Australian Demographic and Social Research Institute

The Effects of Future Immigration Scenarios on GDP and GDP Per Capita in Australia

Peter McDonald and Jeromey Temple

BACKGROUND

Australia's labour force grew at close to two per cent per annum between 1980 and 2000. This rapid growth was due to full entry to the labour force of the baby boom generation, increased participation of women and overseas migration. Rapid growth occurred in the 20-year period to 2000 despite a counter trend for male labour force participation rates to fall especially at older ages. In future years, the baby boom generation will begin to pass out of the labour force. The increase in women's participation is likely to continue but, as this participation is already relatively high, the scope for future major increases from this source is limited. Furthermore, in the past decade age-specific labour force participation rates have risen sharply at older ages, thus reducing the scope for future rises in participation to accommodate rising labour demand. Today, the Australian labour force is growing at about 1.2 per cent per annum and this rate is falling. Preliminary modeling has shown that current labour supply growth would be close to zero without international migration.

In the light of the strong demand for labour in Australia in the past twelve months, and historically low rates of unemployment, concerns have arisen about the capacity for Australia's labour demand to be met from domestic sources alone. Accordingly, the Department of Immigration and Citizenship has determined a need to undertake research into the interrelationship between Australia's projected population directions and its long-term future labour supply, with particular emphasis on the role of migration.

In this context, at the time of its May 2008 Budget, the Federal Government announced that a working party led by the Minister for Immigration and Citizenship, Senator Evans and the Deputy Prime Minister, Julia Gillard, and including the Treasurer and Minister for Trade, will develop a longer-term reform package which will be considered as part of the 2009-10 Budget (Evans 2008).

This direction is supported in a policy discussion paper for the Academy of Social Sciences in Australia that recommended:

> The Federal Government should provide a long-term skill requirements plan for Australia, based on high quality demographic-economic modelling and industry and state / territory government assessments of emerging needs for industries, skills and regions. This plan should provide the envelope and aspirational targeting for the Government's education and training policies, but do so on a regular annual update basis (McDonald and Withers: 2008: 5.).

The present discussion paper represents an early step in this direction. It undertakes projections and analysis of the potential role of immigration in meeting future labour force needs to inform government consideration of future settings of Australia's temporary and permanent migration programs.

THE LABOUR DEMAND CONTEXT

This report does not attempt to estimate future labour demand however some comments on the likely labour demand context are warranted. There are seven important indications of future labour demand:

1. We can expect major future investment in new physical infrastructure. Physical infrastructure in Australia has deteriorated over the past 30 years and is now a threat to future economic productivity. Inadequate infrastructure also represents a major obstacle to meeting climate change objectives and the inevitable transformation of energy sources. There is an urgent need for upgrading or increasing water supplies, transport facilities, ports, energy supply, housing and office space, and state-of-the-art communications. This infrastructure bottleneck has already been identified in broad terms and the Commonwealth Government through the creation of Infrastructure Australia is addressing the priority areas for investment. State and Territory Governments are also moving in the same direction. Capital is being identified for these developments but labour is an equally important component.

2. The mining boom can be expected to continue for many years. Long-term contracts are already in place. The mining boom, directly and indirectly, has been a major driver of increased labour demand and we can expect this situation to continue.
3. The new directions of the economy and the ways in which we live our lives especially as a result of the carbon pollution reduction scheme will require substantial new investment in education and training.
4. The ageing of the population will generate new demands for labour. The most obvious additional demand will be for workers in the health and caring sectors, but, in the more immediate future, the newly retired will be demanding of a wide range of service workers as they spend their pension accumulations.
5. Beyond demand generated by the ageing of the population, there is likely to be increased investment in health services delivery. Polls indicate that there is a broad sense that health service delivery is below the standard expected by the community.
6. The Treasury's Intergenerational Reports (and this study as well) estimate that Australian living standards (GDP per capita) will double in the next 40 years. The beneficiaries will be seeking ways to enjoy this outcome through increased expenditure on goods and services. . Increased demand for service workers is an implication.
7. Beyond the impacts on education and training, radical changes in the way we live our lives in the context of climate change will generate new occupations and industries, many of which are difficult to imagine at present. In particular, the reduction of carbon emissions and the reversal of environmental degradation will be demanding of labour as well as capital and technology.

In addition, if these labour demands are met to a large extent by immigration, Australia's population is likely to grow much more rapidly than has been projected in the past. Population growth has a multiplier effect upon the demand for labour. The additional population must be fed, clothed, housed and generally serviced.

Downturns in the business cycle can modify these upbeat views of Australia's future labour demand, but, if a long-term perspective is taken, chronic long-term under-supply of labour is a larger threat than a possibility of moderate, short-term over-supply. Also, Australia needs to be very cautious about expanding its population at a rate that is beyond the capacity of housing, infrastructure and the environment to absorb population growth. Supply of labour from overseas must also be done in careful consort with planning for domestic education and training:

> Immigration should not continue to be expanded unless the public can be reassured that all best-practice efforts are being adopted to ensure that all local residents seeking work, education or training will not be disadvantaged by a focus on new overseas workers as a solution to shortage of workers (McDonald and Withers 2008; 4).

These views about future labour demand are not expressed in quantified terms because, at present, we do not have reliable ways of estimating long-term labour demand. Any estimate of long-term labour demand will have a wide range of variability, however, for many occupations, including service occupations broadly-defined, long-term estimates are possible and would provide a better planning perspective than no estimates. This issue is discussed later in the paper.

However, it is instructive also to consider short-term labour demand. A recent Treasury Working Paper (McKissack et al. 2008) has concluded that labour demand in the resource-rich States of Queensland and Western Australia over the next three years could only be met through increased population growth as participation is already at a long-term high and unemployment at a long term low. The increase in population from migration required to meet labour demand assuming constant employment to population ratios would be 35,000 per annum for Western Australia and 91,000 per annum for Queensland. Present annual population growth from internal and international migration for these States is 28,000 for Western Australia and 62,000 for Queensland. In 1993, the Industry Commission concluded that in Australia interstate migration plays a relatively

minor role in adjustments to state-specific shocks to the labour market. The recent history of adjustment to increased labour demand in the resource-rich states suggest that this is still the case (McKissack et al. 2008). McKissack et al. conclude that 'in the short term, competition for existing labour supply could lead to significant wage pressures which could spill over into broader inflationary pressures'. Increased wage pressure is already evident in these states. Thus, the demand for additional workers is likely to be met from even higher levels of international migration to these states for which current levels of international migration are already at historic highs.

In another recent study, Richardson and Teese (2008) have estimated that the Australian economy would require a net addition of 500,000 vocationally educated (VET) workers by 2020 over a period where exits from the labour force of persons with these skills will be well in excess of entrants. Again, the likelihood of continued high demand for labour is confirmed over a long period of time.

CHANGES IN LABOUR FORCE PARTICIPATION

A potential source of future labour supply is increases in labour force participation rates. Tables 1 and 2 show the changes in age-specific labour force participation rates in Australia for a selection of years from 1980 to 2008. For comparative purposes, the rates for New Zealand in 2005 are also shown.

For Australian males in the prime working ages, 25-54 years, the most recent participation rates are lower than those that applied in 1980 but a little higher than the rates in 2005. The strong labour demand since 2005 probably explains the recent trend but, given the level of expenditure on welfare to work programs and the high level of labour demand in the past decade, it is instructive that male labour force participation rates in the prime working ages have not changed much in the past decade. Accordingly, it is very doubtful that participation for men in these ages will rise again in the near future to the levels of 1980. At the older ages, 55 years and over, participation rates have risen substantially since 2000 and are continuing to rise. It is notable that participation in 2008

in the 55-59 year old age group remained below the Australian 1980 level but at ages 60-64 and 65 and over, participation in 2008 is well above participation in 1980. Nevertheless, at these older ages, Australian males are much less likely to be in the labour force than their New Zealand counterparts, so there would seem to be scope for further increases.

