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Paper presented to the Conference on Vocational Education and Training: *Towards a Skilled Australia,* Brisbane, February 8-10, 1995

Future Workforce Skills: Projections with the *MONASH* Model

by

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General Paper No. G-116 March 1996

ISSN 1 1031 9034 ISBN 0 7326 0730 2

The Centre of Policy Studies (COPS) is a research centre at Monash University devoted to quantitative analysis of issues relevant to Australian economic policy. The Impact Project is a cooperative venture between the Australian Federal Government and Monash University, La Trobe University, and the Australian National University. COPS and Impact currently operate as a single unit at Monash University with the task of constructing a new economy-wide policy model to be known as *MONASH*. This initiative is supported by the Industry Commission on behalf of the Commonwealth Government, and by several other sponsors. The views expressed herein do not necessarily represent those of any sponsor or government.

ABSTRACT

Since 1993 the Centre of Policy Studies has been using the MONASH model to produce year-by-year forecasts for the Australian economy, typically with forecast horizons of about ten years. MONASH is a large dynamic applied general equilibrium model.

The MONASH forecasting system takes as inputs macroeconomic forecasts from Syntec Economic Services, forecasts for the agricultural and mining sectors from the Australian Bureau of Agricultural and Resource Economics, forecasts for international tourism from the Bureau of Tourism Research, and scenarios on technical change from extrapolations of recent historical experience. The MONASH model then produces consistent forecasts for 112 industries, 56 regions and 282 occupations.

The occupational forecasts give projections of the demand for the ASCO unit groups in each of the six Australian States. These forecasts provide a background for assessing the skills likely to be required in the Australian workforce in the next decade. In this paper we report a selection of our most recent (as at February 1995) forecasts for occupations, and explain how they relate to the macroeconomic and industrial dimensions of the overall forecasts.

J.E.L. Classification Numbers: C68, D58, E47, I20, J21.

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FUTURE WORKFORCE SKILLS: PROJECTIONS WITH THE MONASH MODEL

by

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1. Introduction

Since 1993, the Centre of Policy Studies (CoPS) has been using the MONASH model to produce year-by-year forecasts for the Australian economy, typically with forecast horizons of about ten years (Adams, Dixon, 1994a and b; Adams, Dixon and McDonald, 1994; Adams, Dixon, McDonald, Meagher and Parmenter, 1994). The demand for labour by occupation is one of the forecast variables. The forecasting methodology recognises that the occupational structure of the demand for labour depends on the industrial structure of employment, which in turn depends on factors such as macroeconomic developments, international-trade prospects, industry policy, and changes in technology and household tastes.

Forecasts of the demand for occupations provide a background for assessing the skills likely to be required in the Australian workforce in the future. Among the subscribers to the CoPS forecasts are the Australian National Training Authority (ANTA) and 5 State training authorities. These institutions also have access to projections of future training needs generated by organisations, such as the industry training boards, which focus in great detail on the particular sections of the labour market with which they are concerned. Relative to these narrowly focussed sources of information, the advantage of the MONASH system is that ensures that forecasts of the demand for particular occupations (or for any other structural variables) together comprise a plausible forecast of the development of the economy overall.

In the section 2 of this paper we describe the structure of the MONASH forecasting system. In sections 3 and 4, we summarise the inputs to and the results from our most recent run of the system which was completed in December 1994. Section 5 is a brief conclusion.

2. The MONASH Forecasting system

Figure 1 illustrates the MONASH forecasting system. At its heart is the MONASH model, a dynamic computable general equilibrium model distinguishing 112 industries, 6 States, 56 sub-state regions and 282 occupations. The model is initially calibrated to an up-to-date input-output database which has been estimated at CoPS (Dixon and McDonald, 1992).

