ATTACHMENTS

The following attachments are reproductions of other Productivity Commission publications. All citations can be found in the original publications (available on the Productivity Commission website at *www.pc.gov.au*).

1. ‘Demographic projections’, Technical Paper 1 of *Economic Implications of an Ageing Australia*, Productivity Commission Research Report, 2005, Canberra.
2. ‘Ageing and labour markets’, Chapter 3 of *Economic Implications of an Ageing Australia,* Productivity Commission Research Report, 2005, Canberra.
3. ‘Cohort analysis’, Technical Paper 3 of *Economic Implications of an Ageing Australia,* Productivity Commission Research Report, 2005, Canberra.
4. ‘Productivity and ageing’, Chapter 4 of *Economic Implications of an Ageing Australia,* Productivity Commission Research Report, 2005, Canberra.
5. ‘Consolidating the effects of human capital reform’, Chapter 14 of *Potential Benefits of the National Reform Agenda*, Productivity Commission Report to the Council of Australian Governments, 2007, Canberra.
6. ‘The productivity of outsiders’, Appendix E of *Men Not at Work: An Analysis of Men Outside the Labour Force*, Productivity Commission Staff Working Paper, 2007, Canberra.

Demographic projections

This technical paper sets out the assumptions and methodology used by the Commission in its demographic models, the data used to calibrate them, and the nature of scenarios explored.

The economic effects of ageing depend primarily on the relative number of the future old. Estimates of population ageing can be derived using well-established population models that make assumptions about the future paths of fertility, mortality and net migration.

The Commission developed several demographic models to:

- consider scenarios other than those used in the PC-M series (chapter 2), reflecting the considerable uncertainty about future fertility rates, mortality rates and net overseas migration;[1]
- understand what would have happened had Australia's past demographic trends been different. This explains the demographic pressures underlying Australia's present ageing trends. For example, what would have happened if the rise in fertility that occurred after the Second World War had not occurred?; and
- provide separate estimates of Indigenous and non-Indigenous populations for the Northern Territory, given the distinctive demographic trajectories of these sub-populations.

The models are available publicly (see attached CD) — and can be used to explore assumptions different to those adopted by the Commission.

1.1 The cohort-component model

The standard approach to demographic projections is the cohort-component model, which is a stock–flow model of the population by age groups. It recognises that in moving from a population at a given date to a new population one year later, there are a set of inflows and outflows.

[1] For example, in its own population estimates produced in 2003, the ABS generated 54 alternative projections based on varying combinations of assumptions to reflect this underlying uncertainty.

The cohort-component model is a rigorous way of handling these flows, based on assumptions about future trends in mortality, migration and fertility. There are several steps to the model. At the national level, these involve determining:

- how many survivors there are from the previous year's population;
- the number of births in Australia that survive to be 0 years old in the projection year (the influence of fertility); and
- the impact of net overseas migration (less deaths to migrants that occur after they arrive, but before the end of the relevant projection year).

Each of these components is discussed below.

The base population

The starting point for population projections is the base year population. This is the population at 30 June 2004 classified by age and sex. This is denoted by $P_{x,s\ t}$, where x is the age, running from 0 to *max*-1 with a last open ended age interval of *max*+ (in this case 100+), s is sex and t is the end of the fiscal year 2004.

Calculating deaths in the base population

Ignoring births and net overseas migration for the moment, the numbers in each age–sex sub-population remaining in year t+1 is estimated by applying survival rates to base year sub-populations:

$$P_{x+1,s,t+1} = P_{x,s,t} \times (1 - Q_{x,s,t}) \quad \text{for } (x+1) = 1 \text{ to } max\text{-}1$$

where $Q_{x,s,t}$ is the probability that someone aged x in year t will die over the next year.[2] So for example, if there were 10 000 people aged 10 years old at 30 June 2004 and one in 1000 of these were expected to die over the next year, the population of 11 year olds at 30 June 2005 (before gains from net migration) would be 9990. The population estimate for the last open-ended age interval is different because people aged 99 year olds become 100+, while many 100+ years olds survive to remain 100+ one year later. Accordingly, the population estimates (before accounting for net overseas migration) for the last age group is:

$$P_{\max,s,t+1} = P_{\max-1,s,t} \times (1 - Q_{(\max-1),s,t}) + P_{\max,s,t} \times (1 - Q_{\max,s,t})$$

2 In this context, the relevant age is not *exact age* (as in a standard life table), but rather *age at last birthday* (that is, someone whose age, A, is in the interval $x \le A < x+1$).

These calculations all require death probabilities, Q (or one minus survival rates). These are derived from age-specific central death rates and assumptions about the distribution of the probability of death over a year. Q can be calculated through a series of subsidiary calculations (which make up so-called ‘life tables’). In most model projections, the Commission had direct estimates of Q_x derived by the ABS, or assumed some pattern of change over time from a base year series of Q_x.

However, for one set of mortality scenarios the Commission needed to derive Q_x from central death rates. Following a request from the Commission, age-specific central death rates ($m_{x,s,t}$) for calendar years 2002 to 2051 were estimated by Heather Booth from the Australian National University using the Lee-Carter method based on past data trends.[3] Central death rates record the number of deaths of a person aged x (at last birthday) over a calendar year divided by the mid-calendar year population of people aged x. The Booth data are in single year increments to age 89 with a last open age interval of 90+. As this report is particularly concerned with ageing issues, the Commission derived estimates of central death rates from 90 to 99 and 100+ by relating the Booth estimates for each projection year to 2000-2002 ABS life table data (applying so-called ‘relational’ methods — Rowland 2003; Hannerz 2001). Then Q_x estimates corresponding to these central death rates were produced by constructing life tables for each projection year and sex (box 1.1).

[3] The Lee and Carter (1992) model is a special case of principal components. It is used by the U.S. Census Bureau as a benchmark for their population forecasts, has been recommended by the U.S. Social Security Technical Advisory Panel and has been widely adopted in academic demographic forecasts of mortality (Girosi and King, 2003, p 36). See Booth and Tickle 2003 for more detail and background on these mortality projections. For a more general discussion of the Lee Carter method and its benefits, see Tuljapurkar, Li and Boe, 2000; Preston, 1991; Wilmoth, 1996; Haberland and Bergmann, 1995; Lee, Carter and Tuljapurkar, 1995; Lee and Rofman, 1994; Tuljapurkar and Boe, 1998; and NIPSSR, 2002). Other methods, some with apparent advantages over Lee-Carter, are also now being applied, such as functional data analysis (Hyndman and Ullah 2005 and Hyndman 2004).

Box 1.1 **Generating Q_x from central death rates**

First, the mortality rate, or the probability of dying between *exact* ages x and x+1, ($q_{x,s,t}$) was calculated. Unlike central death rates, $q_{x,s,t}$ is based on the population at the start of the calendar year (so 1 January 2002 in the base year), rather than the midpoint. Consequently, those deaths that have occurred up until the midpoint have to be added to the midpoint population to give an estimate of the starting population. This depends on assumptions about the distribution of deaths over the year, which depends on the age of people.

- Babies are much more likely to die soon after birth rather than later in the year. While there are alternative methods, the PC adopted that of Shahidullah (2001, p. 14) and the London Health Observatory (2001). q_0 was calculated as $m_0/(1+(1-f)m_0)$. f is the separation factor, defined as the share of infant deaths in year t occurring to infants born in the previous year. f is much less than 0.5 because most deaths occur in the first 4 weeks of life. The value of f used was 0.14 (from ABS 2002d).
- For the last open age interval, the probability of death (q_{100+}) is one, since over that interval the future probability of death is 100 percent.
- For other ages there are several common approaches. The PC used that of Greville (Ng and Gentleman 1995), which is based on the observation that there is a roughly linear relationship between the natural log of death rates (m_x) and age (x). Denoting the slope of this line as ln C, the mortality rate can then be calculated as: $q_{x,s,t} = m_{x,s,t} \big/ [1 + m_{x,s,t}(0.5 + (m_{x,s,t} - \ln C)/12)]$. The ABS (2001c) notes that ln C could be assumed to be around 0.95, which was the parameter used by the PC.

Second, the numbers of an assumed starting population of 100 000 surviving at exact ages ($l_{x,s,t}$) is calculated as $l_{x+1,s,t} = l_{x,s,t}\,(1 - q_{x,s,t})$.

Third, a measure of mortality patterns that refers to age at last birthday, rather than exact ages (as in $l_{x,s,t}$) is required since statistical data is gathered on an age at last birthday basis. This measure is the average number of people alive *between* exact ages, $L_{x,s,t}$. It is formed from averaging l in the x and x+1 age categories for all ages except for the first years of life and the last open ended age category. Accordingly, $L_{x,s,t} = 0.5(l_{x,s,t}+l_{x+1,s,t})$. L_0 was calculated as $0.14\, l_0+0.86\, l_1$ recognising that the probability of death is higher earlier than later. The last age category was estimated as discussed below. Ratios of L are survival rates of people. Thus $L_{40,t}/L_{39,t}$ is the share of people aged 39 (on a last birthday basis) at 30 June 2002 who will survive to be 40 years old by 30 June 2003.

Finally, Q can be derived as one minus the survival rates based on L. Accordingly, $Q_x = (1- L_{x+1,} /L_x)$ up to Q_{99}. In order to estimate Q_{100+}, Q_{100} to Q_{130} was first approximated as $Q_x = \min(1, Q_{x-1} {*}Q_{99} /Q_{98}))$. Then L_{100} to L_{130} were estimated as $L_x = (1-Q_{x-1})L_{x-1}$. Accordingly L_{100+} was calculated as $\sum_{x=100}^{130} L_x$ and L_{101+} as $\sum_{x=101}^{130} L_x$. Then Q_{100+} was calculated as: $1-L_{101+}/L_{100+}$. The probability that a baby dies in the first year after birth, Q_b, is calculated as $1-L_{0,s,t}/l_{0,s,t}$.

Births

Births are calculated using calendar year age-specific fertility rates and the relevant sub-populations of fertile women. The fertile years are from 15 to 49 years (with any births to women of other ages added to the lower and upper limits of this age range). It is necessary to average the populations of the relevant females in the t and t+1th years to reflect the fact that females aged x at time t have an average age of x+½.

For example, in the base year of 30 June 2004, the average age of 15 year old females is 15½ years old. At 30 June 2005, those females aged 15 years were on average 14½ years old at 30 June 2004. By averaging these two sub-populations, the average number of females aged 15 years old in the period from 30 June 2004 to 2005 is obtained. Births are calculated by multiplying the two sub-populations by the relevant age-specific fertility rates.

Accordingly, Births (B_t) can be derived as:

$$B_t = \frac{1}{2}\left(\sum_{x=15}^{49} F_{x,T} \times P_{x,f,t+} + \sum_{x=15}^{49} F_{x,T+1} \times P_{x,f,t+1} \right) / 1000$$

where births (B_t) occur over fiscal year ending t+1, and $F_{x,T}$ is the calendar year (T) fertility rate of females aged x.[4] For example, to determine the number of births for the projection year ending 30 June 2003:

$$B_{2001\text{–}02\ to\ 2002\text{–}03} = \frac{1}{2}\left(\sum_{x=15}^{49} F_{x,2002} \times P_{x,f,2001\text{–}02+} + \sum_{x=15}^{49} F_{x,2003} \times P_{x,f,2002\text{–}03} \right) / 1000$$

Male births are calculated as:

$$B_{m,t} = \frac{\alpha}{1+\alpha} B_t$$

where α is the ratio of male to female births (set to 1.05). Female births are found as a residual.

Some live births subsequently die. The population aged zero at t+1 is calculated by subtracting deaths of babies, so that:

$$P_{0,s,t+1} = B_{s,t} \times (1 - Q_{b,s,t})$$

where Q_b is the probability of death over the first year from birth.

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4 The calendar year T for B_t is from t-½ to t+½ years. For example, for calculating births over 2003-04 to 2004-05 (termed $B_{2003\text{-}04}$), T would be the calendar year 2004 and T+1 would be the calendar year 2005.

The contribution of net overseas migration

(Net) overseas migrants are assumed to arrive on average at the midpoint of the relevant projection year. Thus for the projection year ending 30 June 2005, migrants are assumed to arrive on average at midnight 31 December 2004. This means that half the migrants aged x years old arriving during the projection interval will be x+1 years old by 30 June 2005, while half of those arriving aged x+1 years old will still be x+1 years old by 30 June 2005. Because migrants are arriving on average half way through the year, only half the year's probability of death is applied. Accordingly, the contribution to population increase (CP) at the end of June in the t+1 projection year is:

$$CP_{x+1,s,t+1} = (0.5\times NOM_{x,s,t})(1-0.5Q_{x,s,t}) + (0.5\times NOM_{x+1,s,t})(1-0.5Q_{x+1,s,t})$$

for x+1=1 to max-1 years, where $NOM_{x,s,t}$ is the level of net (inwards) overseas migration over the year from t to t+1. The contribution of migrants to the population aged zero years is:

$$CP_{0,s,t+1} = (0.5\times NOM_{0,s,t})(1-0.5Q_{0,s,t})$$

The contribution of migrants to the population aged max^{+} years is:

$$CP_{\max^{+},s,t+1} = 0.5\times NOM_{\max-1,s,t}\times(1-0.5Q_{\max-1,s,t}) + (NOM_{\max^{+},s,t})(1-0.5Q_{\max^{+},s,t}).$$

1.2 Sources of data and assumptions used for the national projections

An expert group formed by the Commission suggested the base case parameters for the national projections (chapter 2). The Commission tested the implications for ageing of various high and low cases flanking the base case assumptions.

Net overseas migration

For most demographic variables, the major problem in projections is determining a realistic set of future scenarios, but there are generally few problems in the measurement of the actual variable. This is not true in the case of net overseas migration because there are significant problems in measuring the duration of stays and departures of migrants (chapter 2).

Only long-term (over a year) and permanent departures and arrivals are included in the calculation of net overseas migration. However, some short term arrivals and departures are in fact long-term or permanent departures and arrivals, and vice versa. For instance, a significant share of long-term arrivals who record an intention to stay for one than one year in Australia (and are thus included as a migrant in net overseas migration) actually stay for less than this period. The ABS makes adjustments for some of these problems. For example, the original estimates of net overseas migration (inwards) for 2002-03 was 154 225. This fell by 25 percent after adjustment to 116 498 (ABS 2004i). However, problems with the recording of stays and departures by migrants means that there remains significant uncertainties about the real underlying level of net migration.

This difficulty is compounded by tempo effects associated with the future movements of long-term visitors, which could affect projected future levels of net overseas migration (McDonald and Kippen 2002a). The net level of long-term visitors has been strongly rising in Australia. During a period of growth in such visitors, inflows of new visitors must exceed outflows of past visitors, since outflows are drawn from a smaller group of earlier arrivals. However, this could change were net visitor levels to stabilise in the future. The degree to which outflows would catch up with inflows would then depend on the conversion of long-term visitors to permanent immigrants. If conversion factors were low, then outflows would approach inflow levels, and the contribution of long-term visitors to net migration would fall significantly from present levels. All things being equal, this would reduce net overseas migration from present levels. Of course, if conversion factors were higher, this effect is considerably weakened. This issue adds an additional source of uncertainty to future migration levels.

On the recommendation of the expert group, the Commission assumed net overseas migration inwards of 115 000 for each year from 2004-05 in the base case. A fixed age structure for net migration — provided by the ABS — was assumed for all projection years.

For the high case, migration increases linearly from 115 000 in 2004-05 to 140 000 in 2014-15, and then stays fixed at 140 000.

For the low case, migration decreases linearly from 115 000 in 2004-05 to 90 000 in 2014-15, and then stays fixed at 90 000.

Total fertility rates (TFRs)

Projections of future fertility are often based on past trends in the TFR. The TFR is a synthetic measure of fertility, calculated as the average number of children women will bear during their lifetimes *if* they experienced the age-specific fertility rates that apply in a given year at each age of their reproductive lives. It is a useful measure for international comparisons of fertility since it ignores age distributions of fertile women and is simple to construct. However, past trends in the TFR may provide misleading indicators of future fertility for several reasons.

- As in all demographic variables, past trends may not pick up changing attitudes to having children or the effects of new policies (such as recent measures to address some of the costs of having children).
- There has been a significant and still continuing shift in the time in their lives when Australian women bear children (the age profile of fertility). Age specific fertility rates have been falling rapidly for younger women, and this has, after a lag, been followed by increased fertility rates for older women. This tempo effect (box 1.2 and chapter 2) means that during the transition to a stable age profile of fertility, the TFR initially falls and then, so long as the completed fertility rate (CFR)[5] does not fall too greatly, rises somewhat in the long run.

Box 1.2 The tempo effect

The effect of delay on the total fertility rate is called the *tempo* effect by demographers. Examining its importance requires information on age-specific and parity-specific fertility rates (ie the extent to which women have different *given* number of children, such as none, 1, 2 and so on). While these data are often incomplete or unavailable, some studies have been undertaken. Research has revealed strong distorting effects of postponement in European countries and the US (Sobotka 2003, 2004). For example, the TFR fell to below 1.5 in the Netherlands in 1983 and 1984 before resuming a gradual rise to 1.72 by 2000. In contrast, the CFR was 1.87 for the 1952 cohort, which has gone through their most fertile years during the TFR trough.

Reflecting the problems in interpreting the TFR, it has been argued that the concern over below-replacement fertility in the United States over the previous 25 years had been largely misplaced because, after adjusting for the rising age at childbearing, the underlying level of (completed) fertility was essentially constant at very close to two children per woman throughout this period (Bongaarts and Feeney 1998, p. 2).

In an Australian context, Kippen (2003) has undertaken simulations that demonstrate that the distortions to the TFR from tempo effects can be pronounced.

On advice from its expert group, the Commission assumes that the TFR will begin to rise slightly over the next few years. This is also consistent with the Australian fertility projections produced by the UN.[6] In the base case, the TFR is assumed to increase by 0.005 per year from its level of 1.754 in 2003 until 2012, and then increase by 0.001 for the next year, reaching a stable TFR of 1.8 in 2013 (and therefore a long-run CFR also of 1.8). The age–specific fertility rates associated with these TFR were provided by the ABS (figure 1.1). They reflect the continued reduction in the age-specific fertility rates of

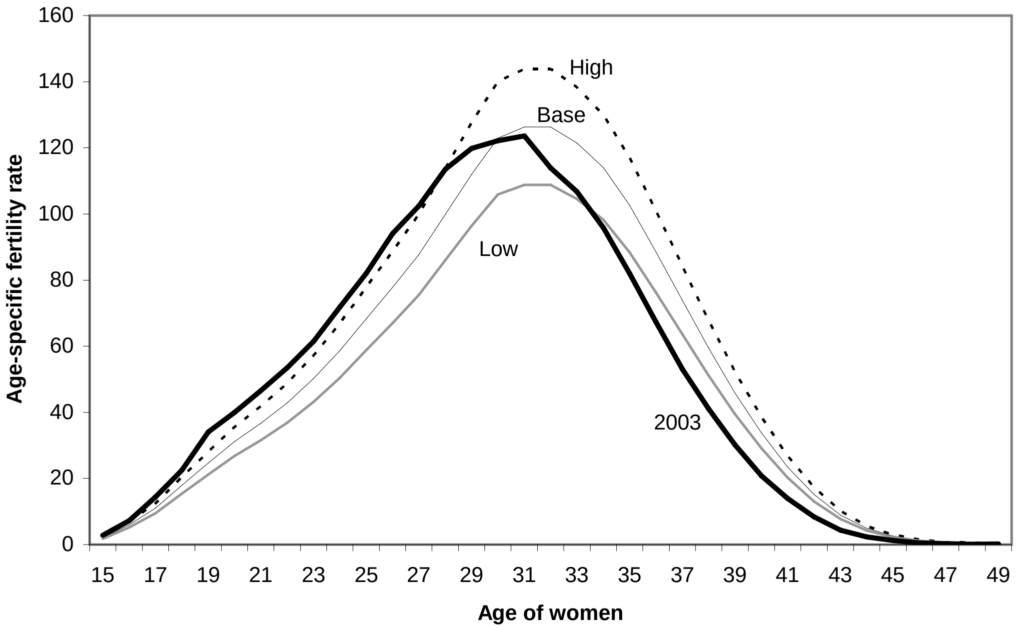
[5] CFRs measure the *actual* life time average number of births per woman of given generation.

[6] The tempo effects are more delayed in the UN estimates. The UN (2003) projects a TFR that initially falls to just below 1.70 before gradually increasing to 1.81 by 2035-40 and stabilising at 1.85 by 2045-50.

younger women (to around 30 years old) and increasing age-specific fertility rates for older women.

Figure 1.1 **The age profile of fertility under different scenarios**

Base, high and low in the long run compared with the 2003 levels

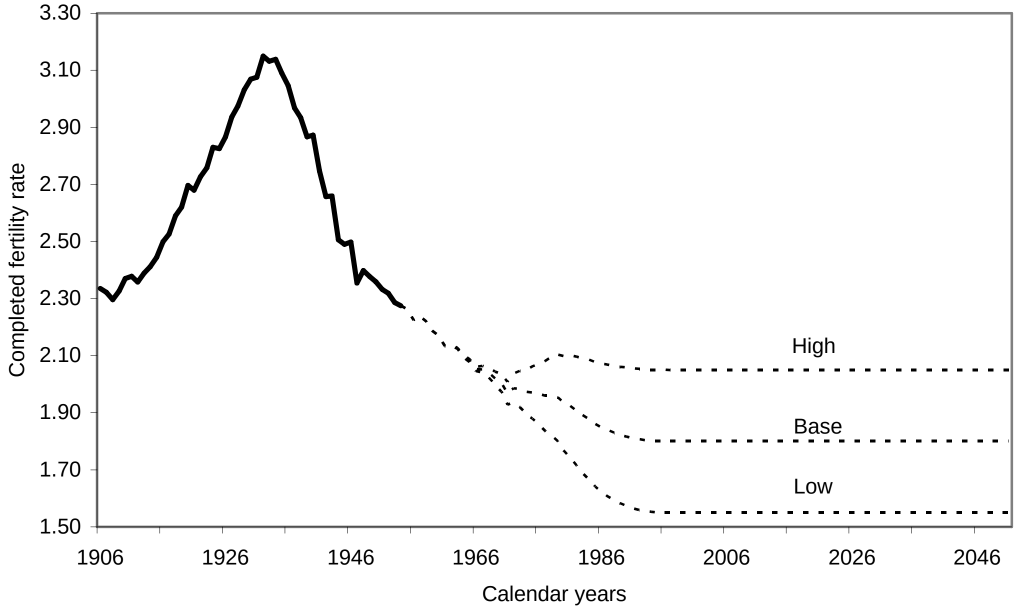


Data source: Unpublished data from the ABS for 2003, ABS estimates for the base case and Commission estimates for the high and low scenarios using Rowland's suggested scaling method (2003, p. 448).

It should be noted that this projected pattern of fertility is still (realistically) associated with a decline in CFRs (figure 1.2) and that it reflects movements in age-specific fertility rates that are quite plausible given historical patterns. To give some indication of the implications of a CFR of 1.8 for the proportion of women at various parity levels, this CFR would, for example, be consistent with: a reduction in the proportion of women having four or more children at the end of their fertile lives from the 1996 levels of 14.5 per cent to 7 per cent; a reduction of the proportion of women with three children from 25.6 per cent to 18 per cent; maintenance of the share of women with two children at 39 per cent; a rise in the proportion of women having only one child at the end of their fertile lives from 10.2 to 18 per cent and finally a rise in the proportion of women that remain childless from 10.7 per cent to 18 per cent. Such a distribution in parities is credible, though clearly policy and other social trends could generate different outcomes. In particular, a concern among demographers is that parity 3 and above contributes roughly half of the CFR, and yet these parities are most affected by postponement of child bearing and social and economic trends affecting women.

Figure 1.2 **Completed fertility rate**

1906 to 2051 female birth cohorts[a]



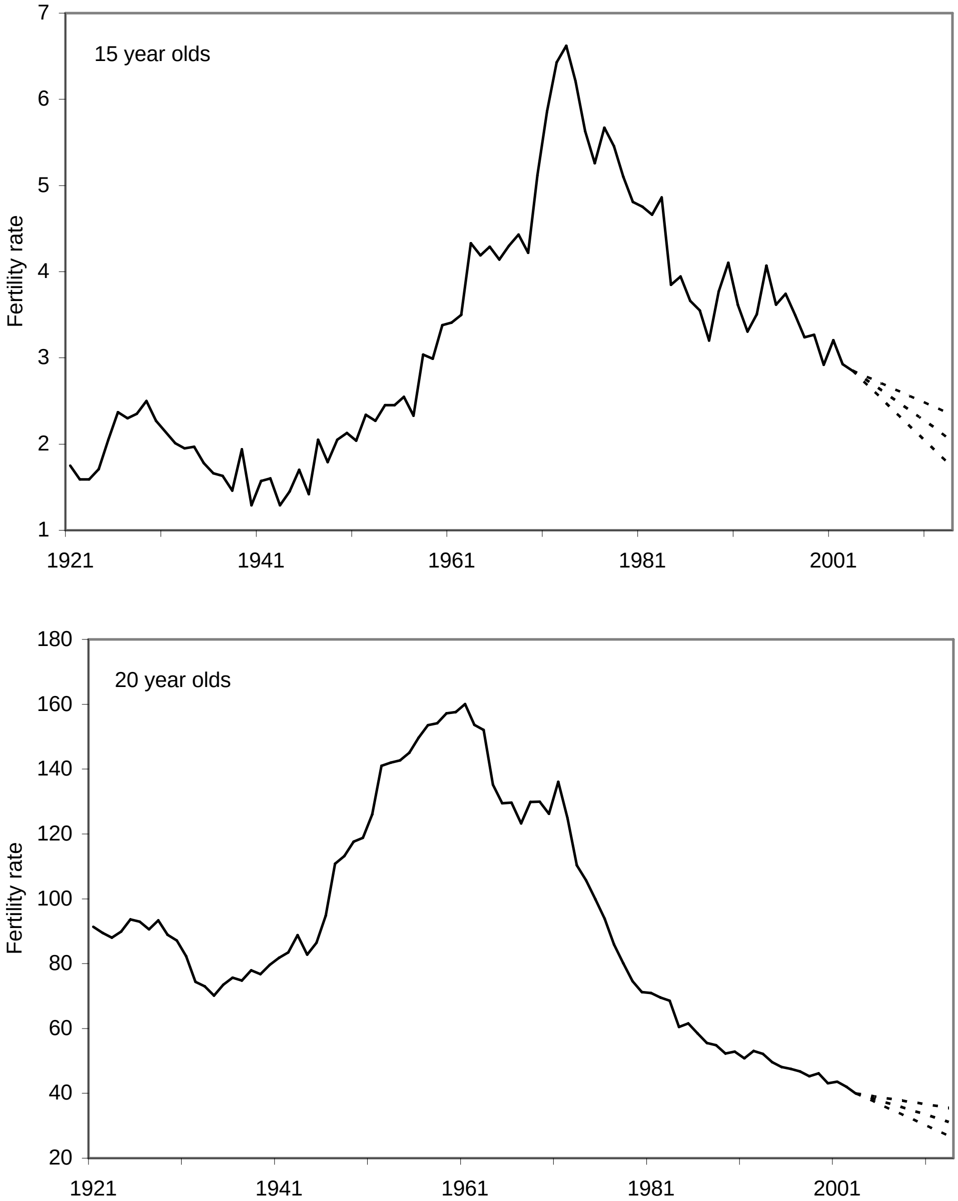
[a] The completed fertility rate is the average lifetime number of children per woman of a given birth cohort. The data up to 1954 is based on historical data, while data for subsequent years are at least partly estimates since they rely on forecasts of age-specific fertility rates for some out years.

Data source: Unpublished data from the ABS based on age-specific fertility rates and projections of age-specific rates made by the Commission.

Because of such uncertainties it is important to consider different scenarios. Quite different future fertility patterns may plausibly emerge. Figures 1.3 to 1.5 show the trajectories of high and low scenarios around the base case, compared with historical trends for a broad range of ages. Such outcomes are less likely than the base case, but are still feasible.