Recent taxation policy changes related to the transition to retirement are very likely to increase male participation in the 55-59 year-old age group. Furthermore, there are a range of reasons not related to policy that older males will increase their participation. Future jobs will be less likely to be physically demanding. The next generation of 55 year-olds started work later than their older peers, so, if they work the same years, they will also end later. More people will be self-employed or have a higher degree of autonomy in their work. The next generation will be healthier and more aware of the long years that remain in their lives. The coming 55-64 year age group will have had their children at later ages and their children will stay financially dependent for more years. Simultaneously, they may have financial responsibilities for their own parents. Being the baby-boom generation, they have expectations of higher living standards in retirement than their parents had. The Aged Pension alone will not be enough. And their years living on retirement income will be longer. In the 1990s, labour force participation at ages 55-64 was low because many of those who had been spewed out of manufacturing industry in the 1980s had never been able to return to work. This generation is passing on to older ages. Because of cohort changes in women's participation, the wives of 55-64 year-old men will be more likely to be working in the future: wives will not be less likely to be encouraging their husbands out of the labour force. And, maybe, the next generations of 55-64 year olds will have lives that are more 'work-defined' and they may like their jobs more that previous generations did.

In contrast to men, labour force participation rates for women in the prime working ages in Australia have risen substantially since 1980 and these rates are continuing to rise in the recent past. At ages 55 and over, participation for women has risen very strongly across time and, notably, there are large rises from 2005 to 2008. As is the case for men,

however, the participation rates of Australian women at these ages remain well below those of their New Zealand counterparts and so the scope for continued rapid increase is clear. The Productivity Commission has projected that, by 2030, female participation rates in these older ages in Australia will rise to levels around those evident for New Zealand in 2005 (Productivity Commission 2005). The trends in Table 2 suggest that this result will be achieved much earlier than 2030.

Table 1. Labour Force Participation Rates, Males by Age Group, Australia 1980-2008 (a) and New Zealand 2005

Year	15-19	20-24	25-34	35-44	45-54	55-59	60-64	65+
1980	63.8	91.1	95.8	95.8	91.5	82.4	51.8	11.3
1995	56.3	87.8	93.3	92.1	89.2	74.5	45.1	10.3
2000	59.3	87.5	93.2	91.7	87.0	71.6	46.5	10.1
2005	57.4	85.1	90.8	91.2	87.9	76.2	54.8	12.2
2008 (May)	58.0	84.5	92.4	91.7	88.6	77.1	58.0	13.9
New Zealand 2005	53.7	79.3	91.3	92.9	91.3	86.0	70.1	15.7

(a) Data relate to the month of July except, as indicated, for 2008

Table 2. Labour Force Participation Rates, Females by Age Group, Australia 1980-2008 (a) and New Zealand 2005

Year	15-19	20-24	25-34	35-44	45-54	55-59	60-64	65+
1980	60.0	71.3	53.2	58.5	48.5	29.0	15.0	3.2
1995	57.6	77.7	68.2	71.8	68.9	40.7	15.3	2.9
2000	58.9	77.9	70.8	71.5	71.3	48.0	21.7	2.9
2005	61.6	76.6	72.7	73.2	75.7	55.8	30.6	4.4
2008 May	59.6	79.0	74.0	74.8	77.6	60.4	38.0	5.2
New Zealand 2005	52.5	65.8	70.0	75.8	80.5	71.7	46.6	8.0

(b) Data relate to the month of July except, as indicated, for 2008

OBJECTIVES OF THE REPORT

This report undertakes modeling to test the relationship between immigration on one hand and demographic, labour force and economic growth on the other hand. The detailed description of the modeling procedure is provided in Appendix 1. This appendix also describes the limitations of the results.

Model inputs

The model has the following 10 inputs:

1. A base population by sex and age in single years. The 30 June 2007 Estimated Resident Population of Australia is used in all scenarios.
2. The Total Fertility Rate (TFR) and associated age specific probabilities of birth (single years of age). TFR varies according to the particular scenario.
3. Expectations of Life at Birth for men and women and the associated age and sex specific probabilities of death (single years of age). For men, expectation of life is assumed to increase monotonically from 77 years in 2007 to 87 in 2052. For women, the assumed increase is from 83 years to 91 years. This single pathway is used in all scenarios.
4. The numbers of permanent and long-term arrivals and departures to Australia and their associated age and sex distributions (single years of age). Scenarios make use of varying assumptions about net overseas migration (NOM), the excess of arrivals over departures. NOM varies according to the particular scenario. In addition, levels of NOM are calculated that would yield targeted constant annual growth rates of the labour force under given assumptions about other input parameters.
5. Age and sex specific labour force participation rates in five-year age groups from 15-19 to 65-69 and age group 70 and over. Three varying labour force participation assumptions are included in the scenarios.

6. Age and sex specific rates of unemployment (same age groups as 5). A single assumption is used for all scenarios, set at 80 per cent of the levels used in the 2005 Productivity Commission report, *Economic Implications of an Ageing Australia*.[1]
7. Part-time work shares for each age and sex category (same age groups as 5). A single assumption is used (see footnote 1).
8. Average weekly hours worked by full-time workers by age and sex (same age groups as 5). A single assumption is used (see footnote 1)
9. Average weekly hours worked by part-time workers by age and sex (same age groups as 5). A single assumption is used (see footnote 1).
10. Aggregate annual productivity growth. Four assumptions are used. The age and sex productivity profile is assumed to be flat, that is, all age and sex groups of workers are assumed to be equally productive. Importantly also, migrants and the domestic population are assumed to have the same productivity.[2]

Model Outputs

The outputs from the models that are discussed in this report are divided into three types:

1. Population outcomes including future population size, population rates of growth and the percentage of the population aged 65 years and over.
2. Labour force outcomes including the future size of the labour force, the growth rate of the labour force, the labour market entry-exit ratio (defined as the number

[1] The 80 per cent level was temporarily assumed as the appropriate 'medium' level in the development (gamma version) of the MoDEM2 model for unemployment rates, part-time work shares, average full-time weekly work hours and average weekly part-time work hours. The Productivity Commission was still in the process of updating these assumptions in the MoDEM model at the time that the scenarios in this report were made. The 'medium' assumptions in the final version of MoDEM may be different to the ones uses in the development version. As the concern in this report is with the relative outcomes of the various scenarios rather than with their absolute outcomes, the results are not likely to be sensitive to a change to a new 'medium' level assumption. We have confirmed this conclusion by running two of the scenarios using assumptions in the Economics of Ageing report.

[2] In future modeling, assumptions about equal productivity of age groups and immigrants and the domestic population could be investigated and varied.

of persons aged 15-24 divided by the number of persons aged 55-64), and the proportion of the labour force aged 55 years and over.

3. GDP per capita and growth of GDP per capita.

DESCRIPTION OF APPLICATIONS OF THE MODEL

Application 1

The first application examines the impacts of variations in NOM. The impacts of eleven different future levels of NOM are considered (in thousands per annum: 0, 100, 180, 190, 200, 210, 220, 230, 240, 250 and 260). NOM is assumed to move to each of these levels immediately. Fertility is assumed to remain constant at its current level. For the labour supply outputs, three varying assumptions are made in relation to future age and sex specific labour force participation rates. These three assumptions are set out in the description below of Application 3. For the economic growth outputs, only one assumption is made about future labour force participation rates: that they remain at April 2008 levels.

In a variation of Application 1, five targets for annual labour force growth are set (zero, 0.5 per cent, 1.0 per cent, 1.25 per cent and 1.5 per cent) and the levels of NOM that would be required to meet these targets are calculated. As it is not possible to move quickly to the target rates of labour force growth because of the pre-existing structural drivers, the targets are reached over a period of 20 years. In these calculations, fertility is held constant at the current level but each of the three assumptions about future labour force participation are considered.