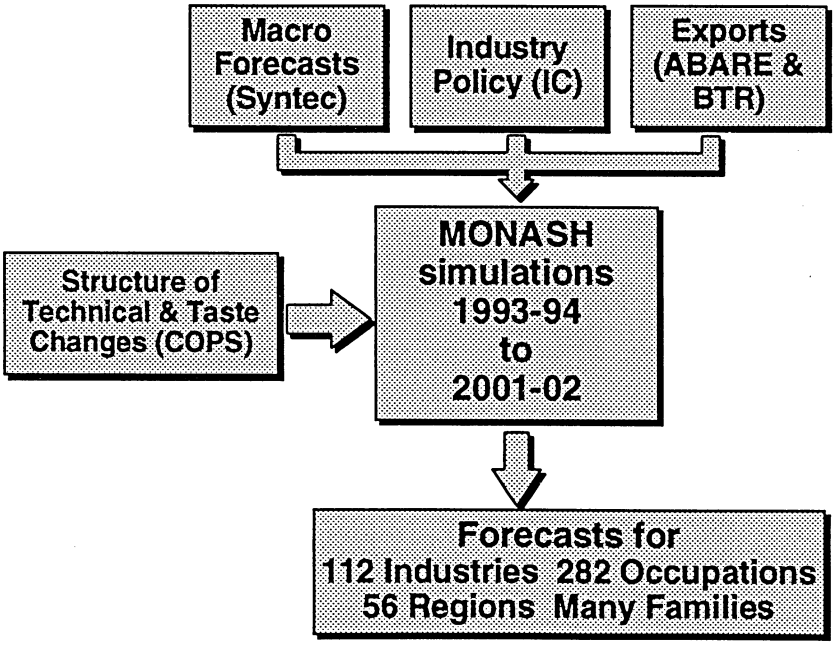

Figure 1: The MONASH Forecasting Methodology

It produces annual solutions, with investment decisions and capital accumulation linking the years. In the current version of the model, investors are assumed to take this year's rates of return as their expectations about next year's rates. Hence, the model can be solved recursively (cf., Malakellis, 1994; Dixon and Parmenter, 1995). The results of each year's solution are used to update the database, providing the starting point for the next year's solution. For each annual solution, the model first produces results for macroeconomic variables and the industrial structure at the economy-wide level. Results for States, regions and occupations are derived by tops-down disaggregations.

In running the MONASH forecasting system, we feed into the MONASH model expert views on the range of issues covered by the boxes at the top of Figure 1. We take forecasts for most macroeconomic variables from a specialised macroeconomic forecasting agency, Syntec Economic Services[1]. Prospects for the major export sectors are taken from the relevant government agencies, the Australian Bureau of Agricultural and Resource Economics (ABARE) in the case of agriculture and mining, and the Bureau of Tourism Research (BTR) in the case of international tourism. Quantitative

[1] An alternative with which we are experimenting is the incorporation of a formal macroeconometric model such as the Murphy Model, see Malakellis and Dixon (1994).

details of the government's industry policies are supplied by the Industry Commission (IC). Scenarios on changes in technology and in household tastes, crucial determinants of changes in the structure of the economy, are compiled at CoPS on the basis of estimates of changes in technology and tastes occurring in recent years (Parmenter, Meagher and Higgs, 1994; Dixon and McDonald, 1993).

3. Inputs to the MONASH Forecasts

The most recent run of the MONASH forecasting system was completed and reported to subscribers to the forecasting project in December 1994. The forecasts cover the period 1993-94 to 2001-02. The assumptions about the macroeconomy, export prospects, industry policy, technology and household tastes which were fed into the MONASH model are summarised below.

3.1 The Macroeconomy

Syntec's views about Australia's macroeconomic prospects are driven primarily by their assessment of prospects for the international economy. They expect strong recovery of the European and Japanese economies to offset a slackening of US growth, producing a period sustained moderate growth in the second half of the 1990s. This translates to favourable prospects for Australia, with GDP growth forecast to average 3.7 per cent per year through our forecast period.

In recent years, Australia's international trade has grown much more rapidly than its GDP. Syntec macroeconomic forecasts assume a continuation of this phenomenon. The average annual growth rate both of export and import volumes is forecast to be close to 7 per cent.

3.2 Export Prospects

From ABARE sources, we compile as input to the MONASH-model forecasting simulations detailed scenarios on the prospects for world prices, export volumes and output levels of Australia's main agricultural and mineral products. The scenarios underlying the forecasts reported in this paper can be summarised as follows:

- poor export prospects (average annual growth in export volumes <1.5%) coarse grains, fishing, oil and gas, sugar, cotton ginning;
- good export prospects (average annual growth in export volumes >4.5%) non-ferrous metal ores, meat;
- middle export prospects (average annual growth in export volumes 1.5% –4.5%) wool, wheat, iron ore, black coal, processed metal ores.