Figure 1.3 **Age-specific fertility rates**

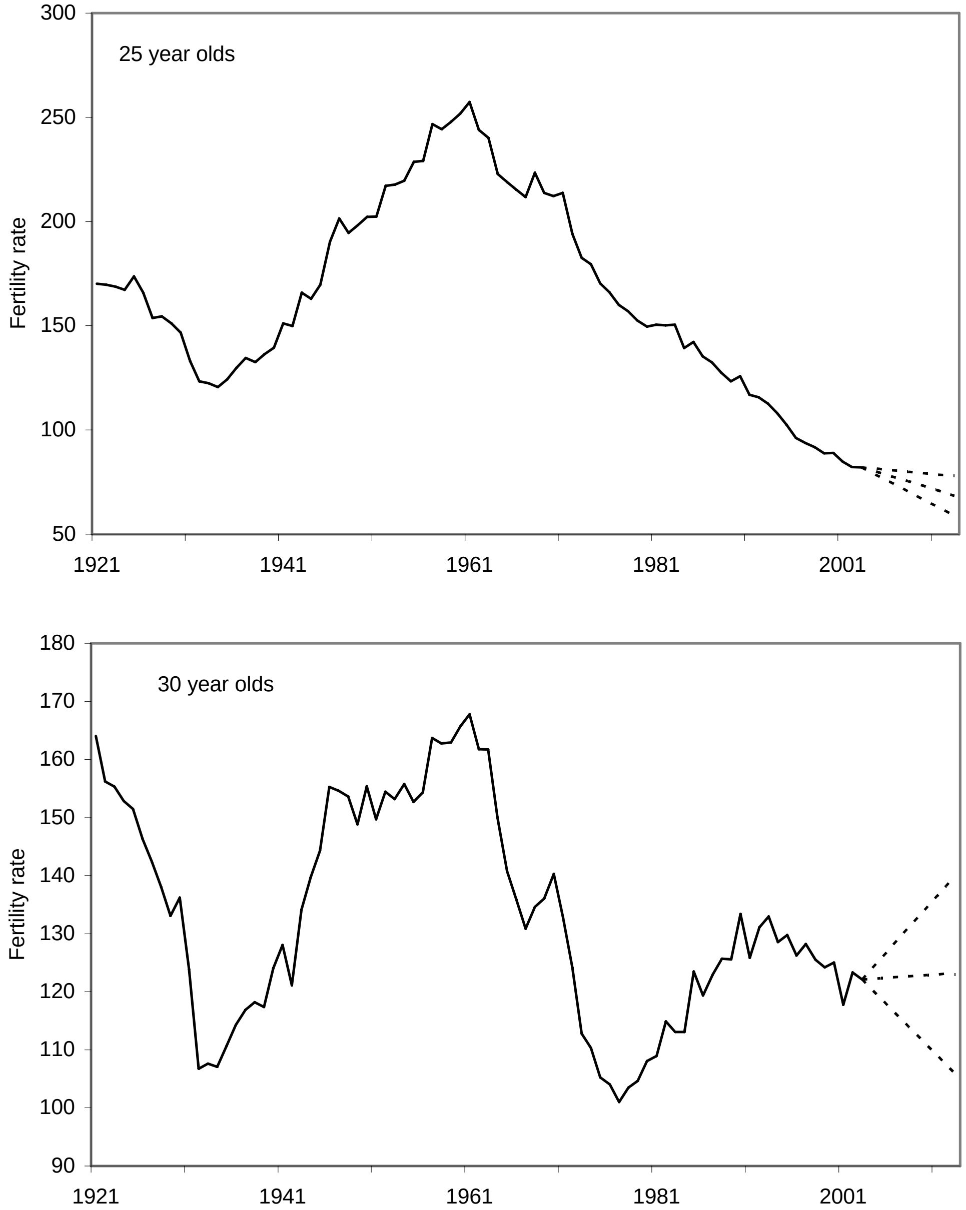
15 and 20 year olds, 1921 to 2013



Data source: Unpublished data from the ABS on age-specific fertility rates and projections of age-specific rates made by the Commission.

Figure 1.4 **Age-specific fertility rates**

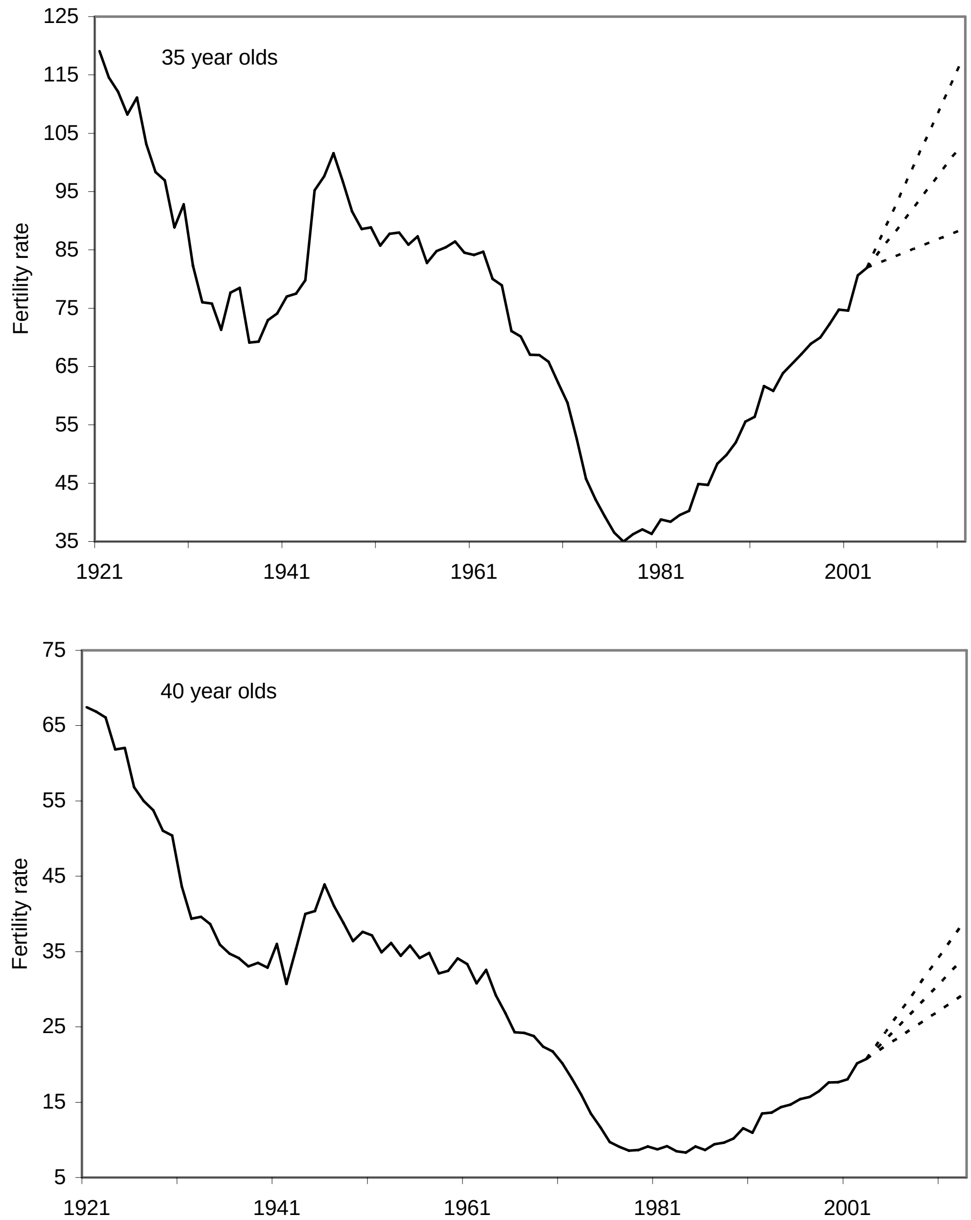
25 and 30 year olds, 1921 to 2013



Data source: Unpublished data from the ABS on age-specific fertility rates and projections of age-specific rates made by the Commission.

Figure 1.5 **Age-specific fertility rates**

35 and 40 year olds, 1921 to 2013



Data source: Unpublished data from the ABS on age-specific fertility rates and projections of age-specific rates made by the Commission.

In the low case, the TFR decreases linearly from its 2003 level to 1.55 in 2013. The age-specific rates associated with this TFR in 2013 were estimated as $ASFR_{x,low} = ASFR_{x,base\ case} . (1.55/1.8)$, where x is years of age from 15 to 49. The age-specific rates for years 2004 to 2012 were linearly interpolated. The low scenario reflects less growth in fertility rates for older women and stronger declines in fertility rates for younger women. It is consistent with some of the projections suggested by Kippen (2004) on the basis of parity data. It suggests a slightly accelerating reduction in the CFR.

In the high case, the TFR increases linearly from its 2003 level to 2.05 in 2013. The age-specific rates associated with this TFR in 2013 were estimated as $ASFR_{x,high} = ASFR_{x,base\ case}$. (2.05/1.8), where x is years of age from 15 to 49. The age-specific rates for years 2004 to 2012 were linearly interpolated. The high case reflects relatively modest future reductions in fertility rates for younger women, combined with large increases in fertility rates for older women associated with the tempo effect. Despite this, this scenario still (realistically) suggests a fall in the CFR.

The PC's demographic model allows the choice of other TFR scenarios, but imposes the same shape (not level) of the age profile of fertility (as in Rowland's 2003 model).

Life expectancy

There have been significant historical reductions in mortality rates, which are widely projected to continue. However, as noted in chapter 2, there are several methods for projecting mortality, with differing implications for the extent of such reductions. For example, Heather Booth's forecasts (commissioned by the PC) using the Lee-Carter method results in bigger reductions in mortality rates than those underlying the ABS B series. On the other hand, Hyndman (2004) has shown that Lee-Carter methods can exaggerate future reductions in mortality (at least for the United States).

In the PC-M series, the Commission has adopted the mortality rates (Q_x) underlying the ABS B series as its base case. This results in a male and female life expectancy of 84.2 and 87.7 years respectively by 2050-51. The Commission considered several other scenarios (with implied life expectancies shown in table 1.1).

- A low gain in life expectancy (PC Low series), in which life expectancy for males and females only rises to 83 and 86 years respectively by 2050-51;[7]. For example, lower gains might be precipitated by rising obesity rates and associated increases in diabetes II. Climate change, antibiotic resistance and new diseases (such as SARS) may also have unexpected impacts on mortality.
- A high gain in life expectancy (PC High series), in which life expectancy for males and females rises to 92.2 and 95 years respectively by 2050-51. These might reflect new medical technologies and lifestyle responses by people to emerging risks, such as diabetes II. The gains considered in this scenario are the same as the life expectancy gains used by the ABS in its series A projections, but the age-specific mortality patterns

[7] This is a departure from the ABS practice in the 2003 population projections, which included only the possibility of medium or high gains in life expectancy.

are slightly different. In particular, the PC high series uses a higher value of Q100+ to maintain the usual shape of the mortality profile by age.

- The ABS A series mortality rates;
- High, medium and low options estimated by Heather Booth from the Australian National University.

The projection program accompanying the report allows other assumptions by users to be assessed as well.

Table 1.1 **Life expectancies associated with various scenarios**

	2004-05		2050-51	
	Males	*Females*	*Males*	*Females*
	years	years	years	years
PC-M / ABS B series	78.4	83.6	84.2	87.7
PC Low series	78.4	83.6	83.0	86.0
PC High series[a]	78.4	83.6	92.2	95.0
Booth Medium series	78.2	83.4	88.0	92.2
Booth Low series	77.1	82.1	83.3	86.4
Booth High series	79.3	84.6	92.4	97.7
ABS High series	78.4	83.6	92.2	95.0

a Although the ABS high series and the PC high series have the same life expectancies, they have a different underlying mortality pattern.

Source: Based on data provided by Heather Booth from the Australian National University, unpublished estimates of Qx from the ABS, and Commission estimates.

Alan Hall (DR51) notes that a useful way of assessing the impact of mortality on the age-distribution is to consider the age structure of the synthetic life table population (table 1.2). This method usefully abstracts from short term influences — such as baby booms or epidemics — that can affect the age structure of a population over the medium term. Mortality-based age structures derived from a life table will only be equivalent to the actual age distribution if the population is stationary (not changing in numbers or age structure), with zero migration (Rowland p. 307). Table 1.2 confirms that much of the future ageing of the population is due to mortality gains already made (noting that the aged dependency rate of the *projected actual* population in 2004-05 is only 19.5 per cent). It also shows that potential for even older age structures in the very long run relative to those likely to be encountered in 2050-51, especially in scenarios in which life expectancy gains to that year gave been large. For example, the potential long-run age dependency rate under Booth's high case (given the life table for 2050) is around 62 percent, whereas the projected observed dependency rate for 2050-51 is 10 percentage points less. The dependency ratios predicted on the basis of mortality rates at 2050 are close to those of population projections to 2151 (chapter 2).

Table 1.2 **The aged and total dependency ratios associated with life table mortality rates versus projected populations**

	2004-05		2050-51	
	ADR	*TDR*	*ADR*	*TDR*
Using Life tables[a]				
PC-M / ABS B series	36.9	67.7	45.4	76.0
PC Low series	36.9	67.7	42.4	73.0
PC High series	36.9	67.7	58.8	89.1
Booth Medium series	36.1	67.0	52.1	82.5
Booth Low series	34.3	65.2	42.8	73.4
Booth High series	38.0	68.8	61.6	91.8
ABS High series	36.9	67.7	58.6	88.8
Projected populations				
PC-M	19.5	48.5	42.7	69.8
PC Low series	19.5	48.5	38.4	65.3
PC High series	19.5	48.5	49.5	76.5
Booth Medium series	19.4	48.5	43.5	70.3
Booth Low series	19.4	48.4	39.5	66.6
Booth High series	19.5	48.6	52.6	79.5
ABS High series	19.5	48.5	50.5	77.5

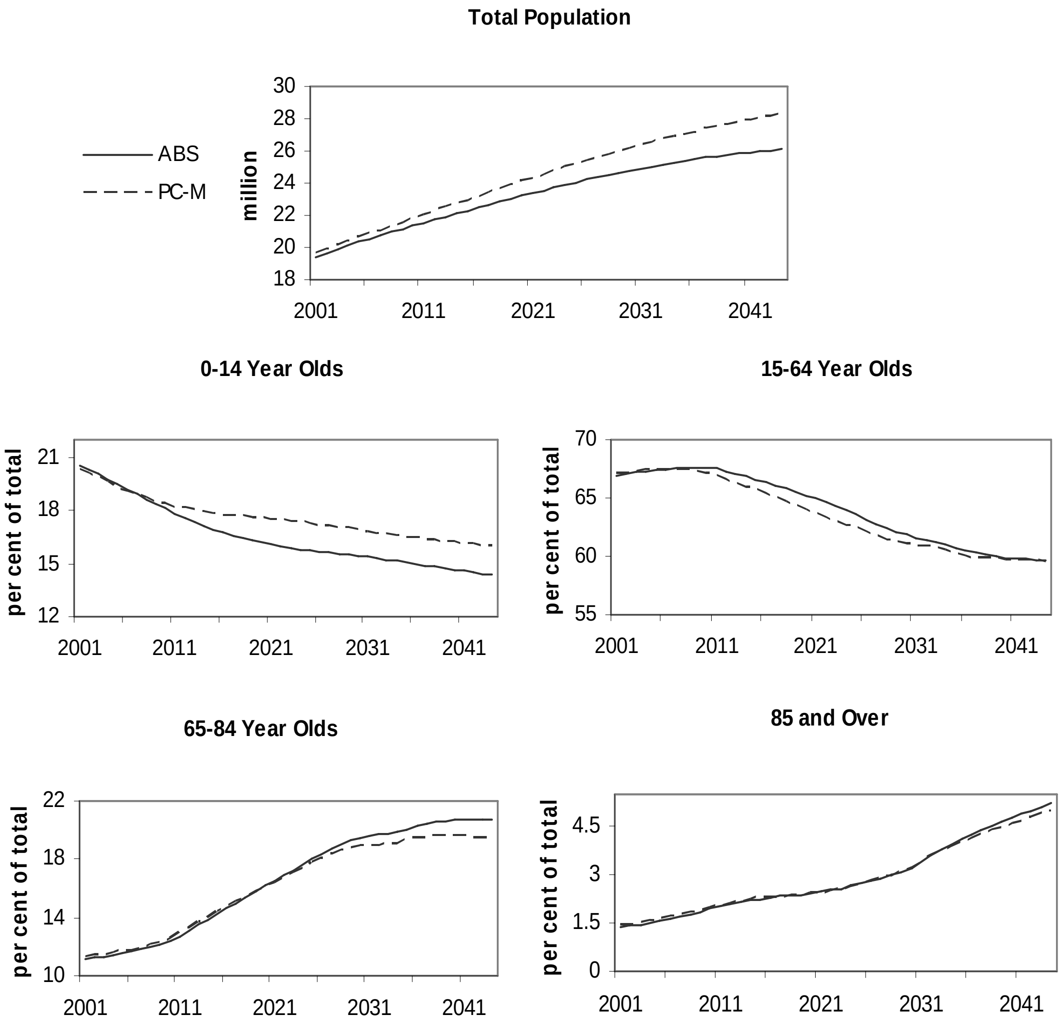
a The life table dependency ratios are based on adding up Lx for males and females for the old and young and comparing with the sum of Lx for people aged 15-64 years. Alan Hall (sub. DR51) and Rowland (2003) provide more information on the methods and interpretation.

Source: Based on data provided by Heather Booth from the Australian National University, unpublished estimates of Qx from the ABS, and Commission estimates.

How do the new projections compare with the ABS B series?

The Commission's PC-M series have a higher population than the ABS B series, reflecting the higher fertility and net migration assumptions. They also result in less ageing (figure 1.6).

Figure 1.6 **Differences between the ABS B series and the PC-M series**



Data source: ABS B series data and Commission estimates.

1.3 Northern Territory demographic projections

The cohort-component model is also applied for the demographic projections for Indigenous and non-Indigenous populations of the Northern Territory. When summed, these produce a different estimate of the Northern Territory population than that estimated under the PC-M model. The alternative total for the Northern Territory population is referred to as the PC-NTALT model.

Estimating sub-populations for the Northern Territory involve several complicated methodological and data issues.

Net overseas migration

Zero net Indigenous net migration was assumed for the Northern Territory. For the non-Indigenous population, it was assumed that about 0.3 percent of Australian net inwards migration was directed to the Northern Territory (the assumption used by the ABS in its B series population projections in 2003). This results in net inwards migration of 345 per year. The age structure applying to all Australian net inwards migrants is assumed for overseas migrants to the Northern Territory. In the high migration case, 500 net migrants a year were assumed, while in the low case, 200 were assumed.

Net interstate migration

As well as net migration overseas, people may migrate to and from other States. This is referred to as net interstate migration and is calculated as Northern Territory arrivals minus Northern Territory departures. Several approaches were adopted for net interstate migration, depending on Indigenous status.

Net migration plays a particularly important role for non-Indigenous demography in the Northern Territory. Arrival and departure numbers are large and have significant potential effects on the age distribution of the population. It is quite common for projections — as in the approach used for net overseas migration to Australia — to assume a constant value of net interstate migration with a fixed age distribution for all projection years. However, in the case of the non-Indigenous population, simulations revealed that such a projection method can result in the complete depletion of populations in some age–sex ranges. This is unrealistic as outflows could be expected to fall as the sub-population in a given age–sex range fell, and this would then result in net migration inflows for this age range. To overcome the limitations of this approach, the Commission separately modelled inflows and outflows. This was achieved by estimating inwards and outwards interstate migration *propensities* for each age–sex group and applying these to population numbers. Propensities for outward interstate migration (POIM) from the Northern Territory (used to estimate departures from the Northern Territory) were calculated as:

$$POIM_{x,s} = OIM_{x,s} / NIPOPNT_{x,s}$$

where OIM is outward interstate migration from the Northern Territory and NIPOPNT is the non-Indigenous population of the Northern Territory. The propensities were estimated for five year age intervals from 2001 Population Census data provided by the Northern

Territory Government, with propensities for single years of age derived using cubic spline methods.[8] It was assumed that these propensities remained fixed over time.

Propensities for inward interstate migration (PIIM) to the Northern Territory (used to estimate arrivals to the Northern Territory) were calculated as:

$$PIIM_{x,s} = IIM_{x,s} / POPAUS_{x,s}$$

where IIM is inward interstate migration to the Northern Territory and POPAUS is the total population of Australia less the Northern Territory.[9] As above, single year of age propensities were estimated for 2001, and were assumed to remain fixed over time.

These propensities were then applied to one year lagged NIPOPNT (estimated by the Commission) and POPAUS (ABS series B) projections to derive the inflows and outflows of non-Indigenous people in the Northern Territory.

For Indigenous people in the Northern Territory, a fixed annual value for net interstate migration was assumed (similar to the approach used for net overseas migration to Australia), with a fixed age distribution based on age of arrivals versus departures from Census data (provided by the Northern Territory Government).[10] The ABS used the same approach in its projections. This is a feasible approach because net interstate migration by Indigenous people in the Northern Territory is very small, averaging around -75 from 1996 to 2001 (ABS 2004g, p. 17). The base case for Indigenous population projections assumes net interstate migration of -75 for the Northern Territory (as in the ABS's experimental estimates). A low and high case of -100 and -50 respectively was adopted.

Fertility

Fertility is measured as in the Australia-wide projection model. Fertility rates for Indigenous women have been falling rapidly. The age-specific fertility rates for calendar years 2001 to 2003 were estimated from various ABS sources using cubic splines, with adjustment for birth over counts, as undertaken by the ABS.[11] In the base case it was

8 Cubic splines were applied to the cumulative shares of departures by age, and then differenced to obtain propensities by individual year. This ensured that the single year data added up to interval data.

9 Ideally, POPAUS would exclude Indigenous people, but no long term projections of all Indigenous people are readily available. In any case, the bias resulting from their inclusion is so small as to be irrelevant because of their small share of the overall non-Northern Territory population.

10 Data were smoothed and interpolated to provide information for single years of age.

11 The 2001 data were from ABS (*Experimental Estimates and projections, Aboriginal and Torres Strait Islander Australians, 2004,* Cat. no. 3238.0, p.14). The 2002 and 2003 data were from ABS

assumed that in the ensuing years the age-specific fertility rates took 30 years to reach the fertility rates applying to Australia as a whole in 2013, and then stayed fixed. This gave a TFR nearly identical to that used for the relevant years of the ABS experimental estimates to 2009 (for example, in both cases the TFR was 2.4 in 2009). Under the low fertility case, it was assumed that the transition took 20 years, while in the high fertility scenario, it was assumed that it took 40 years.

The fertility rate for non-Indigenous Northern Territory women is much lower than for comparable Indigenous women, but still higher than other Australian women. Under the base case, it is assumed that the age-specific fertility rates take 15 years to reach the anticipated fertility rates applying to Australia as a whole in 2013, and then stayed fixed. Under the low case, the transition is completed in 10 years and in the high case, 20 years.

Paternity

Birth rates where the mother is non-Indigenous and the father is Indigenous are referred to as ‘paternity’ (ABS 1995). Children born from these relationships are counted as part of the Indigenous population. The method for calculating of the number of Indigenous births associated with paternity is similar to that for fertility:

$$B_t = \frac{1}{2}\left(\sum_{x=15}^{49} PR_{x,T} \times P_{x,f,t+} + \sum_{x=15}^{49} PR_{x,T+1} \times P_{x,f,t+1} \right) / 1000$$

where PR is the paternity rate, defined as the number of children of Indigenous fathers that are born to non-Indigenous women per 1000 Indigenous fathers. These births are simply added to Indigenous births associated with fertility. Of course, these births must be subtracted in the projections for the non-Indigenous population.

Age-specific paternity rates of Indigenous fathers (PR_x) for June 2001 were estimated from ABS data (2004g) using cubic splines. Under the base case it was assumed that paternity rates grew logistically:

$$PR_{x,t} = (1 + \frac{1}{1 + \frac{(1/s - 1)}{1.05} \times 1.05^{(t-2001)}}) \times PR_{x,t-1}$$

with a growth in the first year of s (with s = 0.02 or 2 percent growth). The ABS assumed zero change in paternity rates in the Northern Territory in its experimental estimates to 2009. However, Northern Territory paternity rates are much lower than all other

(*Births Australia*, Cat. no. 3301.0) with adjustment for over counts from the Experimental Estimates publication (p. 76).

jurisdictions, so this is probably not a realistic assumption over the long projection horizon used by the Commission.[12]

In the high paternity rate case, it was assumed that s = 0.05 and in the low case, s = 0.01.

Life expectancy

The life expectancy assumptions used for Australia as a whole (above) were used to generate non-Indigenous population estimates for the Northern Territory (with high, medium and low life expectancy scenarios for non-Indigenous Northern Territorians set to the equivalents for Australia).

The expected long-term trend for Indigenous life expectancy in the Northern Territory is more difficult to forecast. This reflects several factors.

First, there are inadequacies in data on Indigenous deaths and population estimates that may distort historical trends in life expectancy (ABS 2004h, AIHW 2004, p. 195). These inadequacies appear to be less severe for the Northern Territory (ABS 2004h, p. 11), which probably reflects fewer difficulties in the identification of Indigenous status and smaller migration flows in that jurisdiction. Some commentators — for example, Ring and Firman (1998) — consider that there have been few, if any, improvements in health status and life expectancy in Indigenous Australians in the Northern Territory and Western Australia from the 1980s. Indeed, some sources of mortality have been increasing, such as diabetes (Ring and Firman) and smoking-related lung cancers (Condon et al. 2004a). In its most recent set of experimental projections and estimates of the Indigenous population, the ABS (2004) *assumed* no reduction in age-specific death rates between 1991 and 2009 for Indigenous people in all jurisdictions. However, the ABS emphasise that further research is needed to identify trends. The ABS is presently collaborating with the AIHW to determine whether Indigenous mortality has changed over recent decades. The most recent authoritative study of Northern Territory Indigenous mortality patterns over the period from 1966 to 2001 (Condon et al. 2004b) suggests that, in fact, there have been some beneficial reductions in mortality in that jurisdiction. The reductions were predictably greatest for infants (with a decline of 85 per cent over the period). Much more modest gains were realised for older Indigenous people (of 30 percent in females and 19 percent in males aged 5 years and over).

Second, there is much uncertainty about how rapidly policy measures aimed at addressing Indigenous disadvantage will begin to work. On the available data, Indigenous Northern

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[12] For example, the average Australian paternity rate of Indigenous fathers was 6.4 in 2001 compared with 1.0 for the Northern Territory. It should be noted that the ABS explored the implications of trend growth rates in paternity rates of 1, 2 and 5 percent, as well as its base case zero assumption.

Territorians can expect to live around 20 years less than their non-Indigenous counterparts. This provides the potential for substantial catch-up in life expectancy if the underlying causes of elevated mortality rates can be addressed (such as better health services; enhanced housing, education and work opportunities; improved diet; and reduced smoking and substance abuse). For example, Condon et al (2004a) note that enhanced pap test programs among Indigenous women could significantly reduce the high rate of fatalities associated with cancers of the cervix. Governments around Australia are trying to address these underlying causes. The experience of some other indigenous groups — such as New Zealand Maoris and Native Americans — suggest very significant increases in life expectancy can occur over several decades (Ring and Firman 1998).

In the projections undertaken for the Northern Territory, the Commission explores three scenarios for life expectancy.

The medium case

Under this case, it is assumed that it takes 100 years to realise the average life expectancy experienced by Australians as a whole in 2001-02. This implies a gain in life expectancy for males of around 11 years to 2044-45 and 12 years to 2050-51 or about 0.25 years per year (this is equivalent to one of the options selected by the ABS in its experimental estimates). Gains of this magnitude and from the same starting base were realised by the (mainly) white population of Australia over roughly 50 years in the mid 20th century. For example, male Australian life expectancy improved from 57.6 to 69.6 from 1915 to 1976 (61 years), while female life expectancy improved from 65.2 years to 75.7 years from 1927 to 1974 (47 years). So it is clearly *technically* possible for sustained life expectancy gains of this magnitude over periods less than 100 years.

