



Australian Government
Productivity Commission

Computable General
Equilibrium Modelling of
Workplace Relations

Workplace Relations Framework
Technical Supplement to the Inquiry Report

January 2016

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The Productivity Commission

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The Commission's independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by concern for the wellbeing of the community as a whole.

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Acknowledgments

The Commission thanks participants for their inputs at three modelling workshops on 23 June 2015, 24 June 2015 and 28 October 2015. These workshops discussed the modelling scenarios and considered the initial modelling results. All three workshops were attended by academics and representatives of Australian government agencies. The participants are listed in appendix A of the inquiry report into Australia's Workplace Relations Framework (No. 76, 30 November 2015). These consultations assisted the Commission to subsequently refine and improve the database construction, the modelling scenarios and the results as outlined in the inquiry report and presented in more detail in this supplement.

Abbreviations

ABS	Australian Bureau of Statistics
ANZCO	Australian and New Zealand Standard Classification of Occupations
CES	Constant elasticity of substitution
CET	Constant elasticity of transformation
CGE	Computable general equilibrium
COAG	Council of Australian Governments
CURF	Confidentialised unit record file
GDP	Gross domestic product
GST	Goods and services tax
FWC	Fair Work Commission
MMRF	Monash Multi Regional Forecasting
VUMR	Victoria University Multi Regional
WR	Workplace relations
PC	Productivity Commission

1 Introduction

1.1 Background

Like most other developed economies, Australia sets statutorily-binding minimum wages. The rates vary between adults, juniors, apprentices and trainees, and some people with disabilities. In addition, under the award system, the Fair Work Commission (FWC) sets wage floors for many industries and occupations. In effect, there are hundreds of minimum wages in Australia.

Under the *Fair Work Act 2009*, an expert panel of the FWC adjusts the national minimum wage each year following an annual wage review. It also adjusts the minimum wages for different work classifications in awards, normally in line with the adjustment to the national minimum wage. The annual adjustments made over the last six years are shown in table 1.1.

Table 1.1 **Minimum wage changes**
2010–2015

	<i>Unit</i>	<i>Jul 2010</i>	<i>Jul 2011</i>	<i>Jul 2012</i>	<i>Jul 2013</i>	<i>Jul 2014</i>	<i>Jul 2015</i>
Minimum wage							
Old minimum wage	hourly \$	14.31	15.00	15.51	15.96	16.37	16.87
New minimum wage	hourly \$	15.00	15.51	15.96	16.37	16.87	17.29
Percentage increase	%	4.8	3.4	2.9	2.6	3.1	2.5

In its report on Workplace Relations Frameworks, the Productivity Commission (2015c) identified several impacts from minimum wages.

The report found that increases in minimum wages would provide direct financial benefits to (most) low-wage workers and households. It found that the benefits of minimum wage adjustments are spread throughout the income distribution, but favour middle-income households. People in lower-income households benefit less because those minimum wage earners located in the bottom quintile of equivalised household income tend to work relatively fewer hours on average and because many lower-income households do not contain wage-earners and/or transfer payments represent a more significant share of net household income than wages. However, an employee in a low-income household is much more likely to be paid at, or close to, the minimum wage than higher-income households.

Drawing on a range of empirical and qualitative evidence, the report's assessment was that modest increases in Australia's minimum wage are unlikely to measurably affect employment. However, large increases in the minimum wage 'bite' (the ratio of the minimum wage to the median wage) or steep rises in the minimum wage compared with product prices would make lower-skilled, less experienced employees less attractive to employers and reduce employment on both an hours and headcount basis, particularly over the longer term. It also considered that some reductions from current levels of the minimum wage bite could increase employment at the economywide level but there are more caveats and uncertainty in this area.

The Productivity Commission used microsimulation modelling to explore the 'morning after' effects of a change in minimum wages on the size and distribution of household incomes. The modelling scenario was based on the 2012 minimum wage adjustment of 2.9 per cent, and took into account changes in various taxes and transfers affected by an increase in minimum wages. Some limited behavioural (disemployment) effects were also modelled.

However, the report noted that minimum wage regulation can have broader and more indirect effects on the living standards of people on low incomes (and, indeed, on the broader community). These can arise through changes to output and input prices, government finances, the incentives for workers to undertake education and acquire skills, and the composition of the economy. These induced effects give rise to wider resource allocation effects that may vary geographically and by industry. Many of these 'economywide' effects are more readily modelled in a 'computable general equilibrium' (CGE) framework.

The report provided the key results of some CGE modelling of the potential economywide effects of certain minimum wage scenarios. This technical supplement provides further detail and documentation of the CGE analysis.

1.2 Overview of the CGE modelling

The modelling used the Victoria University Multi-Regional (VUMR) model in dynamic mode, adapted by the Productivity Commission to differentiate between workers whose wages are directly altered by minimum wage decisions and other workers. The model database is based on ABS input-output tables and has considerable occupational and industry detail. A hypothetical policy scenario has been modelled in which the wages of award-reliant workers continue to grow, but by 1 percentage point less annually, for 5 years from 2017-18, than under the counterfactual. The modelling projects effects over time, and considers possible adjustment implications and the timescale over which changes may occur.

The Productivity Commission held three modelling workshops on 23 June 2015, 24 June 2015 and 28 October 2015 to discuss the modelling scenarios and to consider the initial

modelling results. All three workshops were attended by academics and representatives of Australian government agencies (inquiry report, appendix A). These consultations assisted the Commission to subsequently refine and improve the database construction, the modelling scenarios and the results as outlined in the inquiry report and presented in more detail in this supplement.

Importantly, while the VUMR model is widely used and the modelling approach adopted has been subject to expert scrutiny, the modelling projections in this supplement should not be interpreted as forecasts of actual changes. Different model structures, behavioural parameters and closure assumptions reflect different interpretations of real world institutions and forces, and their underlying drivers. These influence the outcomes of the modelling of any policy scenario. This is particularly relevant to the modelling of wage changes, including the degree to which wage shocks affect the overall number of persons employed rather than the average hours worked by those in employment.

While the Productivity Commission did not base its policy advice on the CGE modelling results, it recognises the potential under certain labour market conditions for minimum wage moderation to provide for a long-run expansion in employment, accompanied by flow-on increases in economic activity and incomes more generally. The modelling illustrates pathways by which such effects can arise.

2 Modelling approach

2.1 The model

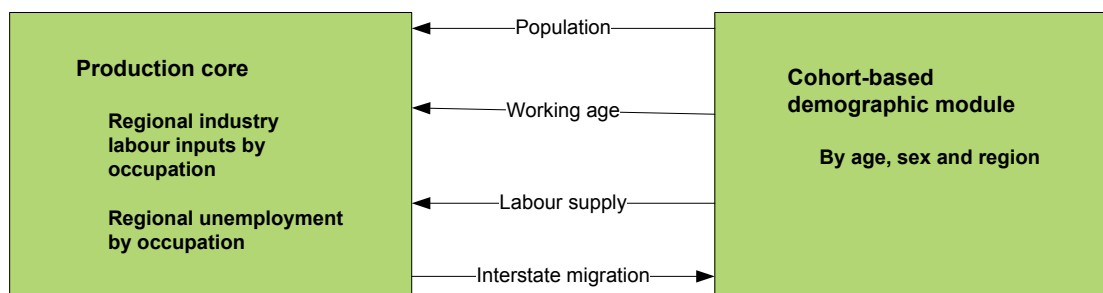
The FWC's annual wage review directly affects employees paid exactly at the national minimum wage and employees paid above the minimum wage, but whose hourly pay rates are determined by awards covered by the national workplace relations system. To explore the economywide impacts of changes to the growth of award wages, it is necessary to consider the direct impacts on award-reliant workers and the flow-on effects to the broader labour force, to national demands for goods and services and the productive capacities of the economy.

The VUMR model builds on that used in the Productivity Commission's 2012 study on the impacts of reforms made by the Council of Australian Governments and documented in Centre of Policy Studies (2014).¹ Production in each state and territory is disaggregated into 79 industries and the workforce into 8 occupational groups. It includes a cohort based demographic module which is integrated with the production core of the model, as well as detailed accounting of government finances for each State and Territory government and the Australian Government (figure 2.1). Within the framework, labour demand and supply is modelled for each occupational group by region and industry.

For this supplement, the model (and its associated database) has been disaggregated into workers paid at award rates (including the minimum wage) and other workers. The demand for labour has been modified accordingly to introduce an additional level of substitution between award wage workers and other workers based on the relative effective price of labour. The supply of labour has also been modified to allow the national supply of workers in each occupation to respond positively to a change in award wages relative to other wages. The version incorporating this additional detail and applied in this supplement is termed the VUMR-WR (Workplace Relations) model.

¹ The Productivity Commission has made extensive use of economywide CGE models to assess the economywide impacts of policy reforms (including changes in government industry assistance). In 2012, it used a CGE modelling framework to assess the impacts of Council of Australian Government's (COAG) policy reforms (PC 2012) and, in 2013, it adapted this framework to assess the impacts of prospective changes in Australia's automotive industry (PC 2014). CGE modelling is also being used in the Commission inquiry into Australia's migrant intake (PC 2015a).

Figure 2.1 **Stylised representation of the VUMR-WR model**



In this supplement, the VUMR-WR model is applied in *dynamic* mode to explore the transition path of the economy in response to award wage changes, including possible adjustment implications. Under the dynamic approach, the modelling scenarios consider the path of the economy over the period 2017-18 to 2024-25 with and without moderation of the growth of award wages over the first five years of that period.

Details of the VUMR-WR model are provided in appendix A. A detailed description of the theoretical structure of the model is provided in *A Dynamic Multi-Regional Applied General Equilibrium Model of the Australian Economy* (CoPS 2014).

2.2 Policy scenarios

The economywide impacts of changes in award wage depend on many factors, including:

- the number of people employed on minimum wages or wages linked to the minimums
- the locations, occupations and industries where these workers are employed
- the linkages to the wider economy of the firms and industries that employ these workers
- expectations about the FWC's future minimum wage determinations
- the timing of determinations
- general economic conditions prevailing at the time.

In scenario 1, award wages are assumed to grow in line with other wages for each occupation. This assumption of wage growth reflects the recent trend and provides a simple counterfactual for considering moderation of award wage growth. In scenario 1, the unemployment rate is assumed to be fixed.

In scenario 2, award wages are modelled as temporarily growing one percentage point slower each year than in scenario 1, from 2017-18 to 2021-22. While still increasing in real terms, award wages would be around 5 per cent below those in scenario 1 by 2021-22 and

thereafter. It is assumed that the moderated growth in award wages is passed directly through to all workers who are award-reliant (table 2.1).

Table 2.1 Illustrative scenarios modelled

<i>Scenario</i>	<i>Footprint of directly affected workers</i>	<i>Real award wages</i>	<i>Other wages</i>	<i>Unemployment rate</i>
Key illustrative minimum wage scenarios				
Scenario 1: award wages grow with other wages in each occupation	No distinction between award and non-award wages	Determined by supply and demand	Determined by supply and demand	Assumed unchanged
Scenario 2: moderate award wages growth	Workers who are award-reliant	Grows 1 percentage point slower than in scenario 1 between 2017-18 and 2021-22	Same as scenario 1	Assumed to adjust between 2017-18 and 2021-22
Sensitivity testing to examine alternative modelling assumptions				
Alternative assumptions about the minimum wage footprint.				
Alternative assumptions about the responsiveness of demand to a change in the price of labour relative to capital and the responsiveness of demand and supply to award wage changes.				

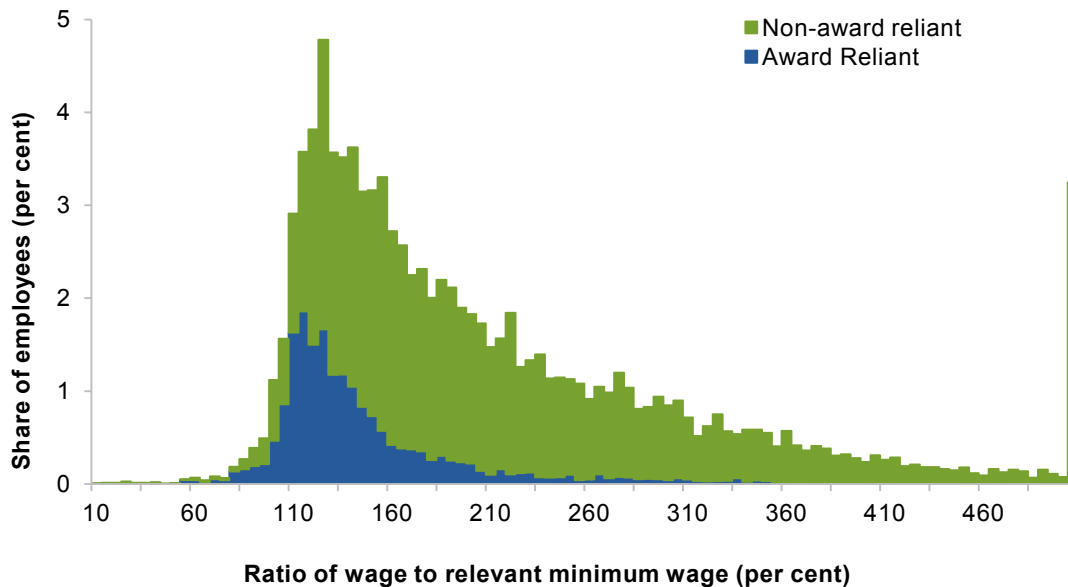
For the purposes of the modelling, award-reliant workers are identified using the Australian Bureau of Statistics' (ABS) Survey of Employee Earnings and Hours, which includes a variable identifying workers whose wages are set equal to the minimum award wages. These 'award-reliant' workers account for around 19 per cent of the workforce (figure 2.2). Non-award wages are determined by the market and will therefore only be affected indirectly by the change in award wages. Unemployment is allowed to adjust over the five-year period of the moderate wage policy, in response to the change in award wages.