International tourism now accounts for a very large share (about 11 %) of Australia' export revenue. Following the views of the BTR, we assume that expenditures by international tourists will grow at an annual rate of 10% through our forecast period.

3.3 Industry policy

Historically, industry policy has afforded many manufacturing industries protection against import competition *via* tariffs, import quotas, etc. In our forecasts, we adopt IC projections of the changes in the tariff equivalents of these structures implied by current government plans. These plans imply quite sharp reductions in protection up to 1995-96, especially for the textiles, clothing and footwear industries and for motor vehicles. These reductions in protection are projected to continue in the second half of the 1990s but at slower rates.

3.4 Technology and Household Tastes

Changes in technology and household tastes are not directly observable. Our methodology for estimating historical patterns of such changes involves simulations with our model in which we ensure that the model reproduces historical changes in a wide range of observable variables: commodity outputs and prices, export and import volumes, employment and investment by industry, etc. In these simulations, we solve for patterns of changes in technology and tastes which are required by the model to explain the parts of the observed changes in variables such as outputs and trade volumes which cannot be explained by the other mechanisms built into the model (e.g., responses to changes in purchasers' aggregate expenditure levels and to changes in relative prices). We use these estimated patterns of past changes in technology and tastes as the basis for formulating scenarios on future changes.

Examples of technological and taste change which show up strongly in our historical estimates and which in our forecasting scenario we have assumed will continue are:

- a shift in household tastes away from products such as tobacco and alcoholic beverages, which are thought to pose health risks, and in favour of products thought to promote good health (e.g., fruit and vegetables);
- changes in production technologies favouring the use of communication services and the associated hardware;
- changes in technology economising on the use of transport and storage; and
- reform of public-sector industries leading to unusually rapid improvements in factor productivity.

4. MONASH Forecasts 1993-94 to 2001-02

Output from the MONASH system includes forecasts of the demand for labour by occupation at the State level. Examples of these are reported in section 4.3. First we will summarise the corresponding forecasts for industry prospects at the national level and for the relative growth prospects of the States. Some familiarity with these is necessary for explaining the detailed employment forecasts.

4.1 Industry Prospects

The MONASH model produces forecasts for 112 industry groups. The prospects for each industry can be tightly related to the assumptions adopted in the forecasting exercise and to the characterisation of the industry in the model's data. Examples of the factors which are prominent in explaining industries' prospects in the most recent forecasts are as follows.

- Very strong growth prospects are forecast for the industries which produce communications services and the associated electronic equipment. These industries are strongly favoured by our assumptions about technical change.
- Rapid growth of export volumes is a feature of our macroeconomic assumptions. According to ABARE, the mining sector will make a strong contribution to export growth. Continuing strong growth of international tourism forecast by the BTR results in strong prospects for the related service industries (e.g., air transport, restaurants and hotels). The facilitation of international trade accounts for a large share of the activity of the wholesale trade industry. Hence it also enjoys strong growth prospects.
- Transport and storage is another industry strongly oriented to the facilitation of international trade. Nevertheless, its prospects are weak according to our forecasts. The explanation is the transport-saving technical change included in the technology scenario adopted in the forecasts.
- The average annual growth prospects of agriculture over the whole forecast period are quite weak. This reflects ABARE views with an allowance built in for the damaging effects of the drought in the early part of the period.
- The sector with the weakest forecast growth prospects is textiles, clothing and footwear. Industries in this sector are extremely exposed to competition from imports. Strong import growth is a feature of the macroeconomic assumptions adopted in the forecasts. Among the import-competing industries, textiles, clothing and footwear are particularly hard hit because of the effects of the governments tariff-reform program.

4.2 State Prospects

The tops-down procedure which we use to infer prospects at the State level in the MONASH forecasting system accounts for the following factors[2].

1. *State differences in industrial structures.* The forecasting system includes data on the industrial structures of the States. The simplest way in which to infer State prospects from national-level forecasts would be to assume that for each industry, the growth rate forecast at the national level will apply in each State. Under such an assumption, we would recognise, for example, that rapid expansion of international tourism would stimulate Queensland relative to the other states because tourism accounts for a relatively large share of economic activity in Queensland.

[2] A similar procedure is used to infer prospects for each States statistical divisions.