That said, the gains generally eclipse those apparently measured for Indigenous populations in the last 30 years. This scenario requires less rapid gains in infant mortality than found by Condon et al. (2004), but significantly better gains for older Indigenous people, particularly males. For example, it would imply a 50 per cent reduction in mortality rates (Q_x) for males aged 35 years over the 34 year period from 2000-01 to 2034-35, which is much more than the gains occurring over the 34 year period from 1966-67 to 2000-01 for this group.

The overall gain in life expectancy would still leave a large gap in life expectancy between Indigenous and non-Indigenous Northern Territorians.

It should be emphasised that a gain of 11 years in life expectancy does not mean that an average middle aged Indigenous person alive today will benefit from a 11 year extension of life.

The low and high cases

Under the (pessimistic) low scenario, no improvement in life expectancy occurs over the projection horizon.

Under the high scenario, the Commission assumes that it takes 60 years to realise the average life expectancy experienced by Australians as a whole in 2001-02. This implies a gain in life expectancy of around 16 years for males to 2044-45 and 18 years to 2050-51 or about 0.37 years gain per year. This optimistic scenario has lower gains than the highest scenario explored by the ABS in its experimental estimates to 2009 (which assumed gains of 0.5 years of life expectancy per year).

The Commission emphasises the particularly large effects of uncertainty about mortality trends for population projections for the Indigenous population of the Northern Territory. The Commission has included the projection program used to generate Indigenous population estimates and users can nominate alternative assumptions.

Unexplained growth

A major concern of the ABS is that there are discrepancies between populations in successive five year population censuses that cannot be explained by estimated deaths, births, net interstate migration and net overseas migration over the intervening period. In particular, Indigenous populations grow at a faster rate than expected, with annual unexplained growth of 1.6 per cent for Indigenous populations in Australia as a whole from 1996 to 2001 (ABS 2004g, p. 19). Problems in collection of Indigenous demographic statistics represent one reason for this. Another major factor is that some people who once identified themselves as non-Indigenous subsequently identify themselves as Indigenous. However, this problem is much less severe for the Northern Territory, with only 0.3 percent unexplained growth per annum from 1996 to 2001. This issue has been ignored in the projections undertaken here.

Differences with the PC-M population estimates for the Northern Territory

The projections under the PC-M model (as in the B series before them) give a different picture of the total Northern Territory population than that provided by adding together the sub-populations estimated above (PC-NTALT). Overall, the population projected under PC-NTALT is significantly less than the PC-M series for the Northern Territory (about 75 percent of the PC-M series by 2050-51 or around 80 000 less people). Overall, the Commission considers that PC-NTALT provides the best overall view of the Northern

Territory population, since it takes account of the different trajectories of the sub-populations.

3 Ageing and labour markets

Key points

- Labour participation rates — the proportion of people in a job or looking for one — are inherently lower at older ages. By increasing the proportion of older people, population ageing will depress aggregate participation rates.
  - Over the next 40 years, aggregate labour force participation rates in Australia are projected to fall by around 7 percentage points from their current level of 63.5 per cent to 56.3 per cent by 2044-45.
  - Falling aggregate participation rates still occur even in scenarios in which labour participation rates for specific age/sex groups, such as older males, increase substantially.
  - There are few prospects that the demographic effects on participation can be significantly offset except through government interventions that raise participation rates broadly.
- Average weekly hours worked per employee are projected to fall. This reflects the rising incidence of part-time work generally and the increasing labour market share of older workers, who have a greater tendency to work part-time than others.
- Ageing has a small positive twist for unemployment. This reflects the fact that unemployment rates tend to be highest for young people, being in transition from education to work, and lowest for older people, who have the alternative of retirement.
- The negative effects of ageing on participation and average hours worked far outweigh the positive influences via lowered unemployment.
- Overall, labour supply grows much more sluggishly as a result of ageing.
  - In the 7 years from 2003-04 to 2010-11, the number of workers is projected to grow by around one million, while it would take nearly the full 21 years from 2023-24 to 2044-45 for the same growth to occur.
  - In the next 40 years, effective labour supply growth will grow more slowly than the population (unlike in the past), so that hours worked per capita decline by around 10 per cent.
- Relatively small increases in the average age of employees are anticipated over the next 40 years — roughly 1.8 years for males and 2.6 years for females.
- Even with the projected decline in participation, the ratio of employees to the total population will be higher in 2045 than at almost any time in the last century.
- Volunteering rates are likely to increase modestly in the next 40 years. This is mostly attributable to the decline in the population share of young people, who tend to have relatively low volunteering rates.

3.1 Why does ageing matter for the labour market?

At the turn of the 20th century, many older Australian males worked until near death, enjoying a relatively brief retirement. Consequently, in that era, workforce ageing did not have much effect on the total male labour supply.

In the ensuing century, Australians gained around 20 years of extra life expectancy and earned nearly five times more income per capita — fundamentally altering the nature of their expectations about leisure and work. Today, many males are anticipated to participate in the formal labour force for less than half of their (roughly) 80 year life expectancies.[1] Labour force participation for *both* sexes is now concentrated in the ages from 20 to 55 years.[2] People have lower participation rates at earlier ages (when acquiring education) and at higher ages (when many have voluntarily or involuntarily retired, or have cut back their involvement in work).

If this pattern persists, then the shift in the age structure of the population over the next half century will imply that many more Australians will be in age groups that have lower labour market involvement. Other things being equal, this can be expected to slow labour supply and, in turn, economic growth. Since governments fund services through taxes on current income, a fall in economic growth will affect the future ability of Australian governments to generate revenue to meet health, aged, education and other obligations.

Ageing may also have other labour market consequences. Today's generation of older workers have different characteristics to middle-aged and younger workers. For example:

- they are more experienced, but on average less educated and receive less training;
- they appear to be more productive than younger workers, but slightly less so than middle-aged workers;
- they are less likely to become unemployed than other age groups, but once unemployed take longer to find a new job;
- in any given year, they tend to change jobs less often and are less willing or able to move jobs to another location; and
- they tend to have a greater incidence of disability and ill health, and suffer some general physical and cognitive declines.

1 The labour force includes those *with* jobs and those *looking* for work.

2 Box 3.1 gives the usual definition of participation and other standard definitions of labour supply.

Box 3.1 Definitions of terms used in labour supply

There are several measures of labour markets and their links to the population. These are useful building blocks for describing the past and in modelling future scenarios.

- The *prime workforce* is the population aged between 15 and 64 years inclusive, covering those years when formal employment is most likely. This is more commonly referred to as the *potential workforce*, but this label can be misunderstood since it inaccurately implies that labour force participation rates are zero at ages after 64 years.
- The *effective labour supply* is the total supply of hours worked.
- The *feasible workforce* is the number of people who could feasibly be in the labour force and is measured as the civilian population. It is the base used to determine the labour force participation ratio.
- The *aged dependency rate* is the ratio of the 'old' (those aged 65 years and over) to the prime workforce.
- The *youth dependency rate* is the ratio of the 'young' (those aged below 15 years) to the prime workforce.
- The *labour force* includes all people in the civilian population who are in work (the *employed*) or actively looking for work (the *unemployed*).
- The *civilian population* is the Australian resident population aged 15 years and over, less permanent defence personnel.
- The *participation rate* is the share of the labour force in the civilian population (that is, as a share of the feasible workforce).
- The *unemployment rate* is the share of the labour force who are unemployed.
- An overall summary of the extent to which a country's population is actively employed is given by the *employment to population ratio* — the share of the population who are employed.

To the extent that these differences persist, they suggest that an ageing population may reduce unemployment, but also decrease labour market flexibility. The variations in worker productivity over different ages, combined with possible macroeconomic effects of ageing on capital accumulation and innovation, suggest that ageing may affect worker productivity too (chapter 4).

Of course, the old of tomorrow are likely to be different from the old of today, and this may also affect labour market outcomes. For instance, at given ages they may be healthier and more highly educated. This may mean higher labour market participation rates and productivity than would be anticipated from the characteristics observed among the current old.

It should be emphasised that the labour force does not count non-market activities as ‘employment’. It excludes unpaid work, such as home activities like cooking, cleaning and childcare, and volunteering generally. Ageing may affect the amount of these economically and socially valuable activities. For example, per capita unpaid contributions outside the home made by people aged over 65 years are greater than those made by the young, but less than those made by middle aged groups (de Vaus et al. 2003). While they may not be counted as part of GDP and the labour force, some account needs to be taken of age-related trends in these activities in reaching a view about how well off Australians will be in generations to come.

In sum, ageing matters for labour markets and prosperity in numerous ways. This chapter is one of three that pieces together the jigsaw of effects that ageing may have for labour markets, aggregate labour supply and economic growth over the next half century. This chapter:

- sets out the framework for estimating future labour supply and economic growth;
- examines past trends in key labour supply measures;
- explores the mechanisms that will shape the impact of population ageing on labour markets, using the past as a guide to what may be important in the future; and
- provides projections of labour supply.

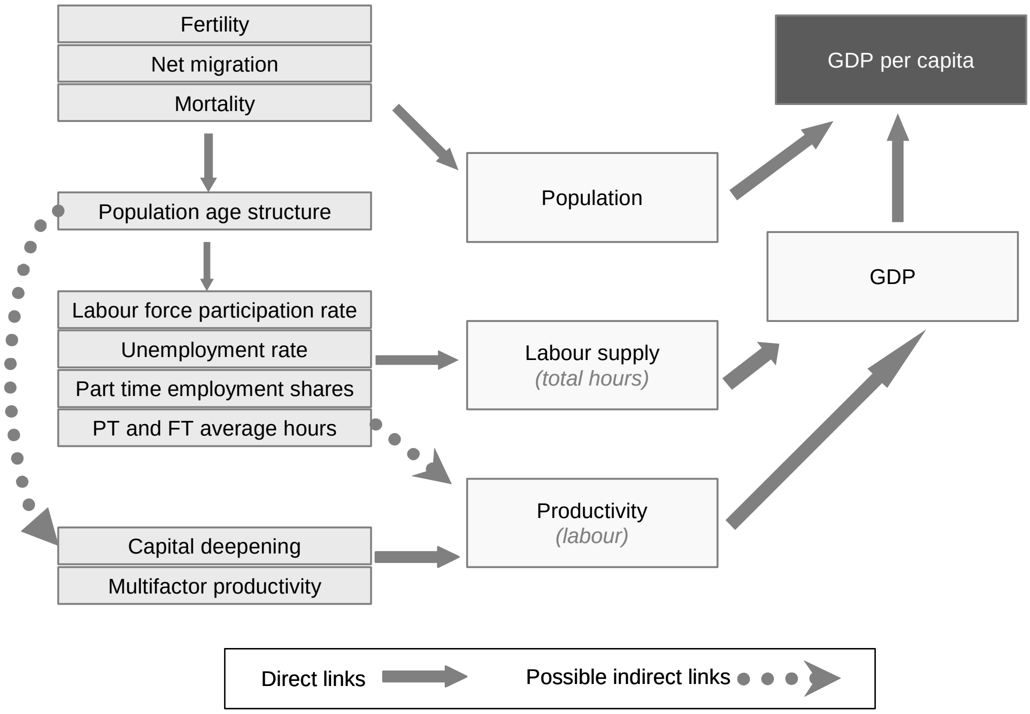
Chapter 4 provides evidence on the possible labour productivity effects of an ageing population. Finally, chapter 5 brings these elements together into projections of economic growth (and the contributing role of ageing) for Australia and its individual States.

3.2 The determinants of economic growth

The sum of a nation’s (recorded) economic output per capita (measured as GDP per capita) depends broadly on three things, now popularly referred to as the three ‘Ps’ (figure 3.1):

- *population* — the total number of people (*and* the associated number of people of working age);
- *participation* — the amount of work measured as the number of hours of work undertaken in any given year; and
- *productivity* — labour productivity or output per hour.

Figure 3.1 **The three Ps of national economic output**[a]



[a] The figure expands upon the conceptual framework outlined by Henry (2003).

The first P has been discussed and projected in chapter 2. This chapter and the next are devoted to projecting the latter two Ps.

Estimating future economic growth is like peeling an onion. GDP per capita can be represented as the multiple of a chain of other labour market and other economic variables (box 3.2).[3] The percentage increase in GDP per capita in any given year is approximately equal to:

- the percentage increase in the labour participation rate;
- minus the change in the unemployment rate (*not* the percentage change);
- plus the percentage change in average hours worked per employee;
- plus the percentage increase in the ratio of the civilian population (civilians aged 15 years and above) to the total population; and
- plus the percentage change in labour productivity.

[3] A similar approach was adopted by Bacon (1999) and the Intergenerational Report.

Box 3.2 **The algebra of economic growth**

In formal terms, growth can be broken into its various constituent parts as follows:

$$\frac{GDP_t}{POP_t} \equiv \frac{LF_t}{CPOP_t} \times \frac{EMP_t}{LF_t} \times \frac{Hours_t}{EMP_t} \times \frac{CPOP_t}{POP_t} \times \frac{GDP_t}{Hours_t}$$
$$= \frac{LF_t}{CPOP_t} \times (1 - UR_t) \times \frac{Hours_t}{EMP_t} \times \frac{CPOP_t}{POP_t} \times \frac{GDP_t}{Hours_t}$$

where CPOP is the civilian population, POP is the total population, EMP is employment, LF is the labour force, GDP is (real) gross domestic product, Hours are total hours worked and UR is the unemployment rate.

In turn, this identity can be reformulated in growth terms, so that:

$$\Delta \log \left(\frac{GDP}{POP} \right)_t \equiv \Delta \log \left(\frac{LF}{CPOP} \right)_t + \Delta \log (1 - UR)_t + \Delta \log \left(\frac{Hours}{EMP} \right)_t +$$
$$\Delta \log \left(\frac{CPOP}{POP} \right)_t + \Delta \log \left(\frac{GDP}{Hours} \right)_t$$

noting that for small changes, Δlog x is close to the percentage change in x.

This simple formulation provides a basis for a modular approach to projecting GDP per capita — projections for each component can be made separately and simply added together. This report uses many methods for deriving the components, such as cohort analysis, econometric models of trends and educated assumptions.

Generally, each of the layers is examined at the ‘age-gender-state-time’ specific level and, in some cases, at even more disaggregated levels. For example, in the case of average hours worked per week, the total is derived by separately projecting average hours by sex, age group, State location, and part-time or full-time status from 2003-04 to 2044-45. When weighted by employment shares, these sub-components give an estimate of aggregate average hours worked.

By considering how any given labour market characteristic varies by age, it is possible, by keeping age shares fixed, to conjecture what would have happened had population ageing not occurred. However, it should be emphasised that the validity of such ‘thought experiments’ depends on whether other variables do not also change as the age structure changes (box 3.3).

Box 3.3 **Accounting for feedbacks**

While each component of labour supply can be considered separately, there may be feedbacks from one component to another.

- As well as affecting population growth, changes in fertility rates may influence the propensity of women to participate in the labour force (and vice versa).
- Productivity shocks may be associated with changes in labour participation, since they affect wage rates and the attractiveness of working (while aggregate productivity rates may reflect compositional effects associated with shifts in the age structure of the workforce).
- The biggest effects on average hours worked arise from shifts in the composition of labour participation from full-time to part-time work, from males to females, and from younger to older workers, rather than a change in average hours worked for full-time or part-time jobs per se.
- Several interacting processes affect the labour force over the business cycle. It may be important when undertaking trend analysis of participation and unemployment rates to *control* for these business cycle impacts, so as to better estimate any trend components for projections. But such cyclical effects on participation rates are unlikely to matter for the long-run projection of participation rates.
- There may be links between increases in participation rates and part-time work for some older age groups, as people marginally attached to the labour force are more likely to secure part-time jobs than full-time jobs.

3.3 Labour supply trends: the view backwards

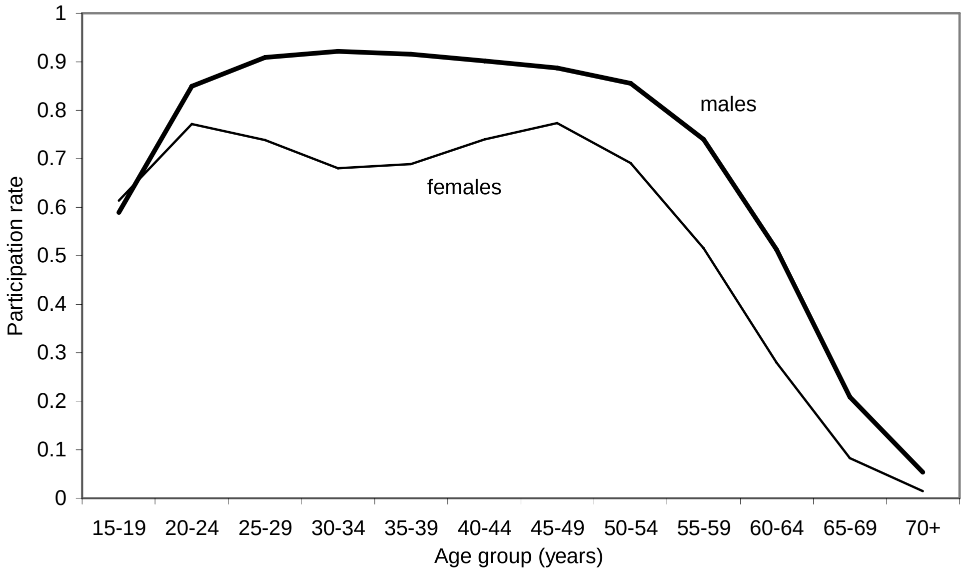
This section briefly considers each of the major components used to derive effective labour supply (figure 3.2) and their links with ageing as suggested by past patterns.

Figure 3.2 **Deriving total hours worked (labour supply) per capita**

Labour participation rates

A major feature of labour participation is that different age groups have persistently different likelihoods of participating in the labour market, with lower participation rates for the very young (reflecting involvement in education) and for older Australians (mainly reflecting retirement preferences and disability). This age profile of participation rates underlies the importance of the changing age structure of the workforce in shaping aggregate participation rates (figure 3.3).

Figure 3.3 **Participation rates are higher for males than females**
2003-04



Data source: ABS (*Labour Force, Australia, Detailed*, Cat. no. 6291.0.55.001).

There have been large shifts in participation rates over time. After a long gradual slide in the participation rate from the mid 1850s (with more women in the population), Australia's participation rate climbed by around 10 percentage points from the Second World War to the new millennium (reflecting a rise in female participation). At around 63 per cent, it is currently at an historical peak for the post-war period (figure 3.4). It is likely that most of the long-term trends are explained by slow changes in social and institutional factors, particularly changing attitudes to and preferences by women for paid employment.

Superimposed on the long-run trend are short-term swings in participation associated with the business cycle — usually regarded as reflecting the so-called 'encouraged/discouraged worker' effect. Since job search is costly, a lower probability of getting a job reduces the payoff from seeking a job. This discourages active participation when the probability of getting a job is low, such as during economic slowdowns, and increases it in times of economic buoyancy. Working against this 'encouraged/discouraged' worker effect is the 'added' worker effect, which occurs when a member of a household enters the labour market during an economic downturn to provide substitute income for a partner who has lost his or her job. The empirical evidence suggests that the added worker effect is not significant, and as a consequence, labour participation rates are procyclical.

The Department of Employment and Workplace Relations (DEWR sub. DR71, pp. 4-6) suggested that net encouragement effects would generate long-run increases in participation rates, and that the Commission should build these into its projections:

> As long as cycles in the economy continue, this asymmetry [between encouragement and discouragement] will tend to increase participation rates.

This conjecture was based on evidence of a long-run relationship between participation rates and employment to population rates, which DEWR saw as capturing encouraged/discouraged worker effects. However, the finding that cyclical effects of this kind have such protracted impacts may be associated with deficiencies in the employment to population ratio as a measure of job search success. As noted by Reserve Bank of Australia research (Debelle and Vickery 1998), the employment to population ratio has drawbacks in this role. For a given ratio of the civilian population aged 15+ to the population, the participation rate is exactly equal to the employment to population ratio plus the unemployment to population ratio. Given this, while higher employment to population ratios may 'cause' higher participation rates, the causality may also run the other way. Anything that increases participation rates will tend also to increase employment to population ratios, unless unemployment rises.[4] Consequently, while there are clearly relationships between the employment to population ratio and participation, they are not easily interpreted.

Most models using the employment to population ratio as a measure of job likelihood do so in a form that picks up short-run labour supply effects only (for example, the Treasury TRYM model — Stacey and Downes 1995). Other measures that attempt to pick up the ease of finding a job are effectively non-trending over the long run, suggesting that encouraged-discouraged worker effects are best seen as a short-run phenomenon. For example:

- There is no apparent long-run link between unemployment rates and trends in participation rates (figure 3.4).[5]
- Over a shorter time span (1979-2004), using peak to peak methods, the vacancy rate does not appear to have a strong trend, suggesting that it is probably not associated with the long-run movement in participation rates.

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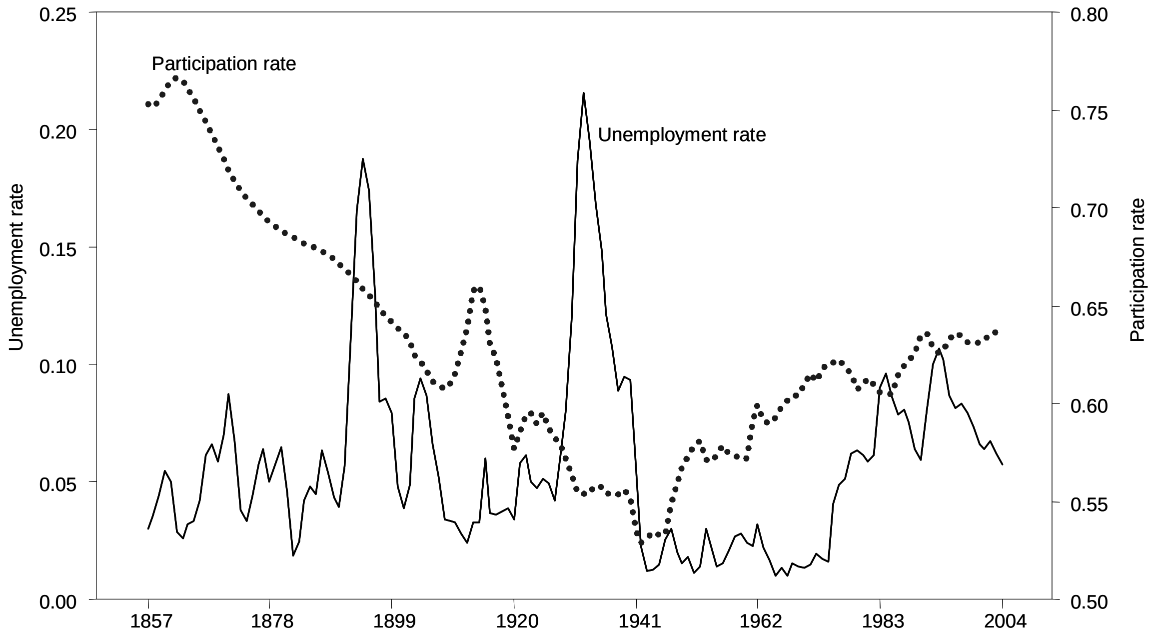
[4] Debelle and Vickery consequently use more direct measures of employment probability — the vacancy rate or the vacancy rate relative to the pool of unemployed. This reveals strong discouraged worker effects during periods when the vacancy rate is low.

[5] Though unemployment rates also have some disadvantages as a measure of finding a job, as noted by DEWR.

Figure 3.4 **Labour participation and unemployment rates**

1856-57 to 2003-04[a]



[a] Data from 1856 to 1947 are derived from population, unemployment and workforce data, adjusted for estimates of the proportion of the population aged 15 years and over, sourced from ABS (*Australian Historical Population Statistics*, Cat. no. 3105.0.65.001); Withers et al. (1985, p. 89, pp. 96-97, pp. 133-135 pp. 203ff) and Vamplew (1987, p. 30-35, p. 44). Data for series from 1948 to 1963 were estimated by splicing ABS labour force data from Butlin (1977, p. 91) onto the more recent estimates. Data for series from 1964 to 1977 were estimated by splicing ABS labour force data from Foster and Stewart (1991, p. 151) onto the more recent ABS estimates. Data for the series from August 1977-78 to 2003-04 are from the ABS (*Labour Force, Australia, Detailed* - Electronic Delivery Cat. No. 6291.0.55.001). A possible puzzle in the above data is the high aggregate participation rate in the 19th century, given that available evidence on female participation (at least at the end of the 19th century) suggested low female participation rates. One explanation is the higher male to population ratio in 19th century Australia, in part, prompted by immigration resulting from the gold rush in the 1850s (McLean 2004).

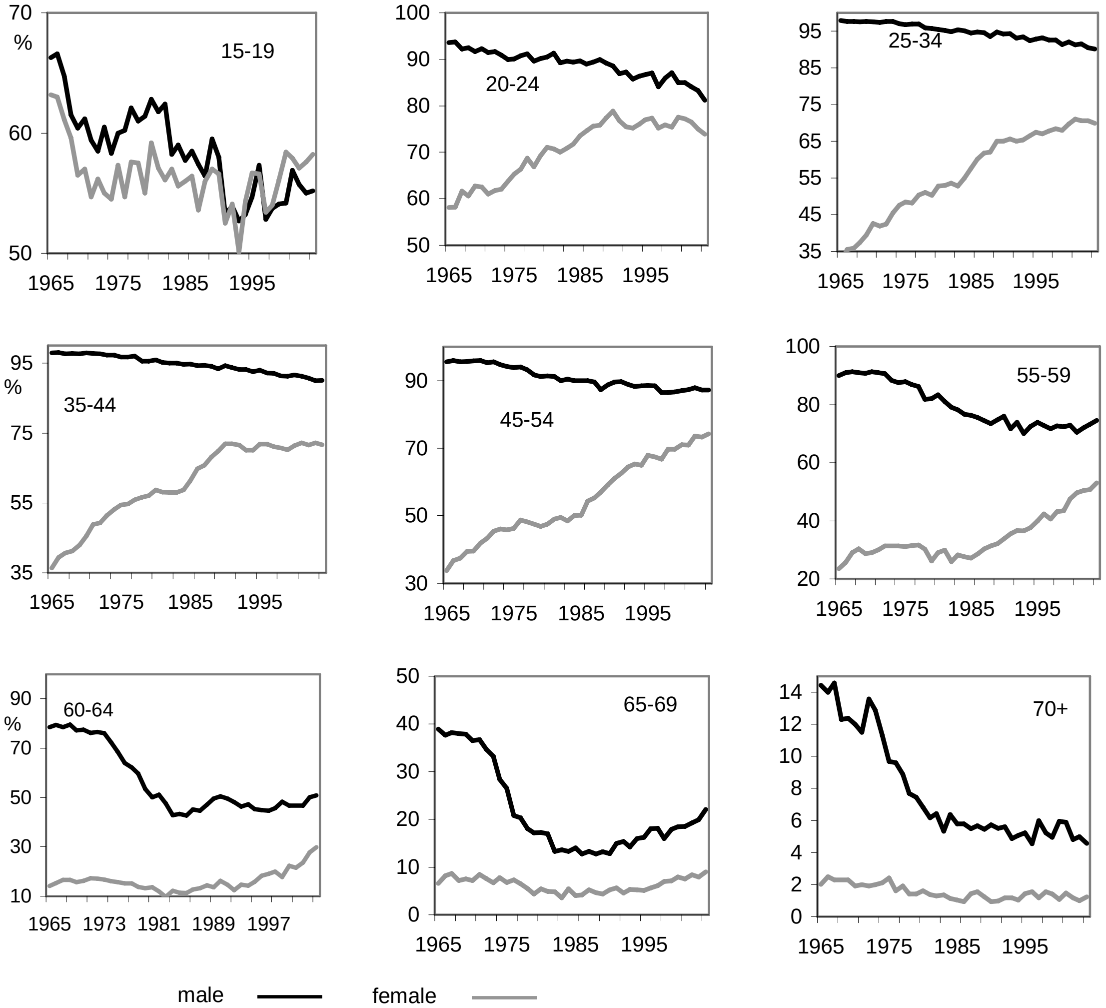
Data sources: ABS (*Labour Force, Australia, Detailed* Cat. No. 6291.0.55.001 and *Australian Historical Population Statistics*, Cat. no. 3105.0.65.001); Foster and Stewart (1991); Butlin (1977); Vamplew (1987); and Withers et al. (1985).

