D00	Electricity gas water	0.015	-4.90	-33.09	-0.18	-1.47	-0.52	7
E00	Construction	0.279	1.64	13.87	-0.30	-2.34	3.22	1
F00	Wholesale trade	0.049	2.89	25.57	0.62	5.03	1.49	4
G00	Retail trade	0.155	2.00	17.18	-0.12	-0.97	2.51	2
H00	Accomodation cafes restaurants	0.026	1.61	13.59	-1.53	-11.61	0.05	16
I00	Transport and storage	0.020	0.18	1.46	-1.78	-13.35	-0.23	11
J00	Communication services	0.021	-3.57	-25.22	-0.04	-0.29	-0.52	6
K00	Finance and insurance	0.002	-2.75	-20.02	0.42	3.43	-0.03	17
L00	Property and business services	0.034	3.14	28.09	0.30	2.42	1.02	5
M00	Government administration and defence	0.014	1.04	8.66	-0.46	-3.64	0.07	13
N00	Education	0.012	3.55	32.24	-0.21	-1.65	0.38	8
O00	Health and community services	0.017	2.12	18.23	-1.11	-8.56	0.16	12
P00	Cultural and recreational services	0.019	2.68	23.57	-1.09	-8.43	0.29	10
Q00	Personal and other services	0.062	-2.90	-20.95	-0.93	-7.22	-1.75	3
	Total	1.000					5.91	

made by the industry to the employment growth of the occupation. Summing the industry contributions yields the total growth rate for the occupation. The final column of the table ranks the industries according to the absolute values of their contributions.

Thus, over the period 1998-99 to 2006-07, employment of *Tradespersons and related workers* is forecast to increase by 5.91 per cent. Of this amount, 3.22 percentage points, or 54 per cent, can be attributed to changes in employment in the *Construction* industry. Moreover, a positive contribution of 3.87 (i.e., 0.279 x 13.87) percentage points can be attributed to employment growth in *Construction* as a whole, and a negative contribution of 0.65 (i.e., 0.279 x 2.34) percentage points to a redistribution of employment within *Construction* against *Tradespersons and related workers* in favour of other occupations.

The order of the categories belonging to each of the pairs in the shift/share menu can be reversed via a transpose button, enabling the analyst to identify (for example) the relative importance of the contribution of the occupation *Tradespersons and related workers* to employment growth in the industry *Construction*. For each table generated during the analysis, pull-down menus offer alternative choices for the level of aggregation level and/or the region.

The third method for interrogating the system (not yet implemented on the CD-ROM) is designed to identify the sources of differences in employment growth between the regions. It is based on the decomposition[4]:

$$g_r - g_A = \Sigma_i \{ (S_{ir} - S_{iA}) * (g_{iA} - g_A) + S_{ir} * (g_{ir} - g_{iA}) \}$$

where

g_r is the aggregate employment growth rate in region r,

g_A is the aggregate employment growth rate in Australia as a whole,

g_{ir} is the employment growth rate for industry i in region r,

g_{iA} is the employment growth rate for industry i in Australia as a whole,

S_{ir} is the employment share of industry i in region r, and

S_{iA} is the employment share of industry i in Australia as a whole.

[4] The authors are indebted to Peter Dixon for suggesting this decomposition.

The ith component of the summation on the right hand side is the contribution of the ith industry to the deviation between employment growth in region r and employment growth in Australia as a whole. The first term in this contribution is positive if:

- industry i is a fast growing industry (i.e., $g_{iA} > g_A$) and it is over-represented in region r (i.e., $S_{ir} > S_{iA}$), or
- industry i is a slow growing industry (i.e., $g_{iA} < g_A$) and it is under-represented in region r (i.e., $S_{ir} < S_{iA}$).

The second term of the contribution is positive if industry i grows more quickly in region r than it does in Australia (i.e., $g_{ir} > g_{iA}$).