2. *State-specific industry effects.* For some industries, we do have a sound basis for forecasting that growth rates within an industry will differ between states. The forecasts which we take from ABARE, for example, often include such information. The oil and gas industry is a good example. Overall ABARE forecasts only moderate prospects for this sector but this forecast is a combination of strong prospects in Western Australia and weak prospects in Victoria where Bass-Straight oil reserves are running out.

3. *Population movements.* Differences in the economic performances of the states are accompanied by population movements. To some extent population movements are stimulated by differences in economic performance. Our forecasting system implicitly assumes that the working-age population will relocate itself in line with job prospects. For other groups it is reasonable to assume that population movements are a cause rather than an effect of differences in economic performance. In our forecasts we account for the movement of retirement-aged persons for non-economic reasons. These movements favour northern Queensland, south-eastern Queensland and northern NSW at the expense of other regions in the eastern states.

4. *State-government expenditures.* Our forecasts include differences between the states in state-government spending. In particular, they recognise that severe budgetary problems in Victoria and South Australia have led to relatively vigorous attempts to restrain spending.

5. *Local multipliers.* The tops-down method regional method used in the MONASH forecasting system recognises the presence in the states of a group of industries producing commodities (mainly services) which are not traded between the states. The prospects of these "local" industries in any state depend on the demand for their products within that state. Recognition of this builds in local multiplier effects to the regional calculations.

Using the tops-down procedure, we forecast that state's growth rates of GSP and aggregate employment will be in a rather narrow band. Queensland, Western Australia and NSW are forecast to have growth prospects stronger than those of Victoria, South Australia and Tasmania but there is less variation across states than has been evident in the recent past. Two factors account for the flattening of the state growth prospects. The first is the waning of the tariff-reform program, the bulk of the impact of which fell on Victoria and South Australia. The second is rapid growth of non-traditional exports (manufacturing and services) which is spreading the impact of export growth away from Western Australia and Queensland.

4.3 Employment Forecasts

Output from the MONASH system includes forecasts of the demand for labour classified according to the ABS Australian Standard Classification of Occupations (ASCO). Results are available for the 8 ASCO major groups, the

52 minor groups or the 282 unit groups. To illustrate the forecasts we confine ourselves here to the major groups.

Table 1 contains our latest forecasts of the average annual rates of growth of employment by ASCO major group and by state. Note from the last row of the table that the forecast average annual rate of growth of aggregate employment at the national level is 2.36 per cent, with the corresponding state growth rates varying from 2.62 per cent for Queensland to 1.95 per cent for Victoria. From the last column of the table we see that, at the national level, occupation 6 (*Sales and personal service workers*) is forecast to be the fastest growing occupation and occupation 7 (*Plant and machinery operators and drivers*) the slowest.

For any cell in Table 1 (or in the corresponding tables showing forecasts for employment growth for the ASCO minor or unit groups) we can produce a table explaining the result in that cell in terms of the underlying industry contributions[3]. Table 2 is the table which explains the forecast rate of growth for occupation 6 at the national level (3.09 per cent). The table contains a row for each of the 10 largest employers of the occupation, ranked by their shares in the occupation's aggregate employment[4]. As well as the employment shares, the table contains the forecast average annual rates of growth of employment in the industries, their total employment growth over the 8-year forecast period[5] and their contributions to the 8-year growth in employment of the occupation. Our assumption is that each industry's demand for each occupation grows at the same rate as the aggregate rate of growth of employment in the industry, i.e., that the occupational structure of employment in the industry does not change. Hence, an industry's contribution to the growth of employment in an occupation is given by the product of the industry's share in the aggregate employment of the occupation and the industry's employment growth rate[6].

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[3] For subscribers to the CoPS/Syntec forecasting project, these tables are available on a dial-up basis from the Monash computer system.

[4] In producing the dial-up tables, users can select the number of industries shown in the table.

[5] E.g., in row 1, $30.337 = 1.03367^8 - 1$. To ensure that the adding-up properties of the calculations are preserved, it is necessary to work in terms of 8-year rather than average annual growth rates.

[6] E.g., in row 1, $10.265 = 0.338 \times 30.337$.

