

THE ECONOMIC IMPACT OF MIGRATION

Migration Council
AUSTRALIA





The Migration Council Australia would like to acknowledge the Department of Immigration and Border Protection, the Department of Social Services, the Department of Industry and the Australian Bureau of Statistics for their assistance.

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EXECUTIVE SUMMARY

For too long the economic contribution of migration to Australia has been significantly undervalued.

This report documents the first comprehensive analysis in almost a decade of the impact of migration on our key economic indicators and the verdict is conclusive: migration is central to Australia's future prosperity.

Australia's projected population will be 38 million by 2050 and migration will be contributing \$1,625 billion (1.6 trillion) to Australia's GDP.

Moreover, migration will have added

- 15.7 per cent to our workforce participation rate
- 21.9 per cent to after tax real wages for low skilled workers
- 5.9 per cent in GDP per capita growth

Overall, by 2050, each individual migrant will on average be contributing approximately 10 per cent more to Australia's economy than existing residents.

The economic impact of migration flows through into every aspect of the economy. It has a profound positive impact not just on population growth, but also on labour participation and employment, on wages and incomes, on our national skills base and on net productivity. Set out in terms of the three 'Ps' — participation, productivity and population — migration is a significant factor.

In the absence of a migration program, Australia's population in 2050 would be 24 million; with the program we project a population by 2050 of 38 million. This population increase adds economic gains in and of itself, however the interaction of migration with our economic indicators is complex, and the returns go far beyond the benefits of simple population gain.

Over the next 35 years, migration will drive employment growth. As migrants are concentrated in the prime working age group and are relatively highly educated they have a positive impact on the employment rate. By 2050, the percentage gain in employment of 45.1 per cent outstrips the population gain of 37.0 per cent. Further, migration will ensure Australia remains a highly skilled nation, as it will have led to a 60.4 per cent increase in the population with a university education.

Migration has mixed effects on labour productivity. On the one hand, productivity receives a boost, as high levels of education are associated both with high personal productivity and a contribution to general productivity through research and development. On the other hand, there is a loss in productivity from applying a larger labour force to a fixed stock of natural resources, including mineral resources and land.

However, the gain in employment easily outweighs the loss in productivity, so by 2050, migration leads to a 5.9 per cent gain in GDP per capita. This gain in GDP per capita flows through to an even larger gain in living standards.

This gain in living standards drives a further benefit to the budget bottom-line as government revenues increase with the gains to employment, while any rise in government expenditures is limited to the effect of the population increase.

Migration in fact provides savings across the population in expenditures on education, transfer payments and government network infrastructure. Migrants who initially enter Australia on a student visa pay the full costs of their education, providing a saving to the government budget compared to the subsidised places offered to Australian-born residents. Further, the elderly are under-represented in the migrant intake, so migrants generate only a limited increase in government payments. Finally, because of fixed costs, per capita expenditures on government network infrastructure fall as migrants boost the population.

Overall, the gain in GDP per capita combines with the net fiscal benefit of migration to lead to a rise in household consumption. Comparing this with the population gain, migrants offer a premium boost to the economy compared to Australian born residents. Importantly, this premium is shared with Australian residents. As the budget bottom line improves, personal income tax rates can be lower and this in turn supports higher household consumption. This research demonstrates that by 2050, real after-tax wages would be significantly higher.

The findings in this report are based on independent economic modeling completed in 2014–15 by Independent Economics.

Two migration scenarios projected out to 2050 have been simulated using the Independent Macro–econometric Model (Macro Model). The first scenario assumes our current migration framework continues, the second assumes zero migration from now to 2050.

The Macro Model captures the standard linkages between migration and the economy, such as the boost to the labour force. In addition, it goes beyond previous studies in this area to allow for economies of scale in infrastructure, diseconomies of scale from fixed natural resources and semi–endogenous growth from education and research and development.

The following report is broken into three chapters: explaining the model; the results; and our conclusions. The results chapter includes sections dealing with population, participation, productivity and distribution.

This report demonstrates the critical role that migration will continue to play in Australia's economic future and wellbeing. This highlights the need to ensure policy remains dynamic and is able to respond to changing global circumstances.



**BY 2050,
MIGRATION WILL
BE CONTRIBUTING
\$1,625 BILLION TO
AUSTRALIA'S GDP.**

THE MODEL

1

AUSTRALIA'S MIGRATION PROGRAM

Australia's migration policy framework consists of the Migration Program, Temporary Entry visas and the Humanitarian Program. The allocation of places to each of the streams within this framework shapes the number and type of migrants Australia attracts and receives. (See Table A)

Each type of visa stream is designed for a particular purpose, and therefore encompasses different eligibility requirements. Differences in rationale, design and eligibility means that each visa stream has a different economic impact.

The economics of migration

In analysing the impact of Australia's migration program it is necessary to consider a number of assumptions and factors. Under simple assumptions – of a fully scalable economy and where migrants have the same characteristics as the existing Australian population – migration would not have an effect on living standards. Rather, migration would simply increase the size of the Australian economy in proportion to the increase in the population arising from migration.

However, migration is a complex process and various factors do impact across the economy and labour market. There are effects from scale — increasing the population — and arising from the difference between new migrants and the existing population, as well as economies of scale from network infrastructure, diseconomies of scale from fixed factors, a terms of trade effect and endogenous growth effects.

These factors are discussed below.

- **Migrant characteristics** Migrants generally do not have the same age, education or wealth as existing Australian residents. Rather, because of the emphasis on students and skilled migrants in Australia's migration program, many migrants bring higher education and skill levels and higher labour force participation rates than existing Australian residents, leading to economic benefits directly for migrants and indirectly for the existing population.
- **Economies of scale from network infrastructure** The fixed costs of providing infrastructure (such as telecommunications, electricity etc) change depending on the number of people using the infrastructure. When migration contributes to a bigger population, these costs are lower per capita.

TABLE A SUMMARISES THE KEY TYPES OF VISA (STREAMS) THAT ARE INCLUDED UNDER EACH PROGRAM

MIGRATION PROGRAMME	
Skilled	Grants permanent residency to those individuals with skills that are in demand in Australia.
Family	Grants permanent residency to relatives of an Australian citizen, permanent resident or eligible New Zealand citizen.
TEMPORARY ENTRY	
Student	For individuals completing a university qualification, vocational education and training qualification or other qualification at an Australian education institution.
Temporary work (sub-class 457)	Allows businesses, who cannot find an Australian citizen to complete the skilled work, to sponsor a migrant worker. The visa is eligible for up to four years.
Visitor	Allows individuals to travel to Australia for business or holiday purposes for a short period of time, up to one year.
Working Holiday and other temporary	The working holiday visa is designed for young people from certain eligible countries to holiday and work in Australia. Eligible for one year with possibility of an additional year.
HUMANITARIAN	
Humanitarian	Grants permanent residency to individuals who are subject to persecution or discrimination in their home country.

- **Diseconomies of scale from fixed factors**

Factors such as land, water and mineral resources are fixed. A larger population, through migration, means each resource is spread more thinly, creating costs for the economy — potentially leading to lower living standards.

- **Terms of trade** As the size of the Australian economy increases relative to the size of the world economy, a fall is expected in Australia's terms of trade, leading to a reduced real income for the population.

- **Endogenous growth** Factors such as human capital accumulation and productivity growth related to research and development (R&D) can affect the long-term growth rate of the economy. Both of these factors are impacted by migrants, who lift the educational attainment of the Australian population.

Modeling the economic impact of migration

Previous modeling of the economic impact of Australia's migration policies occurred in 2006, when the Productivity Commission produced a report into the economic benefits of population and migration, and Independent Economics (then trading as Econtech Pty Ltd) subsequently provided modeling to the (then) Department of Immigration and Citizenship in the same year.

These studies were based on Australia's migration program and policies in 2004–05. However, there have been significant developments since then: Australia's Net Overseas Migration (NOM) rose from around 143,000 migrants in 2004–05 to around 239,000 migrants in 2011–12.

Furthermore, during these years Australia's skilled migration expanded and increased its focus — both on skilled migration and temporary visas as a pathway to permanent migration. For example, net migration under 457 visas rose from 7 per cent of NOM in 2004–05 to 15 per cent by 2011–12.

Net Overseas Migration

Each of the visa streams within Australia's migration policy framework contributes to the total of Australia's Net Overseas Migration (NOM). Broadly speaking, NOM is the number of newly arrived migrants minus the number of newly departed migrants. More specifically, NOM is calculated as the difference between the number of persons entering Australia who stay in Australia for more than 12 months within a 16-month period and the number of persons leaving Australia who remains overseas for 12 months or more over a 16 month period.

This report provides a more up-to-date analysis of the economic impact of migration, incorporating the changes to Australia's migration program since the last analysis, almost a decade ago.

To estimate the economic impact of migration to Australia, a baseline scenario was developed that projected Australia's NOM out to 2050 based on current policy and migration trends.¹ This baseline scenario was then compared with an alternative hypothetical scenario, where there was no migration from here on.² This allowed a comparison of the economic outcomes arising from the two scenarios, demonstrating the overall economic impact of migration to Australia.

To estimate the economic impact of migration, the two migration scenarios were simulated to the year 2050 using the Independent Macro–econometric Model (Macro Model). The Macro Model builds on the 2006 Econtech analysis, capturing the standard linkages between migration and the economy, such as the boost to the labour force from migration. In addition, it goes beyond previous studies in this area to allow for economies of scale in infrastructure, diseconomies of scale from fixed natural resources and semi–endogenous growth from education and research and development to also be considered.

¹ Current Department of Immigration and Border Protection (DIBP) forecasts extend to 2017–18 (256,900); these forecasts were broadly adopted in this report and then extended to 2050–51. In extending the DIBP (2014) projection beyond 2017–18, the annual level of NOM was held constant at 250,000 migrants until 2029–30 and thereafter grown so that its contribution to population growth was kept constant at 0.85 percentage points (based on NOM's average contribution to population growth between 1999–2000 and 2013–14).

² It is highly unlikely that a scenario of zero migration will occur in the near future; however, utilising this scenario provides a basis to capture and analyse the economic impact of migration to Australia.

A comparison of the model features is shown below:

TABLE B. MODEL COMPARISON

MODEL ATTRIBUTE	2006 COMMISSION	2006 ECONTECH	2014 INDEPENDENT ECONOMICS
Labour skills and migration	✓	✓	✓
Labour force participation and migration	✓	✓	✓
Link from higher exports to lower terms-of-trade	✓	✓	✓
Link from population growth to investment	?	✓	✓
Link from financial wealth of migrants to living standards	✗	✓	✓
Natural resources diseconomies of scale	✗	✗	✓
Infrastructure economies of scale	✗	✗	✓
Semi-endogenous growth a) Link from education spending to productivity	✗	✗	✓
Semi-endogenous growth b) Link from R&D to productivity	✗	✗	✓
Population and government spending (social security, health, education)	✗	✗	✓

The expanded attributes allow the modeling to better capture both the positive and negative impacts of migration.

The Independent Macro–econometric Model

This report’s analysis of the effects of the macroeconomic shocks on the key economic parameters is undertaken using the Independent Macro–econometric model. This Macro Model is well suited for analysing the economic effects of the macroeconomic shocks for the following reasons.