As an example, consider the case of Western Australia, the State with the best employment growth prospects. Over the forecasting period, employment in Western Australia is forecast to grow by 18.09 per cent (or 2.10 per cent per annum) compared with 11.51 per cent (or 1.37 per cent per annum) for Australia as a whole. Table 5 shows the contributions made by various industries to the difference of 6.58 percentage points. Among the industries listed, the largest contribution (of 2.12 percentage points, or about a third of the total) comes from *Manufacturing*. Moreover, the table shows that it is the difference between the employment growth rates forecast for Western Australia and Australia (19.34 per cent and 0.90 per cent, respectively), rather than the difference between their base period employment shares (10.09 per cent and 12.54 per cent , respectively), which accounts for the large contribution.

The analysis can be carried further by applying the decomposition to the *Manufacturing* sector separately and increasing the level of disaggregation. From Table 6, the industry Metal products accounts for 6.32 percentage points (or about a third) of the difference of 18.44 percentage points (i.e., 19.34 - 0.90) between the employment growth rates forecast for *Manufacturing* in Western Australia and Australia. As for *Manufacturing* as a whole, the importance of *Metal products* derives mainly from the difference between the regional and national growth rates (33.67 per cent and 7.86per cent respectively).

Finally, when the decomposition is applied to *Metal products*, the component industry *Basic non-ferrous metal manufacturing* is identified as being the most important (Table 6). It contributes 11.11 percentage points (or about 40 per cent) of the difference of 25.81 percentage points (i.e., 33.67 - 7.86) between the employment

Table 5. Industry Contributions to Growth Deviations, Western Australia *

Code	Description	(1) S_{ir}	(2) S_{iA}	(3) g_{ir}	(4) g_{iA}	(5) $(S_{ir} - S_{iA}) * (g_{iA} - g_A)$	(6) $S_{ir} * (g_{ir} - g_{iA})$	(5) + (6) Contribution
A00	Agriculture forestry and fishing	5.14	4.92	20.11	1.89	-0.02	0.94	0.92
B00	Mining	3.35	0.93	-27.03	-23.44	-0.85	-0.12	-0.97
C00	Manufacturing	10.09	12.54	19.34	0.90	0.26	1.86	2.12
D00	Electricity gas and water	0.69	0.75	-26.15	-33.09	0.03	0.05	0.07
E00	Construction	7.87	7.34	17.18	13.87	0.01	0.26	0.27
F00	Wholesale Trade	5.72	5.86	31.78	25.57	-0.02	0.35	0.33
G00	Retail trade	15.14	15.03	25.49	17.18	0.01	1.26	1.27
H00	Accommodation cafes and restaurants	4.49	4.77	17.27	13.59	-0.01	0.17	0.16
I00	Transport and storage	4.65	4.73	20.99	1.46	0.01	0.91	0.92
J00	Communication services	1.50	1.75	-21.94	-25.22	0.09	0.05	0.14
K00	Finance and insurance	3.02	3.70	-12.76	-20.02	0.21	0.22	0.43
L00	Property and business services	11.18	10.92	34.04	28.09	0.04	0.67	0.71
M00	Government administration and defence	3.98	4.00	22.47	8.66	0.00	0.55	0.55
N00	Education	7.19	6.98	26.65	32.24	0.04	-0.40	-0.36
O00	Health and community services	9.15	9.46	16.89	18.23	-0.02	-0.12	-0.14
P00	Cultural and recreational services	2.37	2.42	28.96	23.57	-0.01	0.13	0.12
Q00	Personal and other services	4.47	3.92	-16.08	-20.95	-0.18	0.22	0.04
	All industries	100.00	100.00	18.09	11.51	0.00	6.58	6.58

* The symbols in this table are defined in the text.