Table 1: Employment Growth Rates for ASCO Major Groups, 1993-94 to 2001-02, Per Cent Per Annum

	Occupation	NSW	VIC	QLD	SA	WA	TAS	All States
1	Managers and administrators	2.50	2.15	2.30	2.21	2.52	2.34	2.35
2	Professionals	2.70	1.98	2.83	1.98	2.63	2.31	2.45
3	Para-professionals	2.80	2.11	2.83	2.11	2.75	2.37	2.56
4	Tradespersons	2.59	1.92	2.47	1.79	2.38	1.97	2.29
5	Clerks	2.72	2.17	2.76	2.18	2.71	2.38	2.54
6	Salespersons and personal service workers	3.29	2.63	3.41	2.69	3.34	2.75	3.09
7	Plant and machine operators, and drivers	0.86	0.19	1.09	0.45	1.16	0.19	0.72
8	Labourers and related workers	2.24	1.60	2.40	1.70	2.44	1.72	2.07
9	All occupations	2.58	1.95	2.62	1.99	2.57	2.09	2.36

Table 2. Industry Contributions to Employment Growth, 1993-94 to 2001-02
Salespersons and Personal Service Workers, Australia, Per Cent

Rank		Industry	Employment Share 1993-94	Average Growth Rate	Total Growth Rate	Contribution
1	90	Retail trade	0.338	3.367	30.337	10.265
2	111	Restaurants, hotels and clubs	0.106	3.815	34.919	3.702
3	91	Mechanical repairs	0.086	3.021	26.885	2.315
4	89	Wholesale trade	0.084	4.320	40.263	3.380
5	107	Health	0.055	2.660	23.366	1.274
6	103	Other business services	0.050	1.411	11.861	0.593
7	109	Welfare and religious institutions	0.049	3.761	34.363	1.676
8	99	Banking	0.036	2.389	20.793	0.738
9	110	Entertainment and recreation	0.020	0.638	5.219	0.102
10	102	Insurance and insurance services	0.019	5.982	59.165	1.136
		Other industries	0.158	1.764	15.011	2.370
		All industries	1.000	3.089		27.553

Number of employed persons in group, 1993-94 = 1209984

From Table 2 it is apparent that the reason for the relatively strong employment growth forecast for occupation 6 is its heavy concentration in service industries which have good growth prospects and little scope for labour-saving technical change. Note that the 4 largest employers together account for 60 per cent of the occupations aggregate employment. All four have employment growth rates well above the economy-wide average (2.36 per cent). Output growth in *Retail trade* and *Mechanical repairs* is forecast to outpace GDP growth slightly but, with below-average labour-saving technical change, employment growth in these industries is well above average employment growth. As we noted in section 4.1, *Restaurants, hotels and clubs* and *Wholesale trade* benefit from the rapid growth of exports. Hence, their employment growth is forecast to be even more rapid.

Table 3 sheds light on the relatively slow employment growth (0.72 per cent per year) forecast for occupation 7. This occupation is less heavily concentrated industrially than is occupation 6. Although there are some industries with fast employment growth represented among the occupations largest employers (especially *Other construction*), its prospects are dominated by shrinking employment in its largest employer (*Road transport*) and in *Clothing* and *Rail transport*. In section 4.1 we noted that prospects for output growth are weak in the transport sector because of transport-saving technical change and in the clothing industry because of tariff cuts and import competition. All three of these industries are undergoing significant labour-saving technical change. Hence, weak output-growth prospects translate into shrinking employment.

Tables 4 and 5 illustrate how our explanatory tables can elucidate regional differences in employment prospects for occupations. It can be seen from Table 1 that employment in the slow-growing occupation 7 is forecast to grow most slowly (0.19 per cent per year) in Victoria and least slowly (1.16 per cent per year) in Western Australia. Tables 4 and 5 demonstrate that this difference is attributable to a combination of differences between states in the industrial composition of the occupation's employment and interstate differences in the rates of growth of employment in the main employing industries. For example, the tables show that *Clothing* (an industry with shrinking employment) employs a much larger share of occupation 7 in Victoria than in WA, and that *Non-ferrous metal ores* (which has moderate employment growth) employs a much larger share in WA than in Victoria. Service industries which employ the occupation tend to grow more rapidly in WA than in Victoria because of the difference between the overall growth rates of the two states. *Retail trade* provides a good example.