More details on the specification of these scenarios in the modelling are presented in appendix C.

The difference between scenario 1 and scenario 2 reflects the modelled effects of moderating the real growth in award wages over time.

Sensitivity testing has been undertaken to explore the robustness of the projected changes to alternative assumptions about the extent of the minimum wage footprint and the value of key model parameters.

Figure 2.2 Scenario 2: Proportion of employees who are award-reliant
 Distribution of wages as per cent of national minimum wage^a



^a This distribution of wages takes into account the national minimum wage rate that is applicable to each individual, including youth wage rates, apprenticeship and trainee wage rates and disability wage rates.

Source: Productivity Commission estimates based on ABS (*Employee Earnings and Hours, Australia*, Cat. no. 6306.0, May 2014).

2.3 The modelling in context

The modelling approach seeks to capture many of the relationships that determine the economywide impacts of minimum wage policy in Australia. In simulations, the direct effects of the FWC’s decisions to set wages are imposed on the model as exogenous ‘shocks’ or a model ‘scenario’, as described above, and the flow-on effects are projected.

As with all such analyses, the limitations of the modelling need to be considered when interpreting the results. Like all models, the VUMR-WR model cannot fully replicate the economy and all of the complex interactions within and between the domestic and global economic system. While it provides a more detailed breakdown of labour markets than simple models, it nevertheless does not capture the full heterogeneity of occupations and skills. It also does not take account of the potential linkages between employees’ long-run decisions to invest in skill formation and the effects of minimum wages on employment prospects. The model does not explicitly capture the emergence of new activities and products, or global economic changes. Nor does it take explicit account of social conditions and the feedback effects these may have on the economy.

As the projected effects of the scenarios modelled reflect simplifying assumptions imposed on the model, they should not be interpreted as estimates or forecasts of the actual effects

of the FWC's determinations. Rather, they are indicative of the direction and pattern of change as it is modelled to evolve over time in response to award wage changes. In particular, the assumption that only those employees recorded as award-reliant in the *ABS Survey of Employee Earnings and Hours* are directly affected by a change in award wage may not fully hold in reality. A further issue is the extent to which the employment effects of variations in wages are realised as changes in the number of persons employed or in the hours of work of those in employment, a matter not determined within the model. This is important since unemployment and underemployment can have different impacts on people's lives and the economy. For example, long-term unemployment is more likely to erode skills and demotivate people than working fewer hours than desired. The fiscal savings can also vary depending on whether the outcome of wage moderation affects employment or hours worked — as eligibility for certain social security benefits depends not just on income, but on working status.

The dynamic modelling of the possible timescale of effects is based on a framework of 'adaptive' expectations where industry adjusts gradually to economic change. Under this approach, capital accumulates to equilibrate the actual return on capital with the expected rate and progressively depreciates, based on historical averages. Investment decisions of businesses are modelled as responding to minimum wage changes. To the extent that firms anticipate changes in the economy (flowing from minimum wage changes) and adjust investment, output and employment decisions, the modelling results could understate or overstate actual outcomes.

The behavioural parameters included in the VUMR-WR model determine the responsiveness of producers and consumers to changes in relative prices (including wages) and are based on benchmark model values. To the extent that behavioural responses by producers and consumers differ (such as in purchasing local and imported supplies, the substitution between labour and capital in production, or the relocation of labour between regions) from these benchmark values, results could also understate or overstate outcomes. The behavioural parameters used in the model are the standard parameter values included in successive versions of the model. The main values are included in appendix B.

Similarly, the compilation of the model database is based on simplifying assumptions needed to translate and calibrate available statistical information into a database representing the complex interactions in the economy. Deviations in the model data from actual economic flows would lead to different aggregate results and possible variations in the distributional effects.

3 Main results

This chapter reports on the potential economic effects of a hypothetical scenario of moderating the growth in the minimum wage. This modelling projects the economic impacts over time, and examines the possible adjustment implications and the timescale of changes.

3.1 Labour market implications

Under scenario 1, the expert panel is assumed to set award wages so that they grow in line with other wages for each occupation. This provides a natural benchmark (or counterfactual) against which the economic impacts of changes in relative wages of award-reliant workers can be assessed.

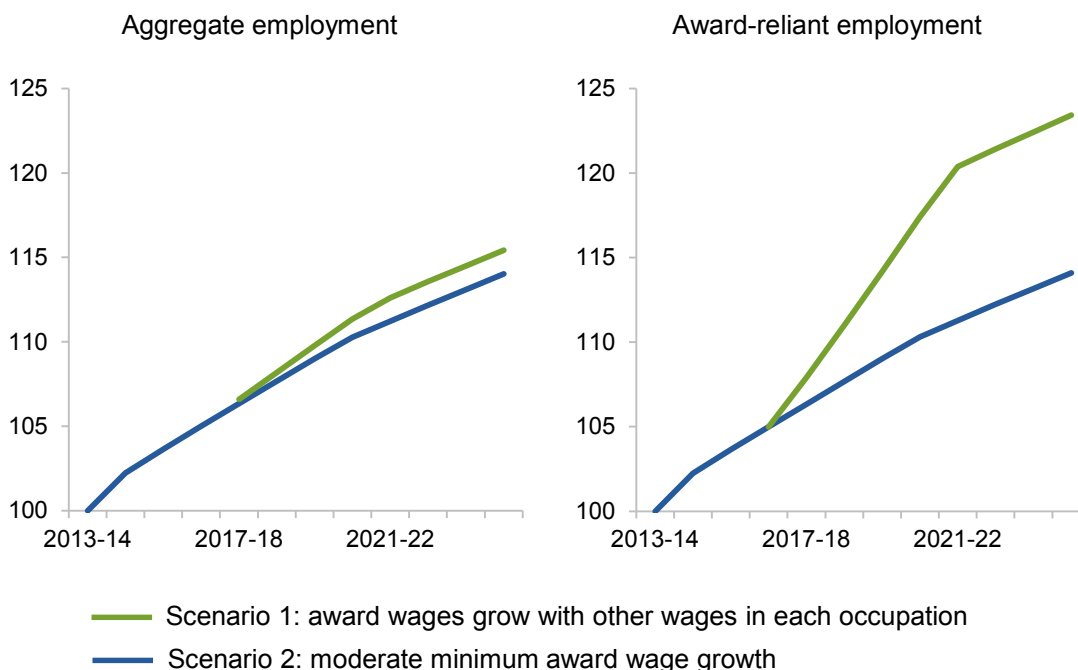
As indicated in chapter 1, about 19 per cent of the workforce is estimated to be award-reliant. In the moderate minimum wage growth scenario (scenario 2), wages for this group of workers are modelled as growing one percentage point slower than in scenario 1 from 2017-18 to 2021-22. Under this scenario, by 2021-22, minimum award wages would be around 5 per cent below minimum award wages in scenario 1. Beyond 2021-22, the expert panel is again assumed to set award wages to grow at the rate of other wages.

Reflecting moderation of wage growth of award wage earners, overall average wage rates are projected to be around half a per cent lower than otherwise by 2021-22. (This outcome is a consequence of the relatively modest share of employees who are award-reliant and the lower average wage rate for such employees compared with others.)

The initial growth in projected employment occurs as businesses respond to the moderation in award wages by shifting toward more labour-intensive activities. All else being equal, the moderated wage growth would also improve the trade competitiveness of domestic industry. Over time, output would increase, thereby increasing the demand for labour. Aggregate employment (measured in hours) is projected to be about 0.2 per cent higher in 2017-18. As the economy adjusts over time, aggregate employment measured in hours worked is projected to be about 1.2 per cent above what it would otherwise be in 2024-25 (scenario 1) (figure 3.1). With the main employment-augmenting adjustment concentrated on award-reliant workers, employment of this group is projected to be 8 per cent above the level in 2024-25 than would otherwise prevail. If this increase were entirely realised through job creation, aggregate full-time equivalent employment would be around 150 000 persons larger by 2024-25.

Figure 3.1 Projected effects of the moderate minimum wage growth scenario on hours worked

Index, 2013-14 = 100



Source: Productivity Commission projections based on the VUMR-WR model.

In practice, some of the increased demand would be met through existing employees working additional hours, rather than through new jobs. As discussed in the Productivity Commission’s report on Workplace Relations Frameworks (2015b), many employees would prefer to work more hours (underemployment) in Australia. Since 1992, underemployment is estimated to have accounted for around 6 per cent or more of the Australian labour force (ABS 2015). This represents a large pool from which increased employment could be drawn. Moreover, for businesses, increasing the hours of existing employees involves fewer costs than new hires.

3.2 Aggregate implications

Reflecting the modest aggregate employment effects, the economywide effects are also likely to be modest. Moderating minimum award wage growth by one percentage point each year for five years is projected to lead to levels of gross domestic product and gross national expenditure of around 0.75 per cent above what they would otherwise be by 2024-25 (table 3.1). By 2024-25, gross domestic product is projected to be around \$16 billion larger than it would otherwise have been (in 2013-14 prices). Again, these results are dependent on the underlying parameters and structure of the VUMR-WR model.

While the moderation of the growth in minimum wages may be expected to constrain the growth in wage rates of existing minimum wage workers, the effect on wage income is projected to be more than offset in the modelling by the expansion in employment of minimum wage workers, whether in terms of increased hours or in additional jobs. At an aggregate level, this is shown by the projected expansion in real household consumer spending of 0.7 per cent above its baseline by 2024-25 (table 3.1).

Table 3.1 Projected economywide effects of the moderate minimum wage growth scenario

Percentage difference from scenario 1

	2017-18 %	2024-25 %
Real gross domestic product	0.1	0.8
Real gross national expenditure	0.1	0.8
Components of GNE:		
Real household consumption	0.1	0.7
Real government spending	0.1	0.7
Real investment	0.2	1.3
Export volumes	0.1	0.4
Import volumes	0.1	0.7
Real exchange rate ^a	0.1	0.2
Terms of trade	[-] ^b	-0.1
National labour productivity	-0.1	-0.5

^a Real depreciation of the Australian dollar (defined as the Australian dollar price of imports less the GDP(E) deflator). ^b Between 0 and -0.05.

Source: Productivity Commission projections based on the VUMR-WR model.

While many of the lower production costs associated with moderation of minimum wages relate to non-tradeable goods and services (see below), there are nevertheless projected effects on the costs of tradeables. These cost reductions increase the trade competitiveness of Australia's output relative to scenario 1, as illustrated by the depreciation of the real (floating) exchange rate by 0.2 per cent by 2024-25 (table 3.1). With the increased competitiveness of local industry, export demand is projected to increase. However, the economy initially lacks the productive capacity to expand output, and investment is projected to increase to close this capacity gap.

National labour productivity is projected to decline relative to scenario 1 (table 3.1) because the inflow of new workers into the workforce is associated with a declining marginal product — each additional worker is modelled as contributing less than the previous worker. Compared with scenario 1, the level of national labour productivity is projected to be 0.1 per cent lower in 2017-18 and 0.5 per cent lower in the longer-term, which represents a very small (and temporary) reduction in labour productivity growth.

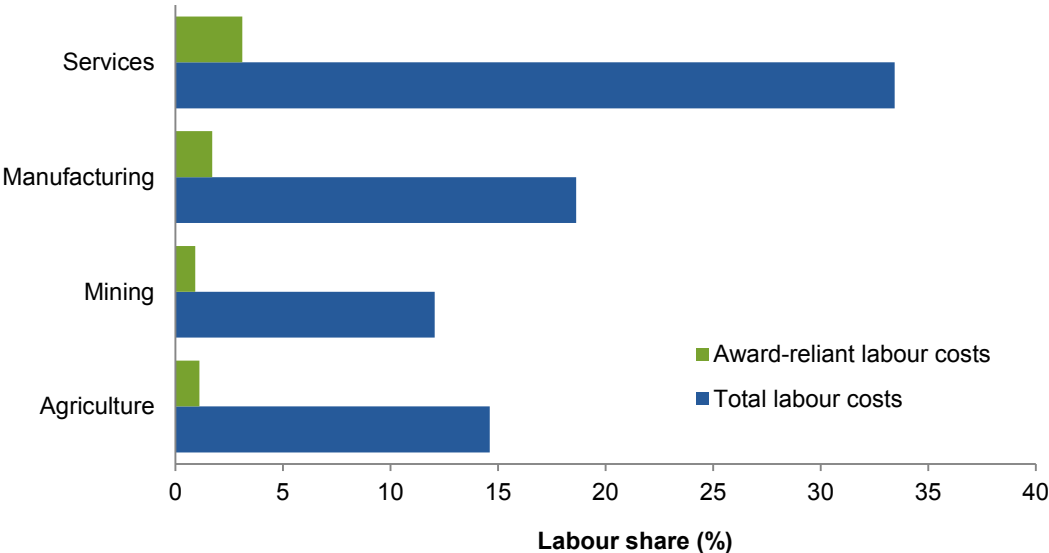
This is not an adverse outcome per se. Providing job opportunities for people who are not currently employed reduces output per hour below its counterfactual level, but it increases per capita output.