Table 6. Industry Contributions to Growth Deviations, Western Australia *

Code	Description	(1) S_{ir}	(2) S_{iA}	(3) g_{ir}	(4) g_{iA}	(5) $(S_{ir} - S_{iA}) * (g_{iA} - g_A)$	(6) $S_{ir} * (g_{ir} - g_{iA})$	(5) + (6) Contribution
210	Food beverages and tobacco	14.16	16.35	31.81	16.09	-0.33	2.23	1.89
220	Textile clothing footwear and leather products	4.35	8.55	-0.45	-15.08	0.67	0.64	1.31
230	Wood and paper products	5.94	6.01	10.07	-8.49	0.01	1.10	1.11
240	Printing publishing and recorded media	11.24	10.21	-7.55	-17.20	-0.19	1.09	0.90
250	Petroleum coal chemical and associated products	8.36	9.56	26.27	14.32	-0.16	1.00	0.84
260	Non-metallic mineral products	5.99	4.47	14.65	3.97	0.05	0.64	0.69
270	Metal products	22.67	15.98	33.67	7.86	0.47	5.85	6.32
280	Machinery and equipment	16.42	20.43	2.71	-14.03	0.60	2.75	3.35
290	Other manufacturing	10.87	8.44	36.35	22.32	0.52	1.53	2.05
C00	*Manufacturing*	100.00	100.00	19.34	0.90	0.00	18.44	18.44
271	Iron and steel manufacturing	9.35	20.90	-5.01	-17.92	2.98	1.21	4.18
272	Basic non-ferrous metal manufacturing	23.12	9.72	59.76	17.08	1.24	9.87	11.11
273	Non-ferrous basic metal product manufacturing	3.57	3.06	59.76	17.08	0.05	1.52	1.57
274	Structural metal product manufacturing	26.32	23.41	30.31	12.48	0.13	4.69	4.83
275	Sheet metal product manufacturing	6.15	11.83	80.06	53.47	-2.59	1.64	-0.95
276	Fabricated metal product manufacturing	31.49	31.08	16.79	0.56	-0.03	5.11	5.08
270	*Metal products*	100.00	100.00	33.67	7.86	0.00	25.81	25.81

* The symbols in this table are defined in the text.

growth rates forecast for *Metal products* in Western Australia and Australia.

The regional decomposition has been used here to identify the relative importance of various industries in accounting for differences in employment growth between Australia and its component States and Territories. However it could equally well be applied to:

- any of the other employment categories (i.e., occupations, qualifications, etc) included in the forecasting system, and
- differences between employment growth in a State or Territory and its component Statistical Divisions.

The final interrogation method, namely, an embodied labour calculation, will show how much labour in any category (industry, occupation, etc.) is tied up in producing goods and services for

- intermediate usage,
- household consumption,
- capital accumulation,
- government consumption, and
- international exports.

However, this calculation has not yet been implemented in any form and no results can be presented here.

4. Assessing the Forecasts

The most obvious method for assessing the *reliability* of a forecasting system is to consider its the track record: did forecasts made in the past come to fruition? (Indeed, if forecasts are treated as having been generated by a "black box", this is the only feasible method of assessment.) In the seven years since the Centre of Policy Studies (CoPS) began using the *MONASH* model to produce regular labour market forecasts, no formal evaluation of the system has been attempted. This situation reflects research priorities in an environment of scarce resources. The *MONASH* forecasting system remains a system under development, and the pressure to incorporate methodological improvements in current forecasts tends to outweigh the pressure to provide evaluations of forecasts made in the past.