- It is able to *consistently analyse the economic impacts of macroeconomic shocks in the short, medium and long term*. Consistent modelling through time is particularly important for analysing economics shocks such as a gain in the terms of trade, where there are different, important effects in both the short–term and long–term.
 - It features *fully–integrated industry modelling*, which models the inter–linkages between six different industries (including mining) and the broader economy within one model. This allows for a fuller analysis of the effects of macroeconomic shocks, such as changes to world mining prices. The six industries are Agriculture, Mining, Manufacturing, Government Services, Other Services and Housing Services.
 - The Macro Model has a *fully–integrated demographic model*. This allows the Macro Model to robustly estimate the economic effects of population ageing, including its effects on the participation rate.
 - The model incorporates a *sophisticated production structure* that allows for the importance of fixed factors such as land and natural resources in industries such as Agriculture, Mining and housing services (Ownership of Dwellings). This enables the model to provide more realistic estimates of the response of these industries to macroeconomic shocks, such as changes in labour productivity.
- Other features of the model that are useful for the analysis include:
- forecasts on a quarter–by–quarter basis to a long–term horizon;
 - strong data consistency for more accurate forecasting;
 - solid theoretical foundations for more robust policy analysis;
 - an understanding of how the Reserve Bank pursues its inflation target in setting monetary policy, taking into account developments in inflation, unemployment and the bond market;
 - modelling of consumer and investment behaviour that allows for the GFC;
 - a new approach to modelling household consumption that uses a target for asset holdings based on labour income;
 - a detailed representation of the interactions between building and construction activity in each industry and the broader economy;
 - an allowance for structural change in the labour market;
 - sophisticated modelling of financial markets in which market agents are forward looking and instantaneously respond to new information. This is a more realistic approach to modelling financial markets and helps the model provide credible short–term forecasts;
 - an industry satellite model that disaggregates selected forecasts for the six broad industries in the macro model to 37 more detailed industries; and,
 - a states satellite model that disaggregates selected national forecasts from the macro model to the state level.

For a detailed explanation of the Independent Macro Model, please see Appendix Two.



**MIGRATION
WILL ENSURE
AUSTRALIA
REMAINS
A HIGHLY
SKILLED
NATION.**

Using the model to simulate the economic impact of migration to 2050, we were able to examine the likely effect of migration on key economic indicators with a degree of precision. These results have been broken down so as to isolate the effect of migration on population, labour participation and productivity. A further section has been included to outline the distributional effects of migration, most notably on wages.

These results paint a comprehensive picture of the interdependence between Australia's migration framework and our economic fortunes.

POPULATION

The Australian population is projected to be 38 million in 2050, rising to 40.1 million by 2055.

Migration is one of two major demographic factors that affect the rate that Australia's population grows. The other is how the existing population increases. This is a combination of the fertility rate and life expectancy, or more simply births minus deaths.

While migration trends can move very quickly in both scale and direction, fertility and mortality are both slow to adjust. For example while the fertility rate increased at the turn of the millennium, it did so progressively over a number of years. This makes changes in births minus deaths more predictable than the migration trend.

Using the two scenario modelling in this research it can be shown that with no migration, our population would stagnate at 24 million by 2050. However, with migration, we can project that Australia's population in 2050 will be 38 million. That is to say, migration adds 14 million — or 37 per cent — to the total population over the next 35 years. This is based on an average NOM of 250,000 per year until 2029–30. After this initial period, an assumption is made that net migration will be equal to 0.85 percentage points.³

This population projection contrasts starkly with previous long-term government projections. For example, previous intergenerational reports offered significantly lower population projections.

³ The assumption of 0.85 percentage points is based on NOM's average contribution to population growth between 1999–2000 and 2013–14. This period accounts for the more recent changes to Australia's migration framework.

There are two primary reasons for this variance. Firstly, in the past, estimates of Australia's projected population have failed to allow for the growth of the migration program. In effect migration has been held at a constant figure as the population increases, reducing the net impact of migration over time.

Secondly, previous projections have relied on long-term historical trends to project future growth, rather than incorporating the effect of significant structural changes in the migration framework.

For example, the third Intergenerational Report published in 2010 projected a population based on an average net migration rate of 0.6 per cent of the population, or 180,000 net migrants per year. This was based on the long-term average from the early 1970s to the late 2000s. By the time the third Intergenerational Report was published in 2010, NOM was already 180,000, allowing for no growth in migration.

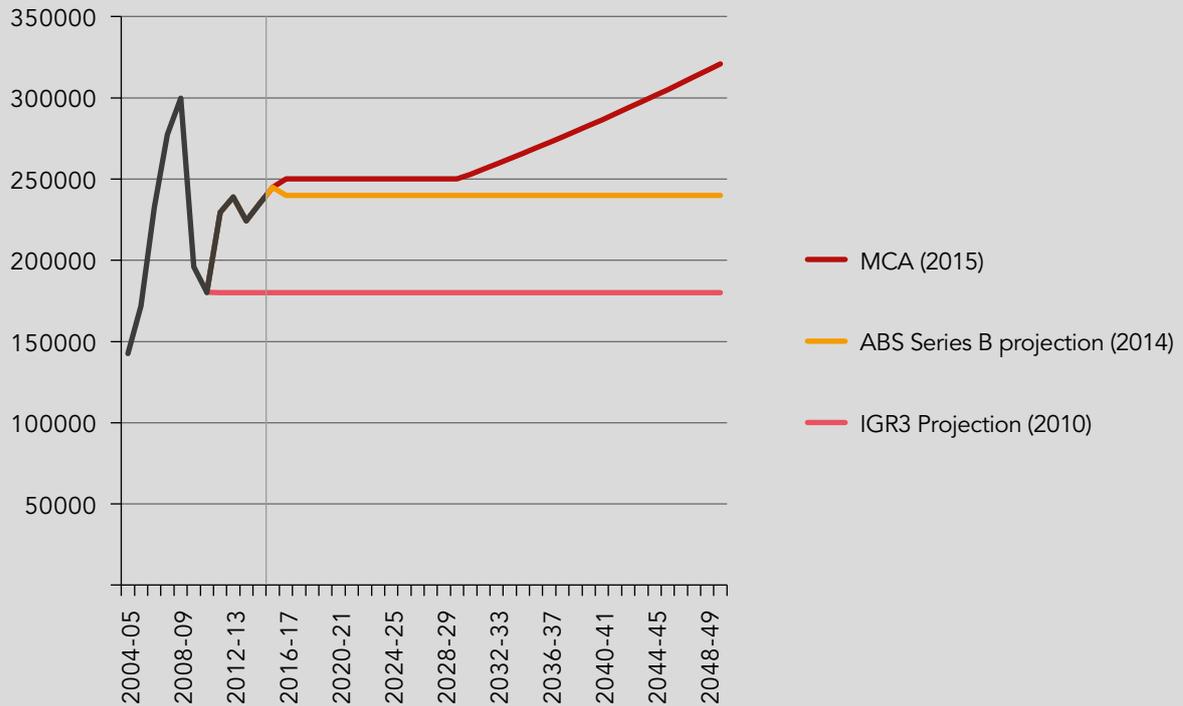
Similarly, historical long-term trends miss capturing the true effect of more recent changes in the migration framework, most notably the growth in temporary migration. Indeed, the ABS population projection series offers a possible range for NOM from a conservative 200,000 to an upper limit of 280,000. Current Department of Immigration and Border Protection forecasts of NOM, which account for more recent policy parameters have net migration rising to 257,000 by 2017–18.



**THE AUSTRALIAN
POPULATION IS
PROJECTED TO
BE 38 MILLION
IN 2050.**

This chart shows the population projections used in this report compared to current ABS projections and the third Intergenerational Report.

PROJECTED NET OVERSEAS MIGRATION (PERSONS PER YEAR)



Source: MCA; ABS; Treasury

The rate of NOM is important. A lower rate of NOM will project a lower population, but because migrants are generally younger than the existing Australian population, a lower rate of NOM also means an older population. A lower rate of NOM will therefore adversely impact on the dependency ratio of workers to non-workers.

Conversely, a higher rate of net migration will project a higher population. This will play a significant role in reducing the economic negatives associated with Australia's ageing society.

Human capital and demography are the two main factors that drive change in the labour market and the economy. Australia's skilled migration policy framework focuses on these two key factors, with migrants coming to Australia being on average both younger and more skilled than the average person in the labour force. These factors demonstrate the importance that policy-makers should place on migration.

As reflected in the previous IGR projections — which failed to take into account how Australia's migration framework fundamentally altered with the prioritisation of skilled migration and the expansion of temporary migration — there is currently a poor understanding of how migration trends ebb and flow, as well as the impact of policy change on the NOM rate.

PARTICIPATION AND EMPLOYMENT

The characteristics of migrants differ from the Australian born population. As such, the impact of the migration program on the labour market is transformative, increasing the rate of participation and employment.

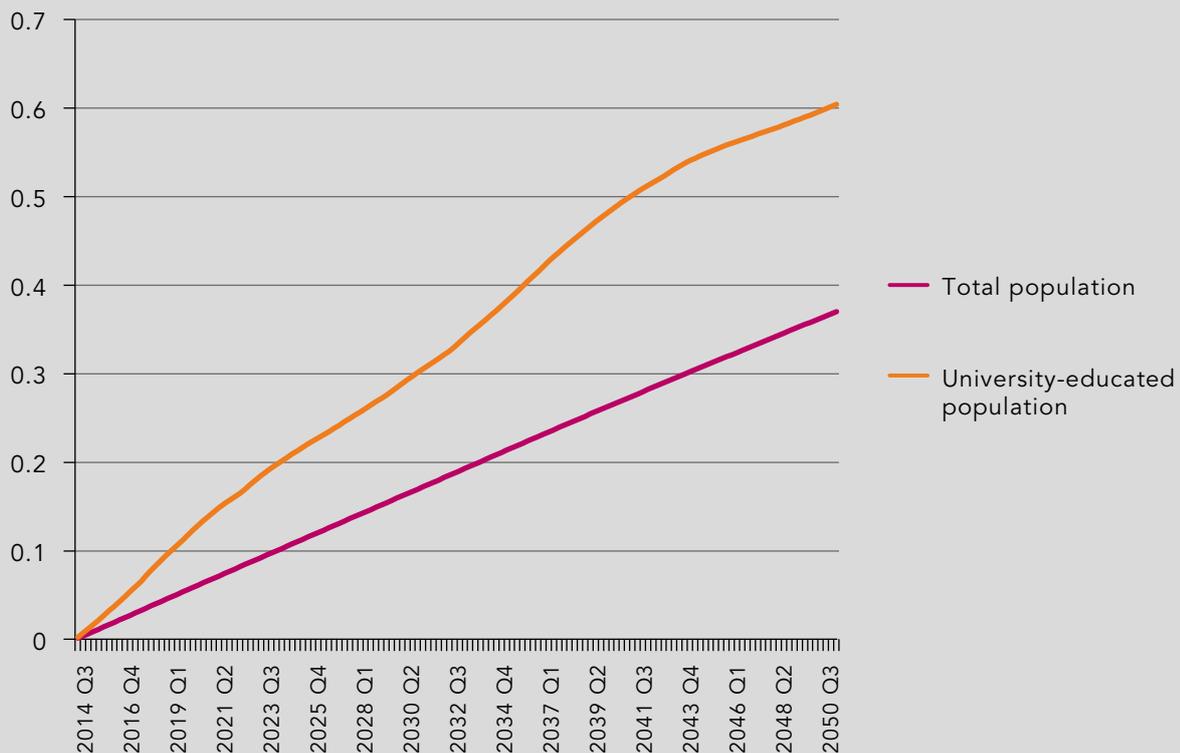
Indeed, as modelling in this research demonstrates, by 2050, migration will have increased the rate of labour participation by 15.7 per cent, or approximately 0.4 per cent per year. To put this in perspective, the expected bump to labour participation over the next 35 years from migration is nearly equal to the gains made over the past 35 years of women’s participation in the workforce.