3.3 Sectoral implications

The effects of wage moderation at the sectoral level are projected to vary between different production sectors, reflecting the importance of labour in each sector’s cost structure and the responsiveness of demand to any reduction in each sector’s price.

Labour, including award-reliant labour, comprises a larger proportion of the production costs in the services sector, and to a lesser degree in manufacturing, than in agriculture and mining (figure 3.2). For this reason, the moderation in minimum award wage growth is projected to lead to a greater reduction in the price of services and manufacturing than in the price of agriculture and mining. However, the projected expansion in output and employment is less in services than in the manufacturing sector (table 3.2). This result reflects the greater trade exposure of the manufacturing sector relative to the services sector, which presents more opportunity to expand output in response to an improvement in competitiveness.

Figure 3.2 **The labour share of production costs by sector in the VUMR-WR model, Australia, 2013-14**



Source: Productivity Commission estimates based on the VUMR-WR model.

Table 3.2 Projected sectoral effects of the moderate minimum wage growth scenario

Percentage difference from scenario 1

	2017-18 %	2024-25 %
Value added (at factor cost)		
Agriculture	0.1	0.5
Mining	0.1	0.4
Manufacturing	0.1	0.8
Services	0.1	0.8
Employment (hours)		
Agriculture	0.3	1.1
Mining	0.3	1.0
Manufacturing	0.3	1.3
Services	0.2	1.2

Source: Productivity Commission projections based on the VUMR-WR model.

Fiscal implications

It is also projected that the Commonwealth fiscal position could be improved, by around \$500 million in 2017-18 (in 2013-14 prices), reflecting a reduction in the payment of unemployment benefits, a rise in personal income tax revenue and a rise in corporate income tax revenue (table 3.3). The fiscal position of State governments is also projected to improve as GST, property tax and payroll tax revenues expand with the level of economic activity more broadly.

Table 3.3 Projected fiscal implications of the moderate minimum wage growth scenario

Value in 2013-14 prices

	2017-18 \$ million	2024-25 \$ million
Commonwealth government, of which:		
Unemployment benefits ^a	-400	-2 500
Personal income tax revenue	10	1 300
Corporate income tax revenue	160	850
State and local governments, of which:		
GST	60	520
Property and payroll taxes	90	770

^a A negative value denotes a reduction in the payment of unemployment benefits, and therefore an improvement in the government's net fiscal position. The effect on unemployment benefits assumes that the number of people in receipt of unemployment benefits falls by the increase in full time equivalent employment. Of course, some employment gains may come from discouraged workers or take the form of additional hours of work for existing employees, which do not entail such savings. On the other hand, some unemployed people in receipt of unemployment benefits may obtain part-time jobs, so that the reductions in unemployment benefits are greater than those shown here.

Source: Productivity Commission projections based on the VUMR-WR model.

4 Sensitivity testing

The scale and potentially the direction of the results reported in the preceding chapter depend on the choice of model parameters and other assumptions. Selective testing has therefore been undertaken to gauge the sensitivity of modelled projections to alternative modelling assumptions, including parameter values.²

First, the sensitivity of modelling results to alternative assumptions about the proportion of employees who are directly affected by a minimum wage change (the minimum wage footprint) is modelled.

Second, alternative assumptions about the responsiveness of the demand for labour to a change in the price of labour relative to the price of capital (represented by the value of the labour capital substitution elasticity) are modelled.

Third, alternative assumptions about the responsiveness of the demand for labour and the supply of labour to award wage changes relative to other wages (represented by the values of the award wage substitution and transformation elasticity values respectively) are modelled.

Overall, the sensitivity tests indicate that the direction of the results of the moderate minimum wage growth scenario are not sensitive to the alternative assumptions. However, the magnitude of the results are affected by the assumed minimum wage footprint and the degree of responsiveness of labour supply and labour demand to relative changes in award wages. The results are otherwise not sensitive to a plausible range of parameter values for the labour capital substitution elasticity.

4.1 Alternative minimum wage footprints

In the scenarios reported in the preceding chapter, the moderation in the growth of wages paid to award-reliant workers were projected to lead to an improvement in employment outcomes, particularly of award-reliant workers. The degree to which employment is affected depends, in part, on the footprint of workers who are directly affected by moderation of minimum wages.

For the purposes of the main scenario, the Productivity Commission has used the latest available ABS Employee Earnings and Hours survey estimate of award wage reliance.

² Each sensitivity test uses the same shocks and closure settings as the scenario on which they are based.

While this is one of the more reliable sources of data on award reliance, there remain uncertainties around the accuracy of this estimate.

In particular, there may be workers earning above the award wage whose wage is nevertheless linked, for example through enterprise agreements or individual contracts, to movements in the award wage. Furthermore, there are various sources of survey error. For example, the hours worked by an employee in the survey period may not be representative of a normal week, or the reported wage may include penalty rates, overtime or shift loading. There is the further issue of some employers not complying with minimum wage requirements. To the extent that non-compliance is an issue in the Australian labour market, a change in minimum wage will affect fewer workers than otherwise.

Given the uncertainty about the proportion of workers who are directly affected by moderation of minimum wages, two additional wage moderation scenarios are modelled. These scenarios are identical to scenario 2 except that the proportion of workers who are directly affected by minimum wage changes is assumed to vary as follows:

- In a high footprint sensitivity, workers are designated to be award wage reliant if they receive a wage up to 130 per cent of the Federal minimum wage. These workers are estimated to account for around 23 per cent of employees.
- In a low footprint sensitivity, workers are designated to be award wage reliant if they receive a wage up to 120 per cent of the Federal minimum wage. These workers are estimated to account for around 15 per cent of employees.

The aggregate employment effect is projected to vary with the size of the footprint of workers directly affected by minimum wage changes (table 4.1). The larger the proportion of the workforce whose wages are directly affected by the moderation in wages, the greater the expansion in economic activity and, hence, in the demand for all workers.

Table 4.1 Estimated employment effects of alternative minimum wage footprint assumptions, 2024-25

Percentage difference from scenario 1

	<i>Aggregate hours worked</i>	<i>Hours worked by award-reliant workers</i>
	%	%
Scenario 2	1.2	8.2
High footprint: Wages up to 130 per cent of Federal minimum wage	1.1	6.7
Low footprint: Wages up to 120 per cent of Federal minimum wage	0.8	7.6

Source: Productivity Commission estimates based on the VUMR-WR model.

However, the impact on those designated as award-reliant workers varies inversely with the footprint. The reason is that the larger the proportion of the workforce who are award-reliant, the less scope there is for substitution by employers towards award-reliant workers.

4.2 Responsiveness of labour demand to a change in wage relative to the price of capital

The primary factor substitution elasticity in the VUMR model determines the degree to which firms are projected to substitute between labour, capital and agricultural land in response to relative price changes. The default value of this elasticity for all industries and regions in the VUMR model is -0.5. This means that a one per cent increase in the relative cost of all labour will lead to a 0.5 per cent reduction in the demand for labour in the modelling (all other things being equal).

The default elasticity lies in the middle of the Australian econometric estimates, which range from -0.3 to -0.7 for a time period greater than one year (appendix C of the inquiry report). The sensitivity analysis estimates the outcomes associated with these lower and upper bounds.³

The tests indicate that, while a higher substitution elasticity leads to greater employment, the difference between the projections is minimal. Greater substitution between labour and capital results in a modestly greater expansion in projected award-reliant employment and in marginally less expansion in capital. Because labour is the fixed factor in the long run, greater substitution results in a marginally lower projected impact on gross domestic product. This suggests that outcomes are not very sensitive to the alternative views concerning the degree of substitution between labour and capital in production (table 4.2).

4.3 Employer responsiveness to award wage changes

The award wage substitution elasticity in the VUMR-WR model determines the extent to which employers can substitute between award-reliant and other workers in response to a change in award wages relative to other wages (appendix A, figure A.1). The default elasticity value for year-to-year simulations is set at -2. This means, for example, that a one per cent increase in the award wage will lead to a two per cent *decrease* in the projected demand for award-reliant workers in a given occupation (all other things being equal). This implies a relatively high degree of responsiveness, such that employers do not materially differentiate within a given occupational group between award-reliant and other workers.

³ This involved changing the VUMR-WR parameter SIGMA1FAC for all industries and regions. The VUMR-WR equation in which this elasticity appears changes the sign of this elasticity, therefore the parameter in the database has a positive value.

Table 4.2 Sensitivity of the effects of moderating the growth of award wages to alternative primary factor substitution elasticity assumptions

Percentage difference from scenario 1

	2017-18	2024-25
	%	%
<i>Scenario 2: Default primary factor substitution elasticity (0.5)</i>		
Real gross domestic product	0.1	0.8
Aggregate hours worked	0.2	1.2
Hours worked by award-reliant workers	1.5	8.2
Capital use	[+] ^a	0.5
<i>Sensitivity: Higher primary factor substitution elasticity (0.7)</i>		
Real gross domestic product	0.1	0.7
Aggregate hours worked	0.2	1.3
Hours worked by award-reliant workers	1.5	8.3
Capital use	[+] ^a	0.5
<i>Sensitivity: Lower primary factor substitution elasticity (0.3)</i>		
Real gross domestic product	0.1	0.8
Aggregate hours worked	0.2	1.2
Hours worked by award-reliant workers	1.4	8.0
Capital use	[+] ^a	0.6

^a Between 0 and 0.05.

Source: Productivity Commission estimates based on the VUMR-WR model.

The default value of -2 is the same as that assumed in the CGE modelling of Australian award wage policy by Dixon, Madden and Rimmer (2010), Dixon and Rimmer (2003) and Dixon and Rimmer (2001). On the other hand, Wheatley (2009) assumes a value of -1 for the elasticity of substitution between low-skilled and high-skilled workers in his analysis of the effect of minimum wages on the employment of low-skilled workers relative to high-skilled workers. Given the absence of clear empirical evidence about the appropriate value, the sensitivity of the modelling results is tested by assuming alternative elasticity values of -1 and -3.⁴

The tests indicate that the projected effects of the moderate award wage growth scenario reported in chapter 3 are sensitive to the value of the award wage substitution elasticity (table 4.3). The higher the absolute value of the elasticity, the greater the projected employment impacts of wage moderation (and the greater the aggregate output effects).

⁴ This involved changing the VUMR-WR parameter SIGMA1LABC for all industries and regions. The VUMR-WR equation in which this elasticity appears changes the sign of this parameter, therefore the parameter in the database has a positive value.

Table 4.3 Sensitivity of the effects of moderating the growth of award wages to alternative award wage substitution elasticity assumptions

Percentage difference from scenario 1

	2017-18	2024-25
	%	%
<i>Scenario 2: Default award wage substitution elasticity (-2)</i>		
Real gross domestic product	0.1	0.8
Aggregate hours worked	0.2	1.2
Hours worked by award-reliant workers	1.5	8.2
Hours worked by other workers	[+] ^a	0.1
<i>Sensitivity: Higher award wage substitution elasticity (-3)</i>		
Real gross domestic product	0.1	1.0
Aggregate hours worked	0.3	1.7
Hours worked by award-reliant workers	2.0	11.1
Hours worked by other workers	[+] ^a	0.1
<i>Sensitivity: Lower award wage substitution elasticity (-1)</i>		
Real gross domestic product	0.1	0.5
Aggregate hours worked	0.1	0.8
Hours worked by award-reliant workers	0.9	4.7
Hours worked by other workers	[+] ^a	0.1

^a Between 0 and 0.05.

Source: Productivity Commission estimates based on the VUMR-WR model.

4.4 Employee responsiveness to award wage change

The award wage transformation elasticity in the VUMR-WR model determines the degree to which workers are projected to substitute between award-reliant employment and other employment in response to a change in award wages relative to other wages (appendix A, figure A.1). The default value for year-to-year simulations is set at +0.2. This implies that a one per cent increase in the award wage, for example, will lead to a 0.2 per cent *increase* in the supply of award-reliant workers (all other things being equal).

A value of 0.2 represents an assumption that award-reliant employees have little scope to move between award-reliant and other employment in response to a change in the award wage relative to other wages. For example, award-reliant employees may need to upskill in order to shift out of an award-reliant job into a higher paid job in response to any relative wage change. On the other hand, non-award workers may be disinclined to move into award-reliant employment.

The limited transformation parameter value is consistent with the Australian empirical literature. Empirical estimates of the labour supply elasticity for broad population groups

range from 0.1 to 1.5, with most Australian studies falling in the range of 0.1 to 0.6 (Dandie and Mercante 2007). Buddelmeyer and Kalb (2008) estimate that the labour supply elasticity of minimum wage workers with respect to minimum wage changes for broad population groups ranges from 0.1 to 0.7.

In contrast, other CGE modelling of Australian award wage policy have assumed that employees on awards were able to move easily between award and non-award jobs (Dixon, Madden and Rimmer 2010; Dixon and Rimmer 2001, 2003).

Dixon and Rimmer (2001) assumed a value of 2 and Dixon and Rimmer (2003) assumed a value of 5. In later work, Dixon, Madden and Rimmer (2010) did not report their assumed value.

Given the uncertainty surrounding the likely parameter value, sensitivity testing has been undertaken around the range of labour supply estimates in the empirical literature, ranging from a low value of 0.1 to a high value of 0.7. Further, given the values used in other CGE analysis of award wage changes, an award wage transformation elasticity value of 5 was also tested.⁵

The tests indicate that the projected results of the moderate award wage growth scenario are sensitive to the assumed value of the award wage transformation elasticity (table 4.4).