Application 2

In order to compare the impacts of changes in immigration with changes in fertility, the second application examines the impacts of eleven varying levels of future fertility (TFR equal to 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9 2.0 and 2.1). TFR is assumed to move to

these levels over a period of 15 years. In relation to the economic growth outputs, for the scenario in which TFR moves to 2.1, the time frame over which this change takes place is also varied to indicate the effects of varying transition times.

Application 3

For the four varying inputs, the following alternative assumptions are utilised in the creation of 18 alternative scenarios that are combinations of the varying inputs. These alternative scenarios are set out in Table 3. In the analysis of outcomes for GDP growth, these same 18 scenarios are repeated for each of the four assumed levels of productivity.

Alternative fertility assumptions

Current: TFR is constant at 1.814.

Low: TFR falls to 1.3 over 15 years and remains at that level thereafter.

High: TFR rises to 2.1 (replacement level) over 5 years and remains at that level thereafter.

Alternative net migration assumptions

Current: NOM is constant at 185,000.

Long-Term: NOM falls to 100,000 over ten years, its historical average level since 1950, and remains at that level thereafter.

High: NOM rises immediately to 230,000 and remains at that level thereafter.

1% LS: NOM adjusts to ensure a constant one per cent annual labour supply growth after a period of 20 years.

Alternative labour force participation assumptions

Current: Age and sex specific labour force participation rates applying in April 2008 are assumed to remain constant.

Maximum: Age specific rates for males aged 25-59 return to 1980 levels and rates for those aged 55 and over are increased. Rates for females are set at those for Sweden in 1995. The transition to the maximum levels takes place between 2007 and 2030. Beyond 2030, rates remain constant at the maximum level.

Average: Arithmetic average of the current and maximum assumptions.

Alternative productivity growth assumptions

Four assumptions are used: 2.00%, 1.75%, 1.50% and 1.25%. Each level is assumed to apply unchanged across the years of the projection.

Table 3: Alternative scenarios

Scenario	Participation Assumption	TFR Assumption	NOM Assumption
1	Current	Current	Current
2	Current	Low	Current
3	Current	High	Current
4	Current	Current	Long-Term
5	Current	Current	High
6	Current	Current	1% LS Growth
7	Maximum	Current	Current
8	Maximum	Low	Current
9	Maximum	High	Current
10	Maximum	Current	Long-Term
11	Maximum	Current	High
12	Maximum	Current	1% LS Growth
13	Average	Current	Current
14	Average	Low	Current
15	Average	High	Current
16	Average	Current	Long-Term
17	Average	Current	High
18	Average	Current	1% LS Growth

RESULTS

Application 1: Population outcomes

In this application, NOM is varied over a wide range while TFR is kept constant at its current level of 1.81. The resulting population sizes for Australia are shown in Table 4. As expected, varying levels of NOM make a huge difference to the population of Australia in 2047. With zero migration, the population size would essentially stabilize just below 23 million by 2027 and remain at that level to 2047. With the highest level of NOM, 260,000 per annum, the population would rise to 29 million by 2027 and to 36.5 million by 2047. If the current level of NOM were to be maintained, the population would rise to around 33 million by 2047.

Table 4. Population of Australia in 2027 and 2047 with varying levels of net overseas migration.

Level of NOM ('000s per annum)	Population (millions)	
	2027	2047
0	22.7	22.9
100	25.1	28.2
180	27.0	32.4
190	27.2	32.9
200	27.4	33.4
210	27.7	33.9
220	27.9	34.5
230	28.2	35.0
240	28.4	35.5
250	28.6	36.0
260	28.9	36.5

Application 1: Labour force outcomes

For this analysis, the three different levels of future labour force participation were examined in association with the varying levels of NOM. The comparisons in Table 5 indicate that, in comparison with variations in NOM, potential variations in labour force participation rates have only a small impact on the future size of the labour force.

Table 5. Size of the labour force in 2047 under varying assumptions of migration and labour force participation.

Net Migration ('000s per annum	Size of the Labour Force (millions) in 2047		
	Current Participation	Maximum Participation	Average Participation
0	10.2	11.1	10.7
190	15.5	16.9	16.2
260	17.5	19.1	18.3

Tables 6 shows the various labour market outcomes for varying levels of NOM assuming that the Average levels of labour force participation will apply in the future. The future size of the labour force is evidently very sensitive to changes in the level of NOM. With zero migration, the labour force would fall in size by 2047. With NOM of 180,000, the labour force would increase by 1.17 per cent per annum from 2007 to 2027, that is, the rate of growth would be the same as it is now and the labour force would grow by 2.5 million workers. Note, however, that even with enhanced levels of participation (the Average level) and with NOM at 180,000 per annum, the growth rate of the labour force would be considerably lower in the second 20-year period, 2027-2047. There is a message here that, in the longer term, barring a rise in fertility or immigration above their present levels, Australia will have to accommodate lower rates of labour force growth. However, there is a window of opportunity in the next 20 years to prepare for that situation.

Table 6. Labour force outcomes for varying levels of migration (assumes Average labour force participation rates and constant TFR)

NOM (000s)	Labour Force (millions)		Annual Average Labour Force Growth Rate %	
	2007 = 11.0		2007 = 1.18	
	2027	2047	2007-27	2027-47
0	11.4	10.7	0.17	-0.32
100	12.8	13.6	0.76	0.30
180	13.9	15.9	1.17	0.67
220	14.5	17.1	1.38	0.82
260	15.1	18.3	1.58	0.96

Application 1: Target levels for labour force growth

Here, the aim is to calculate the level of NOM that would be required to maintain the growth of the labour force at constant rates of zero, 0.5 per cent per annum, 1.0 per, 1.25 per cent and 1.5 per cent after an initial period of 20 years in which these targets are

achieved. Again, all three assumptions about future labour force participation are used in the analysis. This time, the different participation assumptions have a larger effect upon the results.

Table 7 contains several important conclusions. First, if participation rises to the levels of the Average assumption (probably the most likely of the assumptions), levels of migration comparable with historical standards are required just to maintain the labour force growth rate at a zero level.

To maintain the growth of the labour force after 20 years at around its present level (1.25%), under the average participation assumption, NOM would have to rise to 239,000 by 2017 and to 405,000 by 2047. While it may be feasible, even likely, that NOM will rise to 239,000 by 2017 – it may be close to that level in 2008-09 – the very high levels of NOM towards the end of the projection period would be very challenging in terms of recruitment, settlement and impacts on infrastructure, services and the environment. Under these assumptions, the labour force in 2047 would be about 70 per cent larger than it is now and the Australian population would have risen to 37 million. As NOM would be driving the growth of the labour force, it would have to continue to rise beyond the middle of the century to higher and higher levels.

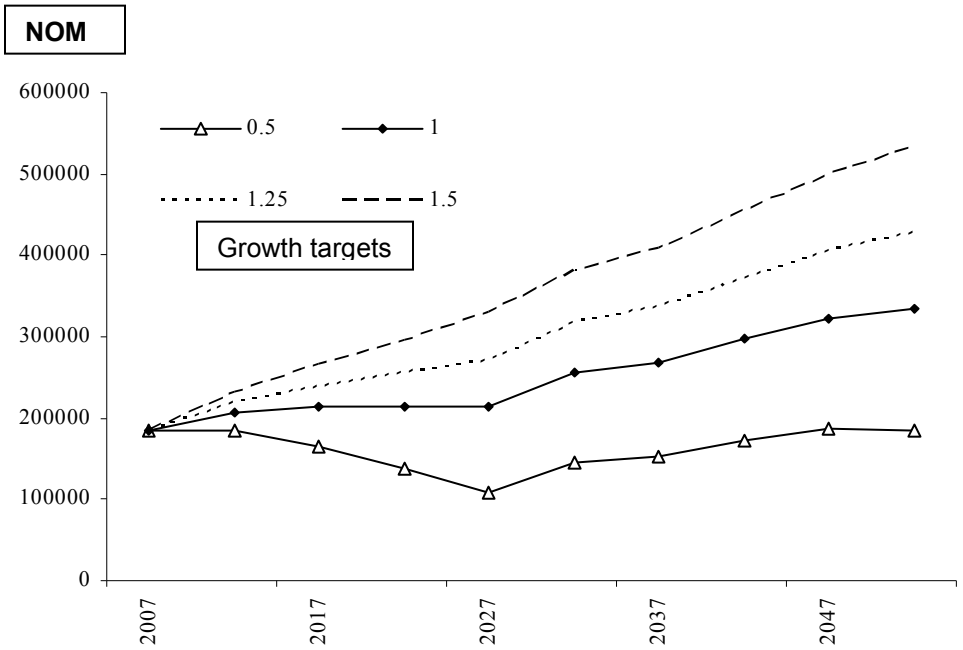
Table 7. Levels of NOM required to attain constant targeted levels of labour force growth, 2007-2047, using three labour force participation scenarios.