This modelling further demonstrates that by 2050, there will be a gain in employment though migration of 45 per cent, easily outstripping the population gain of 37 per cent. In simple terms, this means that migration plays a role in job creation. The gap between employment and population represents a raw premium in terms of the economic benefit of migration.

In addition, new migrants hold a higher level of qualification than the average person in the labour force. The skill profile of migrants is critical in managing our workforce capacity and in addressing gaps in our labour market. In part, the additional jobs premium that migrants yield is a reflection of the increased capacity for investment that comes from a stable, diverse and more highly skilled workforce.

Migrants, on average, are more highly educated than existing residents. This is particularly the case for migrants who initially enter Australia on a student visa. The Chart below compares the percentage boost to total population with the percentage boost to population with a university education. By 2050, the boost to the population with a university education of 60.4 per cent easily outstrips the boost to the total population of 37.0 per cent.

MIGRATION DIFFERENCE; POPULATION, UNIVERSITY EDUCATED POPULATION



Moreover, the increasing rate of labour participation driven by migration has strong economic benefits. The most important is the role migrants play in mitigating the effects of an ageing population. Structural demographic changes will have significant long-term impacts on the tax burden, revenue projections and the workforce capacity of the Australian economy. While migration cannot solve Australia's demographic problems, it can assist on the margins by extending an adjustment period to alleviate the worst effects of an ageing labour force.

This is because migration does not just add additional population; it adds younger workers who have high participation rates. Thus it alleviates the workforce capacity issues, shifting the ratio of working age to non-working age people. Further, because migrants are more highly educated on average, they can be expected to participate more in research and development, adding to economic growth with its disbursed benefits.

A further participation bonus arises from migrants having higher rates of participation than the Australian born population, with these higher participation rates giving rise to increased labour incomes and a corresponding boost to tax revenue. The boost to tax revenue is, however, offset against migrants being relatively young and having lower net wealth than existing residents.

Migrants may contribute more to the government in taxes than they draw in government services. They generally receive less government entitlements, particularly if they arrive on temporary visas. Often the costs of their education have already been met in their source country or, if they arrive on a student visa, they pay the full costs of their education as they are not eligible for a government-funded place. Further, relatively few entrants are old enough to be immediately eligible for the age pension.

The major visa categories that are generating migration to Australia, such as international students and temporary and permanent skilled visas, are exemplary in terms of their characteristic profiles. International students are proportionally younger and receive their education at Australia's higher education providers.

Under more recent changes to the migration framework, a new streamlined 'post-study work' visa now allows international students to enter the labour market full time for up to four years at the completion of their studies. While skilled migrants tend to be slightly older than international students they have very high participation rates in the labour market. Moreover, their previous work experience in other countries enables them to transfer knowledge and skills to our domestic workforce.

Previous research on migration and labour participation supports this economic modelling. Cully (2011) found migrants contributed 1.9 percentage points of growth to the aggregate participation rate from 2000 to 2010. New migrants arriving in this decade were younger than previous migrants (via policy change) and the migrants who were already in Australia increased their propensity to work. Without these effects, the labour participation rate would have been less positive in the first decade of the 21st century.

PRODUCTIVITY AND GROWTH

Migration has mixed effects on labour productivity but its overall effect on growth is conclusive and compelling. Using the model to simulate the economic impact of the migration program to 2050, we can project the economy will be 40 per cent larger as a result of migration. Expressed in dollar terms, migration will be contributing \$1.6 trillion to the Australian economy. Taken together, these two figures underscore just how significant migration is to Australia's future prosperity.

The effect of migration on productivity is complex. On the one hand, productivity receives a boost because migrants are concentrated in the prime working age group and are relatively highly educated. Moreover, they are more likely to participate in the workforce and have higher levels of personal productivity. In the modelling, we also take account of the contribution migrants make to general productivity through research and development.

On the other hand, a higher population means applying a larger labour force to a fixed stock of natural resources. Further, a larger economy may lead to a lower terms-of-trade as less favourable export prices need to be accepted to achieve a larger share of world markets.

On the whole, using the model to simulate the economic impact of the migration program to 2050, productivity decreases by 7.9 per cent. This occurs as capital in the economy adjusts to a larger labour market. The process of adjustment occurs slowly at first with growth accelerating as the projection extends towards 2050. As will be discussed later in this section, the effect is not uniform across industries: sectors of the economy that engage our national resources are more likely to be affected.

However, comparing the GDP gain of 40.7 per cent with the population gain of 37.0 per cent, it follows that migrants offer a premium of 10.1 per cent in their GDP per capita compared to existing residents. This means it only takes roughly 9 migrants to produce the same amount of economic activity as 10 existing residents.

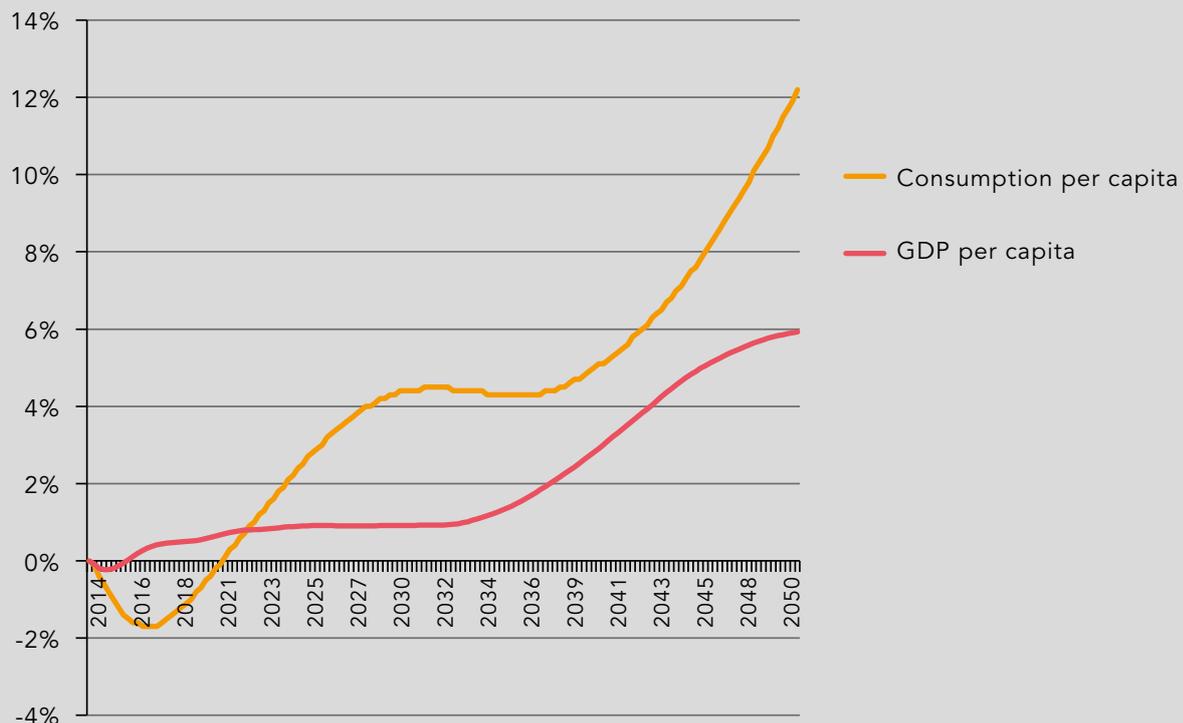
Overall the gain in the employment rate under the migration scenario to 2050 easily outweighs the loss in productivity. As a result, by 2050 migration leads to a 5.9 per cent gain in GDP per capita, or approximately \$6,151 per capita at 2012–13 prices.

This per capita GDP premium is important in that it clarifies that migration does not just make the economy bigger by adding more people. Migrants make a per capita contribution that exceeds existing residents. Not only do they add more population, they assist in fuelling growth.

In addition to GDP per capita, household consumption per capita arising from migration increases by 12.2 per cent (\$6,977). Household consumption is closely linked to living standards and this increase suggests substantial economic gains for the existing population is generated by migration.

It is also important to note that these GDP gains do not appear immediately. Rather, these gains occur as capital adjusts to a higher population. This “lags” the gains, as can be seen below:

PER CAPITA GROWTH OVER TIME



Large structural changes over the past two decades in Australia's migration policy have placed us in an advantageous position. Our efforts to prioritise skills as a primary driver of selection means we are now well positioned to reap the benefits over the coming decades.

PERMANENT RESIDENCY VISAS: ONSHORE AND SKILLED

PROGRAMME YEAR	TOTAL	% ONSHORE	% SKILLED
1996–97	73587	22.5%	47.1%
1997–98	66840	22.9%	51.5%
1998–99	67821	22.2%	51.5%
1999–00	70237	24.8%	50.3%
2000–01	80597	28.1%	55.5%
2001–02	93054	33.9%	57.5%
2002–03	108072	29.0%	61.1%
2003–04	114362	32.1%	62.3%
2004–05	120064	33.0%	64.9%
2005–06	142933	30.3%	68.1%
2006–07	148200	33.6%	66.1%
2007–08	158630	34.3%	68.4%
2008–09	171318	37.0%	67.0%
2009–10	168623	37.7%	64.0%
2010–11	168685	48.1%	67.4%
2011–12	184998	42.9%	68.0%
2012–13	190000	49.9%	67.9%
2013–14	190000	50.4%	67.7%