The aggregate story hides many of the underlying demographic and social currents that have affected labour force participation. Understanding these forces may be important for realistic projections. Data on historical participation rates reveal large, sometimes countervailing, changes in participation rates for *given* age-gender groups (figure 3.5). In particular:

- female participation rates have risen for all but the youngest and oldest groups;
- male participation rates have generally declined. In percentage terms, this decline has been greatest for older males; and
- over the longer run, the increasing duration of education among younger people has delayed their entry to the workforce. However, youth participation rates have risen in

the last decade despite rising educational attendance — a trend associated with the increased availability of casual and part-time jobs.

Figure 3.5 **Participation rates by age groups, male and female**
August 1965 to August 2004

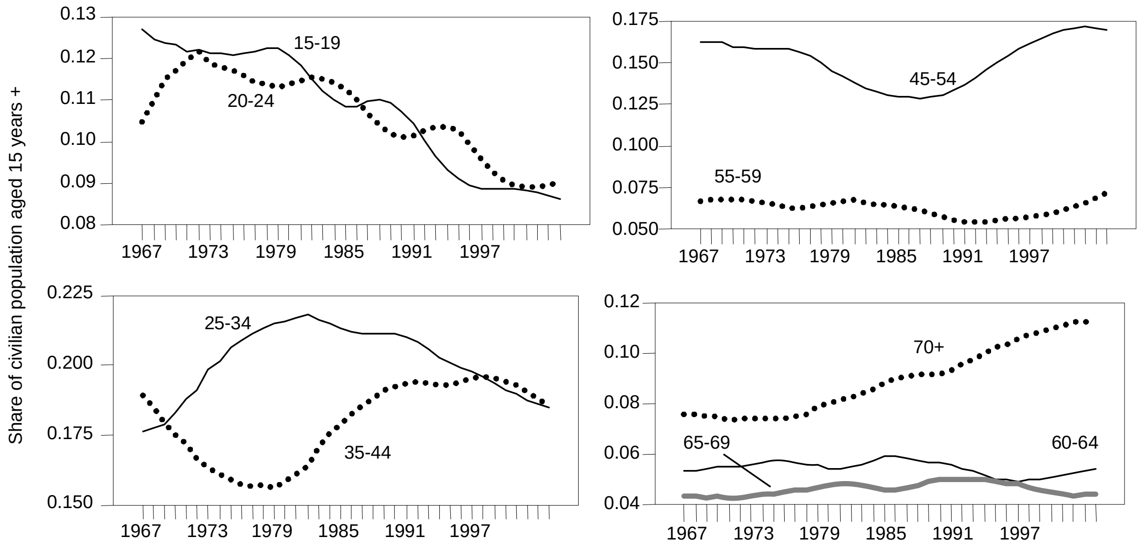


Data sources: Data for 1965 are from Foster and Stewart (1991) (with data for 55-59, 60-64, 65-69 and 70+ age groups estimated from data on 55-64 and 65+ age groups). Data for 1966 to 1977 are from ABS (*The Labour Force, Australia, Historical Summary 1966 to 1984*, Cat. no. 6204.0), while data for 1978 to 2004 are from ABS (*Labour Force, Australia, Detailed* - Electronic Delivery Cat. no. 6291.0.55.001, including unpublished data for the 65-69 and 70+ age groups and estimation of August 2004 data for these two age groups from June 2004 data).

There have been significant shifts in the age structure of the civilian population potentially available for work (those aged 15 years and over) over the past 25 years (figure 3.6). But with the exception of the growing importance of people over 70 years old, the direction of the demographic shifts has not, so far, particularly favoured high or low participation age groups. This is because people aged 20-54 years have similar (high) labour participation rates. So the adverse effect on aggregate participation rates of the reduced population share of the young since the 1980s has been largely offset by the favourable effect of the increased population share of mature workers aged 35-54 years.

Figure 3.6 **Trends in population shares by working age groups**

Shares of civilian population over four decades



Data source: ABS (*Labour Force, Australia, Detailed* Cat. no. 6291.0.55.001) and ABS (*The Labour Force, Australia, Historical Summary 1966 to 1984*, Cat. no. 6204.0).

This is confirmed by more formal analysis that breaks down changes in the aggregate participation rate into those that can be attributed to shifts between age groups with differing participation rates — the ageing effect — and those that can be attributed to trends in participation rates within age groups. Over the four decades from August 1966 to August 2004, the trend effects have been the main source of change in the aggregate participation rate. Of the 2.75 percentage point change in the participation rate over this period, 5.3 percentage points can be attributed to trends in participation rates within age groups and -2.55 percentage points to shifts in the age structure of the population (age effects). Over this period, population ageing has had modest negative effects on Australia's overall labour participation rate and has been more than offset by trend rises in participation rates within age groups.[6]

6 Over the *very* long run, workforce ageing seems to have played a more significant role. But even this assessment changes on closer scrutiny. Over the period from 1911 to 2003, trend increases in age-specific participation rates accounted for a 7.6 percentage points increase in the aggregate rate. In contrast, compositional shifts in the age structure of people aged 15 years and over accounted for a 6.6 percentage points fall in the aggregate rate. But this assessment ignores the historical role played by 10 to 14 year olds in Australia's labour force. For example, in 1911, 16 per cent of boys and 5.3 per cent of girls aged 10 to 14 years participated in the labour market. (By 2003, this group had no measured labour market role.) This suggests that over this long time span, participation rates should be calculated using the population aged 10 years and more — in line with the labour market involvement of this group in earlier years. In this case, shifts in age-

Overall, the greater general tendency for increased female participation has been the driving factor behind the increasing aggregate labour participation rate in the last 25 years. Had no other changes occurred, the labour participation rate would have increased by 6.1 percentage points from 1978-79 to 2003-04. The fact that the observed increase was actually only 2.7 percentage points largely reflects the offsetting influences of declining male participation trends and workforce ageing.

Cohort effects

The labour market behaviour of people born in different periods — cohorts — can be quite different. Analysis of cohort participation rates, rather than trends in age-specific participation rates, can produce a better understanding of past and likely future trends. The generational differences that underpin cohort analysis reflect:

- different social attitudes (for example, attitudes to the role of women in the workforce after marriage or childbirth);
- varying aptitudes (due to different levels of education and different lifetime exposures to technology and opportunities for learning by doing); and
- the enduring effects of historical events (such as higher disability rates among combatants in the world wars or the 'scarring' effects of mass unemployment).

It is clear, for example, that younger people are on average much better educated than their older brethren, and that better educated people generally have higher participation rates, an issue that is re-visited in section 3.4.

The generation into which a person is born makes a big difference to his or her lifetime labour force participation patterns.[7] This is particularly so for women. Lifetime female participation in the labour force has increased dramatically since Federation and its time profile has also altered (figure 3.7).[8]

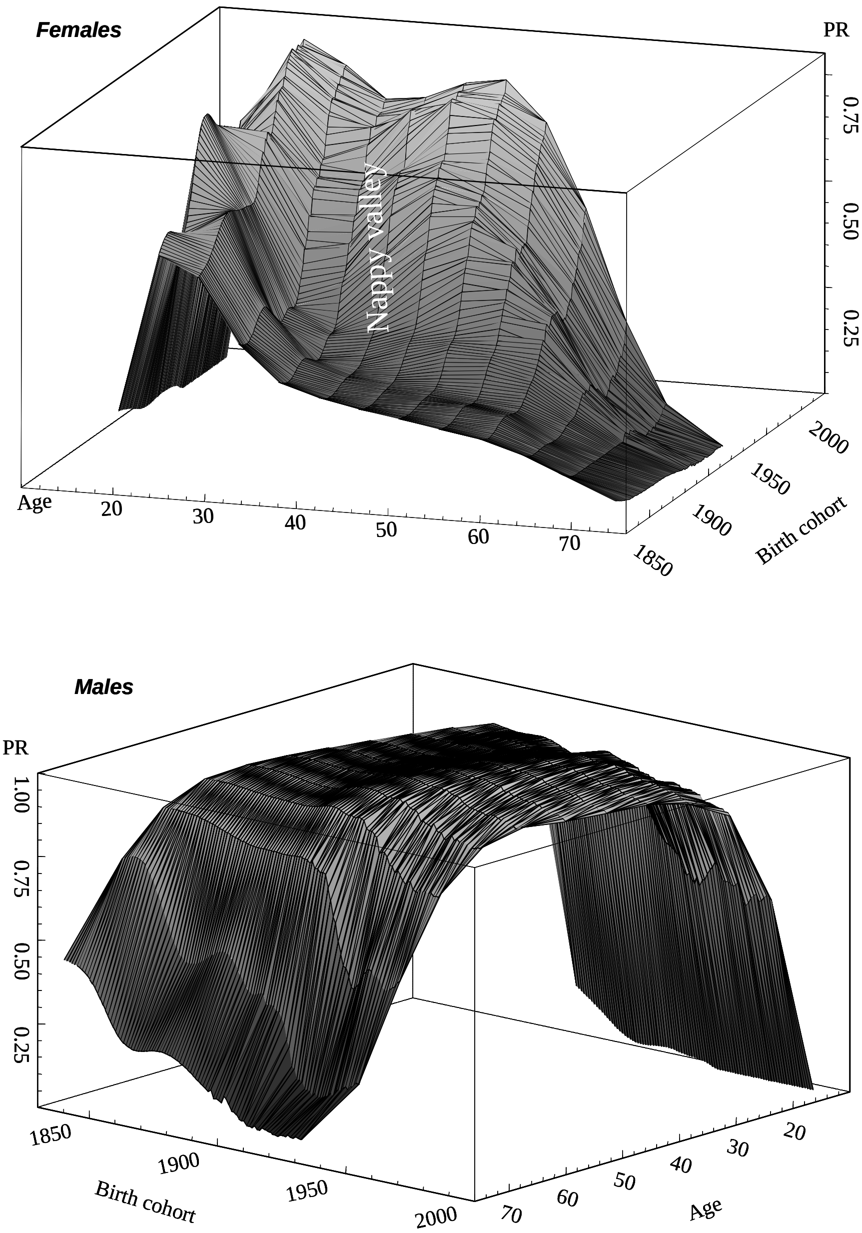
specific participation rates increase the aggregate participation rate by 5.7 percentage points while population ageing reduces the aggregate rate by around 3.2 percentage points.

7 This is confirmed by statistical analysis undertaken by the Commission and by the ABS (Ravindiran et al. 2002).

8 Separate participation rates by gender are not available on a systematic basis for earlier periods. The high aggregate participation rates shown in figure 3.4 for the 19th century are not inconsistent with the co-existence of relatively low female participation rates, because the male population was significantly higher than the female one (reflecting the 1850s gold rush).

Figure 3.7 **Lifetime patterns of work for different cohorts: participation rates by age and birth year of cohort**

All birth years from 1834-38 to 1988-92[a]



a The orientation of the graphs is different so as to reveal particularly salient features of changes in participation rates for different cohorts. Data on ages and birth cohorts are the midpoints of 5 year spans.

Data sources: Technical paper 3 based on various labour force series from the ABS and Withers et al. (1985).

A woman born around Federation would typically have participated in the formal labour market while very young (aged 10 to 19 years), and withdrawn from paid employment with marriage and child bearing. After having (several) children, she generally never returned to a paid job. The section of figure 3.7 depicting participation rates in the childbirth years — 'nappy valley' — is wide and deep for such early cohorts.

A woman born just before the Second World War also had her peak participation rate when young, but her withdrawal from the labour market with the advent of childbearing was temporary.

Later female cohorts have significantly lower participation rates than pre-1920 cohorts when young, reflecting greater involvement in secondary schooling and tertiary education. But against this, the dip in participation associated with childbearing is smaller and less protracted — 'nappy valley' is now shallow and much narrower. This is because women have become better educated, with fewer children and greater access to part-time jobs and childcare. The peak involvement of women in the labour force is now around 40-44 years — in stark contrast to their great-grandmothers.

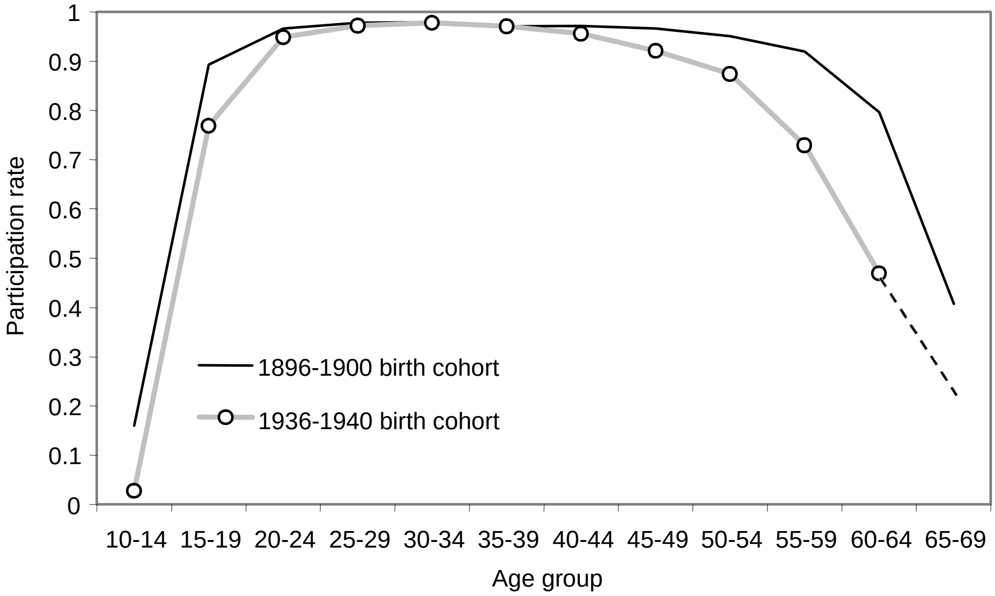
Several factors suggest that more recent birth cohorts will, when older, participate to a greater extent than the group of women currently aged 55 years and over. First, cohort effects are strong, and their effects on older age groups have yet to be fully played out. For example, cohorts born before 1950 have participation rates that are around 10 percentage points higher than the 1936-40 birth cohort. This greater lifetime propensity to be in the labour market can be expected to affect their participation when aged over 55 years. The phased deferral of access to the Age Pension from age 60 to 65 years is likely to further increase female participation rates for later birth cohorts.

Cohort effects are much less pronounced for males than females, and their long-run impact has been to *reduce* rather than increase labour force participation.

- At Federation, the lifetime participation profile of males hardly varied between ages 15 and 60 years, with steeply decreasing rates before and after this age range — like a building with a flat roof and steep sides.
- For later cohorts, the 'roof' started to collapse with older ages (more easily seen in a sample of the data — figure 3.8). For example, the participation rate of males aged 60-64 years was around 80 per cent for the 1896-1900 birth cohort, but some 30 percentage points less for the 1936-40 birth cohort.

Later in this chapter the Commission uses techniques that capitalise on these cohort differences to project labour participation rates.

Figure 3.8 **Comparing male participation rates by age for two cohorts**
Those born 1896-1900 and those born 1936-1940



Data sources: Technical paper 3 based on various labour force series from the ABS and Withers et al. (1985).

Unemployment

Participation rates measure whether people are available for work — but not whether they are actually in a job. Accordingly, it is necessary to subtract the unemployed when projecting the effective labour supply.

Unemployment rates vary by age group (figure 3.9). Young people have higher average unemployment rates, reflecting the matching and search costs associated with a first job. The oldest workers have low unemployment rates, largely because they can often leave the labour force and take up retirement benefits if jobs are hard to find. This suggests that the age structure of the feasible workforce may have an impact on aggregate unemployment rates. However, the size of the effect has been relatively small (figure 3.9).

Hours worked

While the overall participation rate has continued to rise from the 1980s, the most vigorous job growth has been in part-time jobs, while male full-time jobs have decreased at a rapid rate. This implies that the changing mix of part-time and full-time jobs will have had a significant impact on total hours worked (and accordingly effective labour supply and economic growth) — a trend that is expected to persist. This points to the importance of projecting full and part-time participation rates and average hours worked, rather than just participation rates per se.

Figure 3.9 **Unemployment rates and ageing**

1978-79 to 2003-04[a]

a The age-adjusted measure of the unemployment rate is calculated by aggregating age-specific unemployment rates over time using 1978-79 population shares to determine the appropriate weights for the labour force. This then gives an idea of what unemployment would have been with no labour force ageing after 1978-79.

Data source: ABS (*Labour Force, Australia, Detailed* Cat. no. 6291.0.55.001).

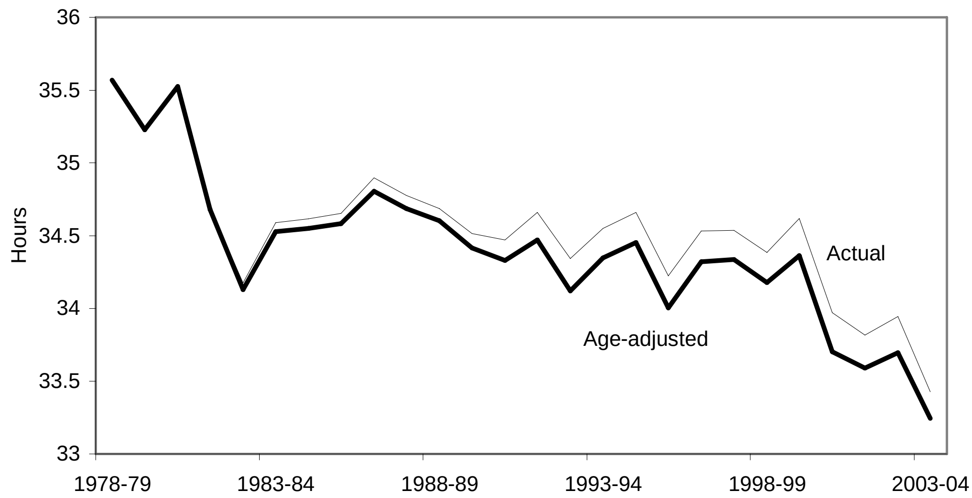
Over the past two decades, average weekly hours worked by full-time employees have risen for both genders and all age groups excepting those aged 65 years and over. Part-time hours worked have followed a more complex pattern:

- for males, average part-time hours fell significantly for most age groups from the early 1980s to the early 1990s — and have since risen generally, though in most cases not recovering to their 1980s levels; and
- average part-time hours increased throughout the two decades for some female age groups (for example, for females aged 25-34, 35-44 and 45-54 years), but showed the same pattern as for males for other age groups (for example, females aged 15-19 and 20-24 years).

Overall, average part-time weekly hours and full-time weekly hours have increased by around 4 and 3 per cent respectively from 1978-79 to 2003-04. But changes in the mix of employment between gender, age and full-time versus part-time status has meant that, in aggregate, average weekly hours worked have *fallen* by 6 per cent over the last 25 years (figure 3.10). This reflects several important structural changes in employment that may also be relevant for future projections of total hours worked:

- part-time work has increased significantly (from 5.1 per cent to 14.7 per cent of employment for males, 34.1 to 45.6 per cent for females and 15.5 per cent to 28.4 per cent overall);
- female participation rates have increased (as noted above). Females have a higher inherent likelihood of working part-time, and within their choice of full-time or part-time work, work less hours on average than males;[9] and
- changes in the age distribution have (over this period) shifted employment to age groups that work longer hours, though the effect is small. Had the age distribution of employment stayed at its 1978-79 levels, average hours worked would have fallen by 2.3 hours per week (or a 6.5 per cent reduction). As it was, shifts in the age distribution meant that hours worked only fell by 2.1 hours or a fall of 6.0 per cent.

Figure 3.10 **Average hours worked per week**
1978-79 to 2003-04[a]



[a] The age-adjusted hours worked were calculated by

$$AgeH_t = \sum_{w=1}^{2}\sum_{s=1}^{2}\sum_{a=1}^{12}\left(\frac{EMP_{w,s,a(1979)}}{EMP_{w,s(1979)}} \times AVHRS_{w,s,a,t} \times \frac{EMP_{w,s,t}}{EMP_t}\right)$$

where w, s and a are work type (full time and part time), sex and age categories. AVHRS are average hours worked for each category and EMP is employment. The difference between AgeH and the unadjusted series reflects shifts in the age distribution of employment. This method for calculating age effects does not take into account the impacts of changes in the age distribution of the population on part time work shares — which is an additional way in which ageing can affect average hours worked.

Data source: ABS (*Labour Force, Australia, Detailed* Cat. no. 6291.0.55.001).

[9] With the exception of part-time working hours for young people aged under 24 years, where male and female patterns of hours worked are indistinguishable.

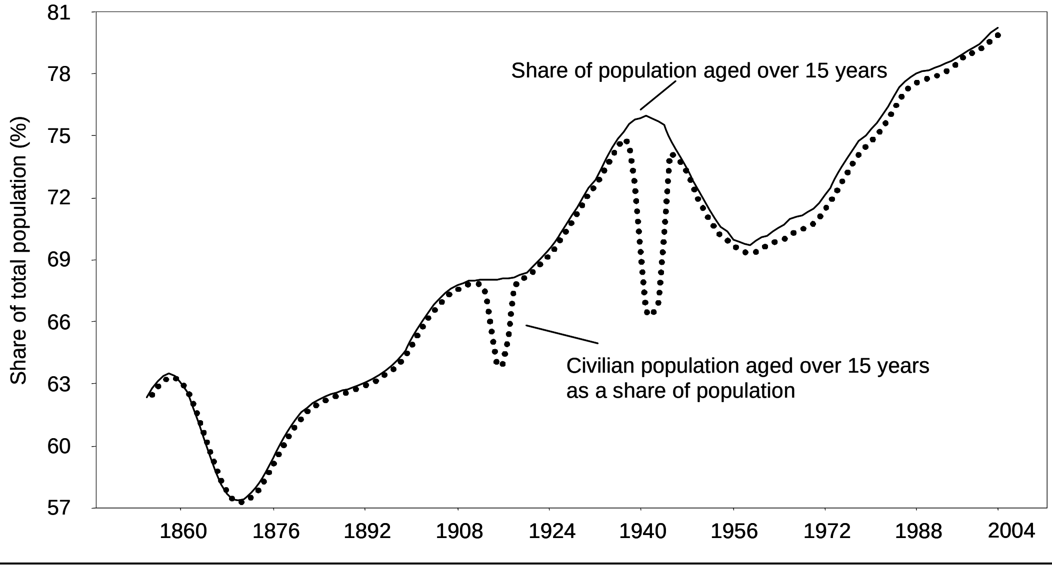
The feasible workforce

The negative effect of population ageing on labour participation rates provides an exaggerated picture of the effects of ageing on output per *capita* because it does not take account of the reduced number of young people (those under age 15 years) who have to be supported. With population ageing, the aggregate labour force participation rate inevitably falls as more people shift into the retirement age bracket where the labour force participation rates are very low. But a typical corollary of ageing is that the proportion of the population aged below 15 years also falls. Accordingly, the effects of ageing on per capita income (as opposed to income per person aged 15 years and over) are moderated.

Historically, like most other developed economies, the relative size of the population aged 15 years and over, which is the maximum size of the workforce, has been generally growing over time (figure 3.11). For example, this demographic feature has meant that, from 1961-62 to 2003-04, real GDP per person aged 15 years and over grew by 123 per cent, while real GDP per capita grew by around 157 per cent, or more than 30 percentage points more. This demographic feature will be a significant restraining influence on the adverse effects of ageing on per capita income growth in the future.

Figure 3.11 **Relative size of the feasible workforce**

1855-56 to 2003-04[a]



[a] Two measures are shown. The first (the strict definition) excludes defence personnel from the feasible workforce so as to be consistent with the basis on which participation rates are measured (This is: CPOP/POP, the ratio of the civilian population to the total population). The second includes such defence personnel and so is simply the share of people aged 15 years and over in the population (POP15+/POP).

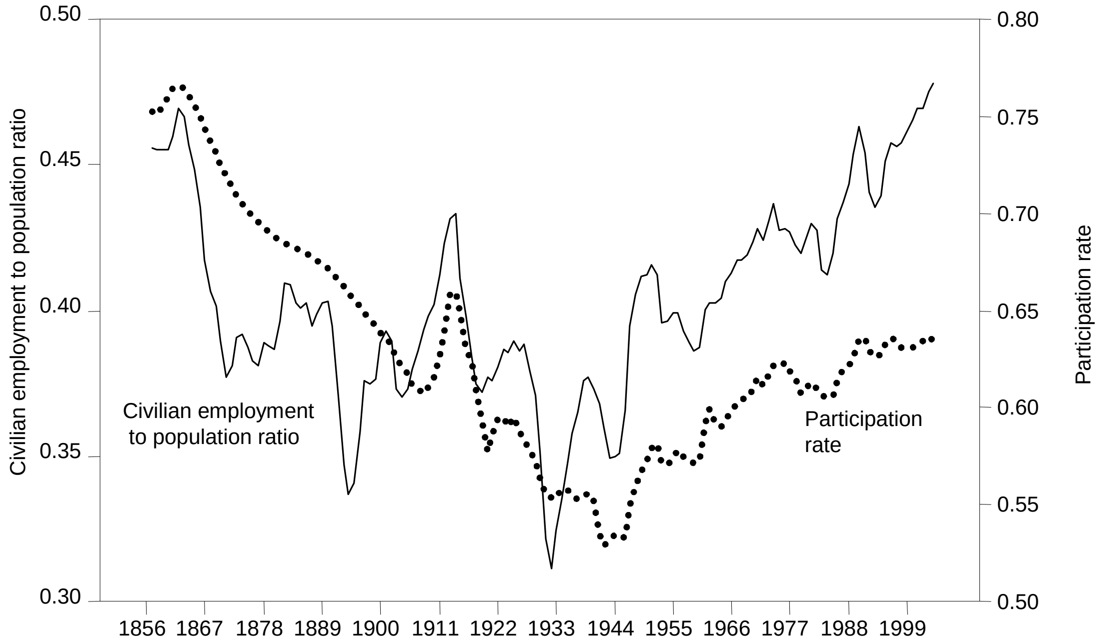
Data sources: Vamplew (1987, pp. 30-35, p. 44) and ABS (*Australian Historical Population Statistics*, Cat. no. 3105.0.65.001 and *Labour Force, Australia, Detailed* Cat. no. 6291.0.55.001).

Another way of identifying the importance of this factor, as well as any long-run shifts in unemployment rates, is to note that GDP per capita can be written as the following identity:

$$\text{GDP/POP} \equiv \textit{Productivity} \times (1\text{-}\textit{Unemployment rate}) \times \textit{Participation rate} \times \textit{Civilian population to population ratio}$$
$$\equiv \textit{Productivity} \times \textit{Employment to population ratio}$$

The employment-to-population ratio picks up the effects of reducing youth dependency, as well as changes in unemployment and participation rates — and is probably the best summary measure of labour supply trends in the economy (figure 3.12). Testimony to the effects of declining youth dependency, the employment to population ratio grew by 24 per cent from its post-war low in 1958-59 to 2003-04 in comparison with the 11 per cent growth in the participation rate over the same period.[10]

Figure 3.12 **Employment to population changes and participation rates**
1855-56 to 2003-04[a]



[a] Data prior to 1900-01 have been interpolated on ten year data using a cubic spline. The data on participation rates and employment were obtained from the sources described in figure 3.4, while those on the population are described in figure 3.6.

Data sources: ABS (*Australian Historical Population Statistics*, Cat. no. 3105.0.65.001 and *Labour Force, Australia, Detailed* Cat. no. 6291.0.55.001); Butlin (1977); Foster and Stewart (1991); Vamplew (1987) and Withers et al.(1985).

10 These growth rates are the percentage changes in the relevant rates, not the percentage points difference in rates. For example, the change in the participation rate is calculated as $100*(PR_{2004}-PR_{1959})/PR_{1959}$ per cent.