However, Borghans *et al.* (1994) have undertaken a comprehensive assessment of a broadly similar forecasting system for the Netherlands. As foreshadowed, their evaluation revealed mixed success and has been summarised by the OECD (1994) as follows:

> The differences between the projections and the outcomes were assessed in terms of a standard loss function. The conclusions were that 'the lowest average loss was for the replacement demand per type of education, and the average loss for the forecasts of replacement demand per occupational class was also quite low.' On the other hand, the forecast for the expansion demand per occupational class had 'by far the lowest reliability'. A comparison of the projections with a variant assuming no change in the labour market since the base year suggested that most components of the projections were 'mediocre'. However, a qualitative indicator, designed to characterise the labour market prospects per type of education, was found to give 'especially good results'. The general conclusion was that 'despite the errors, the forecasts seem to be reasonably good'. (p.85)

Borghans *et al.* went to considerable lengths in the study to identify the reasons behind the deviations of their forecasts from actual outcomes, and hence to identify those aspects of the system most in need of improvement. In other words, they implicitly concluded that their system was worth persevering with.

There is a second potentially informative, but less demanding, criterion for evaluating the performance of a system like *MONASH*. If the model is provided with the actual values of all the exogenous variables (that is, if all the expert opinion incorporated in a *MONASH* forecast turns out to be correct), does the model accurately determine the values of all the endogenous variables? Such an exercise has been conducted by Polo and Sancho (1993) for an applied general equilibrium model of Spain. Again, the results were mixed, with some major indicators being "adequately captured" but with some sectoral variables being accounted for "less satisfactorily". Moreover, they were unable to determine whether the errors resulted from a misspecification of the model or from measurement errors and poor data. One reason for this kind of uncertainty is evident from Figure 1, namely, the appearance of technical change among the exogenous variables of a *MONASH*-type forecast. As technical change cannot be observed directly, the idea that the model can be provided with the "correct" values of all the exogenous variables is somewhat problematic. Indeed, the deviations from observed values of the results of a suitably configured *MONASH* simulation constitute an estimate of what technical change has been in the past.

The *MONASH* system produces a large array of detailed but fully consistent forecasts. Of necessity, such a system is a complicated one and can be thoroughly understood only at the cost of considerable outlays of time and effort. This complexity poses a significant difficulty for policy analysts from any outside organisation attempting to reach an independent assessment of the quality of the CoPS forecasts. However, three features of the CoPS *modus operandi* can provide some reassurance. Firstly, the Monash system is continually exposed to peer group scrutiny via articles in academic journals and via presentations at conferences. Secondly, CoPS conducts regular residential training courses on the operation of the *MONASH* system. These courses attract an international enrolment and are sufficiently intensive to bring the participants up to the level where they can begin to question the details of model formulation and implementation. Although a particular organisation may not be able to participate itself, it is nevertheless important to all users of the *MONASH* system that members of some organisations are subjecting the system to serious detailed scrutiny. Thirdly, as already discussed, CoPS is developing software which enables users to independently interrogate the *MONASH* system. That is, the *MONASH* system offers users the wherewithall to look inside the "black box", and hence to make more sophisticated judgements about the quality of the forecasts than can be had by simple reliance on track record.

5. Concluding Remarks

The application of CGE modelling described in this paper is important because:

- it provides important policy information (on the future distribution of employment) that would not otherwise be available to Australian policy makers;
- the information it provides is both very detailed and coherent (in the sense that all the forecasts conform to a single, plausible scenario for the economy as a whole);
- it demonstrates the power of using a sequence of models in a top-down hierarchy to conduct detailed policy analysis, especially distributional analysis.

The *MONASH* forecasting system has been designed to address the labour market analyst's requirements for detail, accessibility and transparency, and has achieved a reasonable measure of success in this regard. While true reliability remains a more elusive goal, almost all economic decision making is subject to similar uncertainty because it is forward looking. If training resources are to be allocated efficiently, for example, it is mandatory that the future demand for labour of different types be

forecast in one way or another. It takes time to conduct a training course. Furthermore, the skills that result are generally expected to retain their social usefulness for an extended period after the completion of the course. Of its nature, a decision to implement a training program *must* be informed by a view about the future, either explicitly or implicitly. Hence, the accuracy of any particular forecasting methodology should properly be compared with the accuracy of the best available alternative, and not with the accuracy of some non-operational ideal.

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