Greater responsiveness of workers to award wage changes is found to have two opposing effects on the implications of the wage moderation scenario for employment. On the one hand, award-reliant workers are able to shift more easily into non-award wage employment and therefore the projected expansion in award-reliant employment is reduced relative to the scenario with the default parameter values. On the other hand, the increase in labour market flexibility, represented by the greater shift of award-reliant workers into non-award employment, contributes to a greater reduction in non-award wages, leading in turn to a larger projected expansion in employment more broadly. The net effect is a larger projected expansion in aggregate employment than when the default parameter value is used. Reflecting the greater expansion in aggregate employment, the projected expansion in real gross domestic product is greater when the value of the award wage transformation elasticity is higher.

Conversely, when the responsiveness of workers to relative award wage changes is reduced, the award wage moderation scenario has a larger projected effect on award-reliant employment, but a lower overall effect on projections of aggregate employment and gross domestic product than when the default parameter values are used.

⁵ This involved changing the VUMR-WR parameter SIGMALABSC.

Table 4.4 Sensitivity of the effects of moderating the growth of award wages to alternative worker responsiveness to award wage changes

Percentage difference from scenario 1

	2017-18 %	2024-25 %
<i>Scenario 2: Default award wage transformation elasticity (0.2)</i>		
Real gross domestic product	0.1	0.8
Aggregate hours worked	0.2	1.2
Hours worked by award-reliant workers	1.5	8.2
Hours worked by other workers	[+] ^a	0.1
<i>Sensitivity: Higher award wage transformation elasticity (0.7)</i>		
Real gross domestic product	0.1	0.9
Aggregate hours worked	0.3	1.4
Hours worked by award-reliant workers	1.5	8.0
Hours worked by other workers	0.1	0.3
<i>Sensitivity: Lower award wage transformation elasticity (0.1)</i>		
Real gross domestic product	0.1	0.7
Aggregate hours worked	0.2	1.2
Hours worked by award-reliant workers	1.5	8.2
Hours worked by other workers	[+] ^a	[+] ^a
<i>Sensitivity: Award wage transformation elasticity of 5</i>		
Real gross domestic product	0.2	1.8
Aggregate hours worked	0.4	2.3
Hours worked by award-reliant workers	1.3	7.4
Hours worked by other workers	0.3	1.5

^a Between 0 and 0.05.

Source: Productivity Commission estimates based on the VUMR-WR model.

A The VUMR - WR model

This appendix provides an overview of the Victoria University Multi-Regional Workplace Relations (VUMR-WR) model used in this inquiry to assess the economywide effects of alternative policy approaches in the workplace relations system. It is based on the VUMR model, which was formerly known as the Monash Multi-Regional Forecasting (MMRF) model. The VUMR/MMRF model has been used widely by the Commission and others to analyse the effects of public policy in Australia, and is suited to examining the economywide effects of some types of labour market policies.

A.1 An overview of the VUMR model

The VUMR model is a ‘bottom-up’ model that treats each state and territory as a separate economy. It includes:

- 79 industries and 83 commodities in each state, and the inter-linkages between these contained in the input-output tables
- state labour markets, comprised of eight occupations, with the supply of labour moving between states in response to differences in occupational-specific real wages across states
- eight state-specific household sectors, which supply domestic factors of production (labour, capital and agricultural land), consume goods and services, and pay income and commodity taxes
- eight state and territory governments
- the Australian Government.

Important elements of the theoretical structure of the model used in this project include:

- households change their consumption bundles in response to changes in aggregate expenditure and relative prices
- producers adapt their output and their relative use of labour, capital and agricultural land in response to changes in relative prices
- foreign demand for Australian exports responds to the export price of Australian products, and exporters can accrue short-term returns in response to price changes.

The standard version of the VUMR model is documented in more detail in CoPS (2014).

A.2 Modifications to the VUMR model for this inquiry

In order to make the VUMR model better suited to exploring issues associated with changes in award wages, the VUMR model has been extended for the purposes of this inquiry to include:

- award-reliant and non-award ('other') workers for each of the eight occupations in each state, with the supply and demand for award-reliant labour responding to differences in state and occupation specific real wages. Other workers include all other employed people, not just employees
- partial adjustment of both real wages and employment in the short to medium run to gradually eliminate any difference in employment between the scenario under examination and a baseline scenario.

These extensions involved modifications to the theory of the standard VUMR model and its database.

Modifications to the model theory

Demand for and supply of award-reliant labour

In the standard VUMR model, the production technology includes a labour composite based on eight occupational categories (for further details, see CoPS 2014, sec. 3.3). For the purposes of this inquiry, each occupational input is modelled as a constant elasticity of substitution (CES) bundle of award-reliant and other workers (figure A.1).

In the standard VUMR model, labour supply is assumed to move between occupations and regions in response to changes in relative real wages (for further details, see CoPS 2014, sec. 7.3). For the purposes of this inquiry, labour supply is modelled to also move out of or into award-reliant employment in response to changes in award wages relative to the average wage (figure A.2).

Partial adjustment of real wages and employment

The standard VUMR model includes the capacity to model sticky wages in a policy simulation at a national level. In this approach, the deviation from the baseline of the average national wage (deflated by consumer prices) in a policy simulation varies proportionately with the deviation from the baseline of national employment so as to gradually return the level of employment back to the baseline level (for further details, see CoPS 2014). The equation is parameterised so that employment returns to the baseline level after about five years. For the purposes of this inquiry, the standard national labour market approach has been extended to also apply to award-reliant and other workers.

The modifications made to the VUMR-WR model code to implement the above extensions are reported in box A.1.

Figure A.1 Demand for labour in the VUMR-WR model

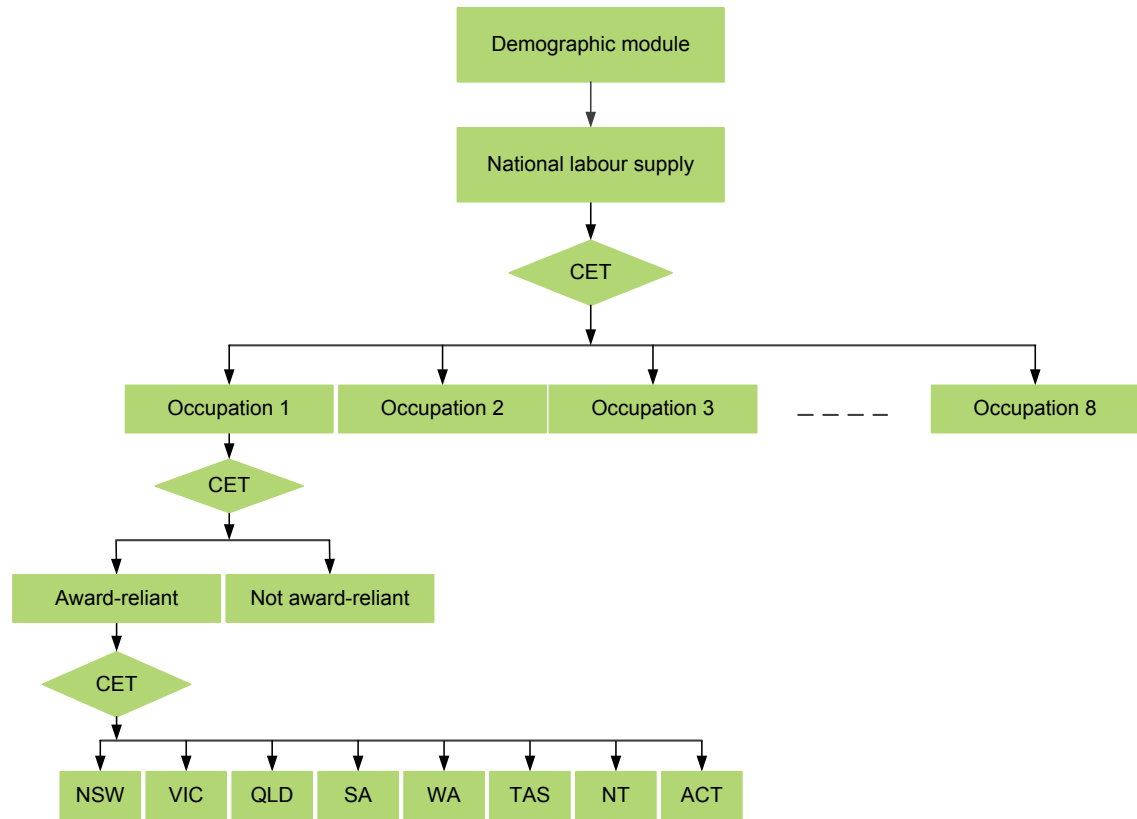
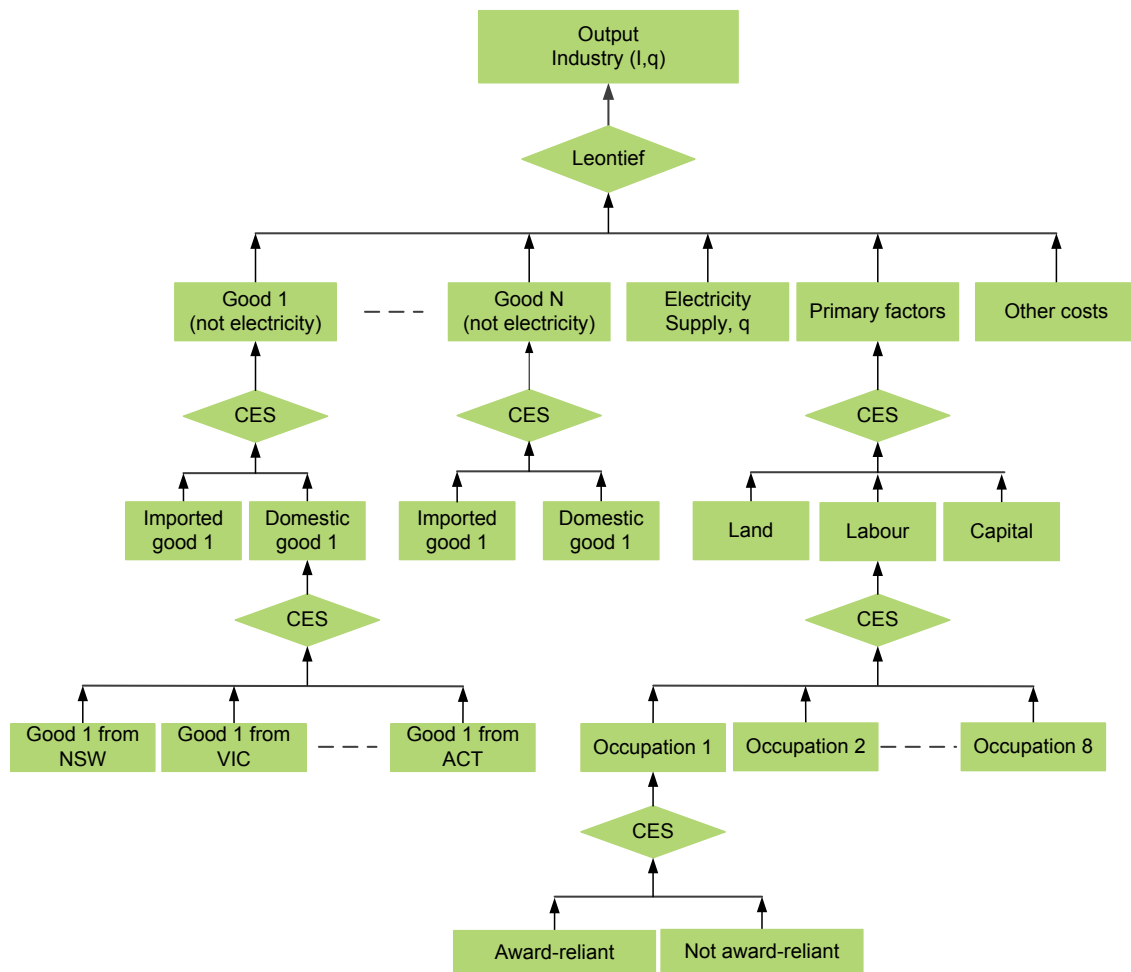


Figure A.2 Supply of labour in the VUMR-WR model



Box A.1 Equations added to the VUMR-WR model for this inquiry

Summary of CES substitution between award-reliant and other workers – labour supply

Equation E_{natlab} # National supply of Labour by occupation & Labour type #
 $(all, o, OCC)(all, c, LABCAT)$

$$natlab(o, c) = natlab_c(o) + SIGMALABSC * [natpwage_i(o, c) - natpwage_{ic}(o)];$$

Variable $(all, o, OCC)(all, c, LABCAT)$

$natlab(o, c)$ # National Labour supply by occupation & Labour type (persons) #;

Variable $(all, c, LABCAT)$

$natlab_o(c)$ # National Labour supply by occupation (persons) #;

(Continued next page)

Box A.1 (continued)

Coefficient (parameter)

SIGMALABSC # CET elasticity of labour supply across labour types #;
Read **SIGMALABSC** from file **COHORTDATA** header "**SLTY**";

Variable (all,o,OCC)(all,c,LABCAT)

natp wage_i(o,c) # Nominal wage rate for occupation o #;

Variable(all,o,OCC)

natp wage_ic(o) # Nominal wage rate for occupation o #;

Summary of CES substitution between award-reliant and other workers – labour demand

Equation E_x1lab # Industry demand for effective labour by state, occupation & skill type #

(all,i,IND)(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)

x1lab(i,q,o,c) =
x1lab_c(i,q,o) + ... - SIGMA1LABC(q,o)*[p1lab(i,q,o,c) + ... -
p1lab_c(i,q,o)];

Variable (all,i,IND)(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)

x1lab(i,q,o,c)

Employment (hours) of skill type c, occupation o in industry i in state q #;

Variable (all,i,IND)(all,q,REGDST)(all,o,OCC) x1lab_c(i,q,o)

Employment (hours) of occupation type o in industry i in state q #;

Summary of CES substitution between award-reliant and other workers – labour demand continued ...