Remarkably (and unlike the participation rate), the present employment-to-population ratio is the highest it has been since useable economic records have been kept for Australia. Ageing will shift the ratio down from this historical peak, but (as shown later) not to levels that are very low by past standards.

What are the lessons from the historical trends?

Quite apart from the fact that projections are partly extrapolated on previous trends, the historical experiences are useful in other ways.

- Even though significant ageing occurred over the 20th century, ageing has so far played second fiddle to other social forces affecting labour market participation.
- Cyclical downturns are relatively unimportant influences over the very long term. This is significant because there may be cyclical downturns over the next forty years. However, their timing and likelihood is conjectural. Since such downturns matter over the short and medium terms only, it is appropriate to use long-term average trends in economic variables in projections, rather than to try to forecast any particular cyclical shocks.
- Participation rates can change markedly in a short period — for example, participation rates for males aged 65 and over halved from the mid 1970s to the early 1980s.
- There are significant switches in trends in participation rates. For example, 65-69 year old male participation rates fell by a trend rate of 1.6 per cent per year from August 1965 to August 1984, but increased by a trend rate of above 0.5 per cent per year from August 1990 to August 2004. It is doubtful that the resurgence in participation rates from 1990 could have been readily predicted beforehand. This underlines the difficulties in projecting participation rates on the basis of past trends.
- The effect of population ageing on the aggregate participation rate was more than offset by within age-group effects — such as increased female participation — over the past 25 years. In the future, these effects will continue, but are unlikely to be as strong. Accordingly, population ageing effects are likely to be bigger. The future will not look like the past — simple extrapolations on the basis of the *aggregate* labour participation rate would be highly misleading because they fail to take account of compositional effects.

3.4 Projections of Australia's labour supply

What will affect future labour supply?

The dynamics of the labour force can be likened to a leaky tub being filled by a hose. Retirement and other moves out of the labour force deplete it, while it is replenished mainly by new younger recruits and women re-entering the workforce after childbirth. The ageing of the population has big effects on these flows by increasing outflows due to retirement, while stemming inflows of new young workers. Much of the future labour supply story is purely demographic — a reasonable approximation to future labour supply growth is the change in the population aged 15 to 64 years (figure 3.13).

Figure 3.13 **Growth in worker numbers is set to decline**
Yearly percentage change in the number of people aged 15-64, 1944-45 to 2044-45

Data sources: PC-M population projections and ABS historical population data for earlier years.

However, there are a myriad of factors apart from the purely demographic that may affect participation rates and therefore labour supply. To get a more precise grasp of labour supply involves peeling the onion of its potential contributing components. To do this requires assumptions about future labour market trends, which can depend on:

- the role of labour shortages;
- trends in future education;
- changes to pension and retirement income policy;
- trends in disability rates; and
- slow moving social trends — such as improved access to paid work for women.

The role of labour shortages

There are well-founded concerns of at least temporary shortages in specific occupations, such as the health care professions, as their workforces age while demand for their services rise (DEWR sub. 71, pp. 8ff, AIHW 2004a, Tasmanian Government sub. DR69, p. 9, Queensland Nurses Union sub. DR59 and MCEETYA 2003). The prospects of specific occupational shortages, however, is often popularly transmuted into a broader concern that the dampening impacts of population ageing on labour supply growth will create lasting economy-wide labour shortages. It is claimed that these widespread shortages will decrease unemployment rates and increase participation rates as people outside the labour force respond to the high demand for workers, thus alleviating these supply limits autonomously.[11]

Labour shortages refers to difficulties experienced by employers generally in employing particular occupations at what were previously adequate wages and conditions (DEWR 2004b) — the demand for people in these occupations at a given wage, exceeds their supply. Such specific skilled labour shortages are on-going features of any market economy as shifts in consumption and production occur (for example, shortages of geologists during the mining boom and bricklayers during the housing boom). Generally, such specific occupational skill shortages (and excesses) are transitory, as training institutions respond to demand, industry structures change and relative occupational wage rates vary. Ageing may create more enduring shortages in some health care professions, reflecting entry barriers and insufficiently attractive regulated wages and conditions in these areas. But whether temporary or long-lived, such *specific* shortages do not loom very large for the whole labour market and therefore cannot significantly affect overall participation rates, primarily shifting *where* people are employed.

In contrast to specific skill shortages, the concept of *economy-wide* labour shortages is more difficult to define and measure (OECD 2003b, pp. 103ff). It does not mean that there are x jobs to fill and only x minus y people available to fill them. This is because an excess demand for labour by businesses (many vacancies) may coexist with a substantial excess supply of labour (unemployment). Among other factors, this can reflect a mismatch between the skills and attributes of the unemployed and available job vacancies, or geographic immobility of labour. So even to the extent that there were labour shortages arising from demographic pressures, these would not mean that there would be jobs for all.

However, it is not clear that ageing would generate on-going *economy-wide* labour shortages in Australia. First, ageing does not actually result in a reduction of available

[11] For example, Visco (2001) suggests that labour scarcity may increase real wages in OECD countries generally, increasing participation rates (though he equally suggests that tax increases to fund social measures associated with ageing may have the opposite effect).

labour inputs, merely a gradual slowing in their growth rate (figure 3.13).[12] Output, capital accumulation and consumption would still grow. However, they would grow at slower rates than had labour supply grown faster. Businesses would therefore generally not face demands for their goods and services that they could not meet with their existing workers and capital.

Suppose, however, a more extreme situation in which labour supply actually fell because of ageing. Realistically, this will not happen in Australia, but it is the fate of several European countries.[13] In this case, as people retired faster than they could be replaced, businesses would have a given quantity of jobs, given demand, but not enough people to fill them. **This situation is exactly the same as that arises when an economy overheats.** Economic analysis suggests that the outcome of overheating should be the same whether the cause be underlying demographic pressures, excessive consumer confidence or low interest rates. Overheating does not generate large permanent increases in the labour force. As an economy overheats (as incipient labour shortages develop), the long-term job vacancy rate rises. Businesses now accept, at existing or higher wages, people that they used to reject. Unemployment rates would start to fall, and some people outside the labour force would be encouraged into the labour market. But wage pressures would rise with decreasing unemployment, and so too inflation (Layard, Nickell and Jackman 1991 and Cahuc and Zylberberg 2004). Government macroeconomic policy would then target inflation by raising real interest rates and dampening demand (and thus raising unemployment) to restore a stable inflation rate.[14] Equilibrium would be achieved at the output that was given by the original labour supply.

This story is the same one that says it is difficult to solve present unemployment with demand management without raising inflation. The essential point is that jobs are not fixed, but respond to feedbacks from the wider economy. Unemployed people and people outside the labour force are generally different from the employed (in skill, motivation and aptitude). They cannot simply occupy vacant jobs without creating wage pressures that invite macroeconomic responses that restore equilibrium unemployment rates. This is why government policies to improve the employability of people currently without jobs or increasing intakes of skilled migrants are important for raising labour supply without inflationary pressures.

[12] In an open economy this could be expected to result in continued capital accumulation that approximately maintains capital labour ratios at their counterfactual levels and (for given productivity levels) constant real wages (See Kotlikoff and Burns 2004, p. 114 for this mechanism). The absence of real wage increases associated with labour supply changes means there is no signal for people not in the labour force to increase their participation rates.

[13] Borsch-Supan (2001) forecasts a 15 per cent decline in the labour force in Germany to 2035.

[14] Called the non-accelerating inflation rate of unemployment or NAIRU.

If the dampening effect of ageing pressures on labour supply could autonomously trigger offsetting changes in unemployment and participation rates, then it would be expected that this would hold in the reverse were demographic change to increase the size of the potential workforce. This is not borne out by studies of the effect of large net migration inflows, which find that they proportionately raise labour supply with negligible effects on unemployment rates.[15]

So the direct effects of ageing on labour supply growth are unlikely to generate an autonomous increase in participation rates and decrease in unemployment (other than through the small effect from the changing age structure of unemployment). The emphasis here is on the word autonomous. It may well be highly desirable for Governments to pursue policies that mobilise Australia's large currently non-employed latent labour force, prompted in part by the challenges of ageing. But the pressures posed by ageing will not elicit this labour market change *without* Government intervention. The projections in this chapter are based on a 'no policy change' assumption. To do otherwise would obscure where policy was needed (chapter 1). Chapter 13 sets out some of the policy directions to stimulate participation rates.

Trends in future education

Educational attainment is strongly linked to labour participation rate outcomes (figure 3.14). Older people currently have low levels of post-school education, but cohort analysis of educational attainment rates suggest that in several decades, older workers will have higher average rates of educational attainment than younger workers (figure 3.15). This occurs for two reasons. First, the current generation of young have relatively high educational attainment rates — and by the middle of this century, they will be the next generation of the old. Second, people continue to acquire education as they age.

This striking change in the age distribution of educational attainment can be expected, all other things being equal, to stimulate labour force participation rates for older workers to some degree — a point emphasised in several submissions to this study (CPA sub. DR60,

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[15] For example, Australia experienced a massive migration intake after WWII, that increased the pool of available labour significantly. But this did not result in an excess supply of labour nor increased unemployment. Jobs expanded to use the bigger pool of able labour, and output grew accordingly. That said, countries with strong demand and labour supply constraints on growth are more likely to ease immigration quotas. Nevertheless, the international literature on migration flows also finds small effects on native unemployment in cases where the migration flow is indisputably a supply shock. Examples include the Mariel Boatlift of 125 000 Cuban immigrants to Miami in 1980, the return of Portuguese colonialists from Africa, the influx into France of pied noirs from Algeria during the early 1960s, and the mass migration to Israel following the lifting of emigration restrictions in the former Soviet Union. The general view of the literature on mass immigration is that it adds to labour supply with an essentially zero impact on other labour market conditions (Gaston and Nelson 2001).

p. 13 and ABARE sub. DR50, pp. 3-4) and in some recent studies (Gruen and Garbutt 2003, Kennedy and Hedley 2003). Gruen and Garbutt (2003, pp. 25-27) assessed the impact of rising education on future labour participation by assuming that age-specific rates of labour participation by education stay at their current level. They find that labour participation rates increase for all ages and both sexes, with particularly large increases for people (and especially women) aged over 55 years.

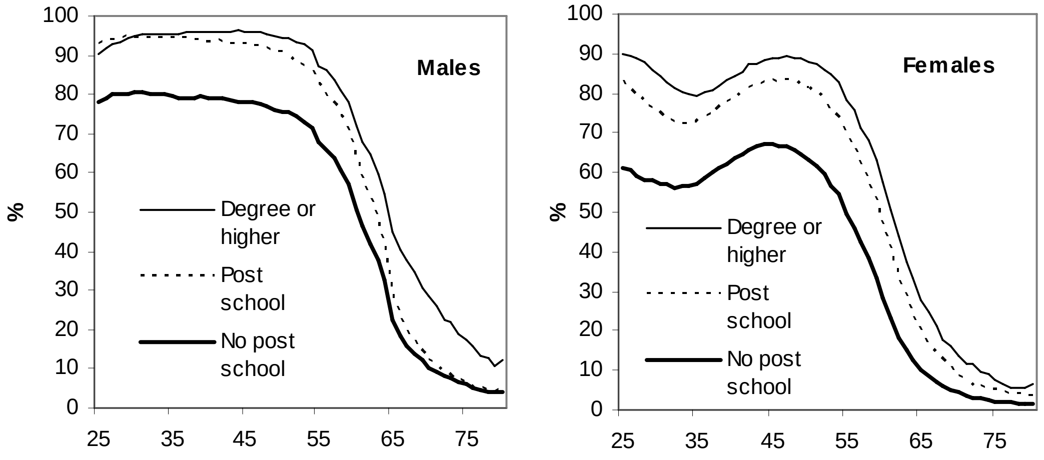
However, future rises in educational attainment of older people may not increase their labour participation rates by as much as might be suggested by the current cross-sectional association between education and participation (appendix B).

- The extension of higher education to many more people changes the mix of people who hold differing levels of educational attainment, with likely impacts on the participation rates they achieve. For example, of the one in 16 women aged 65 years currently holding degrees, most acquired their degrees in the 1960s, when entrance to university was highly limited. The women concerned are likely to be generally more able as a group than the one in four women currently aged 25 who have a degree or higher.
- The continuing decline in the demand for low skill jobs — particularly for males — may accentuate the disadvantage associated with no post-school education, leading to even lower participation rates for these groups.

Consistent with these forces, OECD data suggest that the participation rate associated with a given level of tertiary attainment rate has fallen over time for both women and men of older ages (figure B.4 in appendix B). Continuation of this trend implies that the present relationship between participation rates and educational attainment will not give reliable indications of the future impacts of educational attainment.

Figure 3.14 **Labour force participation rates**

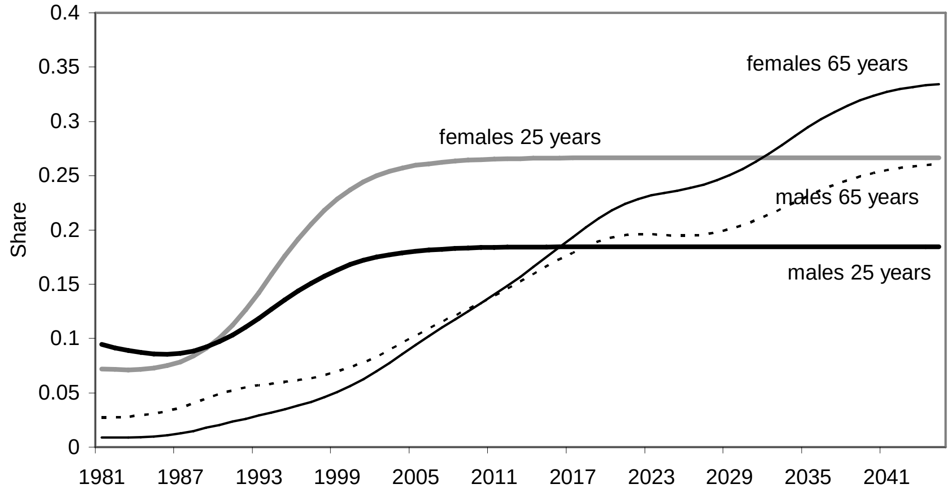
By age and highest educational attainment, 2001



Data source: ABS 2001 Population Census data provided by the Australian Government Department of the Treasury.

Figure 3.15 **Relative educational attainment (holding a degree or more) by sex and age**

1981 to 2045



Data source: Commission estimates based on cohort analysis of ABS Population Census data.

If the projection technique used by Gruen and Garbutt (2003) is applied to 1981 data, it predicts strong increases in participation rates for males and females by 2001. In fact, male participation rates generally fell across age groups from 1981 to 2001. Indeed, the absolute size of the (negative) prediction errors from applying this technique were, on average, higher for those age groups where the percentage change in degree attainment rates were higher. These prediction errors are likely to arise partly because the relationship between educational attainment and participation is not stable, but also because there are other factors that are highly influential in determining participation rates.

It is likely that higher educational attainment would, all others things being equal, still partly stimulate future participation rates, but clearly, just as in the past, there are other forces at work that may offset these gains. A potential advantage of the Commission’s cohort approach (technical paper 3) is that it may capture the general trend towards higher participation (since it has been an enduring feature of labour supply over some decades), as well as other general trends that either reinforce or weaken the benefits of this for labour force participation.

Pension and retirement income policy

The two most important recent policy changes are to the Age Pension and private superannuation arrangements.

Early access to the Age Pension for females is being progressively removed. Ultimately, females will be eligible for the Age Pension only after age 65 years, placing them on the same footing as males. This could be expected to progressively increase participation rates among females aged 60-64 years, although this would be weakened by increased uptake of the Disability Support Pension (DSP).

The introduction of the Superannuation Guarantee in 1992 mandates employers to make superannuation contributions on behalf of their employees. In its initial form, the design of the system provided incentives for early retirement (Bateman and Piggott 2001 and Atkinson and Creedy 1997). Employees (males) who may have delayed retirement to age 65 years to access the Age Pension, could access retirement benefits earlier (age 55 years). Since they could also withdraw superannuation benefits as a lump sum, they could also gain later access to the Age Pension. This financial windfall also encourages earlier retirement, since it reduces the number of years of contributions required for a reasonable standard of living while in retirement.

The Government has made some changes to limit ‘double dipping’ and encourage later retirement. These include encouraging withdrawal of benefits as an income stream rather than as a lump sum, tightening asset tests for eligibility for the Age Pension, allowing some access to superannuation assets prior to full retirement, and a gradually phased increase in the preservation age (age of access to benefits) (DEWR sub. DR71, p. 13-14, Inglis 2000, Australian Government 2004). In the shorter term, there is a legacy of past superannuation policies that may continue to encourage early retirement among some groups. In the longer term, the reforms will tend to encourage higher participation rates among older people, but the size of the effects are unknown. Other developments, such as the emergence of agencies that specialise in superannuation planning to maximise access to the Age Pension, may partly counteract the influences of these measures.

Trends in disability rates

While measuring trends in the age-specific prevalence of disability remains a contested field, there is little doubt that the impact of a given level of disability on labour force participation has been accentuated over the last few decades. The number of people — particularly men — accessing the Disability Support Pension (DSP) has increased rapidly for most age groups. For example, from 1978-79 to 2003-04 there was a near quadrupling in the number of males aged 40-49 years claiming the disability pension. This trend reflects the relative attractiveness[16] of the DSP compared with unemployment benefits for people with a disability facing labour market difficulties.

People on DSP are generally classed as outside the labour force — and indeed the uptake of this benefit appears to be a major contributor to the historical decline in the labour force participation rates of older males (ABS 2005). For instance, had those males aged 60-64 years on a disability pension stayed in the labour force, then labour participation rates for this age group would have *increased* 1.5 percentage points from 1978-79 to 2003-04 instead of falling by 5.4 percentage points.[17] In other words, these simulation results suggest that effectively all of the decline in the participation rate of males aged 60-64 years could be attributed to the increased use of the DSP.

However, the adverse impact of DSP uptake on participation rates has been waning. Indeed, DSP rates have even dropped for males aged 50-64 years over the last five years, while rates for younger people, though still rising, look likely to stabilise in the next few years. Accordingly, one of the major drivers of falling participation rates for men (and one of the significant frictions that prevented older female participation rates from rising even further) is set to play a more marginal role in the future. Nevertheless, both cohort and other projection methods suggest that DSP rates will stabilise at relatively high rates, particularly for males aged 45-64 years old. For example, DSP rates for males aged 55-59 years are expected to be around 10 per cent in the long term. Without policy or other changes, this limits the scope for substantial rises in participation rates for older men.

Notably, ABARE (sub. DR50, pp. 1-3) considers that technological change in health care, such as biotechnology and nanotechnology, will improve the capacity of workers to stay in the workforce. Developments in this area have the potential to reduce inflows into DSP and more generally curtail early retirement. ABARE also argues that to the extent that such

[16] Higher benefits and the absence of activity testing.

[17] DEWR notes that a small proportion of people on DSP are in the labour force (sub. DR71, p. 6). For the purposes of the calculations made here, it is assumed for ease that all DSP beneficiaries are outside the labour force.

improvements extend life expectancy, older people will have to delay retirement in order to build up sufficient capital to last their extended lives. However, improvements in health care technology and life expectancy gains are not new. Indeed, gains in life expectancy will probably be less in the future than the past. Yet despite such historical improvements in technology and life expectancy, DSP numbers swelled, as did earlier exits more generally from the labour market. It may well be that technology has the potential to increase participation *if* all other determinants are held constant. But the trends that militate against higher overall workforce participation (such as increased income) are also set to continue, and may well offset the gains from technology, as they did in the past.

Other trends and cohort analysis

Many of the factors that have led to changes in labour participation rates — including those above — reflect broad technological, social and commercial trends. For example, expansion of flexible casual and part-time job opportunities in the service sector have allowed people, particularly women, to combine childcare and work responsibilities. Falling fertility rates and rising divorce rates have also increased female participation rates, as have increasing educational attainment rates. Collectively, these trends have been major influences on aggregate labour participation rates — and many are likely to continue.

But how can such trends be adequately captured in projections, given that each factor is hard to model separately? The Commission's projection approach recognises that many of these trends operate at the cohort level. For example, educational attainment and cultural attitudes to work are factors that depend on a person's cohort. It is also apparent that occupational and industry choices are often made early in life and so are partly dependent on a person's cohort. DEWR (sub. DR71, p. 6) cites another example of cohort effects for males aged 60-64 years. It noted that ex-service pension conditions appear to have reduced full-time labour participation rates for this group in the past, but that this will not apply to future cohorts of this age group.

Adopting a broad cohort modelling approach to participation rates will collectively pick up many of these broad trends. Cohort methods can also pick up recent shifts in trends too — such as the fall in age-specific DSP rates for older males. The method — which extends an approach derived by the OECD (Burniaux et al. 2003) — relies on estimating the probability that a person of a given age exits or enters the labour market over the next period. Trends in exit and entry rates are modelled over the past, so they can pick up likely future shifts in cohort behaviour. The method used is explained in detail in technical paper 3, as are detailed results.

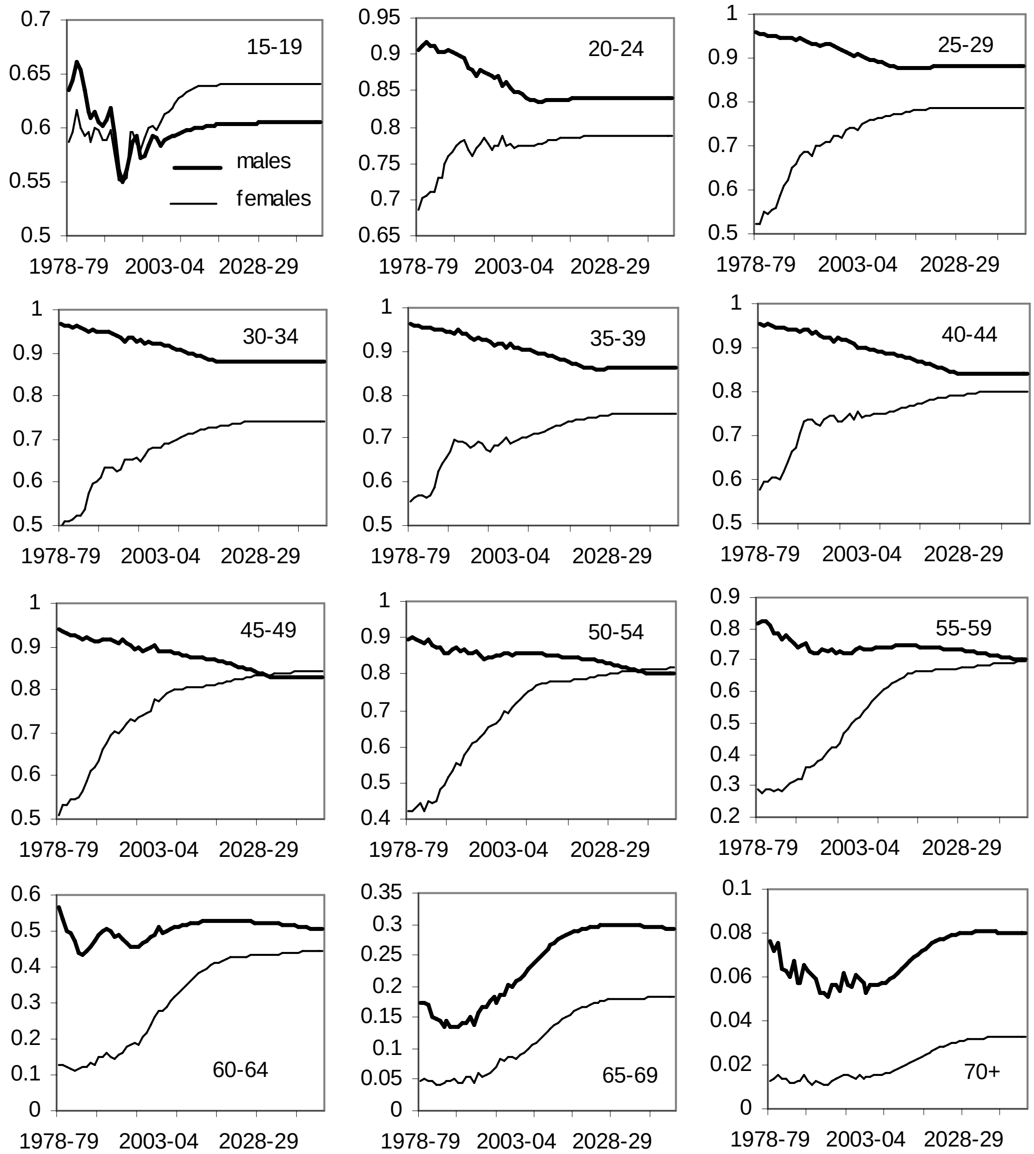
Labour participation rate projections

Taking account of these changing cohort patterns, the Commission generated projections of participation rates for different age groups by gender for Australia as a whole (and for all States). The projections (figure 3.16) show a continuing tendency for greater female participation for all ages over 25 years, with proportional increases greatest at the oldest ages. For example, female participation rates are expected to grow between 2003-04 and 2044-45 by 18, 35, 59, 124 and 125 per cent (not percentage points) for ages from 50-54 to 70+ respectively. For the core years of work from 25 to 59 years, female patterns of workforce involvement increasingly resemble that of males.

There is an abating trend for lower participation rates by males aged from 25 to 59 years. However, participation rates for males aged 65 years and over are expected to rise significantly in the next 40 years (by around 40 and 50 per cent for those aged 65-69 and 70+ years respectively), but still remain low relative to other ages. The greater involvement by older males reflects the trend towards lower exit rates from the labour force for this age group.

The aggregate labour force participation rate for Australia is calculated by weighting the age-specific rates by the relevant age population shares. Over the next forty years, aggregate labour force participation rates in Australia are projected to fall by over 7 percentage points from their current level of 63.5 per cent to 56.3 per cent. (figure 3.17). Had there been no change in the age structure of the population, participation rates would have *risen* by around 2.5 percentage points, reflecting the continued importance of rising female participation. Accordingly, by 2044-45, the difference in participation rates attributable to ageing amounts to nearly 10 percentage points — a margin that would have large effects on Australia's growth prospects.

Figure 3.16 **Projected participation rates by age and sex**
Australia, 1978-79 to 2044-45



Data source: Commission estimates from 2004-05 using a dynamic cohort approach (technical paper 3). Otherwise rates are derived from the ABS (Labour Force Survey, Supertable LM8).

These projections corroborate the findings in the Intergenerational Report, based on older ABS population projections and labour force data, and different methods for forecasting age-specific participation rates. The Intergenerational Report found an aggregate participation rate of around 56 per cent in 2041-42, which is within half a percentage point of the Commission's estimate for the same year.

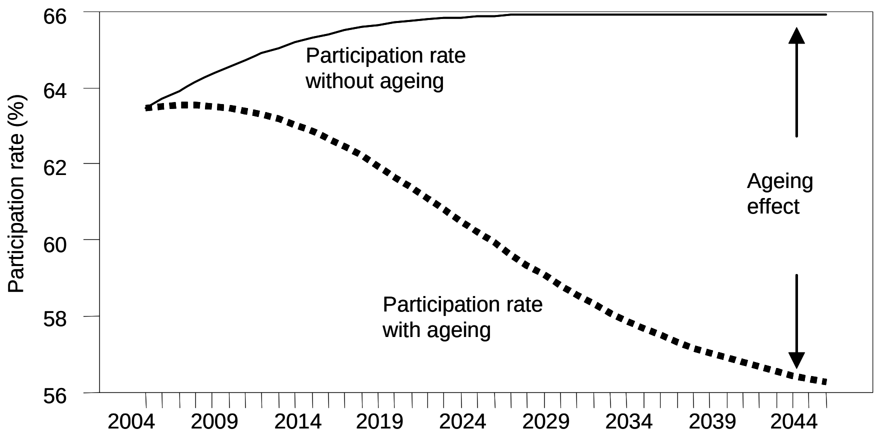
The effect of the demographic transition on Australia's labour force in the next four decades is much greater than has occurred in the last 30 years. And in contrast to the earlier experience, these ageing effects are not offset by trend rises in age-specific participation rates. Past ageing gives a very poor guide to the dramatic effects of future ageing on Australia's labour force.