Table 3. Industry Contributions to Employment Growth, 1993-94 to 2001-02
Plant and Machine Operators and Drivers, Australia, Per Cent

Rank		Industry	Employment Share 1993-94	Average Growth Rate	Total Growth Rate	Contribution
1	93	Road transport	0.238	-1.262	-9.660	-2.303
2	89	Wholesale trade	0.068	4.320	40.263	2.742
3	88	Other construction	0.047	5.660	55.346	2.626
4	105	Public administration	0.043	3.051	27.177	1.162
5	38	Clothing	0.043	-3.307	-23.586	-1.007
6	109	Welfare and religious institutions	0.036	3.761	34.363	1.220
7	94	Railway and other transport, etc.	0.033	-1.375	-10.487	-0.350
8	90	Retail trade	0.029	3.367	30.337	0.894
9	87	Residential building construction	0.023	0.935	7.728	0.180
10	103	Other business services	0.019	1.411	11.861	0.222
		Other industries	0.420	0.149	1.202	0.505
		All industries	1.000	0.718		5.892

$\frac{1}{1}$ Number of employed persons in group, 1993-94 = 565642

Table 4. Industry Contributions to Employment Growth, 1993-94 to 2001-02
Plant and Machine Operators and Drivers, Victoria, Per Cent

Rank		Industry	Employment Share 1993-94	Average Growth Rate	Total Growth Rate	Contribution
1	93	Road transport	0.207	-1.550	-11.751	-2.438
2	89	Wholesale trade	0.075	4.166	38.615	2.910
3	38	Clothing	0.069	-3.307	-23.586	-1.618
4	105	Public administration	0.037	3.051	27.177	1.016
5	94	Railway and other transport, etc.	0.036	-1.375	-10.487	-0.376
6	109	Welfare and religious institutions	0.030	3.115	27.811	0.845
7	90	Retail trade	0.030	2.979	26.467	0.783
8	68	Motor vehicles and parts, etc.	0.028	-1.350	-10.302	-0.291
9	88	Other construction	0.028	5.433	52.694	1.486
10	81	Plastic and related products	0.027	-0.914	-7.082	-0.190
		Other industries	0.432	-0.180	-1.432	-0.619
		All industries	1.000	0.187		1.508

Number of employed persons in group, 1993-94 = 144557

Table 5. Industry Contributions to Employment Growth, 1993-94 to 2001-02
Plant and Machine Operators and Drivers, Western Australia, Per Cent

Rank		Industry	Employment Share 1993-94	Average Growth Rate	Total Growth Rate	Contribution
1	93	Road transport	0.223	-0.805	-6.262	-1.398
2	13	Non-ferrous metal ores	0.072	2.092	18.017	1.298
3	88	Other construction	0.062	5.228	50.332	3.138
4	89	Wholesale trade	0.062	4.318	40.246	2.502
5	105	Public administration	0.046	3.051	27.177	1.255
6	94	Railway and other transport, etc.	0.046	-1.375	-10.487	-0.483
7	109	Welfare and religious institutions	0.036	4.114	38.066	1.383
8	87	Residential building construction	0.034	1.179	9.834	0.337
9	90	Retail trade	0.028	3.652	33.240	0.925
10	17	Services to mining n.e.c.	0.026	1.243	10.390	0.266
		Other industries	0.364	0.144	1.157	0.421
		All industries	1.000	1.157		9.644

Number of employed persons in group, 1993-94 = 66511

5. Conclusion

The forecasting project outlined in this paper is ongoing. Several developments are in prospect. To date, for example, we have assumed that the occupational structure of employment within industries will remain unchanged. We have recently been examining the historical record on within-industry occupational change using Census and Labour-Force-Survey data. Although there are numerous problems with these data, the evidence suggests that changes in the occupational structure of employment within industries have been an important component of recent changes in occupational employment. On the basis of our historical studies we plan to include in our forecasts scenarios on future changes in the occupational structures of industries' workforces, just as we already include scenarios on other aspects of technical change and on changes in household tastes. Another development is to mobilise data data on the sales patterns of commodities at a more disaggregated level than is in the standard MONASH model. Such data are available from the ABS Input-output section (see ABS Cat. No. 5215). This will enable us to make more satisfactory mappings between the industry dimensions of our system and the detailed occupational dimensions, particularly the ASCO unit-group data.

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