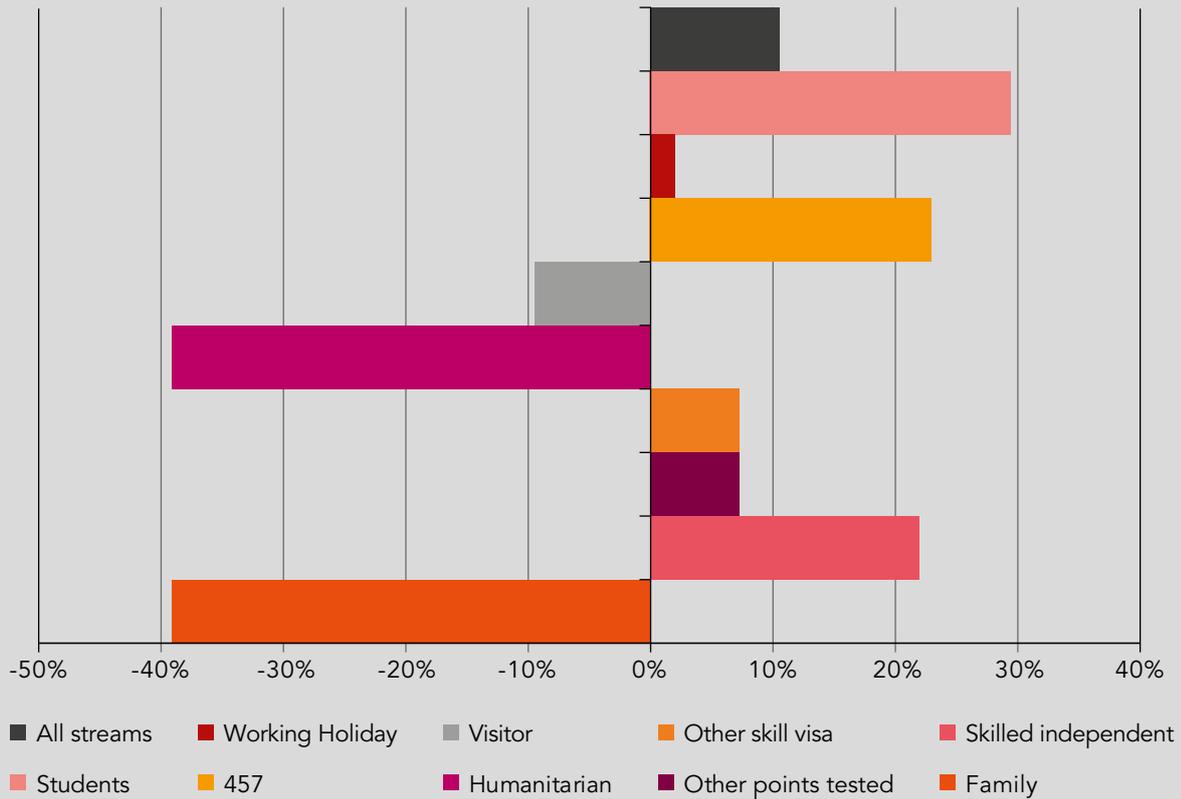
Source: DIBP 2014

By looking to the long-term acceleration of economic benefit, this analysis demonstrates the caution that governments, both politicians and bureaucrats, should apply in considering short-term reactive decisions on migration policy. The economic imperative of migration is strong, yet requires a commitment to extract the full long-term potential.

GDP premium per visa

Each visa stream is designed for a particular purpose and thus has different eligibility requirements, so different visa subclasses create different economic impacts. To capture these differences, the modeling has isolated each major migration stream to measure the GDP per capita contribution.

GDP PREMIUM BY MIGRATION STREAM (PER CENT PER MIGRANT)



As the chart demonstrates, there is a wide variance in economic contribution between various visa categories. Permanent skilled, temporary skilled and student visa holders all show a large, positive effect. The younger average age and the higher human capital common across these streams drives their economic contribution. Other points–tested visas, other skilled visas and working holiday makers all make smaller, but positive, contributions.

Migrants who initially enter Australia on a student visa provide the largest economic benefit. This is because they are young and well educated. 457 visa holders also provide a significant economic benefit, which is largely driven by their high labour force participation rates and skill level. Skilled independent stream migrants also add significantly, reflecting their relative age, language and technical skills. Indeed, 63 per cent of the intake in this stream is in the prime working age group of 25 to 44.

Some other migrant streams, such as those who enter on a Humanitarian visa, and migrants who initially enter on a family visa have a negative economic impact. This is to be expected because they have not been chosen on the basis of their economic characteristics. These streams meet broader social obligations, supporting social cohesion and Australia’s role as a global citizen, and are not intended to yield any net economic gain.

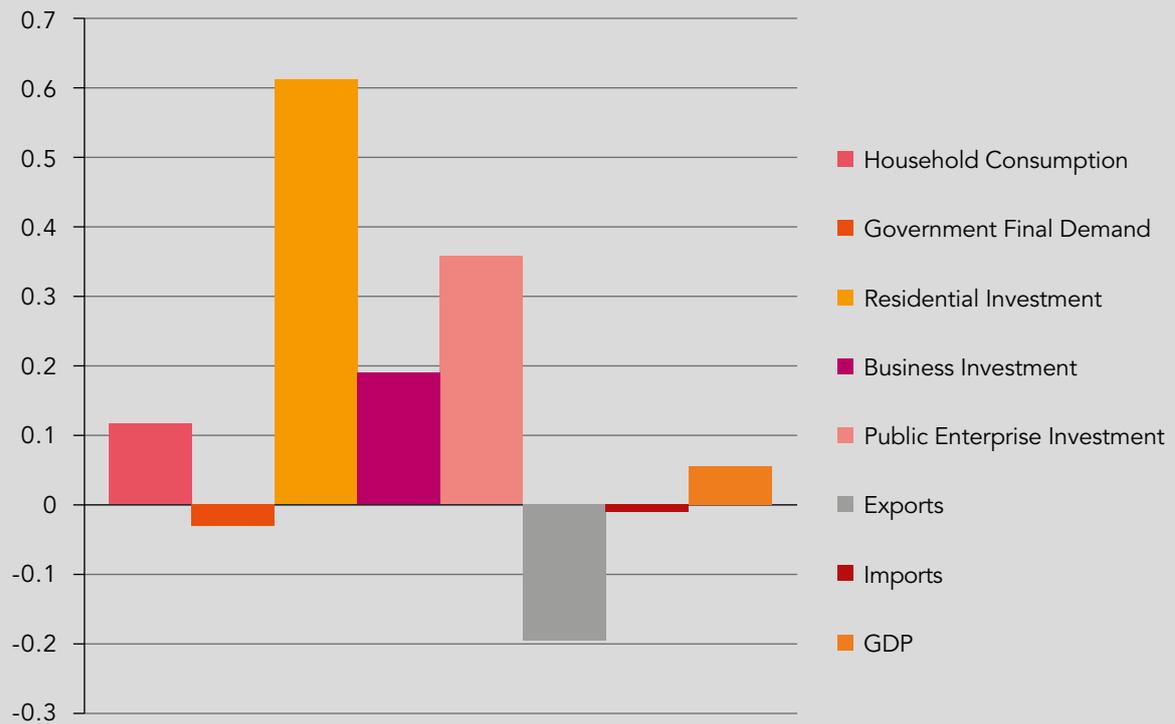
A stream by stream analysis of visa types demonstrates how policy decisions made now have long–term impacts. Policy decisions on student visas, for example, will shape the trend of student migration in the short– and medium–term yet will have a much longer–term economic impact.

Effects of migration on per capita GDP by expenditure

While the migration program boosts total GDP per capita by 5.9 per cent through to 2050, the boost varies significantly between components of GDP.

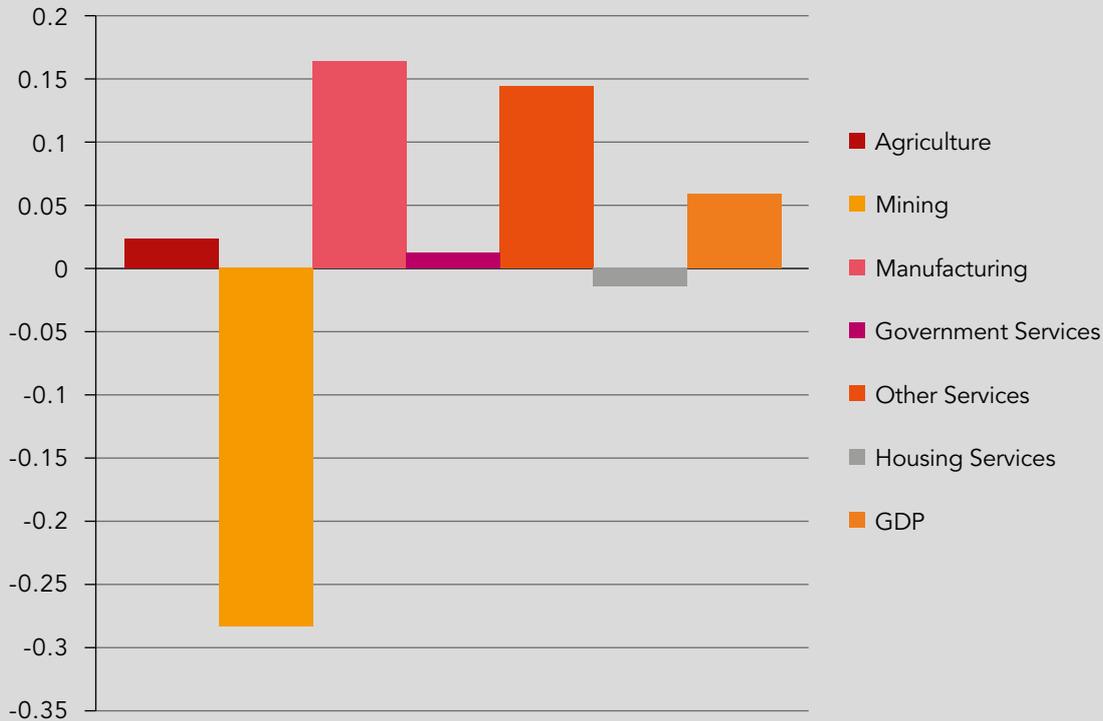
Economic growth is more rapid with the migration policies than without the migration policies. With migration, a larger share of GDP is allocated to investment to support more rapid growth in capital stocks. Thus, in per capita terms, there are large gains in residential, business and public enterprise investment.

EFFECTS OF MIGRATION ON PER CAPITA GDP BY EXPENDITURE



While migration leads to an expansion in exports that weighs on the terms-of-trade, the negative impact of this real income loss on consumption is outweighed by the modest nature of the rise in demand for government services arising from migration. More rapid growth in GDP also means that foreign liabilities can grow more rapidly, without rising relative to GDP. This allows a lower trade balance, so imports strengthen relative to exports. The lower trade balance is also partly financed by the transfers of wealth that migrants bring with them to Australia.

EFFECTS OF MIGRATION ON PER CAPITA GDP BY INDUSTRY (PER CENT DEVIATION IN 2050)



Effects of migration on per capita GDP by industry

This modeling demonstrates how migration has varied economic impacts across industries.

While mining GDP is boosted by migration, in percentage terms this boost falls well short of the boost to population. This is because mining is dependent on a fixed natural resource. Thus mining GDP is substantially lower on a per capita basis.

On a per capita basis, the boost to the Government services industry is modest. This reflects the falls in general government final demand per capita. The boost to Agriculture on a per capita basis is also modest. This is because Agriculture is dependent on the supply of agricultural land, limiting its ability to expand with a higher population.

Both the manufacturing industry and the other services industry achieve large gains from migration, as these industries do not face the same natural constraints as mining and agriculture. They both benefit from their exposure to the strong gain in household consumption per capita, and the more plentiful supply of high-skilled workers. Manufacturing also benefits from the very strong gain in investment demand per capita.

DISTRIBUTION

While it is critical to understand the influence of migration on the economy as a whole, it is equally important to understand the flow of benefits from migration, and in particular the impact of migration on existing residents. While many of the economic gains from migration will go to migrants themselves, in the form of employment and income from that employment, the effects of migration flow through every aspect of the economy. There are also significant gains for existing residents, both in terms of wages and living standards, through the net fiscal benefit they provide to the Government budget.

The distributional effect of migration gains is driven by a benefit to the budget bottom-line. As noted above, the main benefit of migration for existing residents arises as new migrants add 40.7 per cent to GDP but only 37.0 per cent to population.