Uncertainty in the projections

A question remains as to whether the age-specific trends underlying this aggregate projection are likely to be realised. The results for females pass a basic credibility test. It is highly likely that female participation will continue to rise, because the factors that have been driving rising participation are still at work (such as increased education and better matching of female job preferences). But there can be less confidence in the extent of stagnation (and recovery) in labour participation for males aged 20-59 years, because it is unclear that the historical forces that lowered participation thus far will continue. As emphasised by CPA Australia, there is inevitably much uncertainty about long-run participation rates:

> … there have been fundamental changes in the demographic structure of families, social attitudes concerning the role of women and the labour market opportunities available to women. Consequently, the experiences of older cohorts may provide a poor guide to the future outcomes for today's younger cohorts… There remains a significant degree of uncertainty about the likely participation rates of younger cohorts as they age and approach the retirement window. (sub. DR60, p. 11)

Figure 3.17 **Aggregate participation rates fall with ageing**
2003-04 to 2044-45



Data source: Commission estimates.

The Commission's projection approach has the advantage that it can potentially pick up such cohort effects better than examining age-specific participation rates and merely extrapolating them on the basis of historical trends. Nevertheless, it is clear that there must be a significant and widening band of uncertainty surrounding estimates over a 40 year horizon. It is notable that past projections of participation rates have sometimes erred by large amounts. For example:

- Sam and Williams (1982) developed a sophisticated model of Australian participation rates and produced projections from 1980-81 to 2000-01. Their model correctly predicted that male rates would fall and female rates would rise, but the prediction errors were substantial. Male rates fell by 6.1 percentage points over this period, three times the magnitude predicted by the study. Married female participation rates rose by 14.3 percentage points, double the predicted 7.4 percentage point rise, while unmarried female rates rose by 4.1 percentage points compared with a small predicted fall; and
- the ABS's (1999) set of labour participation projections for 1999-2016 were already significantly astray after just five years for specific age groups,[18] though these errors cancelled to produce an accurate *aggregate* participation rate for end June 2004.

These cases highlight the difficulties in producing accurate projections even over relatively short periods, let alone 40 years, and demonstrate the need for sensitivity analysis (table 3.1 and box 3.4).

Such analysis reveals that, with a few exceptions, the *aggregate* participation rates are relatively robust to different assumptions about trends in age-specific participation rates. Indeed, had age-specific rates stayed fixed at their base levels — a common assumption in labour force projections — but ageing had still occurred, the aggregate participation rate by 2044-45 would be 53.4 per cent (scenario B). This is only about 3 percentage points below the participation rate projected by the Commission. This underlines the point that the most important determinant of the future aggregate participation rate is the shift in the age structure of the population.

However, other futures are possible.

- Large changes in participation rates for selective age/gender groups (scenarios C, D, E and F) have relatively modest impacts on the aggregate participation rate.
- Major increases in participation rates for a *broad* group of age-sex groups would be necessary to significantly curtail the effects of ageing on labour force growth (scenario G, H and I). Even such broad increases in participation rates cannot fully offset the impact of ageing (none of the scenarios in table 3.1 and box 3.4 get close to the 65.9 percentage points required for equalisation).

18 For example, the ABS projected a small 0.8 percentage points reduction in the participation rates of males aged 20-24 years by 2004. In fact, by 2004 the rate fell by 5.1 percentage points to 82 per cent, a level that was actually below the projected participation rate for 2016. On the other hand, for females aged 60-64 years, the ABS projected an increase of 1.8 percentage points from 1999-2004, compared with an actual increase of 11.7 percentage points (using ABS Cat. no. 6260.0 values for the base year). In fact, the actual level for 2004 exceeded the ABS's projected value for 2016 for this group by nearly 6 percentage points.

As noted in the Intergenerational Report (p. 28), the relative insensitivity of the aggregate participation rate to changes in age-specific trends has some policy implications. Policies that elicit participation increases for the old alone cannot, by themselves, realistically act as an antidote for the sluggish labour supply growth arising from ageing.

However, to the extent that policy overcomes barriers to participation that confront older Australians and results in outcomes that they desire, then such increases are worthwhile in their own right (and may also be part of a suite of policies aimed at better growth prospects — chapter 13).

Table 3.1 **How different is aggregate participation under different age/gender scenarios?**

	Scenario	*Participation rate in 2044-45*
		%
A	**Base case**	**56.3**
B	No change in age-specific participation rates after 2003-04	53.4
C	Age-specific female rates rise by half the base case increment[a]	54.5
D	Age-specific rates for males aged 20-59 do not fall after 2003-04	57.5
E	Age-specific rates for females aged 60+ converge on males[b]	57.4
F	Age-specific rates for males 55+ yrs 10 points above 2044-45 base	58.3
G	Age-specific rates for both genders 55+ yrs 10 points above 2044-45 base[c]	60.6
H	Age-specific rates increase to OECD 80% percentile by 2044-45[d]	60.9
I	Age-specific rates reach the maximum level between 1978-79 to 2044-45[e]	59.5

[a] In this case, female participation rates climb by half the amount between the base case age-specific values in 2044-45 and the starting year (2003-04). [b] A scenario of this kind was suggested by ABARE (sub. DR50). It is implemented by having older female rates reach the male level by 2044-45. This implies very high growth rates in participation rates by females. [c] The scenario implies particularly large increases in participation rates for some age categories. For example, it would result in a female participation rate for 70 year olds 8.5 times higher than the maximum rate apparent from 1978-79 to 2003-04. [d] The data for the OECD 80% percentile were provided by the Australian Government Treasury. The age-specific rates converge to the values used by Gruen and Garbutt (2003) where these are above the existing participation rates, but do not fall if the PC's projected base case value for 2044-45 already exceeds their estimates. This exception is relatively frequent for females, suggesting that in fact this thought experiment really represents Australia approaching a rate somewhat above the 80% percentile. [e] The data used for this calculation are the ABS actuals from 1978-79 to 2003-04 and the Commission's base case projections from 2004-05 to 2044-45.

Source: Commission estimates.

Box 3.4 **Exploring participation scenarios**

Less rapid growth for women: It may be that female participation rates start to plateau more quickly than under the Commission's base case (scenario C), but this would still only reduce aggregate participation rates by around 2 percentage points.

More male involvement: Several factors may halt the historical fall in prime age male participation rates. These include changes to labour market programs aimed at DSP beneficiaries (mainly males) and policies that reduce entry into DSP, accompanied by a general suite of policies aimed at encouraging more active participation (DEWR sub. DR71, pp. 11ff explores some existing and prospective policies in this area). If it is assumed that male participation rates for those aged 20-59 years stayed at 2003-04 rates (scenario D), the gain relative to the base case in the aggregate participation rate by 2044-45 would be around 1.2 percentage points. It is a moot point whether changes in male participation rates stemming from re-connecting DSP beneficiaries to the labour force would have the same proportional impact on *employment* rates by age group (which, as shown below, are what matters for economic growth). This is because many of those on disability payments would have (and have had) great difficulty obtaining jobs (chapter 5).

Convergence for older women: ABARE (sub. DR50) considered that the absence of convergence of female participation rates by 2045 for older women was unrealistic, citing pension changes, greater work equality and the risk of inadequate retirement savings (an issue also raised by Dr Diana Olsberg, sub. DR54) as forces that could achieve greater convergence. In principle, these drivers are already captured in the Commission's cohort analysis, which factors in trends in exit rates from participation by age. Nevertheless, were this convergence to occur, it would raise the aggregate participation rate by just over 1 percentage point above the base case (scenario E).

Increasing participation rates by older workers: If this were restricted to males (scenario F), the aggregate participation rate would be 2 percentage points more than the base case. (These are close to the results found by the Intergenerational Report in running a similar experiment, p. 28). This is an extreme assumption for the oldest males, implying that participation rates for males 70 years and over and 65-69 year olds in 2044-45 are around 2.1 times greater than the maximum recorded from 1978-79 to 2003-04. This is probably most unrealistic for the last open-ended age interval, since the share of older males (80+) in this group will rise from 30 to 45 per cent over the projection horizon. If participation rates were to rise for both genders (scenario G), the impacts double.

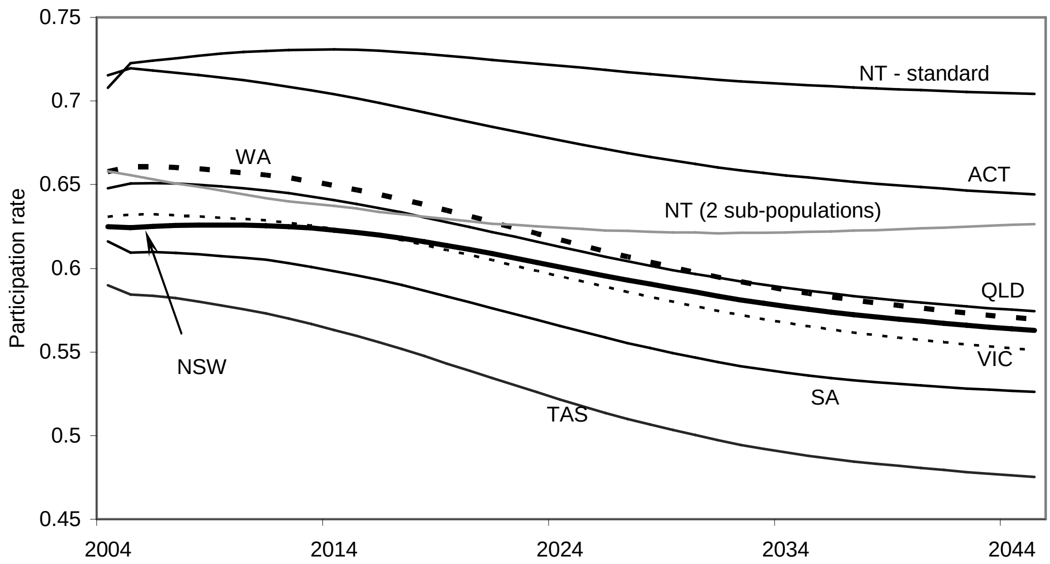
'Becoming Scandinavian': The Commission estimated the impact of reaching the *higher* of either the 80th percentile of a select group of OECD countries or the Commission's projected base case participation rate in 2044-45 for each age/sex group (adapted from a 'what if' experiment run by Gruen and Garbutt 2003). In this case (scenario H), Australia would have age-specific participation rates more like New Zealand and several Scandinavian countries. The result would be an aggregate participation rate in 2044-45 that mitigated the participation effects of ageing by around 50 per cent. This experiment somewhat resembles that of scenario I, with male participation rates that are close to (and sometimes exceeding) the historical maximum over the past 25 years and female rates that are roughly in line with those projected by the Commission.

Return to a golden past: Under scenario I, the aggregate participation rate in 2044-45 is still around 4 percentage points below the 2003-04 level and 6.4 points below the rate in 2044-45 had no changes occurred in the age structure of the population. This scenario is a relatively extreme one. For example, it returns male participation rates to peaks of over 96 per cent for males aged 25-39 years old (which is up to 10 percentage points above the level projected by the Commission for 2044-45 for these age groups), while still allowing female participation rates to grow at strong levels over the next forty years.

State results

The cohort method was also applied to individual States to generate labour force and participation rate projections (figure 3.18 and table 3.2). While most jurisdictions follow a similar pattern, two exhibit more extreme results. There are large declines in participation rates in the most 'greying' jurisdiction — Tasmania. The Tasmanian Government agreed with this assessment, projecting participation rates would fall by between 10.9 and 13.5 percentage points by 2042 (sub. 40, pp. 12-14). In contrast, the standard projection for the Northern Territory suggests that participation rates will hardly decline there at all. This is because demographic projections for the Northern Territory population show much less ageing than other populations.

Figure 3.18 **Participation rates in Australian States and Territories**
2003-04 to 2044-45[a]



[a] NT-alt is based on combining separate projections for the Indigenous and non-Indigenous populations. Data are averages over the fiscal years ending June.

Source: Commission estimates.

However, the Northern Territory result is partly a statistical anomaly. Its two underlying populations have very different characteristics and trajectories, which get conflated if they are modelled as one population (chapter 2). On advice from the Northern Territory Government, the Commission re-calculated participation rate projections for this jurisdiction by generating separate demographic projections and participation rate models for the two sub- populations.[19] This resulted in a somewhat bigger decrease in participation rates, but one that was still much less significant than that facing other jurisdictions. However, labour force participation is not the same as labour supply. The labour force includes people who are unemployed or on labour assistance programs, such as Community Development Employment Projects (CDEP). Accordingly, projections of labour force participation for the Northern Territory, even when adapted for the two sub-populations, will significantly overstate effective labour supply. Moreover, as emphasised by the Northern Territory Government (sub. DR58), the projections require many assumptions about highly uncertain factors, such as the integration of Indigenous Territorians into mainstream work. The projections should be seen as experimental.

The degree to which jurisdictions face declining participation rates reflects two forces. They face different underlying trend growth rates in age-specific participation rates. But overwhelmingly, the major contributor to their differing experiences is the different extent of population ageing (table 3.2).

Table 3.2 **Ageing effects on participation rates by jurisdiction**

2044-45 relative to 2003-04

Jurisdiction	*Aggregate participation rates (with ageing)*				*Without ageing*	*Ageing effect*
	2003-04	2024-25	2044-45	Change 2003-04 to 2044-45	2044-45	
	%	%	%	%	%	%
NSW	62.5	59.8	56.3	-6.2	65.1	8.9
VIC	63.1	59.2	55.1	-8.0	64.5	9.3
QLD	64.8	61	57.4	-7.3	68.1	10.6
SA	61.6	56.2	52.6	-9.0	64.2	11.5
WA	65.8	61.4	57	-8.8	67.2	10.2
TAS	59	51.7	47.5	-11.4	60.4	12.9
ACT	71.5	67.4	64.4	-7.1	75.3	10.9
NT	70.8	72	70.4	-0.4	75.2	4.7
NT alternative[a]	65.8	62.4	62.6	-3.2	68.8	6.2
Australia	**63.5**	**59.9**	**56.3**	**-7.2**	**65.9**	**9.6**

[a] These estimates are based on combining separate projections for the indigenous and non-indigenous populations. The difference between the estimates for the starting year (2003-04) reflects the use of extrapolated ABS Population Census data (2001-02) in the alternative estimates, rather than the use of labour force data from the ABS Labour Force Survey.

Source: Commission estimates.

[19] These projections were not undertaken using cohort methods because of data limitations. It was assumed that there would be some ‘catch-up’ with non-Indigenous Territorians by the Indigenous population. The details are available on request.

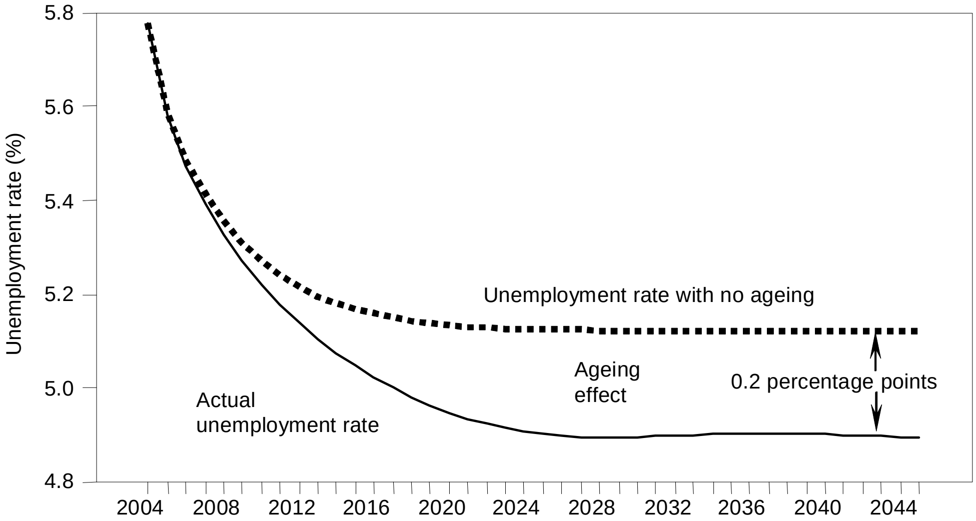
Projections of unemployment and hours worked

Participation is only part of the labour supply story. The other two important elements are unemployment and hours worked.

The dual drivers of the aggregate future unemployment rate is the long-run unemployment rate associated with a stable inflation rate (the so-called 'non-accelerating inflation rate of unemployment' or NAIRU) and demographics that weight individual age-sex unemployment rates. The NAIRU is projected to be just above 5.1 per cent in 2044-45 were the population age structure to be fixed at 2003-04.[20]

The actual long-run unemployment rate is a little less than this because ageing is likely to have a positive twist for unemployment. This reflects the fact that the highest unemployment rates are experienced by young people, in the transition from education to work, and the lowest by older people, who have the alternative of retirement. Consequently, the shift in the age structure of the workforce is likely to lower measured unemployment rates, although the effect is quite small at around 0.2 percentage points (figure 3.19). The result implies that the *effective* labour supply for a *given* participation rate will be higher than in the absence of ageing.

Figure 3.19 **Ageing and aggregate unemployment rates**
2003-04 to 2044-45[a]



[a] The measure of unemployment rate with no ageing is calculated by weighting age-sex specific unemployment rates by labour force shares that would occur without ageing.

Data source: Commission estimates.

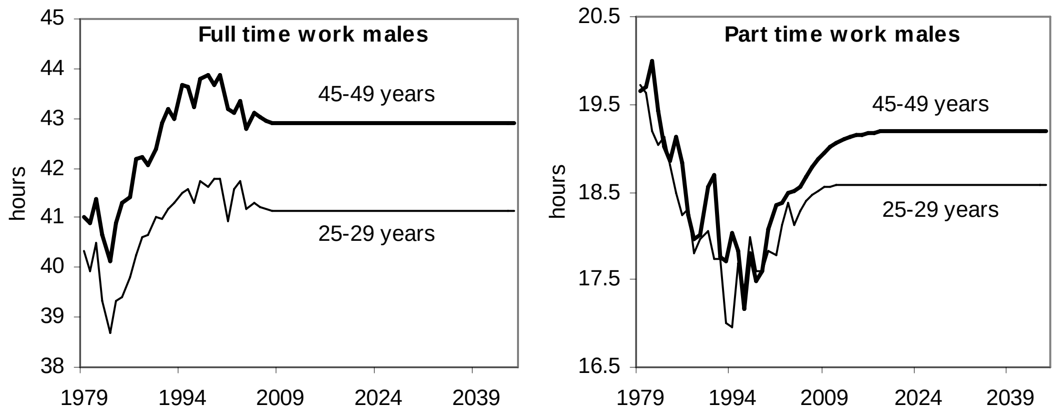
20 DEWR (sub. DR71, p. 7) suggested a lower rate — such as 4 per cent — might be credibly applied. Were such a rate used it would have no long-run effect on economic growth per capita, but would raise GDP permanently by around 1.3 per cent. It would also reduce unemployment benefits by 25 per cent.

Of course, unemployment is not only determined by job matching and search costs, but by broader imbalances in the demand for and supply of labour. Given there will be relatively fewer young people in the labour force, it would be expected that unemployment associated with insufficient demand would more commonly occur among older people, pushing up their unemployment rates. Nevertheless, Australia is currently experiencing a period of stable macroeconomic performance, and this is the basis on which projections in this and other chapters are made. In that context, it is appropriate to project age-specific unemployment rates and then to use demographics and labour force participation rates to derive an aggregate unemployment rate.

The story for average hours worked is different again. Average hours worked are generally projected to increase modestly for part-time workers of most ages, while being stable for full-time workers generally (figure 3.20). However, the *incidence* of part-time work will continue to rise for Australians of most ages (particularly for males). Contributing factors include the preferences of many people for part-time jobs and the ascendancy of the service sector. That, and the fact that older workers have a much higher tendency to work part-time anyway, mean that average weekly hours per employee are projected to fall (figure 3.21).

So ageing has a 'double whammy' depressive effect on labour supply — reducing participation rates and cutting average hours worked. These greatly outweigh the positive influences via lowered unemployment (as is shown in the following section).

Figure 3.20 **Selected projections of average hours worked per week**
Males, 1978-79 to 2044-45



Data sources: Commission estimates and ABS Labour Force Survey data.

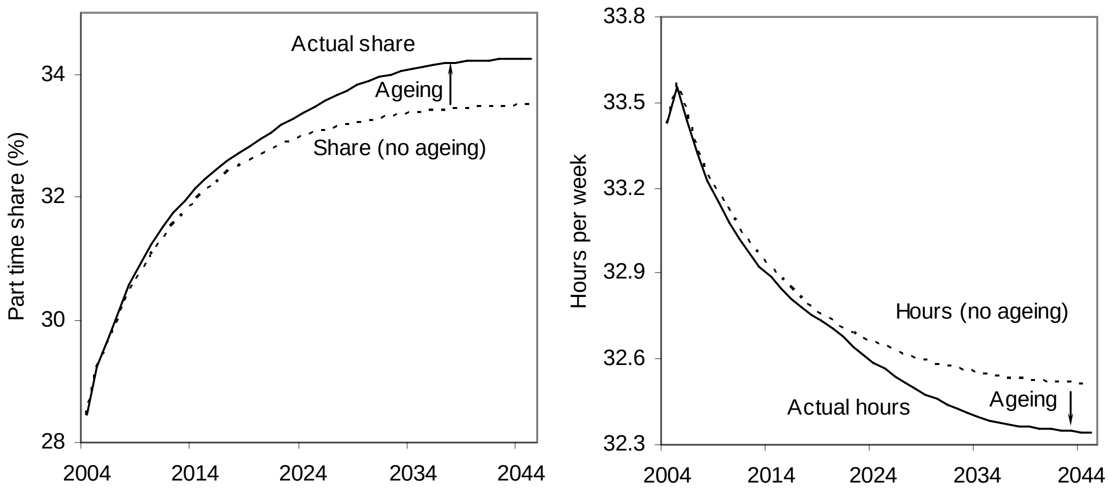
Labour supply projections

These components of labour supply — participation, part-time and full-time work, average hours and unemployment — can be assembled into two perspectives on labour supply:

- employment; and
- the total number of hours actually worked per year (the effective labour supply).

Figure 3.21 **Effects of ageing on part-time employment rates and average hours worked**

2003-04 to 2044-45



Both employment and hours worked change sluggishly as a result of ageing (table 3.3 and figure 3.22). For example, the number of workers is projected to grow by over one million in the seven years from 2003-04 to 2010-11. This is about the same growth in the labour supply that occurs over the entire 21 years from 2023-24 to 2044-45. Annual trend growth rates in the two decades to the 21st century are about four times greater than the annual trend growth rate in the three decades from 2011-12. Indeed, after 2011-12, the pace of effective labour supply growth is slower than population growth (unlike in the past). From their peaks in 2011-12, employment and hours worked per capita decline by around 8 and 10 per cent respectively to 2044-45. Had the population structure not changed, hours worked per capita would have actually risen slightly (figure 3.22).

Table 3.3 Labour supply growth slows with ageing[a]

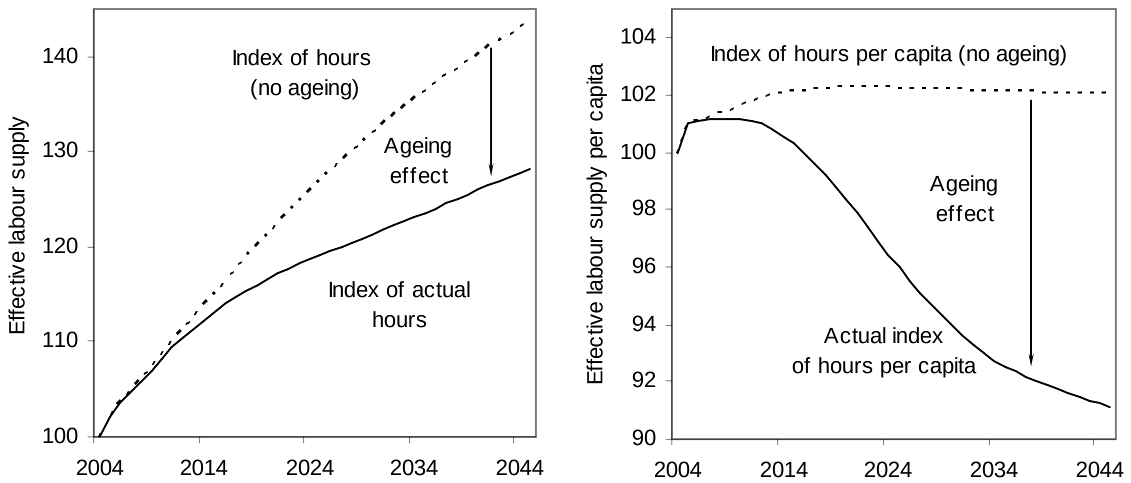
Period	Trend growth rates			
	Employment	Hours worked	Employment per capita	Hours per capita
	%	%	%	%
1979-80 to 1999-00	1.84	1.74	0.50	0.41
1999-00 to 2011-12	1.58	1.24	0.43	0.10
2011-12 to 2020-21	0.76	0.66	-0.25	-0.35
2020-21 to 2030-31	0.45	0.38	-0.38	-0.45
2030-31 to 2044-45	0.39	0.37	-0.16	-0.18
1999-00 to 2044-45	0.70	0.60	-0.17	-0.28

a Growth rates are based on regressing the logged value of the labour supply measure against a time trend.

Source: Commission estimates.

Figure 3.22 Ageing and effective labour supply

Australia 2003-04 to 2044-45



Data source: Commission estimates.

There are significant differences between jurisdictions in trends in hours worked per capita (figure 3.23). This reflects their divergent patterns of population ageing and labour market prospects.

Figure 3.23 **Changes in effective labour supply per capita vary by jurisdiction**

Percentage change in total hours worked per capita, 2003-04 to 2044-45[a]

[a] The increase in total hours per capita in the Northern Territory case reflects the combination of a relatively younger population and assumptions about the increasing engagement of Indigenous Territorians in the Northern Territory labour market. The NTalt series is based on separate modelling of Indigenous and non-Indigenous labour market trends.

Data source: Commission estimates.

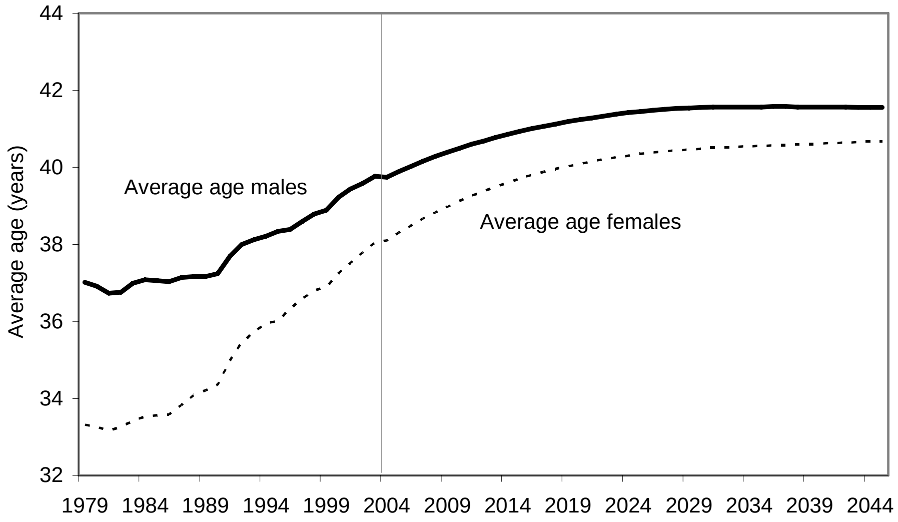
Hours worked per capita is probably the single best indicator of dependency since it takes account of actual employment and hours worked, rather than just the changing age structure of the population in each State. Tasmania stands out particularly as a jurisdiction in which the available hours per capita fall precipitously as a result of ageing.