Targeted Labour Force Growth	Assumed Future Participation	NOM ('000s)				
		2007	2017	2027	2037	2047
Zero	**Current**	185	134	32	56	85
	Maximum	185	144	68	54	84
	Average	185	130	56	55	82
0.5%	**Current**	185	183	131	153	191
	Maximum	185	146	88	153	182
	Average	185	164	108	153	186
1.0%	**Current**	185	233	239	272	330
	Maximum	185	196	191	267	316
	Average	185	214	213	269	322

1.25%	**Current**	185	259	297	340	414
	Maximum	185	221	246	332	397
	Average	185	239	270	335	405
1.5%	**Current**	185	285	357	415	510
	Maximum	185	247	304	404	489
	Average	185	265	329	409	499

This suggests, as already discussed, that Australia might plan to gradually reduce its labour force growth over the next 50 years so that the country is not as dependent upon immigration as is implied by these data. Levels of NOM would remain relatively flat across time if labour force growth were to step down to 1% through to about 2030 and then to about 0.75% thereafter (not shown in the table). A constant level of NOM around 220,000 would achieve this result. Australia's population by 2050 would then grow to around 34.5 million (Table 1). This pathway can be envisaged by stepping across the lines shown in Figure 1 while keeping NOM around 220,000. This says nothing about labour demand, emphasizing the importance of developing long-term estimates of labour demand. Any pathway for future labour supply and immigration must be consistent with labour demand.

Figure 1. Levels of NOM required for specified target levels of labour force growth, 2007-2052, assuming the average level of labour force participation



Application 1: per capita GDP growth outcomes

Growth in GDP per capita is affected by the changing balance between those defined by the model as productive (employed) and those not employed especially children and older persons. The movement in this balance is complex and requires detailed scrutiny of changing age structures. This information is produced as output from the models but considerable work is required to decompose changes in GDP per capita between age structure changes and other changes. This has not been done for this report.

Figure 2 shows the patterns of change in growth of GDP per capita under varying levels of NOM. The results are shown for four assumptions about future productivity. In these projections, fertility and labour force participation are assumed to remain at their current levels.

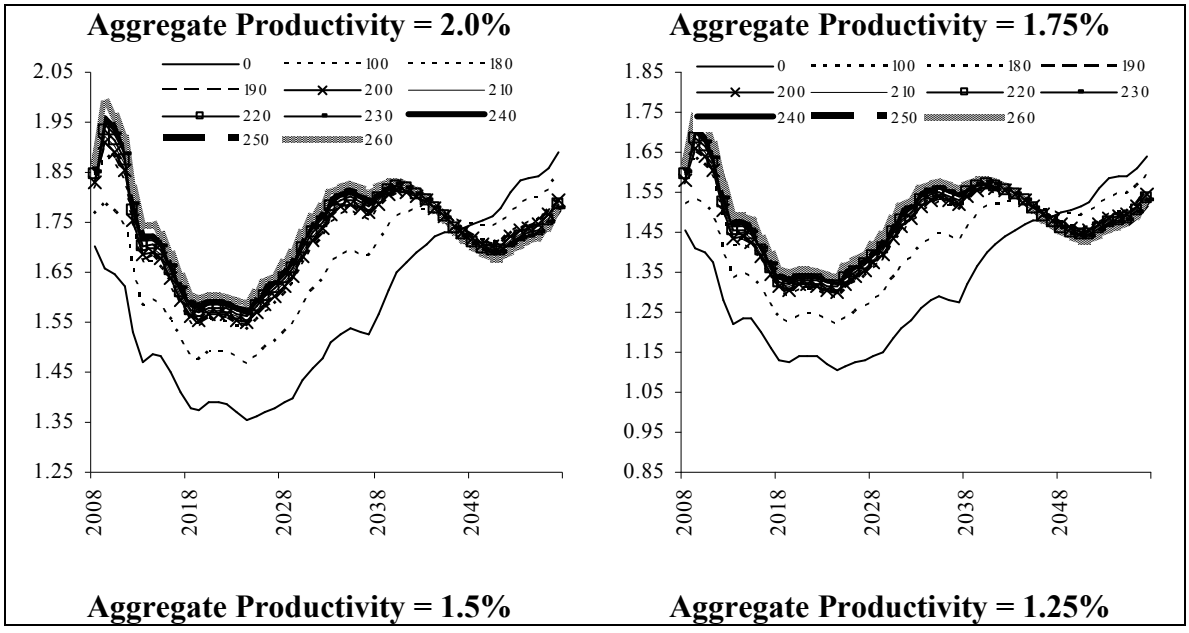
As expected, the assumed level of productivity has a large impact on per capita GDP growth. Also as expected, for each level of NOM, the patterns of change of per capita GDP growth across time are very similar for the different levels of productivity.

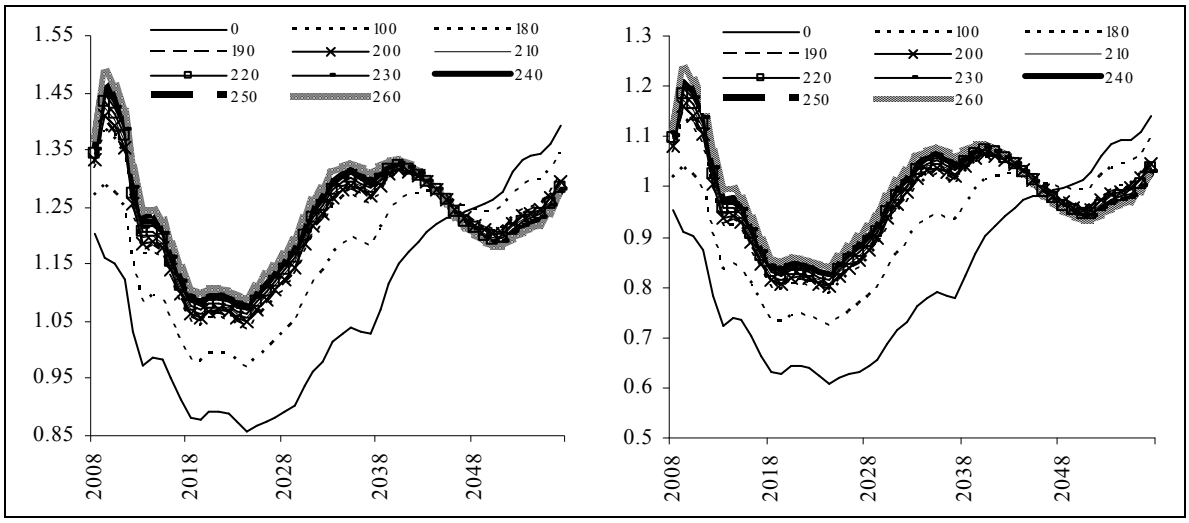
The dominant impression from Figure 2 is the shape of change in per capita GDP across time. Whatever the level of productivity, per capita GDP rises sharply in the few years after 2007 after which it tumbles on a steep downward trajectory. This tumble is very likely to be the result of the ageing of the baby boom generation. No matter what we assume about NOM or productivity, this tumble is inevitable. From about 2025, however, per capita growth of GDP begins to rise again over about a decade for all assumed levels of NOM. When NOM is assumed to be high (180,000 and over), per capita GDP growth then remains relatively flat for a short period before falling again in the 2040s and rising at the end in the 2050s. Because the pattern of change in growth of GDP per capita is different for the zero migration assumption, the fluctuations after 2030 for the cases with NOM set at 180,000 or more must be due to the impact of these levels of migration on population age structure across time. The likely interpretation is that, by the 2040s, the

migrants themselves are entering the dependent age groups and GDP per capita begins to fall as, relative to population, the level of immigration falls.