Coefficient (parameter)(all,q,REGDST)(all,o,OCC)

SIGMA1LABC(q,o) # CES substitution elasticities between labour types #;

Read **SIGMA1LABC** from file **MDATA** header "**SLOC**";

Variable (all,i,IND)(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)

p1lab(i,q,o,c) # Unit cost of labour by industry, state, occupation & labour type #;

Variable (all,i,IND)(all,q,REGDST)(all,o,OCC)

p1lab_c(i,q,o) # Unit cost of occupation o in industry i in state q #;

Equation E_p1lab

Effective price of labour (p1lab) related to the wage rate (pwage)

(all,i,IND)(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)

p1lab(i,q,o,c) = pwage(i,q,o,c) + IF{V1LAB(i,q,o,c) ne 0,
[V1LABINC(i,q,o,c)/V1LAB(i,q,o,c)]*(d_t1labF(i,q) + d_t1labS(i,q))};

(Continued next page)

Box A.1 (continued)

Summary of wage-employment trade-off for award-reliant workers

Equation E_d_fr wage_ct_i # Relates %devrw to %devemp in year-to-year sims. #
(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
$$\left(\frac{C_RWDEV_I(q,o,c)}{C_RWFOR_I(q,o,c)}\right) * [rwdev_i(q,o,c) - rwfor_i(q,o,c)] =$$
$$\left(\frac{C_RWD_L_I(q,o,c)}{C_RWF_L_I(q,o,c)}\right) * [rwdev_l_i(q,o,c) - rwfor_l_i(q,o,c)]$$

+
$$LAB_SLOPE * \left(\frac{C_EMPDEV_I(q,o,c)}{C_EMPFOR_I(q,o,c)}\right) * [empdev_i(q,o,c) - empfor_i(q,o,c)]$$

+ 100*d_fr wage_ct_i(q,o,c);

Equation E_rwdev_i # Equates rwdev with natrwage_ct #
(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
rwdev_i(q,o,c) = rwage_ct_i(q,o,c);

Equation E_f_rw_i # Introduces real wage rate (after tax) into deviation sims. #
(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
rwfor_i(q,o,c) = rwage_ct_i(q,o,c) + f_rw_i(q,o,c);

Equation E_rwdev_l_i # Equation explaining rwdev lagged one year #
(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
rwdev_l_i(q,o,c) =
100*(C_RWDEV_I@1(q,o,c)-C_RWD_L_I@1(q,o,c))/C_RWD_L_I(q,o,c)*d_unity;

Equation E_rwfor_l_i # Equation explaining rwfor lagged one year #
(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
rwfor_l_i(q,o,c) = 100*(C_RWFOR_I@1(q,o,c)/C_RWF_L_I@1(q,o,c)- 1)*d_unity;

Equation E_f_emp_i # Introduces forecast employment into deviation simulation #
(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
empfor_i(q,o,c) = x1lab_i(q,o,c) + f_emp_i(q,o,c);

Equation E_empdev_i # Equates empdev_i with x1lab_i #
(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
empdev_i(q,o,c) = x1lab_i(q,o,c);

Equation E_f_emp_i # Introduces forecast employment into deviation simulation #
(all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
empfor_i(q,o,c) = x1lab_i(q,o,c) + f_emp_i(q,o,c);

Variable (change) (all,q,REGDST)(all,o,OCC)(all,c,LABCAT)
d_fr wage_ct_i(q,o,c) # Shift variable in employment-wage deviation equation #;

Modifications to the VUMR-WR model database

The standard VUMR model database is described in detail in CoPs (forthcoming) and summarised in appendix B. Of particular relevance of this inquiry, labour is specified in

terms of eight occupations that correspond to the one-digit categories in the ABS *Australian and New Zealand Standard Occupational Classification* (table A.1). Labour supply is specified for each of these eight occupations in each state. Labour demand is specified for each occupation in each of the 79 industries in each state.

Table A.1 Occupations in the VUMR model

<i>ANZSCO major occupations (one-digit)</i>	<i>ABS description</i>	<i>Minimum indicative skill level ^a</i>
Managers	Managers plan, organise, direct, control, coordinate and review the operations of government, commercial, agricultural, industrial, non-profit and other organisations, and departments.	Diploma or at least three years of relevant experience (ANZSCO Skill Level 2)
Professionals	Professionals perform analytical, conceptual and creative tasks through the application of theoretical knowledge and experience in the fields of the arts, media, business, design, engineering, the physical and life sciences, transport, education, health, information and communication technology, the law, social sciences and social welfare.	Diploma or at least three years of relevant experience (ANZSCO Skill Level 2)
Technicians and Trades Workers	Technicians and trades workers perform a variety of skilled tasks, applying broad or in-depth technical, trade or industry specific knowledge, often in support of scientific, engineering, building and manufacturing activities.	AQF Certificate IV or at least three years of relevant experience (ANZSCO Skill Level 3)
Community and Personal Service Workers	Community and personal service workers assist Health Professionals in the provision of patient care, provide information and support on a range of social welfare matters, and provide other services in the areas of aged care and childcare, education support, hospitality, defence, policing and emergency services, security, travel and tourism, fitness, sports and personal services	AQF Certificate I or compulsory secondary education (ANZSCO Skill Level 5)
Clerical and Administrative Workers	Clerical and administrative workers provide support to Managers, Professionals and organisations by organising, storing, manipulating and retrieving information.	AQF Certificate I or compulsory secondary education (ANZSCO Skill Level 5)
Sales Workers	Sales workers sell goods, services and property, and provide sales support in areas such as operating cash registers and displaying and demonstrating goods. This category excludes ICT and technical sales representatives who are included in Professional and Technicians occupations respectively.	AQF Certificate I or compulsory secondary education (ANZSCO Skill Level 5)
Machinery Operators and Drivers	Machinery operators and drivers operate machines, plant, vehicles and other equipment to perform a range of agricultural, manufacturing and construction functions, move materials, and transport passengers and freight.	AQF Certificate II or III (ANZSCO Skill Level 4)
Labourers	Labourers perform a variety of routine and repetitive physical tasks using hand and power tools, and machines either as an individual or as part of a team assisting more skilled workers such as Trades Workers, and Machinery Operators and Drivers.	AQF Certificate I or compulsory secondary education (ANZSCO Skill Level 5)

^a While indicative skill levels vary for the occupations within each major occupation group, shown here is the minimum indicative skill level for most occupations within the major occupation group.

Source: ABS (ANZSCO – Australian and New Zealand Standard Classification of Occupations, Version 1.2, 26 June 2013, Cat. no. 1220.0).

For the purposes of the current study, this labour market data has been further disaggregated into two components:

- *award-reliant* workers
- other employed people.

The disaggregation of the labour force was based on detailed labour market information in the ABS *Survey of Employee Earnings and Hours* (appendix B).

A.3 The economic environment (model closure⁶)

The primary focus of this modelling supplement is on the possible impacts on the Australian economy of constraining the growth in award wages under certain labour market conditions. More specifically, the supplement asks the question ‘how might the Australian economy differ if the award wage grows by one/two per cent less each year than average wages for a period of five years?’.

The study examines the transition path of adjustments over time, using a dynamic, or year-to-year modelling environment.

Scenario 1 modelling environment

The dynamic modelling undertaken in this study follows the approach used in the Commission’s previous dynamic modelling of the economywide effects of future automotive assistance arrangements (PC 2014) and in its dynamic modelling of the impacts of COAG reforms (PC 2012).

Each step in the recursive-dynamic modelling is similar to a short-run comparative-static simulation, but with gradual adjustment in capital and labour markets. The initial model database for 2009-10 is updated at each annual step (collectively referred to as the ‘reference case’, or in this inquiry, as the ‘business-as-usual’ scenario).

The key elements of the year-to-year economic environment used in scenario 1 in this study are as follows:

- The model index of consumer prices is the numeraire. That is, changes in domestic prices in the model can be interpreted as changes relative to the general level of prices in the economy. In all simulations, the nominal exchange rate is flexible.

⁶ The term ‘model closure’ is used to refer to the assignment of the model’s variables between those determined outside the model (exogenous variables) and those determined by the model (endogenous variables).

-
- Population growth and the aggregate supply of labour are determined by the demographic module outlined in the Productivity Commission paper *Economy-wide Modelling of the Impacts of COAG Reforms* (PC 2012).
 - Investment, and with it the capital stock, in each industry gradually responds to differences between the expected and actual rates of return on capital. The expected rates of return are determined by values in the standard VUMR model database. The adjustment process is outlined in (CoPS 2014).
 - Nominal government expenditure (including government consumption and other outlays) moves in line with the underlying drivers of economic activity in the model (such as population, unemployment, aggregate economic activity and prices).⁷
 - The budget position is held fixed as a share of GDP or gross state product through the use of lump-sum transfers to, or from, households.
 - Government tax rates are assumed to remain fixed so that revenue moves in line with the various tax bases.
 - Nominal household consumption is determined by post-tax household disposable income, while the balance of trade as a ratio of GDP in local currency prices is allowed to vary. Regional household consumption is determined by regional post-tax household disposable income.

These closure settings align with those used in the dynamic modelling undertaken in PC (2014) and PC (2012) and will be detailed in PC (forthcoming).

The moderate wage growth scenario modelling environment (scenario 2)

The modelling environment used for the moderate wage growth scenario is aligned to that used for scenario 1, except for closure changes required to model the slower growth in award wages (appendix C).

⁷ In the current implementation of the VUMR-WR model, real regional government investment is modelled as moving in line with total real regional investment.

B The VUMR-WR model database

This appendix outlines the VUMR-WR model database used for this inquiry and how it was produced.

B.1 An overview of the VUMR-WR model database

The VUMR-WR model database is composed of:

- a production core, comprised of eight input-output tables (one for each state and territory) that are linked through interstate trade
- fiscal accounts for the Australian government and the eight state and territory governments
- cohort-based population and demographic accounting.

In the production core of the database there are 79 industries, of which there are: 8 agricultural and related industries; 8 mining industries; 21 manufacturing industries; 9 utility industries; 3 construction industries; 5 trade, repair, and food and accommodation industries; 8 transport industries; and 17 finance, government and other service industries. The production core of the database shows how each industry in each state and territory economy is linked to other industries within that state and in other states. It is based on 2009-10 *Input-Output Tables* prepared by the ABS, complemented by various ABS national and state publications. It provides a detailed description of the structure of production according to a constant returns to scale production technology and demand for industry outputs and imports in each state and territory. Within this framework, it shows:

- the flow of industry outputs to other industries (termed ‘intermediate inputs’), final demands by households (consumption), government, investment (for capital formation purposes) and exports
- the transport and distribution costs associated with transferring products from the producer (or the port of entry in the case of imports) to final consumers and other users, as well as product taxes and subsidies pertaining to product flows (including the GST, import duties and excise taxes)
- the cost structure of industries in terms of intermediate inputs of commodities (goods and services supplied by domestic industries and by imports), primary factors of production (labour, capital and agricultural land), other costs to production, and indirect taxes and subsidies not elsewhere classified (such as payroll taxes).

The fiscal accounts detail revenue and expenditure for the nine state, territory and Australian governments and align with the ABS *Government Financial Statistics*. The accounts include a range of:

- government revenue sources, such as income tax, payroll tax, the GST, excise duties, and other commodity taxes and tariffs
- government expenditure, including operating expenses, welfare payments and government grants.

The fiscal accounts for each state and territory government also include, where relevant, those for local government.

The cohort-based population and demographic module supports the modelling of the population over time. The demographic module models population change for age and gender-specific subsets, or cohorts using a ‘stock-flow’ approach, and determines labour supply by applying age, gender and state-specific participation rates to the number of people in each cohort. The module also allows for people to move between states in response to changes in labour demand by state industries.

B.2 Creating the initial model database

The database used for this inquiry was created from the standard VUMR model database for 2009-10, which was produced by the Centre of Policy Studies at Victoria University for the Productivity Commission and The Treasury. It aligns with the 2009-10 ABS *Input-Output Tables*. The database, and how it was produced, is documented in CoPS (forthcoming).

Construction of the standard database involves three broad steps to suit model data and classification requirements (table B.1).⁸

In the first step, the 2009-10 ABS national input–output tables for 114 industries were converted to a 190-industry database to be consistent with another general equilibrium model of the Australian economy (VU-NAT). This conversion was informed by the detailed product information in the 2009-10 ABS *Input-Output Tables (Product Details)*. This produced a national database with a structure that is broadly consistent with that of the regional database used in the VUMR model.

In the second step, the national database was disaggregated to 205 sub-state regions (based on ABS local government areas), to form what is known as the VU-TERM database. This was undertaken using:

⁸ Additional information on these steps are available from CoPS (2014), Horridge, Madden and Wittwer (2005) and Horridge (2012).