Average labour supply age

The labour supply projections allow the estimation of the average age of employees over the next forty years — which provides a simple measure of labour supply ageing (figure 3.24). Relatively small changes in average age are anticipated — around 1.8 years for males and 2.6 years for females.[21] Indeed, there was much more ageing of the labour supply between 1978-79 and 2003-04 (around 4.8 years for females and 2.8 years for males) than is projected for the next forty years.

[21] This is because while the labour supply shares of the old increase dramatically (for example, the labour supply share of 70 year olds and over increases fourfold), they still account for a very small share of the total labour supply. Accordingly, they provide little weight to older ages in computing average ages.

Figure 3.24 **Average age of employees**
Australia, 1978-79 to 2044-45[a]



[a] Average age is calculated by taking the midpoint of the 5 year age spans as the representative age for each age-sex group and weighting these ages by shares of hours worked.

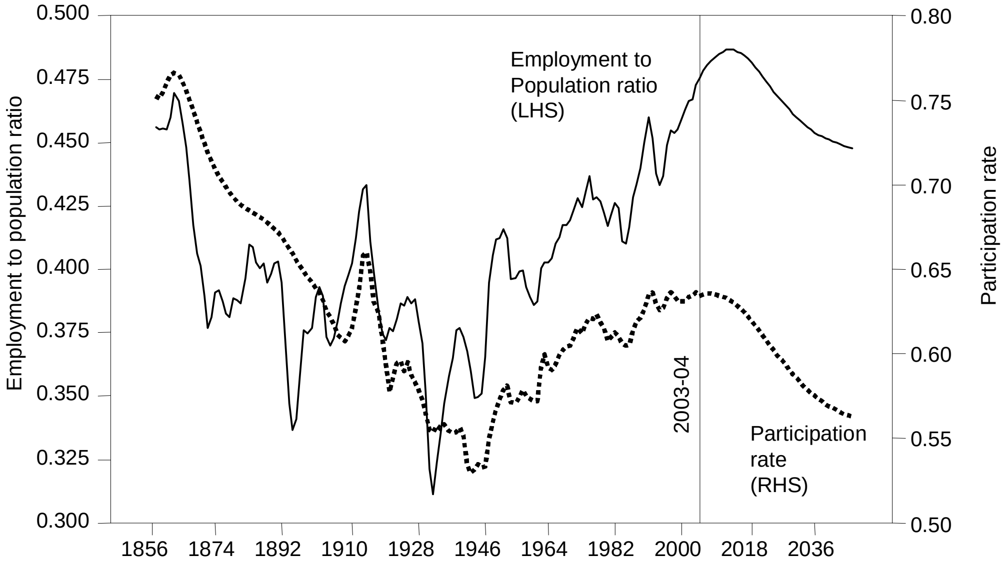
Data source: Commission estimates.

So population ageing does not necessarily translate to a very significant ageing of the workforce (reflecting the fact that participation rates are still highest for younger age groups). Moreover, workforce ageing will vary significantly by industry and occupation. Industries with declining employment shares — such as agriculture — will tend to age more than rapidly growing industries. Even some professions that might initially age rapidly — such as nursing — might expect this trend to reverse as retiring older workers are replaced by new younger entrants.

The labour 'problem' in historical perspective

Adding the Commission's projections to figure 3.12 provides a two hundred year perspective of the Australian labour market (figure 3.25). Adopting this perspective reveals a more positive story than told by the projected outcomes for the next forty years alone. For one thing, it becomes clear that the employment to population ratio over the next forty years is not historically low. Even with the projected decline in participation, the ratio of employees to population will still be higher in 2044-45 than at almost any time in the last century. (This reflects the decline in the ratio of people aged under 15 years to the total population)

Figure 3.25 **Taking a long view: 200 years of Australian labour supply**
1856-57 to 2044-45[a]



[a] These data were constructed from many historical data series — with interpolation based on econometric estimates and cubic splines for some earlier data.

Data source: Commission estimates based on ABS Labour Force data, Vamplew (1987), Withers et al. (1985), and Foster and Stewart (1991).

It is misplaced to *blame* ageing for any economic pains, since the flip side of ageing has been an earlier era of economic gains.

- A significant source of ageing (and the accompanying projected decline in the employment to population ratio over the next 40 years) was the general decline in fertility rates after the baby boom.
- But the presence of the baby boomers and the relative absence of their progeny was a major factor behind the *rise* in employment to population ratios after the Second World War and its current apex. The baby boomer phenomenon produced a big economic growth bulge, which will inevitably vanish as the boomers age.

3.5 Volunteering

This chapter has so far focused on conventional measures of the labour force. While falling outside standard measures of GDP and the labour force, it is also important to consider the contribution made by unpaid labour. This section briefly examines the implications of an ageing population on volunteering.

Volunteering and age

In 2000, nearly one third of Australians aged 18 years and over were engaged in voluntary work through an organisation, contributing over 700 million hours of unpaid work (ABS 2000, Cat. 4441.0).

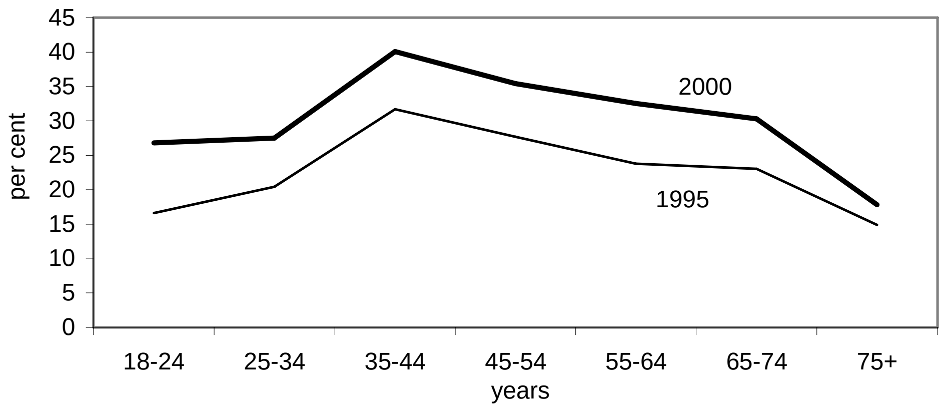
Participation rates for volunteering in organisations increase up to 35 to 44 years and then progressively decrease with age (figure 3.26). However, actual time spent volunteering tends to increase with age, whether the definition of volunteering includes only that undertaken through organisations or includes informal volunteering (such as caring for a sick neighbour).

Age also influences the type of voluntary work undertaken. People aged over 55 years volunteer predominantly in the areas of community, welfare and religion, 35 to 44 year olds volunteer mainly in education, training and youth development and younger volunteers participate principally in sport and recreation.

Projections

Data on participation rates in volunteering were applied to demographic projections to estimate the number of volunteers by age and gender over the next 40 years. Given data limitations, only volunteering through organisations was modelled. It is likely that this will understate the effect of demographic change on volunteering because older people are particularly important providers of caring services to other adults.

Figure 3.26 **Voluntary work through an organisation**
Participation rates by age group, 1995 and 2000



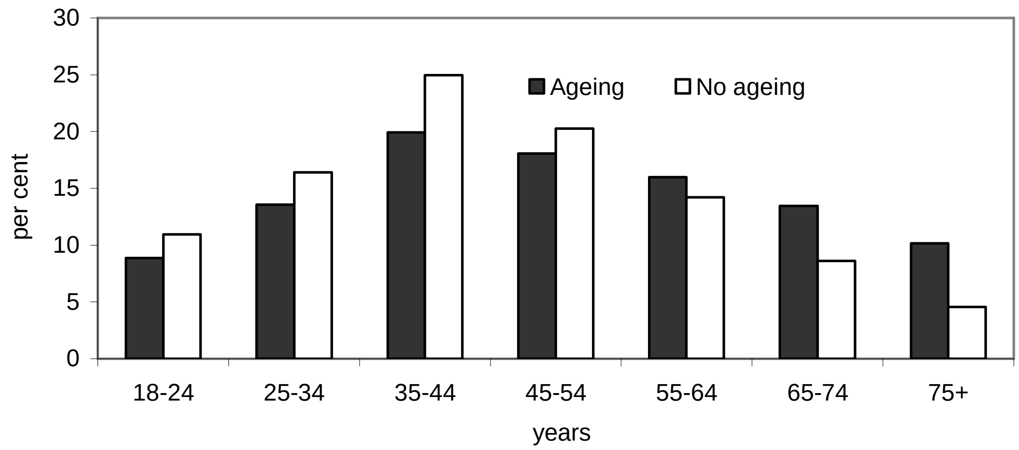
Data source: Data source: ABS, 2000 (*Voluntary Work*, Cat. no. 4441.0).

The number of volunteers is projected to increase from 4.75 million in 2002-03 to 6.84 million in 2044-45, an increase of 44 per cent. Growth in volunteering can primarily be attributed to a growing population. In the absence of population ageing, the number of volunteers would be marginally lower, growing to about 6.77 million in 2044-45.

The likely growth of volunteers was seen as a positive feature of ageing by several participants in this study. For example, Australians for an Ecologically Sustainable Population (sub. 7) noted that this aspect of ageing tended to be overlooked in some negative portrayals of ageing. The Victorian Government (sub. 29, p. 51) and the Australasian Centre on Ageing (sub. 9) considered that, as well as strengthening communities, volunteers significantly contributed to the economy. Several participants recognised the role of volunteers in informal care (for example, the Tasmanian Government, sub. 40, p. 30). (Carers are further examined in chapter 7.)

Although Commission projections found that ageing is likely to have only a limited impact on the overall growth in the number of volunteers, it is likely to have a significant effect on the age structure of volunteers. For example, in the absence of ageing the Commission projects that 25 per cent of volunteers would be aged 35-44 years compared with 20 per cent in an ageing population and 5 per cent of volunteers would be aged 75 years and over compared with 10 per cent in an ageing population (figure 3.27).

Figure 3.27 **Projected share of volunteers by age group 2044-45**
With and without ageing



Data source: Commission estimates.

This is likely to have implications for organisations that rely on younger volunteers. Some participants are concerned that shortfalls in volunteering may occur in areas, such as emergency services (Victorian Government sub. 29, p. 99) and sport and recreation, education, training and youth development (Volunteering Australia sub. 28, p. 6).[22]

This is also consistent with the Commission's projections, which suggest that there will be shifts in the relative importance of different types of volunteering activity. The growth in the number of volunteers is expected to be higher in community and welfare areas, but significantly lower in sport, recreation and education (appendix E).

22 The Securities Institute (sub. 22) noted another risk. It considered that moves to increase the labour force engagement of older people, while increasing formal labour supply, might come at the expense of a smaller pool of volunteers and unpaid workers.

Cohort analysis

3.1 Cohort analysis

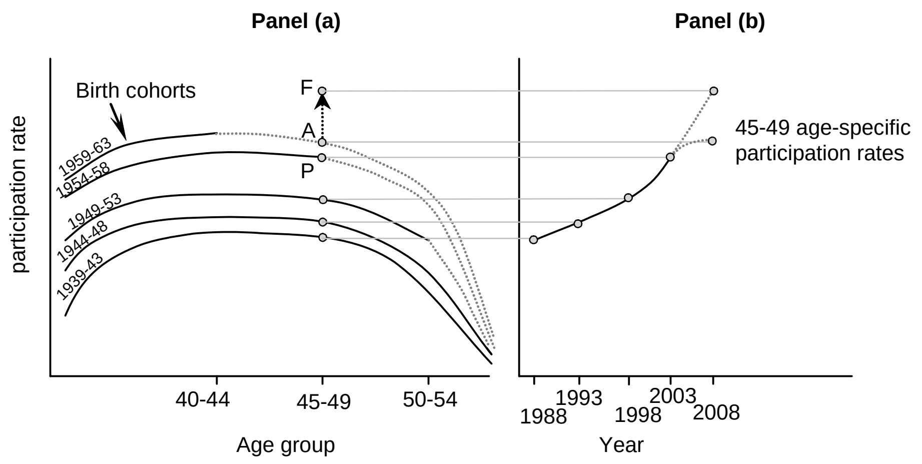
The labour market behaviour of people born in different years (so-called 'cohorts') can be quite different. This has implications for forecasting future patterns in labour supply. These generational variations may reflect their:

- different social attitudes (for example, attitudes to the role of women in the workforce after marriage or childbirth);
- varying aptitudes (due to different levels of education and different lifetime exposures to technology and opportunities for learning by doing); and
- the enduring effects of historical events (such as higher disability rates among combatants in the world wars or the potentially 'scarring' effects of mass unemployment).

Cohort effects may sometimes enable more accurate projections of participation rates. Using hypothetical data, figure 3.1 contrasts the picture of participation rates that can be given by cohort (panel a) versus age-specific information (panel b). Age-specific participation rates reflect the participation rates of different cohorts. In the example below, the observation for 2003 for those aged 45-49 years relates to the 1954-58 birth cohort, while that for 1998 for the same age group relates to the 1949-53 birth cohort.

Based on the past values of the age-specific participation rate shown in panel (b), it would appear likely that the participation rate in 2008 for 45-49 year olds would be around that shown at F. However, this ignores the information given by data in a cohort form. As shown in panel (a), the participation rate for 45-49 year olds in 2008 reflects the labour market behaviour of the 1959-63 birth cohort. In the hypothetical data, this cohort's participation rate is higher for each age than the previous cohort, but by less of an increment than the 1954-58 cohort over the 1949-53 cohort. A reasonable forecast of the participation rates for the 1959-63 cohort when aged 45-49 years is A, considerably less than the 'naïve' forecast based on extrapolating age-specific participation rates over time. Of course, in other circumstances, using a cohort approach may result in a higher projected estimate than one based on past trends of age-specific participation rates, but the point remains that cohort data may be helpful in providing more credible projections.

Figure 3.1 **How understanding cohort effects can provide better projections**



3.2 Cohort data

While true longitudinal data on participation rates are not available, it is possible to construct a synthetic panel of data.[1] However, several data deficiencies must be addressed. Data on participation rates by age are incomplete. For some periods, five year age groups are available, while for other periods, 10 year age groups are available (for example, for data from 1965 to 1977, participation rates are available for 25-34 year olds rather than separately for 25-29 and 30-34 year groups, as are available for other years). Moreover, data for some periods are missing altogether. Thus, yearly data are available from 1965, but for earlier years back to 1901, only infrequent census data are available. These data inadequacies represent an obstacle to analysis of the participation rates of people of given birth years over their lifetimes.

A method for resolving these data inadequacies is to use cubic spline smoothing and other interpolation techniques to fill in the missing gaps (box 3.1). This provides a dataset for examining cohort issues over long time frames. It is the basis for graphical analysis, such as figure 3.7 in chapter 3. More reliable data over shorter periods have been used for the actual projections in chapter 3.

[1] The panel data set is synthetic because it does not compare the same people over time. For example, the change in participation of women born in 1949-53 between ages 40-44 and 45-49 years is calculated by comparing women aged 40-44 years in 1998 with women aged 45-49 years, five years later. Some women present in the 40-44 group in 1998 will have died or emigrated by 2003, while some women present in the 45-49 group in 2003 will have come from overseas during the last five years.

Box 3.1 **Interpolation methods for deriving cohort data**

For the various gaps in the availability of participation rates for quinquennial age groups between 1965 and 1977, a regression approach was used. A stable relationship was found between the participation rates of five year age groups and (among other variables) the ten year age groups in which they are subsumed. For example, for the period for which complete quinquennial group data were available, the following simple relationship was found for the participation rate for females aged 25 to 29 years (with t statistics in parentheses):

$$PR_{females\ 25\text{-}29} = 0.101 + 1.125\ PR_{females\ 25\text{-}34} - 0.211\ PR_{females\ 20\text{-}24}$$

$$(4.9)\quad (26.7)\qquad\qquad (3.5)$$

This explained 99.7 per cent of the variation in participation rates for this group. This was then used to impute the female participation rate for 25-29 year olds for the years in which data were missing. Other missing quinquennial data were imputed in a similar way.

A standard cubic spline was used to interpolate data for the various missing years between 1901 to 1964. This will obviously fail to take account of business cycle impacts in missing years, and this must be noted as a limitation to the kind of analysis that can be undertaken using (at least parts of) the constructed dataset. Given the obviously approximate nature of the interpolated data, birth year cohorts were chosen in a way that favoured interpolated years that are close to, rather than far away from, years where observed data are available.

Snapshots of lifetime participation rates for people being born in each decade from the late 19^{th} century to the end of the 20^{th} century (figures 3.2 and 3.3) reveal the significant shifts that have occurred, particularly for females. (figure 3.7 in chapter 3 presents more fine-detailed 3D plots over an even longer period.)

Statistical evidence about the importance of cohort effects

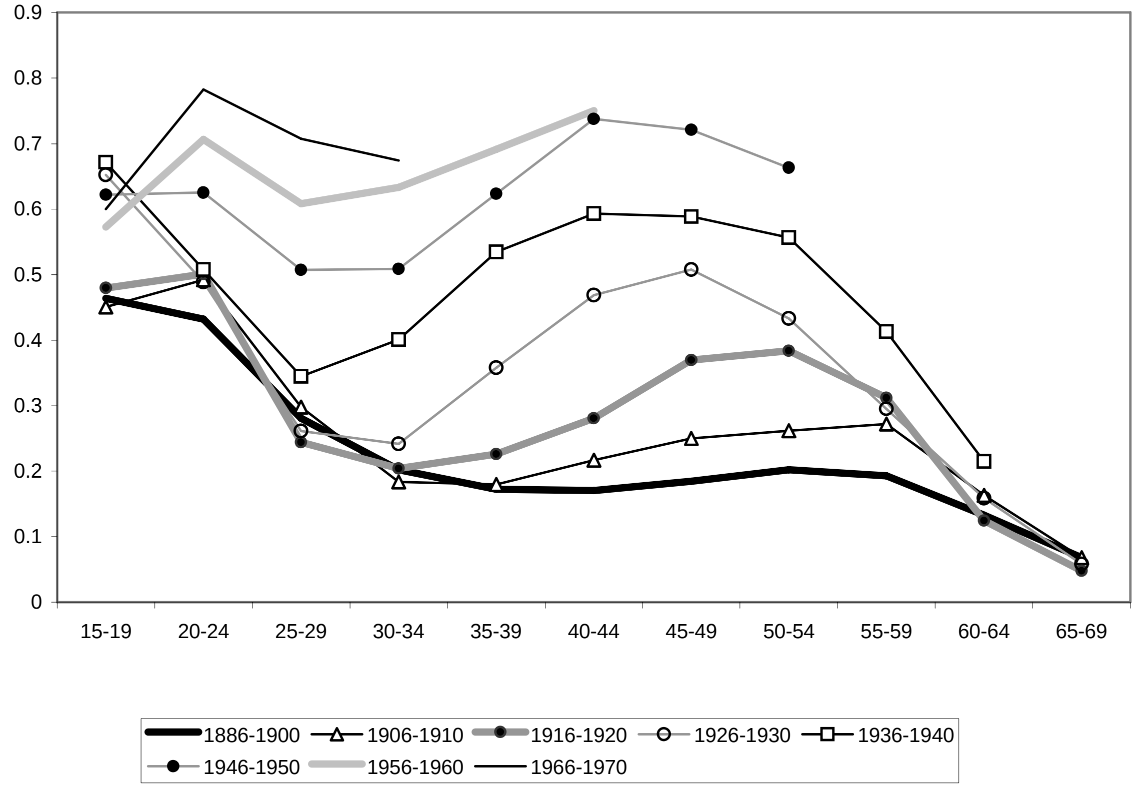
The importance of cohort effects revealed by the qualitative results shown in section 3.3 of chapter 3 are confirmed by econometric analysis. On the basis of recent Australian data based on single years of age (rather than age groups in the data above), Ravindiran et al. (2002) used panel data analysis to substantiate that female cohort effects were strong and positive, while male cohort effects were weak and negative.[2] Participation with age followed the usual inverted-u shape — as above. A third general contributor to changes in participation rates — ‘year’ effects brought about by the business cycle — were relatively

2 Their data set relates to people born between 1937 and 1957 and charts their labour market involvement to 2001.

unimportant, particularly for men. Panel data analysis[3] undertaken by the Commission of the (unbalanced) data set shown in figure 3.7 in chapter 3 revealed broadly similar qualitative results to Ravindiran et al.

Figure 3.2 **Lifetime labour participation rates for females**[a]

Australia, females born in decade waves from 1886-1900 to 1966-1970

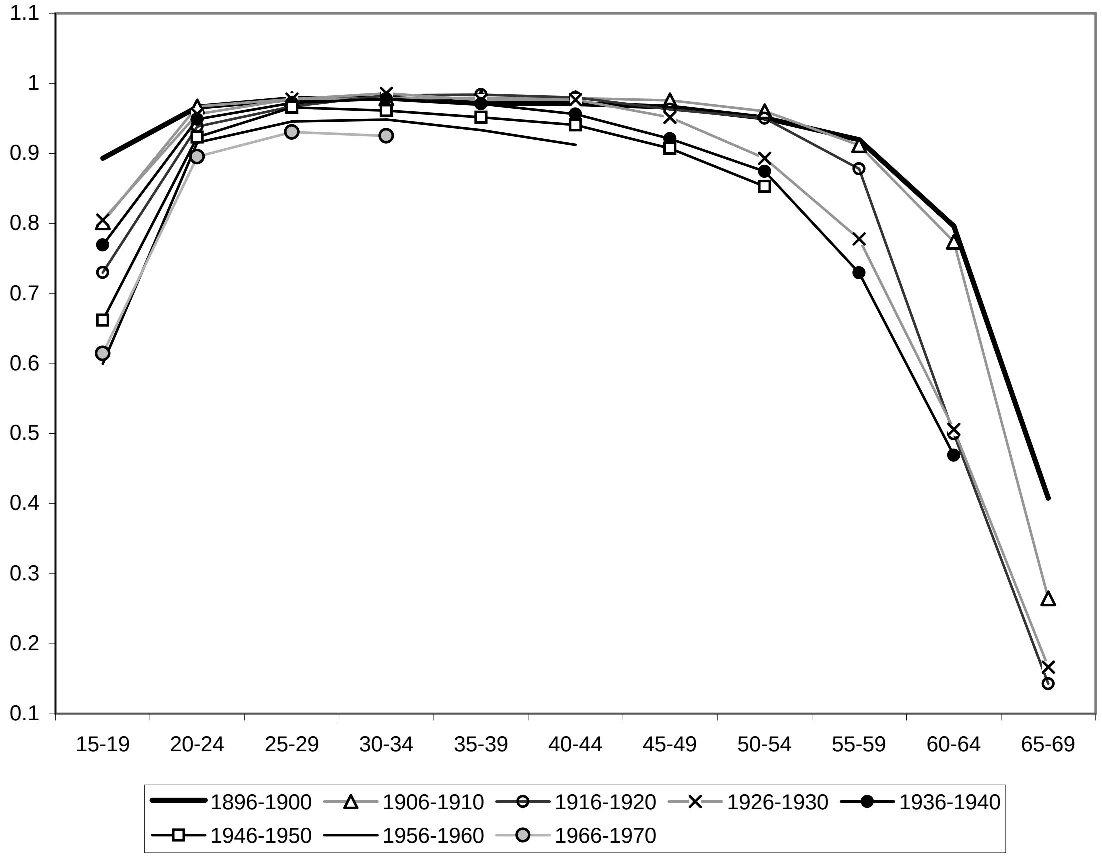


a Data on participation rates for those aged 10 to 14 years are excluded because they confuse the picture provided by other data in the graph. For this age group, participation rates have always been small, and following legislative changes relating to child labour, effectively set to zero in the mid 20th century.

Data sources: Original data sources are ABS (*The Labour Force, Australia, Historical Summary, 1966 to 1984* Cat. no. 6204.0; and *The Labour Force, Australia*, Cat. no. 6203.0) and Withers et al (1985). The Commission used various interpolation methods to construct some data.

3 A fixed effects model was estimated (and appeared justified by the relevant test statistics compared with a random effects model).

Figure 3.3 **Lifetime labour participation rates for males**[a]
Australia, males born in decade waves from 1886-1900 to 1966-1970



[a]See **a** in figure above.

Data sources: See data sources in figure above.

3.3 Exits and entries in a cohort model

Cohort methods for forecasting participation rates rely on measures of exit from and entry to the labour market as cohorts age.

The most straightforward method for incorporating cohort effects into labour supply projections is to take account of the shape of the lifetime labour participation profile for each successive cohort and to extrapolate on that basis.[4] An example is the extrapolation shown in figure 6.1 for the 1959-63 cohort for age 45-49 years.

4 Another approach — using neural networks — was also trialed, but ultimately not used. There is a highly complex non-linear relationship between participation rates and age and cohort effects. Neural network models have the advantage that they do not impose excessive structure on the data and may capture these complex effects. However, while a range of neural network models

The shape of the lifetime participation profile is determined by the pattern of entry and exit from the labour force as a cohort ages. Given that reliable labour force data is usually only available for people in five year age ranges (people aged 15-19 years, 20-24 years and so on), entry rates must be calculated over five year periods. Accordingly, where participation rates are rising for a given cohort, the entry rate at time t is defined as the net addition to the labour force relative to the initial number of people who were *not* in the labour force five years previously:

$$Entry^{t}_{x,x+4} = \frac{increase\ in\ labour\ force\ from\ t-5\ to\ t\ of\ people\ aged\ x+1\ to\ x+9\ years\ at\ t}{number\ of\ people\ aged\ x\ to\ x+4\ years\ not\ in\ the\ labour\ force\ at\ t-5}$$

It should not be assumed that all these entries actually occur at time t — clearly, entries occur smoothly over the period from t-5 to t. The entry rate measures the completed number of entries *by* time t of the cohort aged x to x+4 years five years previously.

Estimating entry (and exit) rates is complicated by net migration and deaths, which mean that the civilian population aged between x+5 and x+9 at time t is different (generally by a small margin) from that aged between x and x+4 at time t-5. The impact of sample attrition and addition can largely be removed by assuming that the observed participation *rate* for people aged x+5 to x+9 at time t would be the same as that which would be observed had no sample attrition or addition occurred. In that case, the entry rate can be estimated as:

$$Entry^{t}_{x,x+4} = \frac{PR^{t}_{x+5,x+9} \times CPOP^{t-5}_{x,x+4} - LF^{t-5}_{x,x+4}}{NLF^{t-5}_{x,x+4}}$$

where PR, CPOP and NLF denote participation rate, civilian population and ‘not in the labour force’, respectively. Dividing through by CPOP and noting that NLF/CPOP = 1-PR, then the entry rate can be re-expressed as:

$$Entry^{t}_{x,x+4} = \frac{PR^{t}_{x+5,x+9} - PR^{t-5}_{x,x+4}}{1 - PR^{t-5}_{x,x+4}}$$

However, it is not feasible for some people in the civilian population to enter the labour force, so for the purpose of defining entry rates, NLF is defined as the difference between the maximum number of people in the civilian population who could be in the labour force (CPOP*) and the observed labour force. In that case, NLF/CPOP = CPOP*/CPOP – LF/CPOP, so that the entry rate can be represented as:

produced credible short run forecasts, their long run forecasts were sometimes implausible. For example, the models forecast participation rates for 2050 approaching 100 per cent for females aged 30-34 years (at the one extreme) and 5 per cent for males aged 65-69 years (at the other).

$$Entry^{t}_{x,x+4} = \frac{PR^{t}_{x+5,x+9} - PR^{t-5}_{x,x+4}}{PR^{*} - PR^{t-5}_{x,x+4}}$$

where PR* is the maximum potential participation rate (with Burniaux et al. 2003 using PR*=0.99 and 0.95 for men and women respectively) and x are ages for quinquennial age groups. For example, for the 1954-58 cohort, the entry rate from 1998 to 2003 is the participation rate for 45-49 year olds in 2003, less the rate for 40-44 year olds in 1998, over the potential number of people who could enter the labour force in this group.