For the purposes of this report, the main conclusion from Figure 2 is that, at least until the 2040s, per capita GDP growth is substantially higher as the level of NOM rises from zero to 100,000 and then to 180,000. Beyond 180,000, however, the effect on per capita GDP growth of additional immigrants is marginal. This latter result stems from the fact that, at high levels of immigration, increasing levels of immigration have a lesser impact on the age structure of the population (McDonald and Kippen 2001).

Figure 2: GDP Per Capita annualised growth under differing assumptions of ANM and Aggregate Productivity Growth. (standard TFR assumptions, with current LFPR assumptions).




0
100
180
190
200
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220
230
240
250
260
1.55
1.45
1.35
1.25
1.15
1.05
0.95
0.85
2008
2018
2028
2038
2048
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5

Application 2: Population outcomes

In Application 2, the Total Fertility Rate (TFR) varies while NOM is held constant at its current level (185,000). In all cases, TFR is assumed to move from its present kevel to the assumed level over a period of 15 years after which it remains constant.

Table 8. Population of Australia in 2027 and 2047 with varying levels of fertility.

Level of TFR	Population (millions)	
	2027	**2047**
1.1	24.8	27.1
1.2	25.1	27.8
1.3	25.4	28.6
1.4	25.7	29.3
1.5	26.1	30.1
1.6	26.4	30.9
1.7	26.7	31.7
1.8	27.0	32.5
1.9	27.4	33.3
2.0	27.7	34.2
2.1	28.0	35.0

With NOM set at 185,000 per annum, this is sufficient to offset the fall in the population that would inevitably occur with very low fertility rates. Even with a TFR of 1.1, Australia's population would grow from 21.0 million in 2007 to 24.8 million in 2027 and to 27.1 million in 2047. With TFR at 1.8 (current) and the current level of NOM, the Australian population would grow to 32.5 million by 2047. Each additional decimal place of TFR adds about 300,000 to the population in 2027 and 800,000 in 2047.

Application 2: Labour force outcomes

As was the case for NOM, varying levels of participation have a much smaller impact on the labour force outcomes than do the changes in fertility. Accordingly, we present here only the outcomes relating to the Average assumption about future participation (Table 9).

Because births take a long time to have an impact on the labour supply, the different birth rates have only a very small impact on labour supply before 2027. This is an important

difference between births and immigration as sources of future labour supply; the impact of immigration is much more immediate. When NOM is set at 185,000, a change in fertility from 1.8 to 1.3 would reduce the labour force in 2047 by 1.7 million workers. A rise in fertility to 2.1 (replacement level) would increase the labour force by 0.9 million by 2047. To obtain the same increase in the size of the labour force in 2047 using an increase in NOM rather than an increase in fertility, NOM would have to rise by only 30,000 per annum from its current level. If the aim is to increase the labour force in the long-term, increasing NOM by 30,000 would seem to be an easier policy pathway than increasing fertility to the replacement level. Nevertheless, Table 9 shows that the annual growth rate of the labour force between 2027 and 2047 is strongly related to the level of fertility that is assumed to apply from 2007. If the aim is to maintain a rate of growth of the labour force around one per cent per annum in the long term, then a combination of the current level of immigration and a rise in fertility to 2.1 would produce that result over the next 40 years.

Table 9. Labour force outcomes deriving from varying levels of fertility, 2027 and 2047 (assumes average labour force participation and NOM = 185,000).

TFR	Size of Labour Force (millions)		Average Annual Labour Force Growth (%)	
	2007 = 11.0		2007 = 1.18	
	2027	2047	2007-27	2027-47
1.1	13.2	13.1	0.91	-0.04
1.3	13.3	13.7	0.95	0.15
1.5	13.4	14.4	0.99	0.36
1.7	13.4	15.0	0.99	0.56
1.8	13.5	15.4	1.02	0.67
1.9	13.5	15.7	1.02	0.75
2.1	13.6	16.3	1.06	0.91

Application 2: per capita GDP growth outcomes

The impacts of varying fertility rates upon per capita GDP growth are shown in Figure 3. This application assumes that NOM is constant at 185,000 per annum and that labour force participation remains at its current level. When TFR is around 1.8 or 1.9, the impacts are the same as those shown in Figure 2 when NOM was around 180,000. It is

the variations from that situation that are of interest. The graph has two phases to it: before 2035 and after 2035.

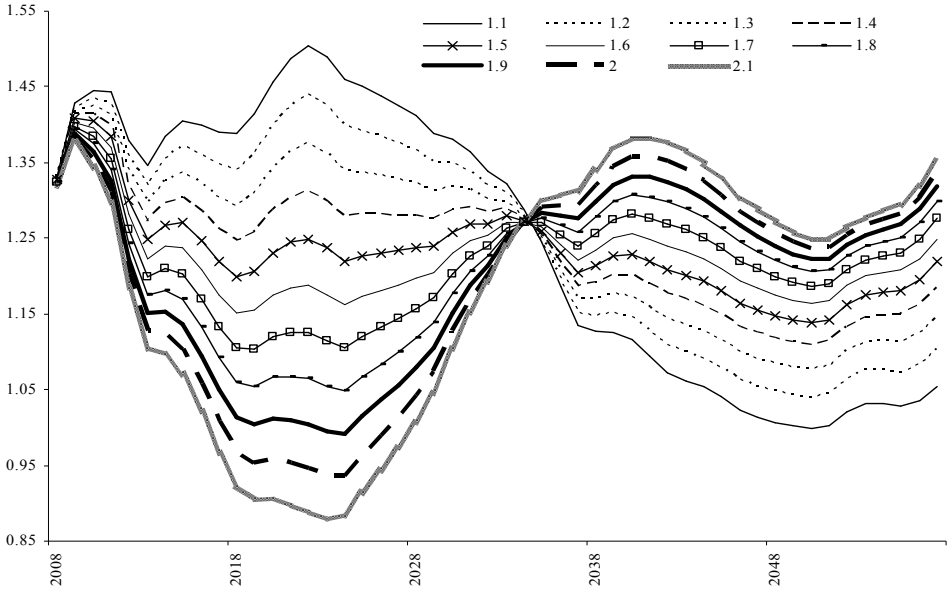
In the first phase, if TFR were to fall over 15 years to 1.1 births per woman, per capita GDP growth would not experience the tumble to 2030 that it would experience if fertility remained at 1.8. This is because the much smaller number of children would offset the larger numbers of older people. As fertility rises above 1.1, the amount of this offset reduces. If fertility rose above 1.8, per capita GDP growth would tumble even more sharply. Comparing Figures 2 and 3, a rise in fertility to 2.1 would have roughly the same impact by 2027 upon GDP growth per capita as a fall in migration to zero.

However, the benefits of very low fertility for per capita GDP growth are temporary. With TFR at 1.1, GDP per capita growth would begin to fall sharply from about 2020 and, in the second phase after 2035, the growth rate would fall well below the levels that result from higher levels of fertility.

The interesting cross-over point in Figure 3, around 2035, is an artifact of the assumed time period over which TFR is assumed to change to its long-term level. In Figure 3, this time period is assumed to be 15 years for all assumed levels of fertility. If the change in fertility occurred faster, the fall in GDP growth per capita would occur faster and the later rise would occur earlier.