While government revenues increase with the gains to employment and GDP, any rise in government expenditures is limited to the effect of the population increase. As explored earlier, migrants coming to Australia on a student visa pay the full costs of higher education, providing a saving to the government budget compared to the subsidised places offered to Australian-born residents. Skilled migrants have already had the costs of their education met by their country of origin. Limitations on eligibility for Government services apply to many migration streams. The age demographics of the migrant intake mean that the elderly are under-represented in terms of demand for government transfer payments. These factors reduce the fiscal impact of the increase in population.

Moreover, because of fixed costs, per capita expenditures on government network infrastructure fall as migrants boost the population. Consequently, the demand for government services (as measured by general government final demand) rises by only 35.7 per cent, well below the gain in GDP of 40.7 per cent. Put simply, when migration boosts the population, demand for some government services rise, but by a lower proportion than the population increase.

As the budget bottom line improves under the migration scenario, personal income tax rates can theoretically be lower and this in turn supports higher household consumption. This does not mean that personal income tax rates are cut under the migration program. Rather, it means that very large increases in personal income tax rates that would have been necessary under the zero migration scenario are largely avoided. With no migration, a rapidly ageing population drains the Government budget, forcing large increases in tax rates.

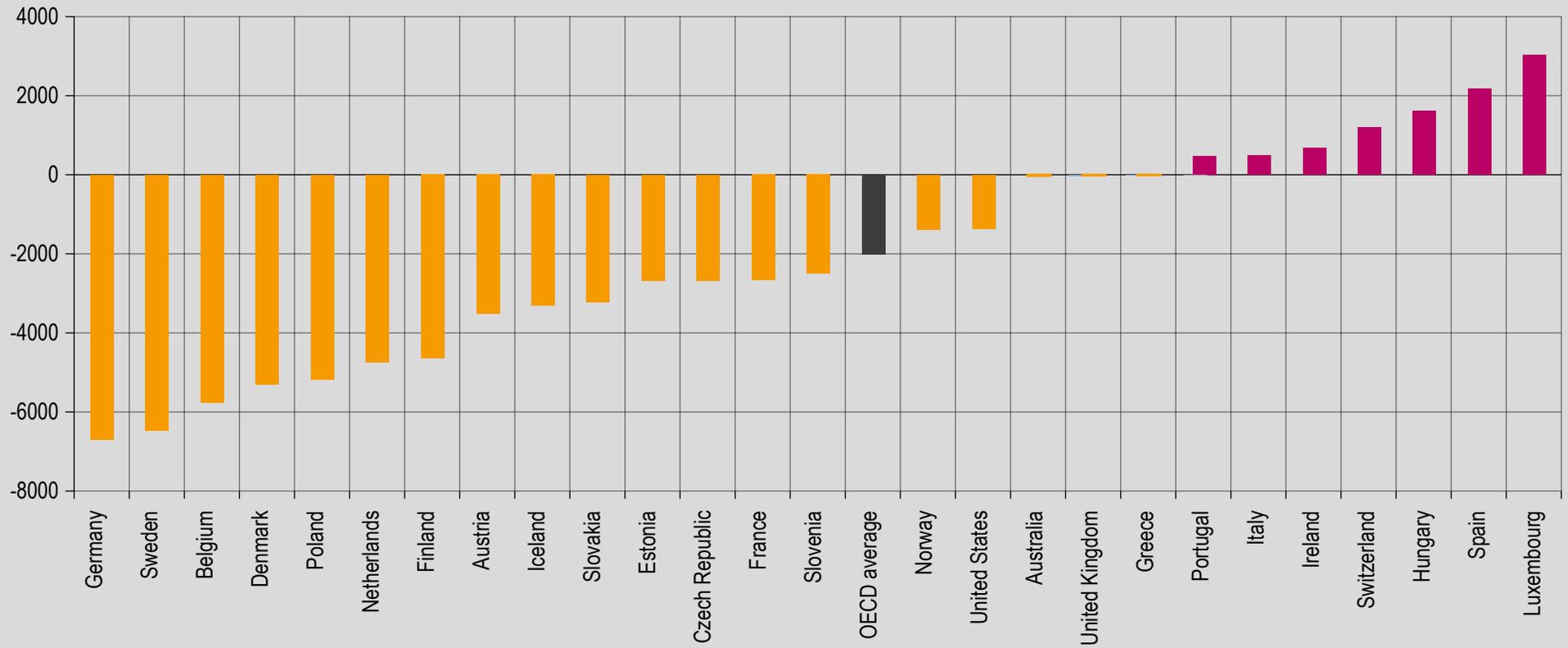
Modelling in this research demonstrates an overall gain in real after-tax wages of 9.7 per cent. Furthermore, these gains have a distributional affect, proportionately benefiting low skilled and medium skilled workers. The effect of migration on wages to 2050 is:

- a 3.5 per cent decrease for high skilled workers
- an 11.0 per cent increase for mid skilled workers
- a 21.9 per cent increase for low skilled workers

These benefits for existing residents vary because of the differential effects of migration in different areas of the labour market. Migration enlarges the economy, boosting demand for workers of all skill levels. However, because the migration program is slanted towards high-skill workers and away from low-skill workers, it initially creates an excess supply of high skill-workers and an excess demand for low-skill workers. This induces significant adjustments in relative wages to re-balance labour markets.

This modelling simulation accords with other existing evidence. A 2013 OECD study showed the net contribution of migrants to various countries net fiscal position.

DIFFERENCES IN THE NET DIRECT FISCAL CONTRIBUTION OF IMMIGRANT AND NATIVE-BORN HOUSEHOLDS AND THE ROLE OF DIFFERENT CHARACTERISTICS, 2007–2009



SOURCE: OECD, 2013

The OECD average contribution by migrants to a net fiscal position is –€2022. By comparison, Australia is –€32. This means there is virtually no difference between what migrants contribute and draw from government compared to Australian-born residents for the period 2007–09.

Further, if this net fiscal position is broken down into government contribution (tax paid) and benefits (welfare provided), an interesting pattern emerges. Migrants contribute less than Australian-born residents in terms of government receipts (–€1811 compared to the OECD average of –€3295) but migrants also use less government support than Australian-born residents on average (–€381, compared to the OECD average of –€247). Migration Council modelling shows that this net fiscal position is likely to rise strongly over time.

However the OECD study focused on the existing population. New migrants to Australia over the next 35 years have different characteristics from those who are already living in Australia. For the most part, this is a reflection of the focus in the current migration framework on skills and education. This will transform the net fiscal contribution of migrants into a strong positive impact.

As migrants have different characteristics to the existing labour force, their impact on across the labour market varies. The post-tax wage increases for both mid- and low-skilled workers are substantive. In part this is a consequence of a skilled migration framework. High skilled new migrants will compete with other high skilled workers in the labour market. Conversely new migrants act as complements to existing workers in mid- and low-skilled occupations. The cumulative effect of a 0.6 per cent per year wage impact for low-skilled workers in particular is a large and significant gain. The distributional effect of migration in benefiting low skilled residents is often overlooked as part of the discourse of Australia's migration framework.

This modelling finding is also supported by a National Bureau of Economic Research paper by Peri, Docquier and Ozden (2010), showing a similar trend in terms of the impact on wages. They show the average impact of immigration on wages between 1990–2000 in Australia was +1.7 per cent or 0.17 per cent per year. When split into low-skilled and high-skilled groups, migration has very different effects. The impact on high skilled wages for the period was –1.1 per cent while for low-skilled wages the result was +4.5 per cent, or 0.45 per cent per year which is a similar result to the modelling simulation.

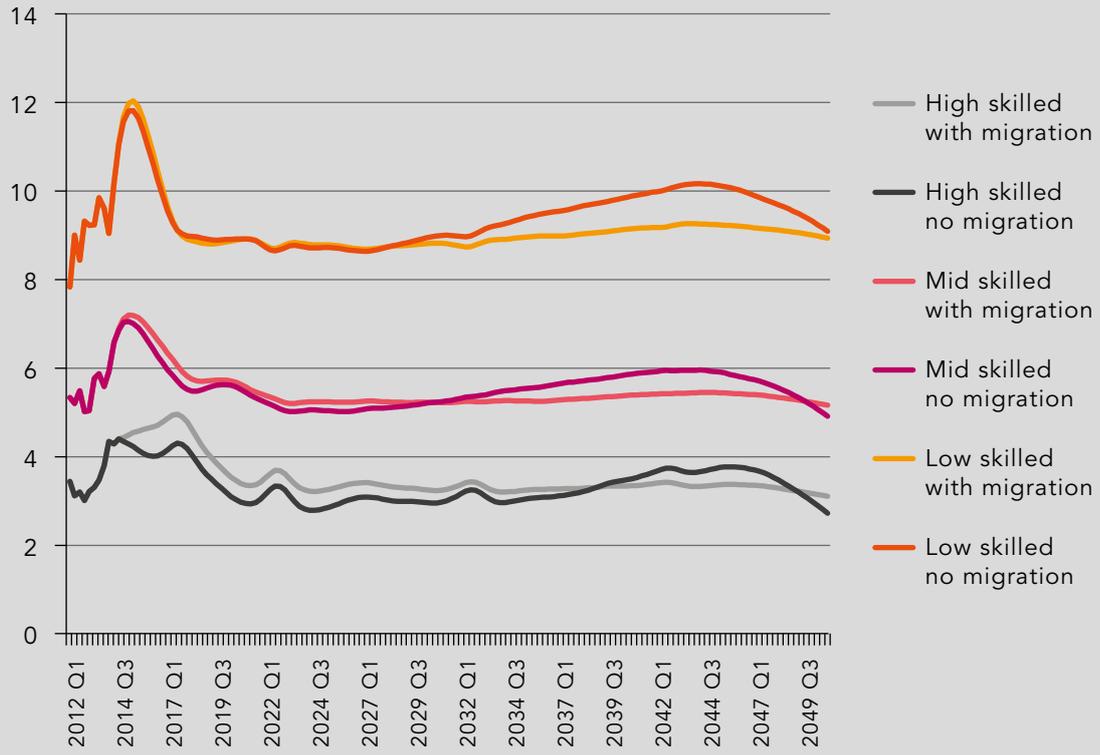
Unlike wages, there is little impact on the unemployment rate by migration. In part, this is because the wage adjustments to each skill level ensure that any impact on unemployment is largely mitigated. In line with historical experience, projected unemployment rates are higher for low skilled workers.

While there are some long-term adjustments occurring over the projected period, the end result is basically neutral.

This research refutes the commonly held conception that migration reduces the capacity of Australians to find work. In reality, migration plays a role in addressing inequality and in generating opportunities for lower income workers.

Overall, the distributional impact of migration on existing Australian residents is a highly positive. An improved employment to population ratio drives higher consumption while migrants draw less on government service provision and contribute a net fiscal benefit via taxes paid.

UNEMPLOYMENT RATES BY SKILL LEVEL, WITH AND WITHOUT MIGRATION



LOOKING TO THE FUTURE

3

This report offers the first window into the true impact of migration on our economy. Through a detailed analysis of the effect on each of our economic indicators a story unfolds — migration is one of our greatest economic assets. It will be the unsung hero of our future prosperity.