- the ABS *Census of Population and Housing, 2011* data on employment by industry to define regional production of the 190 industries at the local government area level
- the ABS *Agricultural Census, 2010-11* data on production and land use in agricultural industries, including at the statistical local area level
- unpublished trade data from 49 ports to estimate international trade flows into, and out of, each statistical division.

Table B.1 Stages in creating the initial VUMR database used for this inquiry

Stage	Regions	Industries
ABS 2009-10 Input Output Tables	1	114
	Australia	Agriculture, mining, manufacturing and service industries disaggregated
VU-NAT	1	190
	Sub state local government areas	Agriculture, mining, manufacturing and service industries aggregated
VU-TERM	205	190
	States and Territories	Industries aggregated
	8	79
		Database 'hammered' to align as best as possible to control targets provided
VUMR	8	79

Sources: CoPS (2014) and CoPS (forthcoming).

Interregional trade flows were then estimated within the constraints provided by the basic data using a gravity modelling approach.

In the third step, data for the regions and industries in the VU-TERM database was aggregated to the state and territory level to generate the standard eight-region VUMR model database for 2009-10. The resulting database has 79 industries and 83 commodities (tables B.2 and B.3).

Table B.2 Concordance between industries in the VUMR database and the 2009-10 ABS input-output industry groups

<i>No.</i>	<i>VUMR industry</i>	<i>IOIG number</i>
1	Sheep and beef cattle	0101 (part)
2	Whole milk and dairy cattle	0101 (part)
3	Animals other than cattle and sheep	0101 (part), 0102
4	Crops and grains	0101 (part)
5	Other agriculture	0103
6	Fishing, hunting and aquaculture	0201, 0401
7	Forestry and logging	0301
8	Agriculture, forestry, fishing support services	0501
9	Coal mining	0601
10	Oil extraction (includes condensate)	0701 (part)
11	Gas extraction	0701 (part)
12	Liquefied natural gas production	0701 (part)
13	Iron ore mining	0801
14	Non-ferrous metal ores	0802
15	Non-metallic mineral mining	0901
16	Exploration and mining support services	1001
17	Meat products	1101
18	Dairy products	1103
19	Other food products	1102, 1104-09
20	Beverages	1201-05
21	Textiles, Clothing and footwear	1301-06
22	Sawmill and other wood products	1401, 1402
23	Pulp, paper and paper products	1501, 1502
24	Printing and recorded media	1601
25	Petroleum and coal products	1701
26	Basic chemicals and products	1801-04
27	Polymer and rubber products	1901-2004
28	Non-metallic mineral products	2001-05 (not 03)
29	Cement, lime and concrete	2003
30	Iron and steel	2101
31	Alumina	2102 (part)
32	Aluminium	2102 (part)
33	Other non-ferrous metals	2102 (part)
34	Metal products	2201-04
35	Motor vehicles and parts	2301
36	Other equipment	2302-2405
37	Furniture and other manufactured products	2501, 2502
38	Electricity generation from coal	2601 (part)
39	Electricity generation from gas	2601 (part)
40	Electricity generation from hydro	2601 (part)

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Table B.2 (continued)

<i>No.</i>	<i>VUMR industry</i>	<i>IOIG number</i>
41	Electricity generation from non-hydro renewables	2601 (part)
42	Electricity generation from alternative source	2601 (part)
43	Electricity supply (retail and wholesale)	2605
44	Gas supply	2701
45	Water and drainage services	2801
46	Waste collection and treatment	2901
47	Residential building construction	3001
48	Non-residential building construction	3002, 3101
49	Construction services	3201
50	Wholesale trade	3301
51	Retail trade	3901
52	Accommodation and food services	4401, 4501
53	Road freight services	4601 (part)
54	Road passenger services	4601 (part)
55	Rail freight services	4602 (part)
56	Rail passenger services	4602 (part)
57	Pipeline services	4801 (part)
58	Water transport services	4801 (part)
59	Air transport services	4901
60	Courier and other transport services	5101, 5201
61	Publishing, information and media	5401-5701, 6001
62	Telecommunication services	5801
63	Banking services	6201 (part)
64	Finance services other than banking	6201 (part)
65	Insurance services	6301 (part)
66	Superannuation fund services	6301 (part)
67	Other financial services	6401
68	Ownership of dwellings	6701, 7310
69	Business services	6601, 6702-7310
70	Public administration and public order and safety	7501, 7701
71	Defence	7601
72	Primary and secondary education	8010
73	Technical, vocational and tertiary education	8110
74	Health care services	8401
75	Residential care and social assistance services	8601
76	Arts and recreation services	8210-9201
77	Automotive repair and maintenance	9401
78	Other repair and maintenance	9402
79	Personal and other services	9501, 9502

Source: CoPS (forthcoming).

Table B.3 Concordance between commodities in the VUMR database and the 2009-10 ABS input-output industry groups

<i>No.</i>	<i>VUMR commodity</i>	<i>IOIG number</i>
1	Sheep and beef cattle	0101 (part)
2	Whole milk and dairy cattle	0101 (part)
3	Animals other than cattle and sheep	0101 (part), 0102
4	Crops and grains	0101 (part)
5	Other agriculture	0103
6	Fishing, hunting and aquaculture	0201, 0401
7	Forestry and logging	0301
8	Agriculture, forestry, fishing support services	0501
9	Coal mining	0601
10	Oil extraction (includes condensate)	0701 (part)
11	Gas extraction	0701 (part)
12	Liquefied natural gas production	0701 (part)
13	Iron ore mining	0801
14	Non-ferrous metal ores	0802
15	Non-metallic mineral mining	0901
16	Exploration and mining support services	1001
17	Meat products	1101
18	Dairy products	1103
19	Other food products	1102, 1104-09
20	Beverages	1201-05
21	Textiles, Clothing and footwear	1301-06
22	Sawmill and other wood products	1401, 1402
23	Pulp, paper and paper products	1501, 1502
24	Printing and recorded media	1601
25	Petroleum and petroleum blends	1701 (part)
26	AvGas and other fuels for air transport	1701 (part)
27	Other petroleum products	1701 (part)
28	Diesel and diesel blends	1701 (part)
29	Refined liquefied petroleum gas	1701 (part)
30	Basic chemicals and products	1801-04
31	Polymer and rubber products	1901-2004
32	Non-metallic mineral products	2001-05 (not 03)
33	Cement, lime and concrete	2003
34	Iron and steel	2101
35	Alumina	2102 (part)
36	Aluminium	2102 (part)
37	Other non-ferrous metals	2102 (part)
38	Metal products	2201-04
39	Motor vehicles and parts	2301

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Table B.3 (continued)

<i>No.</i>	<i>VUMR industry</i>	<i>IOIG number</i>
40	Other equipment	2302-2405
41	Furniture and other manufactured products	2501, 2502
42	Electricity generation from coal	2601 (part)
43	Electricity generation from gas	2601 (part)
44	Electricity generation from hydro	2601 (part)
45	Electricity generation from non-hydro renewables	2601 (part)
46	Electricity generation from alternative source	2601 (part)
47	Electricity supply (retail and wholesale)	2605
48	Gas supply	2701
49	Water and drainage services	2801
50	Waste collection and treatment	2901
51	Residential building construction	3001
52	Non-residential building construction	3002, 3101
53	Construction services	3201
54	Wholesale trade	3301
55	Retail trade	3901
56	Accommodation and food services	4401, 4501
57	Road freight services	4601 (part)
58	Road passenger services	4601 (part)
59	Rail freight services	4602 (part)
60	Rail passenger services	4602 (part)
61	Pipeline services	4801 (part)
62	Water transport services	4801 (part)
63	Air transport services	4901
64	Courier and other transport services	5101, 5201
65	Publishing, information and media	5401-5701, 6001
66	Telecommunication services	5801
67	Banking services	6201 (part)
68	Finance services other than banking	6201 (part)
69	Insurance services	6301 (part)
70	Superannuation fund services	6301 (part)
71	Other financial services	6401
72	Ownership of dwellings	6701, 7310
73	Business services	6601, 6702-7310
74	Public administration and public order and safety	7501, 7701
75	Defence	7601
76	Primary and secondary education	8010
77	Technical, vocational and tertiary education	8110
78	Health care services	8401
79	Residential care and social assistance services	8601

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Table B.3 (continued)

<i>No.</i>	<i>VUMR industry</i>	<i>IOIG number</i>
80	Arts and recreation services	8210-9201
81	Automotive repair and maintenance	9401
82	Other repair and maintenance	9402
83	Personal and other services	9501, 9502

Source: CoPS (forthcoming).

B.3 Introducing award-reliant and other workers into the model database

The initial VUMR database used for this inquiry specifies the supply of labour by occupation and state. Labour demand is also specified for each industry. The labour market data in the model is based on the national industry data in the ABS 2009-10 *Input-Output Tables* (ABS 2013, Cat. no. 5209.0.55.001, table 20) and on the 2009-10 state, occupation and industry data in the ABS *Labour Force Survey* (ABS 2014, Cat. no. 6291.0.55.003).

The labour force data was disaggregated for the purposes of this inquiry into award-reliant and other workers based on the ABS *Employee, Earnings and Hours CURF data* (ABS 2014, Cat. No. 6306.0.55.001).

For the purposes of modelling scenario 2, ‘award-reliant workers’ are identified using the ABS 2014 EEH survey, which includes a variable identifying workers whose wages are set equal to the minimum award wages — these ‘award-reliant’ workers account for around 19 per cent of the workforce. Applying this definition of award-reliant workers to the EEH data gives rise to the estimates of award wage coverage used in the modelling of scenario 2 (table B.4).

It is difficult to ascertain the exact proportion of employees that would be affected by a change in award wages. The Productivity Commission has therefore tested the sensitivity of the results with a scenarios approach. Under this approach, it has modelled the effects of moderate growth in real award wages under alternative assumptions concerning the range of workers who are award-reliant and therefore directly affected by a change in award wages. In the sensitivity analysis, award-reliant workers are defined alternatively as those earning up to 130 and 120 per cent, respectively, of the national minimum wage. Junior rates are accounted for using those listed in the *Miscellaneous Award 2010* — consistent with recent national minimum wage orders. For casual employees, a loading of 25 per cent has been applied. Based on these alternative definitions of award-reliant workers, the estimates of award wage coverage varies between scenarios (table B.4).

Table B.4 Award-reliant labour shares used to disaggregate the 2009-10 VUMR-WR database

	<i>Of total persons employed ^a</i>	<i>Of total wage bill</i>	<i>Of total hours of employed ^a</i>
	%	%	%
Scenario 2: workers who are award-reliant			
Managers	4.4	2.6	4.5
Professionals	5.6	4.4	5.2
Technicians & trades workers	15.2	8.5	14.3
Community & personal service workers	34.5	29.1	32.0
Clerical & administrative workers	12.6	9.1	11.2
Sales workers	35.7	29.0	31.3
Machinery operators & drivers	13.5	9.1	12.0
Labourers	27.2	20.5	23.9
Test 1: workers on wages up to 130 per cent of the Federal minimum wage			
Managers	1.2	0.4	1.2
Professionals	1.5	0.9	1.3
Technicians & trades workers	14.9	9.4	13.7
Community & personal service workers	32.5	21.6	26.9
Clerical & administrative workers	17.5	10.5	14.8
Sales workers	62.7	46.6	55.8
Machinery operators & drivers	18.1	15.4	14.4
Labourers	37.1	28.5	32.1
Test 2: workers on wages up to 120 per cent of the Federal minimum wage			
Managers	0.4	0.3	0.4
Professionals	0.7	0.5	0.6
Technicians & trades workers	11.2	7.4	10.3
Community & personal service workers	20.5	13.6	16.1
Clerical & administrative workers	10.2	6.0	8.4
Sales workers	41.2	27.8	33.7
Machinery operators & drivers	11.2	11.7	8.5
Labourers	23.0	19.4	19.4

^a Employed workers include the self-employed. The number of self-employed by occupation is estimated as the difference between total employment and the total number of employees. The average wage and hours worked for the self-employed are assumed to be the same as for non-minimum wage employees.

Source: Productivity Commission estimates based on ABS (*Employee Earnings and Hours, Australia*, Cat. no. 6306.0, May 2014).

B.4 Model parameters

In models such as the VUMR-WR model, specific parameters mediate the responsiveness of labour demand and supply to changes in the cost of labour or the returns to labour, respectively.

The parameters that affect the demand for workers at the regional industry level are:

- the primary factor substitution elasticity (which determines the extent of substitution between labour, capital and agricultural land in production)
- the occupational substitution elasticity (which determines the extent of substitution in the use of different types of occupations in production)
- the award wage substitution elasticity (which determines the extent of substitution in the use of award-reliant and other workers in production).

The model parameters affecting the supply of workers are:

- the occupational transformation elasticity (which determines the extent to which workers change their occupation)
- the award wage transformation elasticity (which determines the extent to which workers shift between award-reliant and other employment, that might occur, say, through additional education and training)
- the regional transformation elasticity (which determines the extent to which workers move between regions).

The default parameter values in the VUMR-WR model used in this study are representative of a short-run modelling environment in which there is limited scope for adjustment from year to year rather than a longer-run environment where there is greater scope for substitution or transformation (table B.5). The sensitivity of results to the key parameter values is considered in chapter 4.