As a theoretical exercise, if the aim was to keep per capita GDP growth relatively high and relatively flat across time, a TFR of about 1.5 would achieve the best result when NOM is equal to 185,000. Given that policy can only influence fertility by a relatively small amount, theoretical speculation about superior fertility levels is just theory. For an immigrant country like Australia, it is clear that the superior policy approach is to adjust immigration given the known levels of fertility but a moderate level of fertility (around the present level) provides a smoother long term trend in GDP growth per capita than a rise or a large fall in fertility would do.

Figure 3: GDP Per Capita annualised growth under differing assumptions of TFR. (standard migration assumptions, with current LFPR assumptions, Aggregate Productivity = 1.5%)



Application 3: Population outcomes

In relation to the 18 scenarios, population outcomes are the same irrespective of the assumptions about labour force participation rates. So, in Table 10, population outcomes are shown for the six scenarios that involve variations in TFR and NOM.

With a continuation of current levels of TFR and NOM, the population would rise to 27.1 million in 2027 and 32.6 million in 2047. The most likely outcome is this one or one with NOM somewhat higher. With current TFR and NOM rising immediately to 230,000 per annum, the population in 2047 would reach 35.0 million. Thus, we might conclude that the likely range for Australia's population in 2047 is 32.6-35.0 million. This is much higher than the most recently published mid-range projections from the Australian Bureau of Statistics.

The proportions of the 2047 population that would be aged 65 years and over range from 21.9 per cent to 25.9 per cent with the range being due to variations in TFR. Again

assuming that the current level of fertility is the most likely level for the future and that the most likely level for NOM lies between the current level and the high level, the proportion aged 65 years and over in 2047 would lie between 22.6 per cent and 23.3 per cent, a narrow range. This is a much lower level than has been projected for most other industrialized countries. Indeed, it is only slightly higher than present levels in countries such as Japan and Italy.

In all six scenarios, the average annual rate of population growth would be above one per cent per annum from 2007 to 2027.

Table 10. Population outcomes from six scenarios, 2027 and 2047

Assumption		Population	
		2007 = 21.0 million	
TFR	**NOM**	**2027**	**2047**
Current	Current	27.1	32.6
Low	Current	26.0	29.4
High	Current	27.9	34.8
Current	Long-Term	25.9	29.1
Current	High	28.2	35.0
Current	1% LS Growth	27.9	35.5
Assumption		**% Aged 65+**	
		2007 = 13.1	
TFR	**NOM**	**2027**	**2047**
Current	Current	18.7	23.3
Low	Current	19.4	25.9
High	Current	18.1	21.9
Current	Long-Term	19.3	25.0
Current	High	18.2	22.6
Current	1% LS Growth	18.3	22.2
Assumption		**Average Annual Population Growth Rate (%)**	
TFR	**NOM**	**2007-27**	**2027-47**
Current	Current	1.28	0.92
Low	Current	1.07	0.61
High	Current	1.42	1.10
Current	Long-Term	1.05	0.58
Current	High	1.47	1.08
Current	1% LS Growth	1.42	1.20

Application 3: labour force outcomes

The projected sizes of the labour force from the 18 scenarios are shown for 2027 and 2047 in Table 11. Variations in 2027 are due to variations in the levels of NOM and the participation assumptions. In 2047, the lowest size of the labour force across the 18 scenarios is 13.4 million (current TFR, long-term NOM and current participation). This would be the result if NOM were to return to 100,000 per annum. The highest labour force size, 18.2 million, results from the combination of high migration

(230,000 per annum), maximum participation and current TFR. The most likely scenarios would be those that have average participation, current TFR and NOM either current or high. The labour force size in 2047 under these scenarios would range from 16.1 to 17.4 million, the latter number being almost 60 per cent higher than the size of the labour force in 2007.

Table 11. The size of the labour force in 2027 and 2047 according to 18 scenarios.

No.	Assumption			Labour force	
				2007 = 11.0 million	
	Participation	TFR	NOM	2027	2047
1	Current	Current	Current	13.5	15.4
2	Current	Low	Current	13.5	14.2
3	Current	High	Current	13.6	16.2
4	Current	Current	Long-Term	12.8	13.4
5	Current	Current	High	14.1	16.6
6	Current	Current	1% LS Growth	14.0	17.0
7	Maximum	Current	Current	14.5	16.8
8	Maximum	Low	Current	14.5	15.6
9	Maximum	High	Current	14.6	17.7
10	Maximum	Current	Long-Term	13.8	14.7
11	Maximum	Current	High	15.2	18.2
12	Maximum	Current	1% LS Growth	14.6	17.9
13	Average	Current	Current	14.0	16.1
14	Average	Low	Current	14.0	14.9
15	Average	High	Current	14.1	17.0
16	Average	Current	Long-Term	13.3	14.0
17	Average	Current	High	14.7	17.4
18	Average	Current	1% LS Growth	14.3	17.4

It is low fertility that produces the lowest labour force growth rates by 2047. Current participation rates combined with the currently high level of NOM (185,000) would only just prevent the labour supply from falling by 2047 if TFR were to fall to 1.3. Following the same conclusions about the most likely scenarios, the five-year, labour force growth rate to 2047 would range between 2.8 and 3.5 per cent. In annual terms, the higher of these numbers is equivalent to 0.7 per cent per annum.

Table 12. Average annual labour force growth rates, 200727 and 2027-47, according to the 18 scenarios

No.	Assumption			Average Annual Labour Force Growth %	
	Participation	TFR	NOM	2007-27	2027-47
1	Current	Current	Current	1.02	0.66
2	Current	Low	Current	1.02	0.25
3	Current	High	Current	1.06	0.87
4	Current	Current	Long-Term	0.76	0.23
5	Current	Current	High	1.24	0.82
6	Current	Current	1% LS Growth	1.21 (a)	0.97
7	Maximum	Current	Current	1.38	0.74
8	Maximum	Low	Current	1.38	0.37
9	Maximum	High	Current	1.42	0.96
10	Maximum	Current	Long-Term	1.13	0.32
11	Maximum	Current	High	1.62	0.90
12	Maximum	Current	1% LS Growth	1.42 (a)	1.02
13	Average	Current	Current	1.21	0.70
14	Average	Low	Current	1.21	0.31
15	Average	High	Current	1.24	0.94
16	Average	Current	Long-Term	0.95	0.26
17	Average	Current	High	1.45	0.84
18	Average	Current	1% LS Growth	1.31 (a)	0.98

(a). The aim of these scenarios is to produce a constant one per cent rate of growth of labour supply from 2027 onwards. To achieve that result, given the pre-existing structural rigidities and the assumptions, the rate of growth of the labour force in the first 20 years is variable in these scenarios.

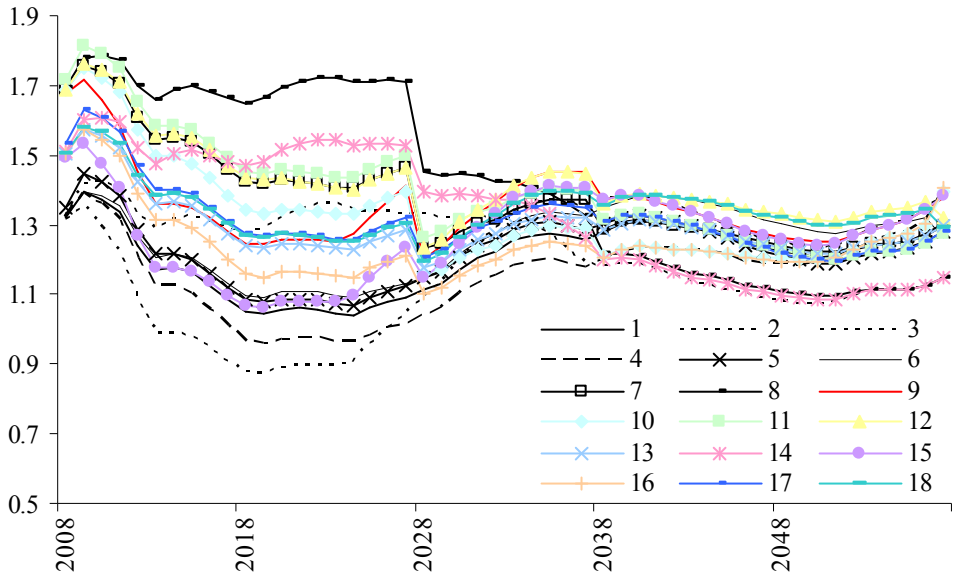
Application 3: per capita GDP growth

Figure 4 shows the projected trends in per capita GDP growth relating to each of the 18 scenarios when productivity growth is set at 1.5 per cent per annum. The patterns are very similar for other levels of assumed productivity although the levels, as expected, reflect the assumed level of productivity.