By 2050, migration will contribute 40 per cent to GDP in a multi-trillion dollar economy, with a per capita GDP benefit of 5.9 per cent.

The past two decades have seen an overarching shift in the policy framework that governs our migration program. The program has been re-shaped to focus on attracting high skilled entrants who will help to address our ageing profile. Further, there has been a shift towards temporary migration, including international students and 457 workers. A complex two-step process now works to select migrants who will fit best with our labour market and who will fill our skills shortages.

The reforms that sit behind this shift to a skilled framework have driven a transformation in the profile and characteristics of new entrants. This has placed Australia in an advantageous situation. We are now perfectly positioned to reap the benefits over the next 35 years.

In this sense the results of this research should not come as a surprise. A migration framework built on a foundation of skills that seeks to improve economic outcomes should yield economic benefits.

However, we should also recognise that we have achieved such success within a balanced program. The strength of our skilled framework has enabled the accommodation of family and humanitarian migration while still maintaining significant overall gains. This is a testament to Australia's position as a leader in managing migration policy. No other developed society can lay claim to the success that Australia has had with mass migration.

In an increasingly uncertain global environment, policy must continue to innovate and push boundaries. New ways to attract migrants must be tested and refined. Fostering entrepreneurship, generating regional linkages and creating more effective skills transfer opportunities can all be assisted by migration. With the rise of a middle class in China and the increase of competition for skills, Australia cannot take for granted the successes of the past. Competition is only going to increase.



**IN AN
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APPENDIX ONE

SUMMARY OF MODEL RESULTS



THESE RESULTS PAINT
A COMPREHENSIVE
PICTURE OF THE
INTERDEPENDENCE
BETWEEN AUSTRALIA'S
MIGRATION
FRAMEWORK AND
OUR ECONOMIC
FORTUNES.

TABLE A SUMMARISES THE KEY TYPES OF VISA (STREAMS) THAT ARE INCLUDED UNDER EACH PROGRAM

	FAMILY	SKILLED INDEPENDENT	OTHER POINTS TESTED	OTHER SKILL VISA	HUMANITARIAN	VISITOR	457	WORKING HOLIDAY	STUDENTS	ALL STREAMS
Population	4.4%	1.7%	2.7%	0.5%	1.4%	3.2%	3.0%	2.4%	17.7%	37.0%
Employment	3.8%	2.3%	3.5%	0.5%	1.2%	3.5%	4.0%	2.9%	23.4%	45.1%
GDP	2.8%	2.1%	2.9%	0.5%	0.9%	2.9%	3.7%	2.4%	22.6%	40.7%
Consumption	2.2%	2.3%	3.2%	1.3%	0.6%	3.1%	4.3%	2.5%	25.3%	44.7%
GDP per capita – per cent	–1.7%	0.3%	0.2%	0.0%	–0.6%	–0.4%	0.7%	0.0%	7.4%	5.9%
\$ per year (at 2012–13 prices)	–\$1,790	\$360	\$188	\$31	–\$618	–\$423	\$763	\$12	\$7,629	\$6,151
% premium per migrant	–37%	21%	7%	7%	–37%	–9%	22%	2%	28%	10%
Consumption per capita – per cent	–2.4%	0.6%	0.5%	0.9%	–0.9%	–0.1%	1.5%	0.2%	12.0%	12.2%
\$ per year (at 2012–13 prices)	–\$1,361	\$324	\$266	\$505	–\$519	–\$79	\$836	\$110	\$6,896	\$6,977
% premium per migrant	–51%	34%	17%	170%	–58%	–2%	42%	7%	43%	21%
Income tax rate (% point difference)	0.6%	–0.8%	–1.0%	–0.2%	0.2%	–0.7%	–2.0%	–0.9%	–15.8%	–20.6%
Real after tax wage – average	–2.1%	0.2%	–0.2%	0.2%	–0.8%	–0.5%	0.9%	0.0%	11.9%	9.7%
high–skilled	–1.2%	–1.0%	–0.6%	0.1%	–0.3%	–0.6%	–0.7%	–0.1%	1.0%	–3.5%
mid–skilled	–2.0%	0.7%	–0.5%	0.3%	–0.8%	–0.5%	1.0%	0.0%	12.7%	11.0%
low–skilled	–3.5%	1.2%	1.0%	0.3%	–1.3%	–0.3%	2.8%	0.1%	21.7%	21.9%

APPENDIX TWO

THE INDEPENDENT MACRO MODEL

This section explains, in turn, the methodology used by Independent Economics to estimate the effects of migration on the Australian economy. Independent Economics has used a suite of linked economy-wide models to develop the estimates. This suite of models includes a demographic model and a macro-econometric model. This section provides more detail on the macro-econometric model and the extensions to the model which were specifically developed for this project. Section A.1 describes the original model and section A.2 describes the extensions.

A.1 Economy-wide modelling methodology

The Independent Macro-econometric model (Macro Model) is Independent Economics' forecasting and policy model. It uses economic principles and evidence from the historical data to capture the broad workings of the Australian economy. This makes it a powerful tool to enhance the robustness of economic forecasting whether the time horizon is short (to 2015) or long (to 2050).

Notably, the approach taken is rigorous in its application of economic theory; this means that it also delivers powerful insights into fiscal and monetary policies. For example, the six-sector Macro Model converges to a balanced growth path. In addition, a separate demographic model is used to provide population inputs and to determine long-term trends in the participation rate.

In the Macro Model, households, firms, the government and foreign agents interact in factor, product and financial markets. The role of each agent is discussed, in turn, below. This is followed by a discussion of the model's market clearing mechanisms.

A.1.1 Economic Agents

Households

Households supply labour, own capital and government bonds, purchase goods and services from businesses and pay taxes to government.

The household's inter-temporal budget constraint is imposed by assuming that households have a savings target. This savings target is defined as the locally-owned stock of produced capital expressed as a multiple of labour income and its value is estimated from historical data.

Since there is a target for the stock of capital that households hold, changes in the government's debt position do not affect the household's stock of real assets in the long run. Consumption gradually adjusts so that this savings target is gradually met.

Consumption is positively affected by income from labour, produced capital, natural resources and bonds and transfers. Conversely, consumption is negatively affected by unanticipated inflation.

Once the aggregate level of consumption is determined it is allocated across the six industries identified in the model (Agriculture, Mining, Manufacturing, Government services and Housing services). Households choose their allocation to maximise a Constant Elasticity of Substitution (CES) utility function.

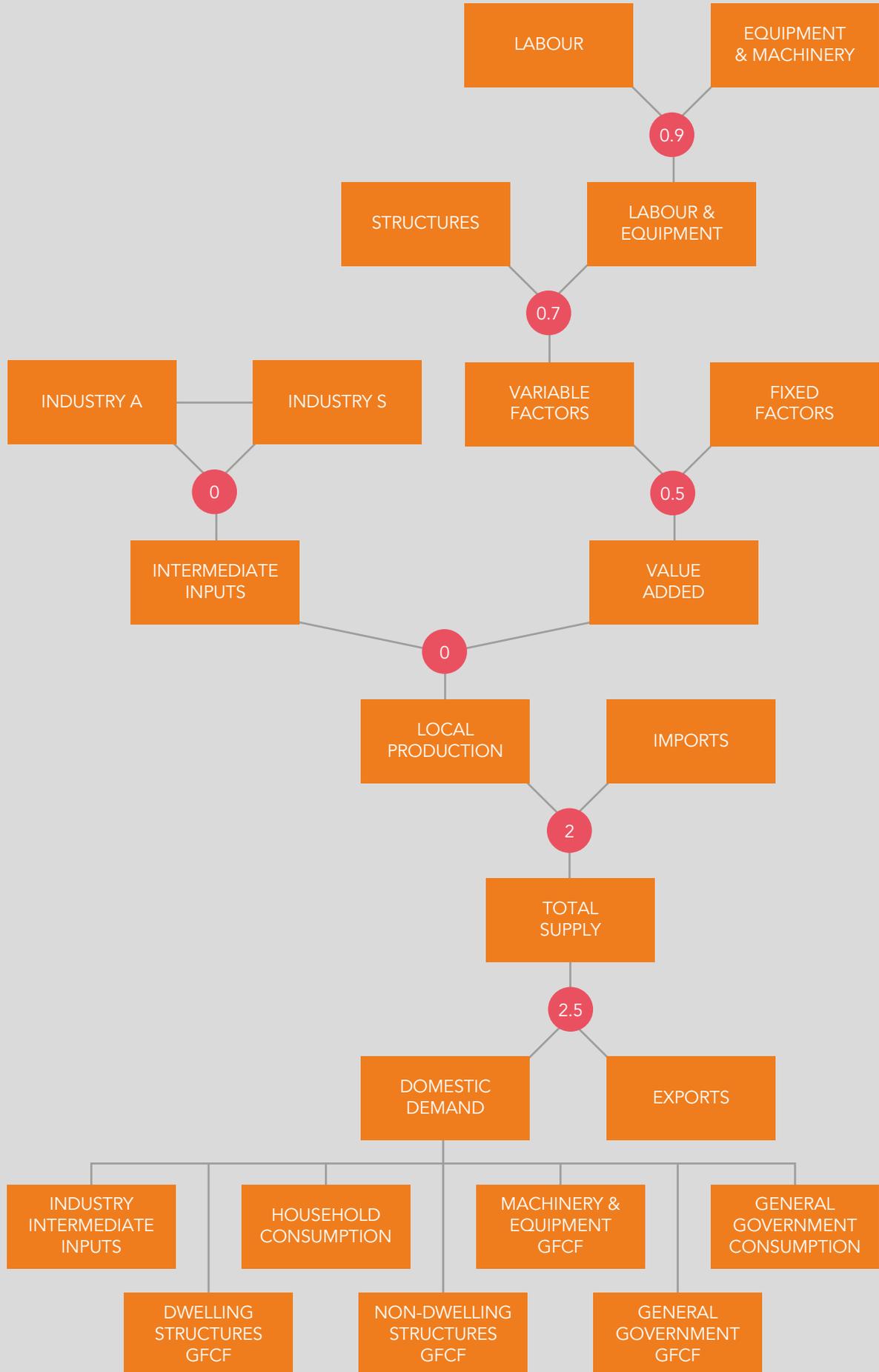
Labour supply is determined by the age, gender and education structure of the population, underlying trends in the participation rate and an encouraged worker effect.

Businesses

A representative business in each industry produces goods and services using labour, natural resources, structures, other types of capital and intermediate inputs. The six industries featured in the Independent Macro–econometric model are based on the latest Australian and New Zealand Standard Industrial Classification (ANZSIC 2006). The mapping between the model's industries and ANZSIC 2006 industries is shown in the table below.

MACRO MODEL INDUSTRY	ANZSIC2006 INDUSTRIES	ANZSIC2006 CODES
Agriculture (A)	Agriculture, forestry & fishing	A
Mining (B)	Mining	B
Manufacturing (C)	Manufacturing	C
Government services (G)	Public administration & safety	O
	Education & training	P
	Health care & social assistance	Q
Other Service Industries (S)	Electricity, gas, water & waste services	D
	Construction	E
	Wholesale trade	F
	Retail trade	G
	Accommodation and food services	H
	Transport, postal and warehousing	I
	Information media & telecommunications	J
	Financial & insurance services	K
	Rental, hiring & real estate services	L
	Professional, scientific & technical services	M
	Administrative and support services	N
	Arts and recreation services	R
	Other services	S
Housing services (T)	Ownership of Dwellings	–

THE PRODUCTION TECHNOLOGY FOR A TYPICAL INDUSTRY IN THE INDEPENDENT MACRO-ECONOMETRIC MODEL IS SHOWN IN THE FIGURE BELOW.