Table B.5 Key default parameter values in the VUMR-WR model

<i>Elasticity</i>	<i>VUMR-WR model parameter</i>	<i>Default value</i>
Demand-side		
Primary factor substitution elasticity ^a	SIGMA1FAC	+0.5
Occupational substitution elasticity ^a	SIGMA1LAB	+0.35
Award wage substitution elasticity ^a	SIGMA1LABC	+2
Supply-side		
Occupational transformation elasticity	SIGMALABO	+0.1
Award wage transformation elasticity	SIGMALABSC	+0.2
Regional transformation elasticity	SIGMALABS	+1

^a The VUMR-WR model equation in which this elasticity appears changes the sign of this elasticity. As a result, an increase in the cost of labour in a given occupation or wage category, for example, will lead to a fall in the demand for labour in that occupation or wage category (all other things being equal).

B.5 Upating the database from 2009-10 to 2013-14

The disaggregated 2009-10 VUMR-WR database was uprated to 2013-14 to reflect the labour market developments that have occurred since 2009-10 (box B.1). The labour market trends used to uprate the 2009-10 database are set out in table B.6.

Box B.1 Recent trends in the Australian labour market

There have been several changes in the Australian labour market since 2009-10, reflecting demographic trends and the recent unwinding of the mining boom.

Australia's population has grown from 21.7 million in June 2009 to 23.1 million in June 2013.

Population ageing continued. In June 2009, 79.5 per cent of Australians were over the age of 15 years. By June 2013, the proportion over the age of 15 years had increased to 79.8 per cent.

While they vary considerably between different age groups, female participation rates have historically been rising over time and male participation rates have been falling. Since 2009, female participation rates have stabilised at around 58.6 per cent, in part the result of the slowing of the Australian economy. Male participation rates have continued to fall since 2009, contributing to a reduction in total participation rates from 66.2 per cent in June, 2009 to 65.7 per cent in June, 2013.

In part reflecting the slowing of the Australian economy associated with the unwinding of the mining boom, average hours worked have fallen moderately. Average hours were 33 hours per week in 2009-10 and 32 hours per week in 2013-14.

While the national unemployment rate has varied over time, it was 5.7 per cent both in June, 2009 and in June, 2013.

Labour productivity growth varied between the sectors of the economy over the period 2009-10 to 2013-14. In the mining sector, measured labour productivity contracted over this period because the sector was undergoing a phase of rapid capital accumulation associated with the mining boom. In contrast, labour productivity improved in the agriculture and manufacturing sectors and in the services sector as a whole.

The database was otherwise uprated according to the general methodology set out in PC (2012). This involved applying shocks to the terms of trade, labour productivity and the macroeconomic expenditure items of household spending, investment, government consumption and imports. The values used are set out in PC (forthcoming). They represent updates of the values applied in PC (2012).

The resulting national output and employment shares by sector broadly align with the sectoral distribution of activity reported in the Australian National Accounts (figure B.1). Actual employment in Australia is concentrated in the services sector in 2013-14, which accounted for 87 per cent of national employment, but only 81 per cent of national production. In contrast, mining accounts for 9 per cent of the national value of production in 2013-14, but only for 2 per cent of national employment.

Table B.6 Labour market developments applied in the uprating of the database, 2009-10 to 2013-14

		2009-10	2013-14
Population	<i>million</i>	21.7	23.1
Share of population aged over 15 years	%	79.5	79.8
Labour force	<i>million</i>	11.4	12.1
Participation rate	%	66.2	65.7
Average hours worked per week	<i>hours</i>	33.2	32.4
Employed persons ^a	<i>million</i>	10.8	11.4

^a Employed workers include the self-employed.

Source: Productivity Commission estimates based on ABS (2014 *Labour Force Survey*, Cat. no. 6291.0.55.003).

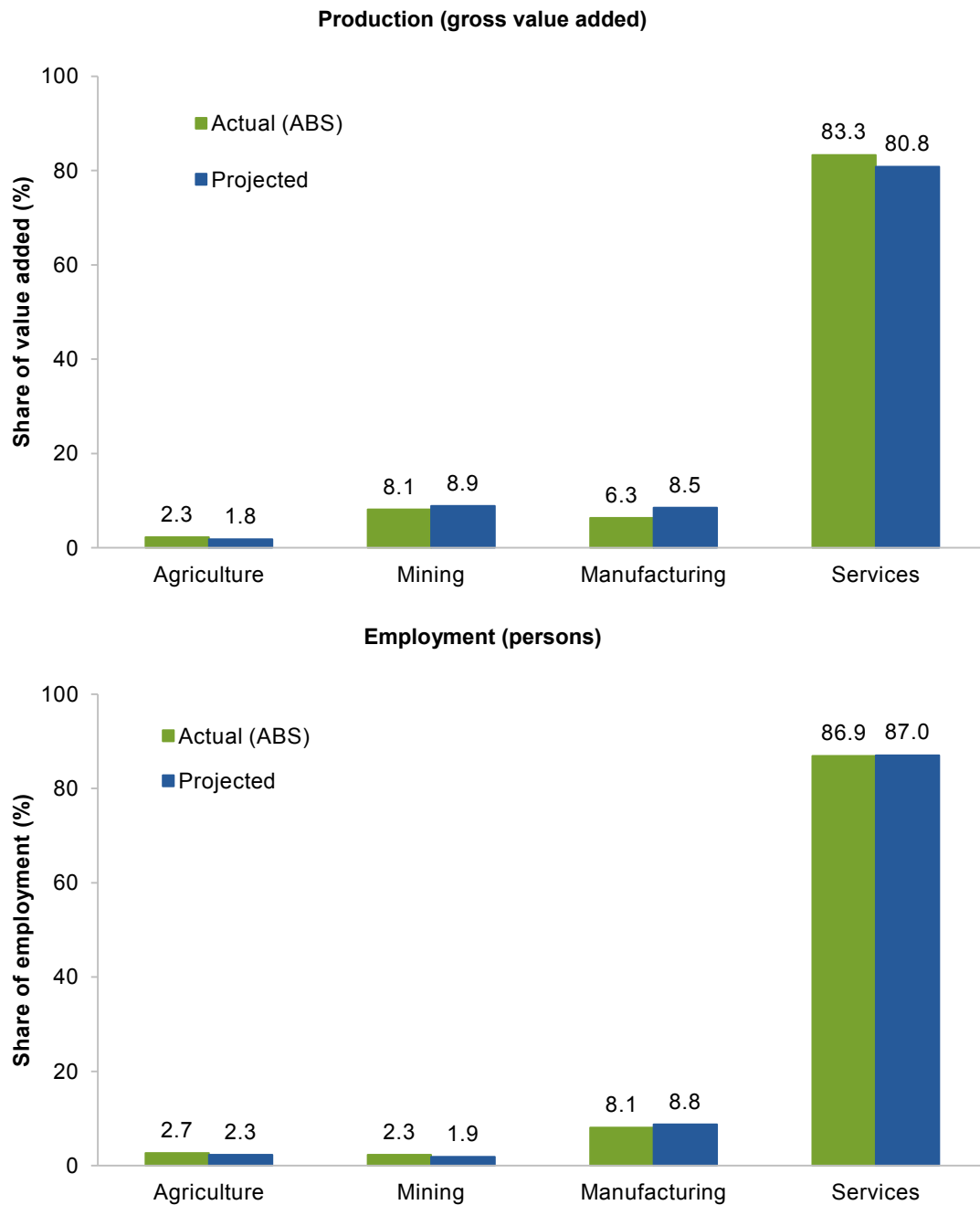
The uprated 2013-14 database was also checked against the latest year for which ABS *Input-Output Tables* are available (2012-13). The resulting database was found to be broadly comparable to the available information for that year.

B.6 Structure of the labour market in the inquiry database

The structure of the labour market in the uprated 2013-14 database used in the inquiry broadly compares well with the 2013-14 labour market data updated and released by the ABS in 2015.

Australia's workforce is generally concentrated in the highly-skilled occupations of Managers (13 per cent), Professionals (22 per cent), Technicians and Trades Workers (14 per cent), and Clerical and Administrative Workers (15 per cent). Similarly, across all the states and territories, these four occupations account for around two thirds of all employed persons (table B.7).

Figure B.1 **Comparison of actual and projected distribution of production and employment by broad industry sector, Australia, 2013-14**



Sources: ABS (2014, *Australian System of National Accounts*, 2013-14, Cat. no. 5204.0); ABS (*Labour Force, Australia, Detailed, Quarterly*, Augus 2015, Cat. no. 6291.0.55.003); Productivity Commission estimates based on the VUMR-WR model.

Table B.7 Employed persons by state and occupation in the VUMR-WR database and in ABS data, 2013-14^a

	VUMR-WR database									ABS
	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aust	Aust
	'000	'000	'000	'000	'000	'000	'000	'000	'000	'000
Managers	464	365	301	112	177	33	18	28	1 497	1 475
Professionals	807	622	491	178	286	54	29	55	2 522	2 543
Technicians and Trades Workers	493	382	347	117	217	34	19	21	1 630	1 670
Community and Personal Service Workers	345	278	230	93	120	27	18	26	1 136	1 142
Clerical and Administrative Workers	558	415	335	120	200	37	21	45	1 730	1 654
Sales Workers	349	269	216	77	123	24	12	15	1 085	1 083
Machinery Operators and Drivers	212	160	173	52	124	16	9	8	753	759
Labourers	329	261	230	81	125	24	11	15	1 076	1 129
Total	3 556	2 752	2 322	830	1 372	248	137	212	11 430	11 454

^a Employed persons include the self-employed.

Sources: ABS (*Labour Force, Australia, Detailed, Quarterly*, Aug 2015, Cat. no. 6291.0.55.003); Productivity Commission estimates based on the VUMR-WR model.

Reflecting the distribution of employed persons, the distribution of hours across all states is concentrated in four occupations — Managers, Professionals, Technicians and Trades Workers, and Clerical and Administrative Workers (table B.8).

Table B.8 Hours worked by state and occupation in the VUMR-WR database and in ABS data, 2013-14^a

	VUMR-WR database									ABS
	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aust	Aust
	million hours									
Managers	812	627	544	191	308	51	34	54	2 620	3 292
Professionals	1 332	1 011	787	305	483	104	49	75	4 148	4 663
Technicians and Trades Workers	850	697	640	220	370	57	35	41	2 911	3 297
Community and Personal Service Workers	568	402	328	152	190	34	26	45	1 744	1 631
Clerical and Administrative Workers	914	688	587	185	344	57	35	76	2 886	2 666
Sales Workers	584	413	384	81	217	32	20	23	1 753	1 454
Machinery Operators and Drivers	381	295	332	90	249	26	17	16	1 406	1 546
Labourers	540	475	398	126	186	30	19	25	1 799	1 696
Total	5 982	4 608	3 999	1 350	2 347	391	236	355	19 268	20 245

^a Annual hours (in millions).

Sources: ABS (*Labour Force, Australia, Detailed, Quarterly*, Aug 2015, Cat. no. 6291.0.55.003); Productivity Commission estimates based on the VUMR-WR model.

As noted earlier, employment is concentrated in the services sector, which accounts for 87 per cent of national employment in both the VUMR-WR database and the ABS labour market data. Manufacturing accounts for a further 9 per cent of national employment, with agriculture and mining together accounting for the remaining 4 per cent. In some occupations, the services sector accounts for almost all employment, including Community and personal service workers, Professionals and Sales workers (table B.9).

Within the services sector, the largest occupations are Professionals, Clerical and Administrative workers, and Technicians and Trades Workers. In the manufacturing sector, the largest occupations are Technicians and Trades Workers, Labourers, Managers, and Machinery Operators and Drivers. In mining, the three largest occupations are Machinery Operators and Drivers, Technicians and Trades Workers, and Professionals. The dominant occupation in the agriculture sector is that of Managers, with the only other significant occupation in this sector being Labourers (table B.9).

Table B.9 Employed persons by sector and occupation in the VUMR-WR database and ABS data, 2013-14^a

	<i>Agriculture</i>	<i>Mining</i>	<i>Manufacturing</i>	<i>Services</i>
	'000	'000	'000	'000
VUMR-WR database				
Managers	161	21	146	1168
Professionals	6	37	86	2393
Technicians and Trades Workers	14	51	266	1300
Community and Personal Service Workers	1	1	8	1126
Clerical and Administrative Workers	11	20	107	1593
Sales Workers	2	1	56	1027
Machinery Operators and Drivers	12	73	149	520
Labourers	58	11	185	823
ABS				
Managers	170	23	142	1140
Professionals	7	47	85	2405
Technicians and Trades Workers	19	73	258	1320
Community and Personal Service Workers	1	3	6	1132
Clerical and Administrative Workers	18	20	97	1519
Sales Workers	1	0	52	1029
Machinery Operators and Drivers	17	87	115	540
Labourers	79	12	173	865

^a Employed persons include the self-employed.

Sources: ABS (*Labour Force, Australia, Detailed, Quarterly*, August 2015, Cat. no. 6291.0.55.003); Productivity Commission estimates based on the VUMR-WR model.

C Modelling of the scenarios

This appendix outlines the key aspects of each of the scenarios modelled. In all scenarios, it is assumed that a change in minimum wages results in an equivalent percentage change in award wages.

C.1 Scenario 1 — Award wages grow at the same rate as average wages

Under scenario 1, economywide wage rates are largely determined by assumptions about demographic change and labour productivity growth. These assumptions are detailed in PC (forthcoming). This scenario implicitly assumes that the expert panel of the FWC sets minimum wage growth rates that accord with the general growth in unregulated wages across the economy. This scenario is used as the counterfactual against which the moderation of growth in award wages is assessed.