The range of per capita GDP growth rates across the 18 scenarios tends to be dominated by the fertility scenarios (Figure 4). Those scenarios with low fertility initially have the highest per capita GDP growth rates but alter the lowest growth rates. The reverse is the case for those scenarios with the high fertility assumption: low growth initially but higher growth later. The variation between the scenarios is much wider before 2030; there is some convergence after 2030.

The most likely scenarios, Scenarios 13 and 17, remain in the mid-range of the outcomes for per capita GDP growth and the rate of growth stays relatively flat across the projection period at about 1.3 per cent. There are advantages in long-term stability of GDP growth so the most likely scenarios have this desirable characteristic.

Figure 4. per capita GDP growth for the 18 scenarios, 2007-2052, assuming productivity growth at 1.5 per cent.



IMPROVING ANALYSIS FOR LONG TERM PROJECTIONS OF LABOUR DEMAND

As noted earlier, results from this analysis ignore two important factors: (1) the modeling ignores labour demand and (2) the modeling ignores feed-back effects between demography and the economy.

Economic, planning and environmental models conventionally treat future demography as 'exogenous', that is, determined outside of or independent of the model. Future demography is the 'front-end' of these models and is estimated statistically from past demographic trends. It is then taken as a given to be fed into economic, planning or

environmental models. Effectively, this approach assumes that there are no feedbacks, that future demography will not be affected by the state of the future economy, changes in the nature of social institutions or the future environment. Recent examples of the exogenous treatment of future demography include the models used in the 2002 and 2007 Treasury *Intergenerational Report*, the 2005 and 2006 Productivity Commission reports (*Economic Implications of an Ageing Australia*; *Economic Impacts of Migration and Population Growth*), all the conventional models of the Australian economy (eg. the Monash CoPS model, the Econtech model) and the CSIRO environment and resource modeling (*Future Dilemmas*). Furthermore, the official population projections made by the Australian Bureau of Statistics are made in isolation from modeling of future economic, social or environmental trends.

In reality, demographic behaviour is very much influenced by the state of the economy, social organization and the state of the environment. If the economy turns down or if there are environmental or social problems, the expected results are that fertility will tend to fall, immigration will tend to fall and mortality may rise or at least slow its rate of decline. The evidence for these associations is strong across Australian history. The economic recessions of the 1890s, 1930s, early 1960s, mid 1970s, early 1980s and early 1990s all produced falls in fertility and migration. Thus, there should be no question that future demography is not independent of future economic, social or environmental conditions. Despite this, the associations are almost never drawn in the context of population projections.

Rather than future demography being predetermined inevitably and inexorably by past trends in demography as is conventionally assumed, it would be preferable if estimates of future demography could be made as an endogenous component of models that incorporate future economic, social and environmental trends. The aim should be to build new models that recognize this reality. We should consider what demographic futures are likely as an endogenous component of targeted or likely longer-term economic, social and environmental goals.

Long-term models of future labour demand (at least 20 years into the future) cannot incorporate major new directions in technology and ways of living and, from this perspective, they will be erroneous. On the other hand, long-term models can be updated on a continuous basis and potential bounds of error can be incorporated. Such long-term models would be a useful resource for future labour force planning. In particular, long-term labour force projections by occupation/industry sector would provide a better basis for both population and skills planning. There is a considerable lead time involved in training people with particular skills that will be in future demand and longer term models of labour demand can be useful in identifying these skill areas.

Some previous research has attempted to model industry specific labour forces. Key among them is the MONASH model maintained by the Centre of Policy Studies at Monash University. The MONASH model is a dynamic computable general equilibrium model (CGE) of the Australian economy. This model has the advantage of simultaneously modeling numerous aspects of the Australian economy and can thereby account for dynamic feedback effects into labour supply. However, the MONASH model is limited considerably because of its focus upon the national level labour supply and its relatively short projection span. For example, MONASH has been used to project sectoral labour supply from 2004-05 to 2009-10 (DEWR, 2005). However, as detailed by McDonald and Kippen (1999), the speed of population ageing is projected to pick up considerably after 2020. The limited range of the MONASH model means that the long-term effects of population ageing are not captured. A global version of the MONASH model to examine long-term global demographic and economic changes (beyond 2020) and their implications for Australia's economy has recently been developed (Tyers and Shi, forthcoming). There is potential for such a model to examine the global supply of skilled and unskilled labour and long-term migration scenarios in response to regional wage differentials and their implications for Australia (Tyers et al. 2006).

The essential requirement is for long-term projections of labour demand and supply by occupation and industry sector. As discussed above, changes in Australia's population age structure and living standard over the next fifty years will have implications for

labour demand in service sectors such as health, education, government and defence. For example, projections of the demand for specific occupations such as doctors and nurses based on current patterns of age-specific consumption of health services or alternate scenarios can be compared with projected supply and are helpful for long-term planning. With these two occupations being prominent in current temporary skilled migration arrivals, such projections are also of interest from a migration policy perspective. More generally, it is possible to examine the ways in which employment in the full range of service occupations has changed over the past 30 years and to model the associations of these changes with economic, social and demographic changes. Such an information base then provides a basis for projection of future employment in the service industries. Other methodologies can be applied to project demand in non-service sectors such as mining, manufacturing and construction.

Of course, long-term projections will be inaccurate because we fail to project that which we do not yet envisage. However, this is more an argument for regular revision than for abandonment of the endeavour. At present, Australian labour force policy tends to be more a matter of reaction than of long-term planning. Labour shortages emerge and attempts are made to plug them through training or immigration. This approach often leads to short cycles of under- and over-supply as has been evident in the IT industry in recent years. A longer-term planning agenda would enable the specification of immigration and local training targets to be better balanced. There has been a tendency to rely upon immigration because it is more immediate and this has been at the expense of better domestic training policy. A longer-term agenda would also enable better planning of future infrastructure and service needs at both the national and the regional levels.

POLICY ANALYSIS OF KEY OUTCOMES

Australia has come through an era when the labour force has grown substantially as a result of the natural growth of the population. This was the period in which the baby-boom generation had its full impact on labour supply. From now on, the baby-boom will

begin to retire and move out of the labour force. In the future, natural decrease will be a feature of the Australian labour force. Without increases in participation rates and with zero net migration, the Australian labour force would begin to fall in number from about 2010.

This comes at a time when labour demand is very strong in Australia driven by the mineral boom and its flow on effects to the broader economy. Besides the mineral boom, this report argues that future labour demand will be also be strong because of the need for Australia to invest heavily in infrastructure, new forms of energy and reversal of environmental degradation. Without this investment, Australia's capacity to take full advantage of present and future productivity opportunities is threatened. Labour demand will also flow from the ageing of the population, from increases in living standards and from new demands in health and education. Finally, the carbon pollution reduction scheme will generate new demands for labour and for training and retraining.

There are risks involved in not meeting labour demand. First, unmet labour demand may force up wages more rapidly than is desirable. Evidence of the impact of labour demand upon wages is provided by the boom states of Queensland and Western Australia where, in recent years, wages have risen substantially. The second major risk is that projects that would enhance Australia's long-term productivity might be delayed along with major projects related to environmental improvement and new energy sources.