A representative business in each industry combines labour and non-structures capital (including machinery and equipment) into a labour and equipment bundle using a Constant Elasticity of Substitution (CES) technology with an elasticity of substitution of 0.9. Similarly, structures and the labour and equipment bundle are combined using CES technology to produce a variable factors bundle. Notably, this variable factors bundle is then combined with fixed factors to produce value added. The explicit modelling of fixed factors in production is a key feature of the Independent Macro-econometric model and is important in allowing for the role of land supply in the housing services sector and the role of mineral resources supply in the mining sector.

Local production is derived by combining value added and intermediate inputs in fixed proportions, a standard assumption in these types of models. A CES function is also used by firms to produce total supply from local production and imports. A high elasticity of substitution (2) is assumed between local production and imports. Finally, domestic businesses decide whether to sell on the domestic or export market based on a Constant Elasticity of Transformation technology, with an elasticity of transformation of 2.5.

In the short term, the quantity of output produced is determined by demand. Businesses are also constrained by the amount of capital they own. Thus, businesses choose the profit maximising level of labour, imports and exports based on a given level of domestic demand, capital, fixed factors, wages, and trade prices.

Over time, domestic prices adjust to equal marginal cost. In addition, the capital stock gradually adjusts so that the marginal product of capital is equal to its user cost. A Tobin's Q formulation is used to model capital stock adjustment. Importantly, the adjustment speed of domestic prices and the capital stock is estimated from quarterly historical data. This means that over time, the short-term constraints on firms are removed and firms simply maximise profits subject to the production technology.

Government

Governments collect taxes from households and businesses, purchase goods and services on behalf of households, invest in the economy, provide transfers to households, borrow from households, and set monetary policy.

The Independent Macro-econometric model recognises the key taxes collected by government and models their impact on behaviour. For example, the model forecasts revenue collections from the corporate income tax and recognises that corporate income tax affects the cost of capital and thus impacts investment decisions. Other taxes recognised in the Independent Macro-econometric model are labour income tax, production taxes by industry, and product taxes by end user.

Similar to households, the government's inter-temporal budget constraint is met by specifying a target deficit relative to nominal GDP. Labour income tax is the swing fiscal policy instrument and gradually adjusts to ensure that the deficit target is met in the long term.

Monetary policy in the Independent Macro-econometric model mimics how the Reserve Bank of Australia (RBA) pursues its inflation-targeting policy. Specifically, a Taylor rule is used to determine how the short-term interest rate reacts to deviations of inflation and the unemployment from their targets. The inflation target is set to 2.5 per cent, the mid-point of the RBA's target band, while the target unemployment rate is the NAIRU, which is estimated from historical data. The responsiveness of the short-term interest rates to deviations of the inflation rate and unemployment rate from their respective targets is estimated using historical data from the mid-1990s, since this is when the RBA's inflation targeting regime began in earnest.

Foreign sector

The foreign sector provides funds, demands exports and supplies imports. As a small country, Australia is assumed to be a price taker for imports. However, it is assumed that Australia has some market power in export markets. That is, an increase in the volume of exports supplied by Australia leads to a small reduction in export prices.

Since households and the government meet their budget constraints in the long term, this means that external balance is also achieved in the long term and growth in net foreign liabilities is sustainable.

A.1.2 Market clearing

There are three key types of markets in the Independent Macro–econometric model, the labour market, the goods markets and asset markets. For each, prices adjust to clear the market.

Wages are ‘sticky’ and gradually adjust to clear the labour market. An inflation–expectations augmented Phillips curve is used to model wage adjustment. In the long–run, wage growth is driven by consumer price inflation and growth in labour efficiency and the unemployment rate settles to the NAIRU.

As noted previously, in the short–term demand drives activity so that demand shocks cause business cycles. Over time, prices gradually adjust to clear the goods market. This means that, in the long term, activity is driven by supply–side factors such as the level of population, participation, productivity and the fixed factor.

In asset markets, the rate of return on capital is determined exogenously since Australia is a small, open economy. For financial assets, the rate of return on long–term bonds is based on the expectations theory of the term structure. Uncovered interest rate parity is used in determining the nominal exchange rate. The underlying assumption is that long–term domestic securities, short–term domestic securities and short–term foreign securities are perfectly substitutable.

A.1.3 Empirical aspects

Behavioural equations in the Independent Macro–econometric model are estimated econometrically from quarterly data starting, in most cases, from the early 1980s.

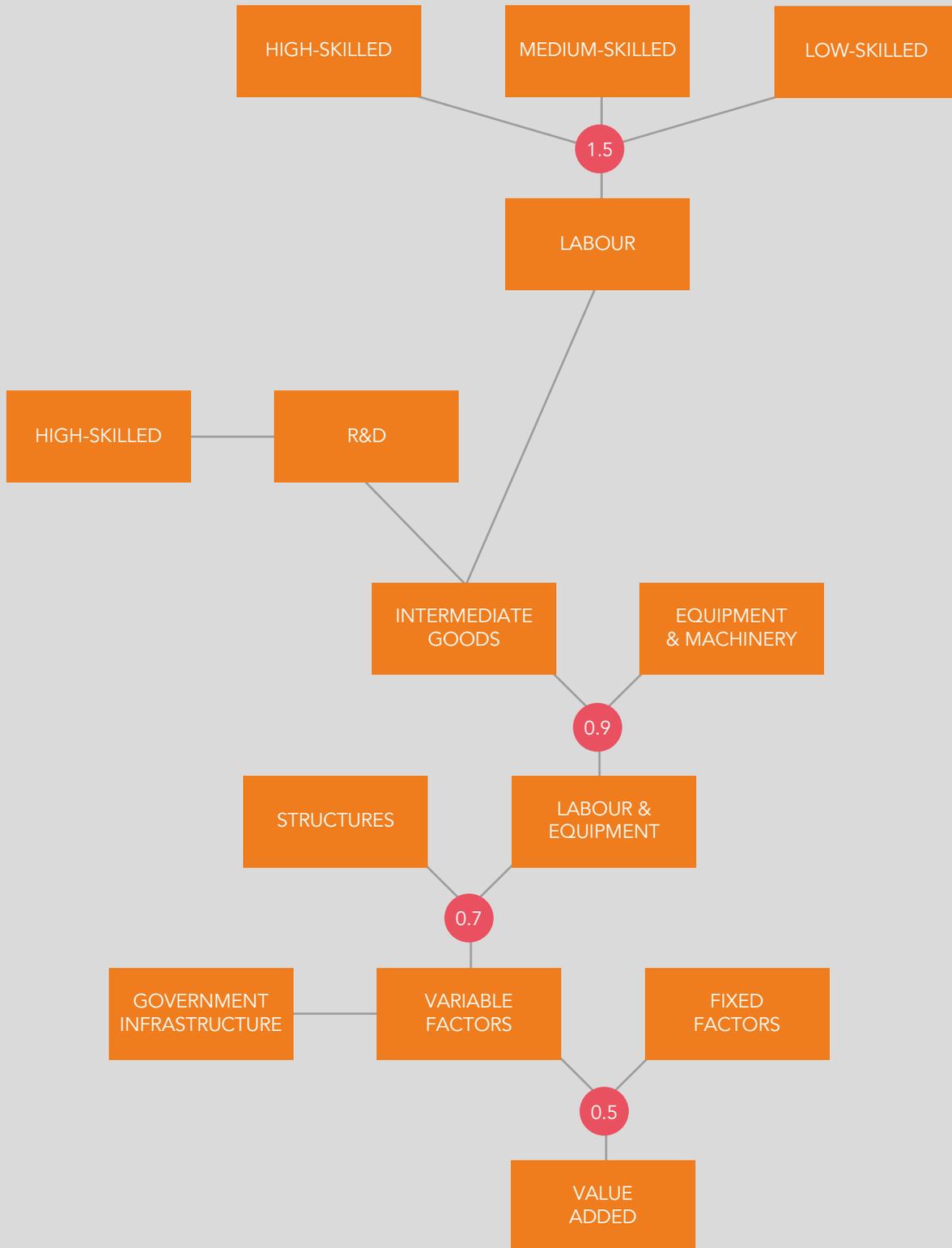
The general–to–specific approach to incorporating dynamic adjustment is used, so that dynamics are fully captured. Diagnostic tests are performed on each estimated equation to check for model adequacy and statistical fit. This high level of data consistency means that the model is not only suitable for policy analysis, but also for forecasting.

A.2 Extensions to the Macro Model

Extending the Macro Model to incorporate semi–endogenous growth involves two separate elements of development work. The first is to explicitly model the link between government education funding and the education attainment of the population. The links between greater education attainment and more favourable labour market outcomes are also incorporated into the model. The second is to extend the firm’s production technology to capture the effects of R&D investment on productivity growth.

In addition, the model is extended to capture economies of scale from government investment in public infrastructure. Currently the production technology in the model exhibits diseconomies of scale due to the presence of fixed factors in each industry. Introducing economies of scale would allow the model to provide more robust estimates of the effects of policies, such as migration policies, which change the size of the Australian economy.

The extensions to the model are discussed in the following subsections. The diagram below summarises the structure of the extended Macro Model.



A.2.1 Human Capital Accumulation

An education attainment module is used to estimate the effects on changes in government funding on the education attainment of the population by gender by age. Ten age groups and three education attainment levels are separately identified in the module.

These education attainment groups are based on an aggregation of the Australian Bureau of Statistics (ABS) Australian Standard Classification of Education. The aggregation used in the module is shown in the table below.

TABLE A.1.1: EDUCATION ATTAINMENTS SPECIFIED IN THE MODULE

ABS EDUCATION ATTAINMENT	MODULE EDUCATION ATTAINMENT
POSTGRADUATE DEGREE	
GRADUATE DIPLOMA/GRADUATE CERTIFICATE	Higher Education
BACHELOR DEGREE	
ADVANCED DIPLOMA/DIPLOMA	Vocational Education and Training
CERTIFICATE III/IV	
CERTIFICATE I/II	
CERTIFICATE N.F.D	School
WITHOUT NON-SCHOOL QUALIFICATION	

Several assumptions have been made to simplify the analysis of human capital accumulation. The main assumption is that there is excess demand for education, so that an increase in education funding by government always results in a boost to the number of students.

Higher education attainment leads to more favourable labour market outcomes since more educated individuals have: higher participation rates, lower unemployment rates, have greater productivity and work higher hours on average (e.g. more likely to be employed full time). The first three effects are allowed for in the extended Macro Model through the addition of heterogeneous labour. A boost to the number of university educated individuals lead to an increase in the number of high-skilled labour. In the Macro Model high skilled labour have higher participation rates, a lower sustainable rate of unemployment and are more productive than their counterparts.

The standard version of the Macro Model has a single type of labour, while the extended Macro Model features three types of labour, high-skilled, medium-skilled and low-skilled labour. The labour types are based on an aggregation of the ABS occupation classification (ANZSCO), as shown in the table to the right.