The key demographic assumptions of the projections compared to data for 2013-14 (the benchmark year used in each scenario modelled) are reported in table C.1. The demographic projections are based on age, gender and state specific fertility rates and mortality rates. These assumptions accord with those generally applied in demographic modelling.

Table C.1 Key demographic assumptions

	Units	VUMR variable	2013-14	2024-25
Starting population	million	C_NATPOP	23	27
Total fertility rate (average of states)	births per woman	LRT_TFR	1.86	1.86
Male births per 100 female births	per 100 female births	POPALPHA	105.6	105.6
Net overseas migration as a share of the Australian population	%	C_NOM2POP	0.9	0.6

Sources: Estimates based on ABS (Australian Historical Population Statistics, 2014, Cat. no. 3105.0.65.001); ABS (Australian Demographic Statistics, September 2014, Cat. no. 3101.0).

The working-age population contributes to productive activity through participation in the labour market. These labour supply characteristics govern labour force engagement in scenario 1. Over time, consistent with historical trends, it is assumed that workforce participation will increase fractionally, while workers will move between occupations based on changes in after tax wage rates by occupation. The unemployment rate in each

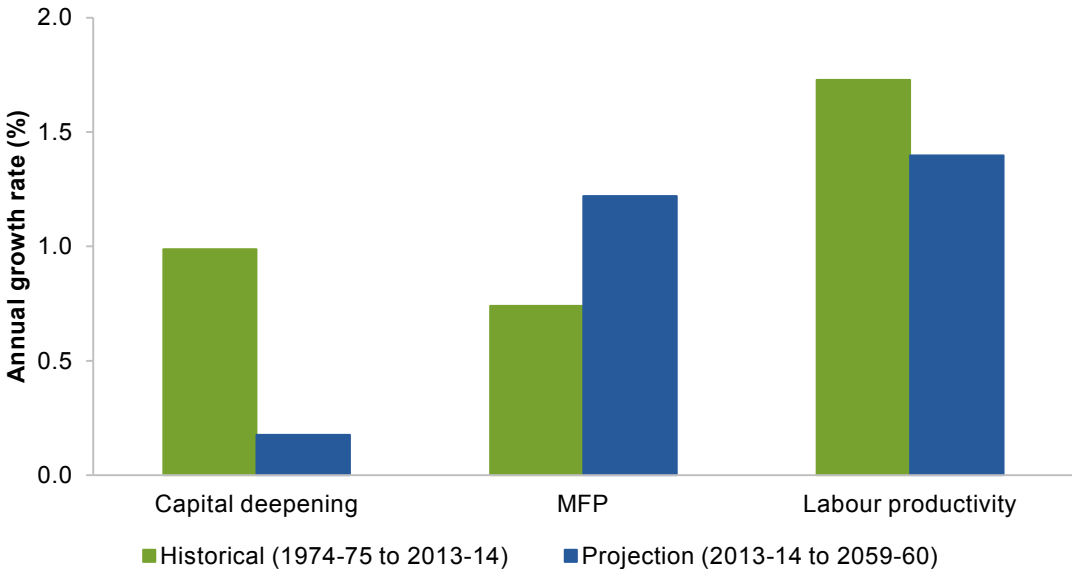
occupation by state is assumed to be exogenous and is fixed at their current 2013-14 levels over the projection period.

Labour productivity growth in scenario 1 has been specified at the industry level. It has been assumed that labour productivity transitions (on average) from current five year average levels (2013-14) to longer-term historical averages (based on the period 1974-75 to 2013-14) over the period 2013-14 to 2017-18. Reflecting these assumptions, national labour productivity, multifactor productivity and capital deepening are projected to increase (figure C.1). National labour productivity and capital deepening are projected to increase at lower rates than have occurred historically.

The lower projected growth in labour productivity reflects, among other factors:

- relatively low (by historical standards) current levels of productivity in a number of industries, most notably the mining and electricity, gas, water and waste sectors, and the assumption of a gradual return to their historically higher productivity levels
- a continuation of the longer-term trend towards service industries, which tend to have relatively lower measured rates of productivity growth (PC forthcoming, 2012).

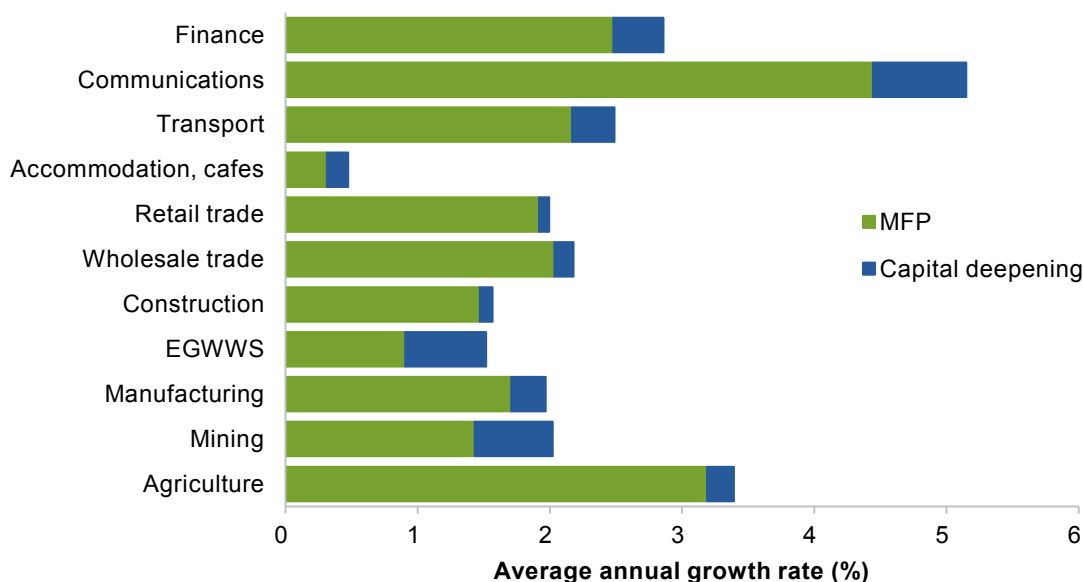
Figure C.1 Actual and projected average annual sources of labour productivity growth, Australia, 1974-75 to 2059-60



Source: Productivity Commission estimates based on the VUMR-WR model.

Following historical trends, this growth in labour productivity to 2059-60 is assumed to be highest in the communications, agriculture and finance sectors and lowest in the accommodation and cafes, construction and utilities sectors (electricity, gas and water) (figure C.2).

Figure C.2 **Projected average annual sources of labour productivity growth, market sector, 2013-14 to 2059-60**



Source: Productivity Commission estimates based on the VUMR-WR model.

The variables shocked and the associated endogenous variable used in the dynamic modelling of scenario 1 are shown in table C.2.

Table C.2 **Modelling of scenario 1**

<i>Rationale</i>	<i>Exogenous variable</i>	<i>Endogenous variable</i>
Non-award wages are determined by supply and demand. Unemployment is held fixed.	Percentage point change in the unemployment rate for non-award wage workers in each state and occupation (d_unro)	Real non-award wages in each state and occupation (rwage_i)
Expert panel sets award wage growth in line with non-award wages. This is achieved in the modelling by holding unemployment of award wage workers fixed.	Percentage point change in the unemployment rate for award-reliant workers in each state and occupation (d_unro)	Real award wages in each state and occupation (rwage_i)

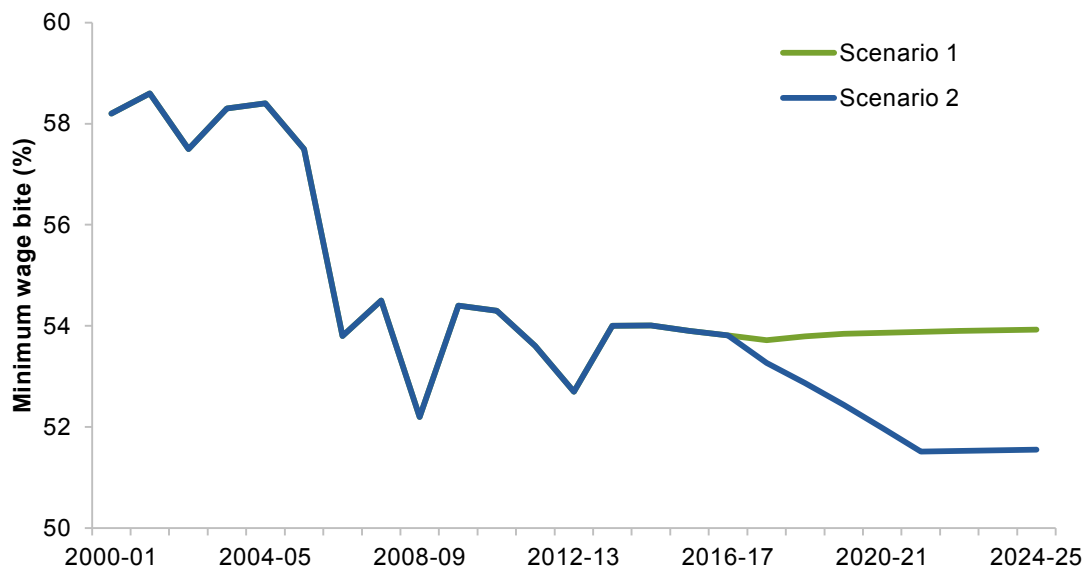
C.2 Scenario 2: Moderate growth in minimum wages

In the moderate wage growth scenario, it is assumed that the real growth in award wages is one percentage point lower than in scenario 1. This illustrates the possible effects of moderating the growth in award wages on employment, incomes and production. It is

assumed that award wages still grow in real terms, thereby improving the living standards of those on award wages, but that the extent of real growth is moderated.

In recent years, Australia’s national minimum wage has remained relatively stable as a proportion of the national median wage (figure C.3). This is projected to continue in scenario 1. In the moderate wage growth scenario, it is assumed that the minimum wage declines as a proportion of the median wage for the five years between 2017-18 and 2021-22, before returning to the trend projected in scenario 1 from 2021-22.

Figure C.3 Trends in minimum wage as a proportion of median wage, Australia^a



^a Based on adult national minimum wage to the median of full time adult ordinary weekly cash earnings.
Sources: OECD Stat database; Productivity Commission estimates based on the VUMR-WR model.

The variables shocked and the associated endogenous variable used in the dynamic modelling of the minimum wage scenario is shown in table C.3.

In the moderate wage growth scenario, non-award wages are endogenous throughout the simulation. But in the five years from 2017-18 to 2021-22, award wages are assumed to grow in real terms by one percentage point less than in scenario 1. From 2021-22, it is assumed that the expert panel sets award wage growth equivalent to the growth of non-award wages. This is achieved in the modelling by allowing award wages to grow in line with average wages.⁹

⁹ In one respect, the award wage is exogenous since the FWC sets it. However, it becomes effectively endogenous when the FWC simply follows the wage growth rate of non-award wages, regardless of that growth rate.

Table C.3 Modelling of the moderate wage growth scenario

<i>Rationale</i>	<i>Exogenous variable</i>	<i>Endogenous variable</i>	<i>Shock</i>
Real non-award wages are endogenous and therefore respond to changes in demand and supply. This is the case throughout the scenario.	Unemployment rate of non-award wage workers in each state and occupation (d_unro)	Real non award wages in each state and occupation (rwage_i)	n.a.
Real award wages are targeted to simulate more moderate growth than in scenario 1 in the period 2017-18 to 2021-22. Unemployment is endogenous in this same five year period and adjusts in response to the change in labour demand.	Real award wages in each state and occupation (rwage_i)	Unemployment rate of award-reliant workers in each state and occupation (d_unro)	1 per cent each year from 2017-18 to 2021-22
After 2021-22, the expert panel sets wage growth equivalent to real non-award wages. This is achieved in the modelling by reverting to the closure in scenario 1.			n.a. after 2021-22
Put in place the medium-run treatment of the award wage and employment of award-reliant workers.	Switch variable for real wages that takes the value of real award wages in scenario 1 (rwfor_i)	The deviation in real award wages between scenario 1 and scenario 2 (f_rw_i)	n.a.
This is reversed after five years, however the effect on the unemployment rate that occurs in the period 2017-18 to 2021-22 is assumed to be permanent.	Switch variable for employment that takes the value of award-reliant employment in scenario 1 (empfor_i)	The deviation in employment between scenario 1 and scenario 2 (f_emp_i)	n.a.
n.a.: not applicable			

Over the five year period in which award wage growth is moderated, the award wage is still assumed to grow faster than inflation. Therefore, while wage growth is moderated, the living standards of award wage workers continue to improve.

Unemployment is modelled endogenously during the five year period in which award wage growth is moderated. In other words, unemployment adjusts to changes in labour demand and labour supply. After 2021-22, the unemployment rate is assumed fixed and minimum wages are allowed to adjust in response to any further changes in labour demand and labour supply.

The relationship between unemployment and wages in the VUMR model is allowed to shift during the five year policy implementation period from 2017-18 to 2021-22. The unemployment rate that results at the end of this five year period is fixed in the ensuing years, through to the end of the scenario. This assumption is compatible with assuming that the change in award wage affects the non-cyclical component of unemployment (sometimes referred to as the non-accelerating inflation rate of unemployment, or the NAIRU). The predominant view is that the non-cyclical component of unemployment is currently between 5 and 6 per cent (Ballantyne, De Voss and Jacobs 2014).

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