The report shows that even a theoretical maximum increase in participation rates by age would have only a limited impact on meeting likely future labour demand. Fertility has a very important long-term effect on the supply of labour and, for the benefit of the longer-term future, this effect should not be ignored. Maintaining fertility around its present level would be a good result for Australia. However, in the short to medium term (the next 20 years), immigration is the only means available to meet large aggregate increases in labour demand in Australia. In terms of meeting future demand for specific skills, domestic training would also play a vital role. The report argues that it would be

beneficial to have better estimates of the skills required in the Australian labour force in the next 15-20 years.

Whatever immigration or participation strategy is followed[3], the modeling shows that, with constant productivity, a sharp fall in Australia's per capita GDP growth is inevitable from 2010 to 2025. After that, per capita GDP starts to rise again reaching a new peak around 2035 and thereafter remaining relatively high (Figure 2). This is simply the result of the inevitable ageing of Australia's population, the retirement of the large baby-boom generation. However, the modeling also shows that per capita GDP growth increases strongly as net migration increases from zero to 100,000 and increases again as net migration rises to 180,000. Further increases in immigration produce little further improvement in the growth of GDP per capita. The 'diminishing returns' to increases in immigration beyond a NOM of 180,000 are driven by the fact that migration has an ever smaller impact on age structure as its level rises. This suggests that the optimal level of net migration for Australia from the perspective of GDP growth per capita would be in the region of 180,000-230,000 per annum.

While this report argues that immigrants will be important to the construction of productive infrastructure in Australia, if increased immigration proceeds without investment in new infrastructure, especially urban infrastructure, the result could be reductions in productivity through increased congestion and inefficiency. Thus, a plan relating to Australia's future levels of immigration must be coordinated with policy for urban infrastructure especially housing, transport, water and appropriate energy supply. With constant fertility and net migration at 180,000 per annum, Australia's population would rise to 27 million by 2027 and to 32.4 million by 2047. These are relatively large increases and most of the additional population would be settled in the existing cities all of which are already under strain from infrastructure shortages.

[3] Aside from an unlikely sudden large fall in fertility which would have unfortunate longer-term consequences.

APPENDIX 1

Methods and Limitations

Projections of Population and Labour Supply

For the underlying population, labour supply and GDP per capita projections, we draw upon two separate models. The model for the projection of population and labour supply is based upon a model built by ADSRI (Temple and McDonald, 2008). The underlying model is as follows:

Using the base demographic data, we define the population in year, y+1 for aged j+1 as:

$$P_{i,j+1}^{y+1} = P_{i,j}^{y} S_{i,j}^{y} \left[1 + M_{ij}^{y}\right], \qquad j \geq 0 \qquad [1]$$

Given:

$P_{i,j}^{y}$ is the population of sex (i) at age (j) in year (y)

$M_{i,j}^{y}$ is the age-sex specific net migration intensity

$S_{i,j}^{y}$ is the age-sex specific survival ratio

The projected labour supply by age and sex ($LS_{i,j+1}^{y+1}$) is than calculated using the age-sex specific participation rate ($PR_{i,j+1}^{y+1}$):

$$LS_{i,j+1}^{y+1} = P_{i,j+1}^{y+1} \times PR_{i,j+1}^{y+1} \qquad j \geq 15 \qquad [2]$$

With the above specifications, we define a number of scenarios for the key parameters of interest:

(i.) set of fertility scenarios which vary b_j^y

(ii.) the set of migration scenarios which vary $m_{i,j}^{y}$ and;

(iii.) the set of labour force participation scenarios that vary $PR_{i,j+1}^{y+1}$.

Using these simple projection methods, it is also possible to create synthetic histories of the labour supply for the projection period.

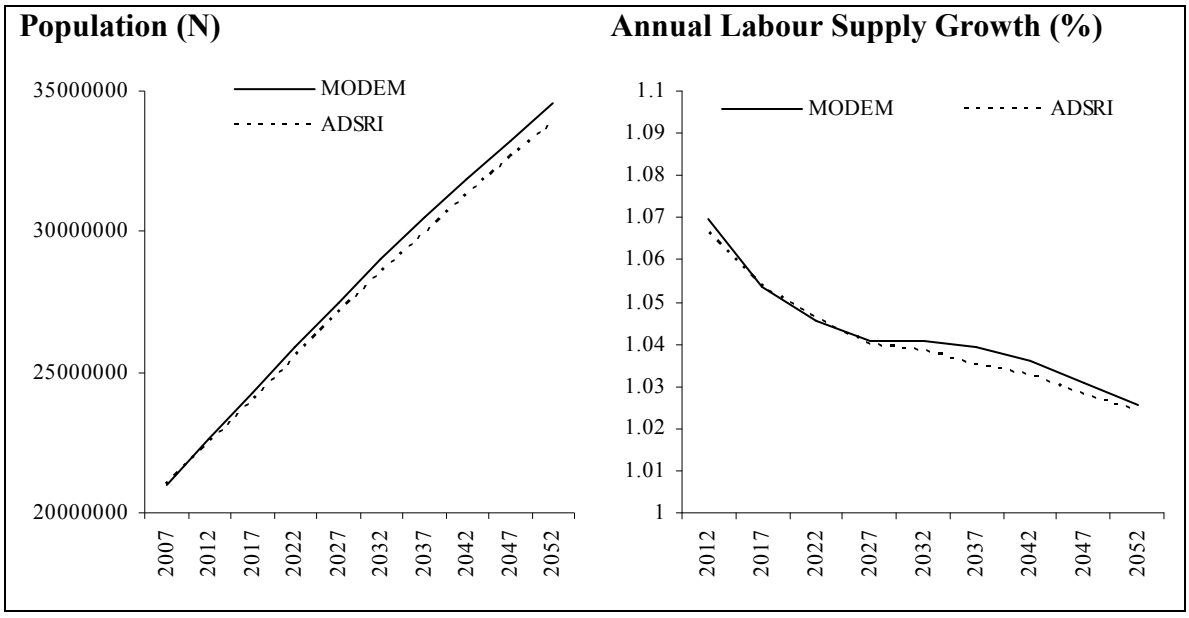
An additional use of this model was to project smoothed NOM profiles to target specific levels of labour supply growth. We adopted an iterative search algorithm to solve the following for growth rate (r) for each intervening time period (n) in the projection period:

$$\log(1+r) = \frac{\log\left(\frac{LS^{y+n}}{LS^{y}}\right)}{n} \qquad [3]$$

This method of calculating the annualised labour supply growth rates are used as they are more accurate than arithmetic growth rates when using five-year age cohort data (Rowland, 2003).

Projections of GDP Per Capita

To calculate simulations of GDP per capita under different scenarios of fertility, migration and labour force participation, we utilise an altered version of the MoDEM model. The original model is publically available from www.pc.gov.au. The mathematical and theoretical underpinnings of the model are found in Cuxson, Hou and Fry, 2007. To ensure the models produced the same underlying population and labour supply projections, we compared the two models for selected scenarios. As shown below for one scenario, both sets of projections are highly comparable. Sources of differences are primarily due to the way in which age groups are projected.



It is important to recognise that the GDP projections are not forecasts. Rather, they are simulations based upon assumptions about population, productivity and labour force participation. Indeed, when interpreting these results, it is the relative differences between the different models that should be considered and not the actual levels of GDP growth. The substantial limitations of the GDP projections are noted below and should be considered when interpreting the results:

- The underlying full and part time average hours worked, part time work share, unemployment and participation rates and productivity profiles are assumed to remain constant between domestic and migrant workers. In reality, there are differences between the two groups with respect to these characteristics (Productivity Commission, 2006).
- The underlying full and part time average hours worked, part time work share, unemployment rates and productivity profiles are calculated as a percentage of the rates projected for the Productivity Commissions report 'Economic Implications of an Ageing Population'. New projections are currently underway by the Productivity Commission but were not publically available at the time of this report. The assumptions used are likely to be an under-estimate of reality and should be treated as very conservative.

- The simulations take no account of macroeconomic shocks affecting growth. In reality, GDP per capita growth exhibits substantial short term variation across the time.
- The simulations take no account of labour demand.

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