TABLE 4.2: OCCUPATIONS IDENTIFIED IN THE MACRO MODEL

ABS OCCUPATIONS	MACRO MODEL LABOUR TYPE
MANAGERS	High-skilled
PROFESSIONALS	
TECHNICIANS AND TRADE WORKERS	
COMMUNITY AND PERSONAL SERVICE WORKERS	Medium-skilled
CLERICAL AND ADMINISTRATIVE WORKERS	
SALES WORKERS	Low-skilled
MACHINERY OPERATORS	
LABOURERS	

As noted earlier, a boost in the education attainment of the population leads to a lift in the supply of high-skilled workers. The channels through which this occurs are now discussed.

The projection of population by education attainment is converted into a projection of labour force by education attainment by modelling the participation rate for each education attainment level using an error correction model.

The labour force by education attainment projection is then converted to a labour force by occupation measure using a matrix of occupation proportions for each education attainment. This assumes that the relationship between education and occupations is fixed.

Other approaches allow for some flexibility in the mapping between education and occupations. However, for simplicity that approach is not pursued here.

The matrix used to complete this conversion is shown below. Notably, the majority of university qualified individuals go on to high-skilled jobs. While the majority of VET-qualified individuals go on to medium-skilled jobs, a substantial proportion also fills low-skilled jobs.

TABLE 4.3: EMPLOYMENT BY EDUCATION BY OCCUPATION MATRIX

	HIGHER EDUCATION	VOCATIONAL EDUCATION	SCHOOL
High-skilled	72.6%	24.1%	17.3%
Medium-skilled	20.1%	56.2%	38.9%
Low-skilled	7.3%	19.8%	43.7%
TOTAL	100%	100%	100%

Source: ABS Cat. No. 6227.0

On the demand side, firms demand each of the three types of workers and combine them into a labour bundle using CES production technology. Thus, the three types of workers are not perfectly substitutable for one another, even after allowing for productivity differences between them.

In the short term, demand for a particular type of labour or occupation depends on that occupation's relative wage and the pattern of industry demand. For example, high-skilled workers are an important input into the Government Services industry, making up approximately 50% of all employment in this industry. A boost in government spending would increase the size of the Government Services industry and hence demand for high-skilled workers. Over time, wages adjust to clear the labour market and the level of employment in each occupation is driven by supply-side factors such as the pattern of education attainment of the labour force. The wage adjustment for each type of labour is modelled as an augmented Phillips curve, while the adjustment from actual to equilibrium labour demand is modelled as an error correction model.

A.2.2 Research & Development

To introduce endogenous growth from R&D into the Macro Model, we broadly follow the semi-endogenous growth approach used by Varga & Veld (2011). This involves extending the model to include a monopolistically competitive "intermediate goods" sector and a R&D sector, which then interact with the labour and machinery & equipment "nest" of the standard Macro Model. The new sectors are discussed in this subsection.

Extended labour and machinery and equipment nest

The labour and machinery & equipment nest now becomes an intermediate goods and machinery & equipment nest. There is a spectrum of differentiated intermediate goods, which are not perfectly substitutable. The number of intermediate goods is determined by the number of patents produced by the R&D sector.

FIRMS IN THIS NEST SOLVE THE FOLLOWING PROBLEM

$$\max_{x_j, KO_i} P_{NK O_i} \cdot NK O_i - \int_0^{AN_i} P_{x_j} x_j dj - P_{KO_i} \cdot KO_i$$

subject to the CES production technology

$$NK O_i = \left[\left(\int_0^{AN_i} x_j^{ai} dj \right)^{\frac{1}{ai}} + (AK O_i \cdot KO_i)^{\frac{\sigma_{NK O_i} - 1}{\sigma_{NK O_i}}} \right]^{\frac{\sigma_{NK O_i}}{\sigma_{NK O_i} - 1}}$$

A representative firm in this industry chooses the amount of each x_j to use to maximise profit. This gives the following first order condition, which gives demand for intermediate good x_j .

$$P_{x_j} = P_{NK O_i} \cdot NK O_i^{\frac{1}{\sigma_{NK O_i}}} \cdot \left(\int_0^{AN_i} x_j^{ai} dj \right)^{\left(\frac{1}{ai} \cdot \frac{\sigma_{NK O_i} - 1}{\sigma_{NK O_i}} \right) - 1} \cdot x_j^{ai - 1}$$

Where:

P_{x_j} is the price of the intermediate good x_j

$NK O_i$ is the labour and machinery and equipment bundle in industry i

x_j is intermediate good of type j

AN_i the number of patents in industry i

$\sigma_{NK O_i}$ is the elasticity of substitution between intermediate goods and machinery and equipment

$\frac{1}{(1-ai)}$ is the elasticity of substitution between different types of intermediate goods

However, in a symmetric equilibrium $x_j = x \forall j$. Hence, the first order condition can be simplified as follows and gives the demand for each x .

$$P_x = x^{\frac{-1}{\sigma_{NK0i}}} \cdot P_{NK0i} \cdot NK0i^{\frac{1}{\sigma_{NK0i}}} \cdot ANi^{\frac{\sigma_{NK0i}(1-\alpha)-1}{\alpha\sigma_{NK0i}}}$$

If α is set to one then the intermediate goods are perfectly substitutable and we would return to the original setup for the machinery and equipment nest.

Intermediate goods sector

A spectrum of intermediate goods firms purchase a patent from the R&D sector and then use a unit of the labour bundle to produce a unit of the intermediate good.

Since these firms produce a differentiated product that are not perfect substitutes, rents are able to be extracted when they sell the intermediate good to firms in the machinery and equipment nest.

THAT IS, THE FIRMS SOLVE THE FOLLOWING PROBLEM

$$\max_x P_x x - WSRi \cdot l - P_{Ai}$$

subject to

$$x = l$$

Intermediate goods firms are constrained by a production technology where a unit of the labour bundle is used to produce a unit of the intermediate good.

The first order condition of the intermediate goods firm reduces to the familiar mark-up over marginal cost condition.

$$P_x = \frac{WSRi}{\alpha}$$

Free entry into the intermediate goods industry drives profits to zero. This implies that the price of a patent is the discounted present value of the monopolistic producers flow profit:

$$P_{Ai} = \frac{\frac{(1-\alpha)}{\alpha} \cdot WSRi \cdot x}{r}$$

Finally, given our aggregate labour bundle $NSRi$ and the symmetry of the intermediate goods firms, we have:

$$\int_0^{ANi} x_j dj = NSRi \quad x = \frac{NSRi}{ANi}$$

Research & Development sector

This sector uses high-skilled labour to produce patents that are then used by the intermediate goods sector.

R&D FIRMS SOLVE THE FOLLOWING PROFIT MAXIMISATION PROBLEM

$$\max_x P_{Ai} \Delta ANi - WH \cdot NSRiHR$$

subject to the production technology below

$$\Delta ANi = [\tau A_i^{*\omega} AN_{t-1}^{\phi} NSRiHR_t^{\gamma-1}] NSRiHR_t$$

Where:

ANi is the domestic stock of knowledge and this stock varies by industry;

Ai^* is the international stock of knowledge and this stock varies by industry;

$NSRiHR$ is the number of high-skilled workers employed in R&D (researchers) sector of industry i ;

ω and ϕ reflect the strength of the spill over effects from international and domestic knowledge, respectively;

τ represents total factor efficiency; and

γ is the elasticity of production to the number of researchers.

The first order condition for the R&D firm gives the demand for high skilled labour in the R&D sector.

Note that each R&D firm takes the term in square brackets as given; this follows Jones (1995) and implies that there is some duplication in research.

$$WH = P_{Ai} [\tau A_i^{*\omega} AN_{t-1}^{\phi} NSRiHR_t^{\gamma-1}]$$

Rewriting the production technology as:

$$\frac{\Delta ANi}{ANi} = \tau A_i^{*\omega} AN_{t-1}^{\phi-1} NSRiHR_t^{\gamma}$$

taking derivatives with respect to time implies that balanced growth is given by:

$$g_{Ai} = \frac{\omega g_{Ai^*} + \gamma g_N}{1-\phi}$$

In the short to medium term, the profit maximising decisions of firms determine the pace of technological progress. However, in the long term, the pace of growth is determined by growth in the labour supply and growth in the stock of knowledge in the rest of the world, both of which are taken to be exogenous.

This setup is similar to that used by other large scale models to introduce endogenous growth. The Macro Model's approach differs in the following respects. Firstly, other models generally have a single aggregated industry and hence a single R&D sector. In contrast, the Macro Model has five industries which utilise labour and each has its own R&D sector. It is assumed that there are no spillovers across industries.

Secondly, the production technology in the Macro Model uses a detailed nested CES structure, while other models use a Cobb–Douglas technology. Balanced growth in a model using the CES production technology requires that innovations are labour augmenting (i.e. Harrod–neutral technical progress). As noted by Klump (2007), in the long–run, only capital can be accumulated and so the size of the labour force constrains the size of the economy. To prevent the labour share of income from exploding, innovations need to be labour augmenting. In the Macro Model the intermediate goods sector uses the labour bundle to produce goods. Models which use Cobb–Douglas technology can have the intermediate goods sector use capital in production.

A.2.3 Government Investment in infrastructure

The standard version of the Macro Model treats the effects of a rise in general government consumption and general government investment in broadly the same manner. That is, general government investment does not result in an increase in the capital stock of the economy.

This assumption is relaxed in the extended macro model. Government investment in infrastructure such as transport and communications is capitalised and is incorporated into each firm's production function.⁴ In addition, economies of scale in government infrastructure are allowed for by incorporating the presence of fixed costs.

THE NEW PRODUCTION TECHNOLOGY IS GIVEN BY

$$V ASR_i = [(AV AR_i \cdot [KGGR - \overline{KGGR}]^\theta \cdot V AR_i)^{\frac{\sigma V_{Ai}-1}{\sigma V_{Ai}}} + (AF_i \cdot F_i)^{\frac{\sigma V_{Ai}-1}{\sigma V_{Ai}-1}}]^{\frac{\sigma V_{Ai}}{\sigma V_{Ai}-1}}$$

Where:

$V ASR_i$ is the value added bundle in industry i ;

$V AR_i$ is the variable factors bundle in industry i ;

F_i is the fixed factor in industry i ;

$AV AR_i$ is the scale factor for variable factors;

AF_i is the scale factor for fixed factors;

$KGGR$ is the economy-wide stock of general government infrastructure;

\overline{KGGR} is the threshold level of general government infrastructure;

θ is the elasticity of value added to public infrastructure; and

σV_{Ai} is the elasticity of substitution between variable and fixed factors.

Government infrastructure is introduced in this nesting because it has similar production characteristics to structures and structures forms part of the variable factors bundle.

Notably, the chosen production technology means that there are still constant returns to scale in the private factors; a relatively strong assumption.

This implementation was chosen because it is one of the more straightforward methods of incorporating the presence of fixed costs and follows the approach used by Ratto et.al. (2008) to allow for overhead labour costs.

⁴ Other types of network infrastructure such as utilities are already capitalised within the model. They are part of the capital stock of the Other Services industry.

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THIS REPORT WAS PREPARED FOR
MIGRATION COUNCIL AUSTRALIA