Where participation rates are falling for a given cohort, the *exit rate* is defined as the net reduction in the labour force relative to the number of people who were initially in the labour force in that cohort:

$$Exit^{t}_{x,x+4} = \frac{PR^{t-5}_{x,x+4} - PR^{t}_{x+5,x+9}}{PR^{t-5}_{x,x+4}}$$

3.4 Cohort exit and entry rates

Fixed exit and entry rates

The analysis by Burniaux et al. (2003) employs fixed entry and exit ratios — based on the last observed values of these ratios. If entry and exit rates remain fixed at their current values, then only data from 1999 and 2004 are required to estimate future participation rates for each of the age groups for five year intervals into the future. This has the advantage of computational simplicity and would be appropriate if exit and entry rates were non-trending.

For example, the participation rate for the 1960-64 female cohort when aged 45-49 years (that is, in 2009, five years after 2004) can be estimated as from the appropriate exit rate as:

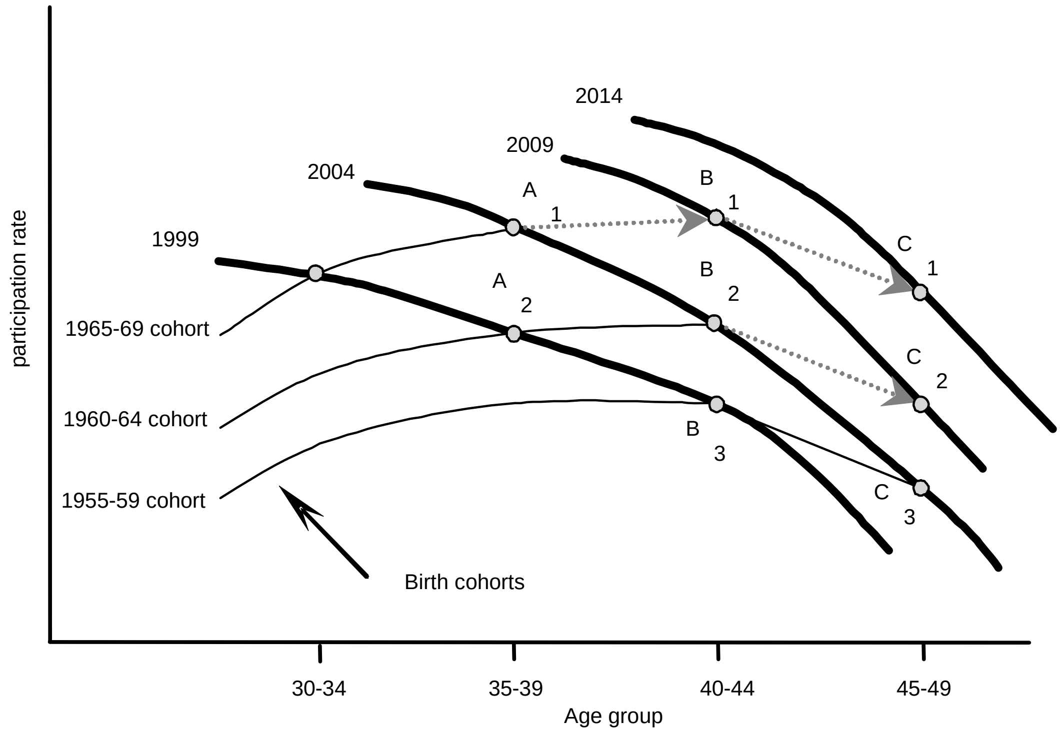
$$PR^{2009}_{1960-64\,cohort} = \left\{1 - \frac{PR^{1999}_{40-44} - PR^{2004}_{45-49}}{PR^{1999}_{40-44}}\right\}_{1955-59\,cohort} \times PR^{2004}_{1960-64\,cohort}$$

which is equivalent to $C_3/B_3 \times B_2$ in figure 3.4.

Similarly, the participation rate for the younger female cohort born in 1965-1969 when aged 40-44 years (again in 2009) can be estimated from the appropriate *entry rate* (noting from figure 6.4 that A1 to B1 rises so that entry has occurred) as:

$$PR^{2009}_{1965-69\,cohort} = PR^{2004}_{1965-69\,cohort} + \left\{\frac{PR^{2004}_{40-44} - PR^{1999}_{35-39}}{PR^{*} - PR^{1999}_{35-39}}\right\}_{1960-64\,cohort} \times (PR^{*} - PR^{2004}_{1965-69\,cohort})$$

Figure 3.4 **The dynamic cohort method for projecting participation rates**



Data source: Burniaux et al. (2003).

This leaves gaps between each of the years 2004, 2009, 2014, 2019 and so on. These gaps can be completed using interpolation.[5]

Time varying entry and exit rates

As Burniaux et al. (2003) note, it would be desirable to also produce forecasts of participation rates that allow entry and exit rates to evolve over time. The future evolution of exit and entry rates will determine what happens to the labour force involvement of present cohorts. This section sets out the method used for estimating such dynamic exit and entry rates for Australia. Such time varying exit and entry rates were used in the projections in chapter 3.

[5] If fixed entry/exit rates are used, linear interpolation is probably most appropriate for several reasons. First, it is easier to implement than spline methods and is justified by the small differences between rates observed at five year intervals. Second, the participation rates converge to a set value for each of the age groups, and linear interpolation gives exact results when this occurs, whereas spline methods do not.

The pattern of exit and entry rates in the past time is sometimes quite erratic, making it hard to forecast their future paths. Smoothing helps to reduce noise (but at the risk of producing spurious trends). Exit rates using smoothed data are shown in figure 3.5. Where exit rates are negative, it means that entry is occurring, and that it is more informative to graph the entry rate. For example, the comparable entry rate for people aged 15-19 years is shown in figure 3.6.

The data reveal that some rates appear to have stabilised — as in exit rates for females aged 25-29 years and entry rates for females aged 15-19 years. Others appear to still be trending. For example, exit rates for older workers of both genders (aged 55-64 years) have generally been dropping, and this may continue.

Clarifying bounds for exit and entry rates in dynamic models

There are bounds on potential exit rates, which are important when projecting dynamic exit rates. When net exits occur, then the exit rates (*Exit*) is bounded: $0 \le Exit \le 1$. When all members of a cohort exit the labour force over a period, then X=1, the highest possible bound. When there is no net attrition, *Exit* = 0. If there is negative net exits (entry) then, in theory, in the extreme $Exit \to -\infty$.

Given knowledge of the future path of *Exit*, forecasts of participation rates can be made by noting that:

$$PR^{t}_{x+5,x+9} = (1 - Exit_{a,a+4,t}) \times PR^{t-5}_{x,x+4}$$

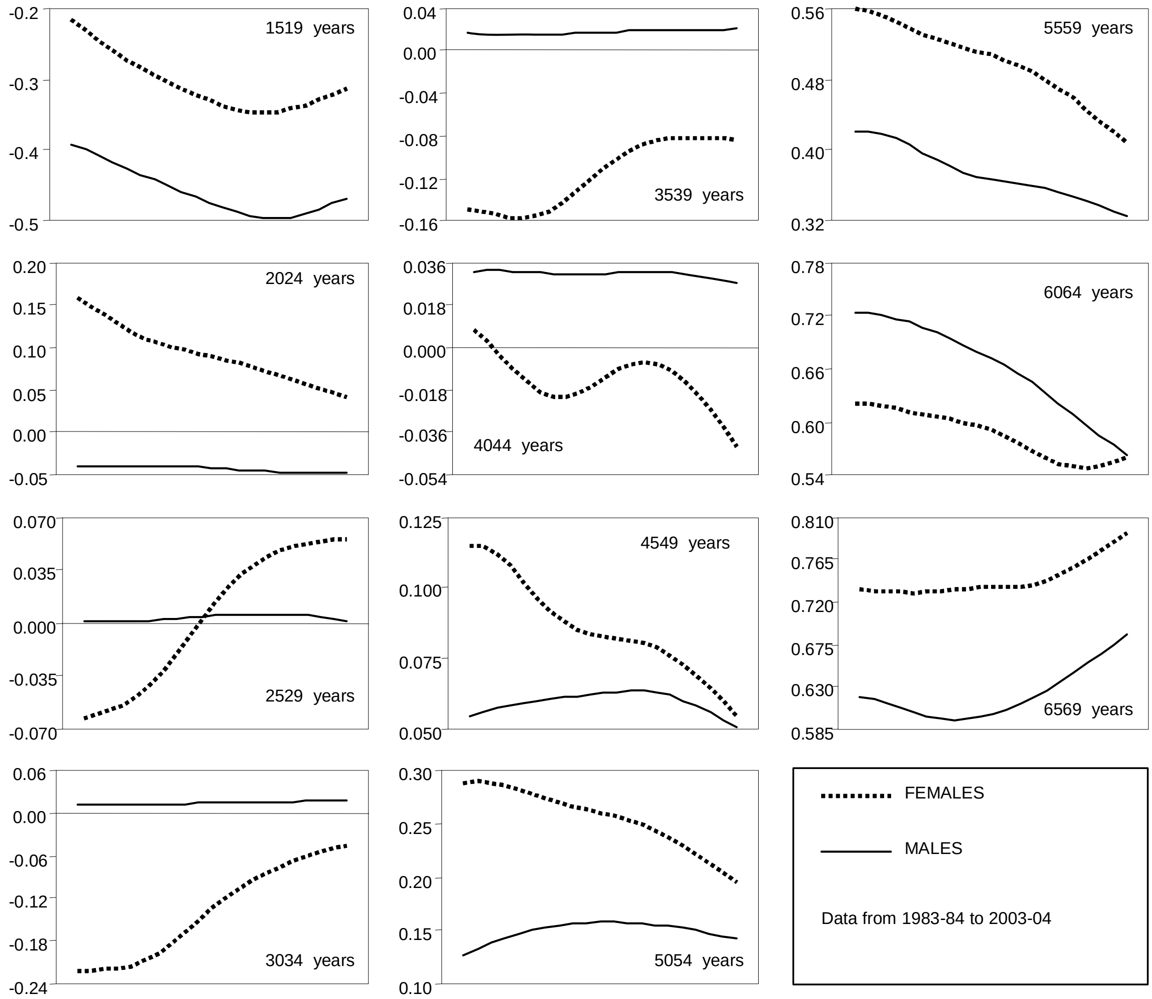
While in theory negative net exit rates cover cases where net entry occurs, it is useful to also set out a direct measure of entry rates (*Entry*). These are defined relative to the stock of people that could be, but are not, in the labour force.

Where net entry occurs, then $0 \le Entry \le 1$. *Entry* is at its maximum of one when $PR^{t}_{x+5,x+9} = PR^*$. When there is no net entry, *Entry* = 0. If there are negative net entry (positive net exits), then in the extreme it is possible that $Entry \to -\infty$. Forecasts of participation rates based on these entry rates are:

$$PR_{a+5,a+9,t} = Entry_t \times (\max - PR_{a,a+4,t-5}) + PR_{a,a+4,t-5}$$

Figure 3.5 **Exit rates based on smoothed participation rates**[a]

1983-84 to 2003-04

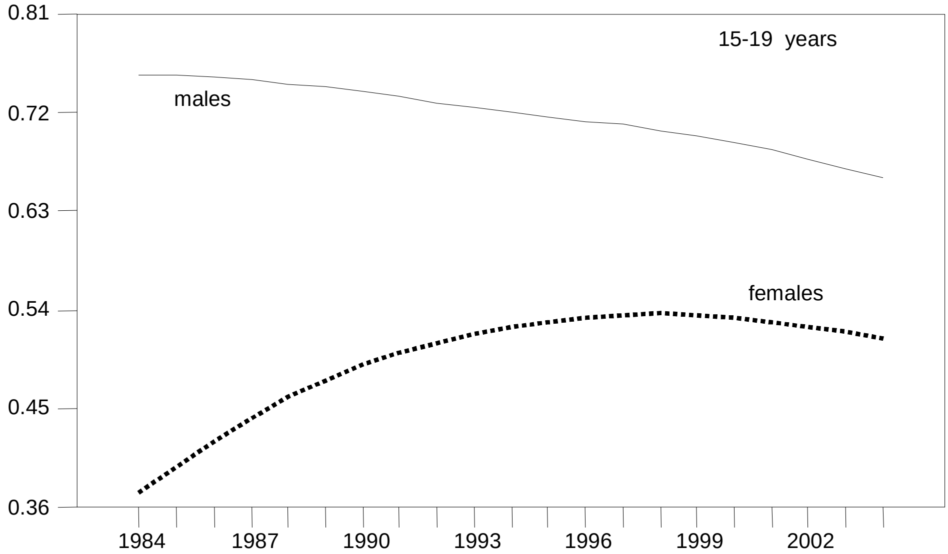


aParticipation rates were smoothed using a Hodrick Prescott filter. Note that an entry or exit rate for age x mean the rate at which a cohort aged x in year t-5 enter or exit the labour force t years later.

Data source: ABS (*Labour Force, Australia, Detailed*, Cat. no. 6291.0.55.001).

Figure 3.6 **Entry rate based on smoothed participation rates**[a]

15-19 year olds, 1983-84 to 2003-04



[a] Participation rates were smoothed using a Hodrick Prescott filter. Note that an entry rate for age x mean the rate at which a cohort aged x in year t-5 enters the labour force t years later.

Data source: ABS (*Labour Force, Australia, Detailed*, Cat. no. 6291.0.55.001).

Because both rates can encompass negative values, it would be possible to forecast *either* entry rates *or* exit rates and use just the single measure to project participation rates.

However, there is a major practical obstacle to forecasting just the exit rate or the entry rate alone and then deriving participation rates. This arises because there is no single observed value of exit rates at the sensible upper bound of entry rates and vice versa. For example, a rise in the participation rate for a cohort from 0.93 to 0.945 over a five year period gives an entry rate of 0.747 and an exit rate of -0.0159 (for a PR* of 0.95). However, a rise in the participation rate from 0.945 to 0.96, which violates the condition for PR*, gives the same value for the exit rate, whereas the value for the entry rate clearly discloses that the upper bound has been exceeded (table 3.1). It is even possible that a seemingly sensible value for the exit rate might result in a participation rate that exceeded one, let alone PR*. Similarly, the same indeterminacy arises when predicting participation rates from negative values for entry rates — a seemingly innocuous value for an entry rate may generate even negative participation rates.

Table 3.1 **No single measure of exit or entry gives determinate results**[a]

PR_t	PR_{t-5}	*Entry rate*	*Exit rate*
0.945	0.930	0.747	-0.0159
0.960	0.945	3.000	-0.0159
0.059	0.180	-0.157	0.6700
-0.080	0.059	-0.157	2.3486

a These calculations were made with PR*=0.95.

Source: Commission estimates.

Given these practical issues, the best approach is to model exit rates when long-run exit rates are likely to be positive and to model entry rates when long run entry rates are likely to be positive.[6] This ensures that forecast participation rates are appropriately bounded.

The fact that appropriately defined exit and entry rates must be bounded suggests that linear and log trend models are not appropriate for projection. In order that the long run does not violate bounds, various s-shaped growth curves were considered appropriate. Ultimately, the analysis used Richards' curves (a generalised logistic), since these curves allow for more flexible inflection points than other common s-shaped curves, such as Gompertz or logistic curves (technical paper 2).

3.5 Modelling and projection strategy

For each age, gender and jurisdiction, the following modelling and projection strategy was adopted.

- Participation rates were smoothed using the Hodrick-Prescott filter to reduce noise associated with the business cycle.
- Exit and entry rates were derived for each quinquennial age group for fiscal years from 1983-84 to 2003-04 (noting that estimating these requires data on smoothed participation rates from 1978-79). These were graphed. Where it appeared likely that an entry (exit) rate was likely to be positive in the long run, then the series was modelled as an entry (exit) rate.
- The smoothed series' were differenced and examined for any significant turning points to identify structural breaks in the series. Since an s-shaped curve must either show decline or fall throughout its course, any sign changes in the smoothed series reveal

6 It may still be the case that the historical data on which these forecasts are based will have some negative values for exit or entry rates, but so long as the long run rate is positive, this does not present problems for forecasting analysis. Indeed, a modelling approach that omits data points that are negative would generate potentially significant biases.

breaks. (However, small changes relative to the mean were ignored as statistical noise.) The starting year for estimation occurred after any structural break.

- The smoothed series' were differenced twice to examine acceleration and de-acceleration of participation rates over time. This identified the inflection points in the s-shaped curves (in some case these were forecast with extrapolation methods — but in all cases, plausible inflection points could be identified). These inflection points were used in the estimation of the s-shaped curves.
- Reasonable priors about appropriate maximum or minimum participation rates were formulated, since the non-linear least squares estimation of s-shaped curves can sometimes result in long run rates that are not credible. These limits were used to constrain the estimation results — but in many cases they were not binding. Accordingly, the results largely represent a statistical approach to projection rather than subjective views about how exit and entry rates might evolve.
- Exit and entry rates were modelled as Richards curves. The rates were estimated using non-linear least squares subject to maximum (or where participation rates were falling, minimum) limits on the long run participation rates (technical paper 2).
- The projected entry and exit rates were then used to estimate participation rates by using the formulae above.

4 Productivity and ageing

Key points

- Population ageing can affect aggregate productivity because average productivity levels differ across age groups.
  - Both cross-sectional wage data and empirical estimates suggest that average productivity levels initially increase with age before declining after middle age. Consequently, changes in the age composition of the labour force may affect aggregate productivity.
  - Experimental estimates suggest a mostly negative, but negligible, effect over the 40 year projection period. This small effect arises because the bulk of workers remain in the most productive age range. Moreover, the beneficial productivity effects of a smaller proportion of young workers largely offsets the effects of a greater proportion of older workers.
- Demographic change may have a role in investment and technical progress — two of the major sources of labour productivity gain. However, such effects are expected to be small.
  - Global ageing will change global demand for and supply of savings and thereby affect interest rates and capital flows. Specific effects on growth of capital deepening in Australia are not clear from existing empirical studies. Moreover, rates of growth in capital deepening have been remarkably stable over the last 40 years in Australia, against a backdrop of significantly changing global investment and demographic conditions.
  - Innovation, entrepreneurship and incentives for technical progress may be linked to demographic change, but there is little persuasive evidence that there will be notable effects in Australia.
- Annual labour productivity growth has averaged about 1.75 per cent over the last 30 years. To the extent that population ageing, itself, is likely to have little effect on aggregate productivity growth, this rate provides a useful starting point for modelling the long term effects of population aging. The Commission has also simulated the effects of average growth rates of 1.45 and 2.05 per cent.

4.1 Introduction

Rising labour productivity has been the main factor behind aggregate economic growth over the past fifty years. As the labour supply will contract relative to Australia's population over the next half century, the significance of labour productivity growth will be further accentuated.

As explained in chapter 3, modelling the budgetary and economic growth impacts of an ageing population requires an estimate of future labour productivity growth.[1] This chapter explains the assumptions used by the Commission.

Labour productivity growth is the result of a complex interaction of many factors. While the historical pattern of year-on-year productivity growth can be quite volatile, long-run projections need only pick up the anticipated trend. Consequently, the Commission's baseline approach (like that of the Intergenerational Report and the Access Economics model of State budgets) assumes a constant average annual labour productivity growth rate over the projection period, rather than elaborate, but potentially spuriously detailed, annual projections. Given some uncertainty about the long-term trend, the Commission has also considered a range of averages more or less favourable than the baseline assumption.

A particular focus for this study is whether labour productivity growth may be impeded or enhanced by population ageing. This issue warrants serious consideration because some research suggests significant effects of ageing on productivity. For example, Lindh and Malmberg (1999) estimate that age effects alone may have reduced average productivity growth rates from 1990 to 1995 by an average of 0.2 percentage points per year, for a sample of 23 OECD countries.[2]

There are several mechanisms by which population ageing could affect labour productivity. At some age, the physical and mental effects of ageing are likely to offset the benefits of experience, so that productivity levels of older people may be less than those of middle-aged people. Depending on when such an effect manifests itself, this implies that changes in the age structure of the workforce could affect aggregate productivity growth. On average, shifts towards very young or very old workforce age structures would be associated with reduced productivity growth. Of course, the relative productivity of different age groups may not be stable over time, because the characteristics of the groups may change (such as better education for older cohorts).

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[1] Growth in labour productivity (real output per worker hour) can be decomposed into the growth in the capital-labour ratio (capital deepening) and growth in multi-factor productivity (which is the 'residual' growth in value added not directly attributable to the measured growth in the quantity and quality of labour and capital inputs).

[2] Similar studies of the role of the age structure in productivity or economic growth include Malmberg (1994), Sarel (1995), Persson (1999), Nahuis et al. (2000), Andersson (2001), Feyrer (2002) and Navaneetham (2002).

Population ageing may also affect productivity growth rates through macroeconomic effects on savings, investment and innovation. For example, to the extent that older people draw down savings to fund their retirement, there would be reduced scope for investment and capital deepening — as noted later, one of the major sources of labour productivity growth.

Another important consideration for this study — which examines the implications of ageing for all Australian jurisdictions — is whether there may be long term convergence or divergence in State labour productivity growth rates.

The chapter is organised as follows:

- section 4.2 summarises the labour productivity assumptions used in some recent Australian studies of the economic effects of demographic change;
- section 4.3 examines past productivity growth rates and what the future may hold;
- section 4.4 considers whether there may be differences in the average level of productivity of workers across age cohorts;
- section 4.5 examines the potential role of demographic change for growth in capital deepening and technical progress; and
- section 4.6 considers whether there may be convergence or divergence in labour productivity growth between the States.

4.2 Labour productivity assumptions used in previous studies

When comparing studies of the estimated long-term impact of demographic change on economic growth and government budgets, it is important to be aware that small differences in assumptions about future productivity growth rates, compounded over many years, can greatly alter projected outcomes. These differences in assumed growth rates can arise from two sources:

- different views about the effects of ageing on productivity; and
- different views about economy-wide productivity changes that are not linked to ageing.

Different views about ageing and productivity

Most Australian studies have not included explicit links between ageing and productivity. The most common base case assumption is that all workers have the same productivity level (value added per hour worked), which grows at the same average annual rate. This is the same as assuming a fixed rate of productivity growth for the economy as a whole. This approach was used in the Intergenerational Report, the Access Economics model used by State governments, the base case of Day and Dowrick (2004) and a recent Australian Government Treasury paper (Gruen and Garbutt 2003). It is also used as the base case in the Commission's projections in this study.

An alternative approach is to assume that average productivity levels differ across demographic groups, so that a change in the age composition of the workforce affects overall productivity. This approach was used, for example, in one scenario by Gruen and Garbutt (2003). They assumed that, in the future, the average level of productivity of workers of different age and gender would be proportional to recent average hourly wages paid to workers in these groups. Workforce ageing produced a slight difference in overall productivity compared with their baseline scenario.

This approach can be further extended by taking into account any cohort effects. For example, average education levels will rise in the old as the current, well-educated young begin to age. In one of their modelling scenarios, Day and Dowrick (2004) explored these cohort effects. They estimated that, by 2041, the average years of education across age groups will have risen by 1.2 years (from 13.0 presently) and this would raise annual labour productivity growth by an *additional* 0.22 percentage points.[3]

Different views about general economy-wide productivity trends

The long-run productivity assumptions used in other studies diverge, not because of different views about the possible effects of ageing, but rather due to different judgments about the relevance of past growth rates and future key drivers.

The Intergenerational Report assumed future labour productivity growth (real output per hour worked) of 1.75 per cent per year on the basis of the past 30 year average for the economy as a whole. It also considered a high growth scenario of 2.0 per cent per year (about the average for the 1990s) and a low growth scenario of 1.2 per cent per year (about the average for the 1980s).

Day and Dowrick (2004) assumed a labour productivity growth rate of 2.0 per cent per year for their baseline scenario. This corresponded to the average for the market sector (not the economy as a whole) since 1978-79. They argued that this is a conservative assumption, because education levels are forecast to increase and this is expected to increase the rate of labour productivity growth; their optimistic scenario assumes a rate of 2.2 per cent per year. They also considered a pessimistic scenario of 1.5 per cent per year growth in labour productivity, which they say may arise if, for example, institutional or

[3] This consists of a positive effect of 0.9 percentage points, due to the higher *level* of education, less 0.68 percentage points, because the *rate* of increase in education levels will be slower than in the past.

policy settings discouraged investment, or because slower labour force growth resulted in less benefit (than the past) from scale economies, or because an ageing workforce may be less dynamic.

Gruen and Garbutt (2003) assumed a long-run average annual growth rate of 1.75 per cent, in line with the Intergenerational Report. However, they gave three reasons why growth might be faster. First, the world's technological frontier may expand faster than in the past because of increasing applications of information and communications technology (ICT), with spillover benefits for Australia. Second, they cited empirical evidence that finds a strong and stable statistical correlation between slower labour force growth and faster labour productivity growth. Third, like Day and Dowrick, they argued that the expected rise in the average level of educational attainment should increase labour productivity growth, though they did not posit an estimate. Notwithstanding the possible contributions of these factors to stronger productivity growth, Gruen and Garbutt noted that it may be a big step to assume, for now, sustained long term growth higher than 1.75 per cent without a continuing policy focus on economic reform.[4]

In submissions to this study, State governments adopted the following assumptions in their analyses:

- The New South Wales Government (sub. DR45, p.21) assumed labour productivity growth of 1.8 per cent per year, noting that this was conservative relative to recent New South Wales growth (2.4 per cent per year for 1989-90 to 2001-02).
- The Victorian Government (sub. 29, p.80) used a base case of 1.75 per cent and an alternative assumption of 2.0 per cent.
- The Queensland Government (sub. 17, p.32) used an annual labour productivity growth rate of 2 per cent for the 'medium' scenario — in line with Queensland's recent experience — and 1.75 per cent and 2.5 per cent for the 'low' and 'high' scenarios, respectively.
- The South Australian Government (sub. 23, p.17) used a rate of 1.75 per cent.

4 The West Australian Government (sub. 39, p. 29) commented that as there was some risk that recent strong productivity growth may not continue, policy settings in Australia must be supportive of continued growth. The Department of Employment and Workplace Relations (sub. DR71, pp. 20-21) considers there is scope for productivity growth higher than 1.75 per cent. It suggested that labour productivity could be increased by increasing the proportion of workers covered by Federal enterprise agreements, increasing the proportion of skilled workers within total employment, increasing the capital to output ratio, increasing the share of ICT in the overall capital stock, and increasing the share of GDP devoted to business research and development. The Australian Nursing Federation (sub. DR72, p.5) expressed concern about the impact on workers and their productivity of the Australian Government's proposed industrial relations changes but agreed that productivity gains will need a concerted investment in research.

- The West Australian Government (sub. 39) used a base rate of 1.75 per cent and 1.25 and 2.25 for sensitivity tests.
- The Tasmanian Government (sub. 40) applied a rate of 1.75 per cent and compared it with a 'low' rate of 1.25 per cent.
- The ACT Government (sub. 21, p.18) used a rate of 2 per cent per year, but noted that it was reasonable to assume that the productivity gains of the past decade will not be maintained over the next 40 years, and so a rate more in keeping with historical levels (1.6 per cent) was also examined.

4.3 Past and future productivity growth

As these studies recognize, Australia's past productivity record is a reasonable starting basis for illustrating potential future economic impacts of ageing.

A methodological caveat

One obstacle to interpreting the past record is that the output of non-marketed services (such as certain public health) is measured by the value of labour inputs. This imposes a zero productivity growth rate on these sectors and is, therefore, likely to underestimate overall productivity growth in the economy.[5] Accordingly, Day and Dowrick (2004) argued that labour productivity for the market sector is a more reliable measure than for the whole economy, and use past trends in market sector productivity in their projections. However, when forecasting the economic growth effects of ageing, Day and Dowrick assumed that the market sector productivity growth rate applies to the whole economy. This raises several issues.

- It assumes that the unmeasured productivity growth in the non-market sector is the same as that of the market sector. This is unlikely to be true, although it is probably better than assuming zero growth (as is implicit in the orthodox approach).
- A more problematic issue is one of consistency. Projecting the implications of ageing on tax revenues and government spending often relies on assuming the continuation of past trends, expressed as a ratio to the existing ABS' National Accounts definition of GDP. Such historical ratios could not be used if future GDP was measured by taking into account non-zero productivity in the non-market sector. For example, such an approach would produce upwardly biased tax revenue projections.

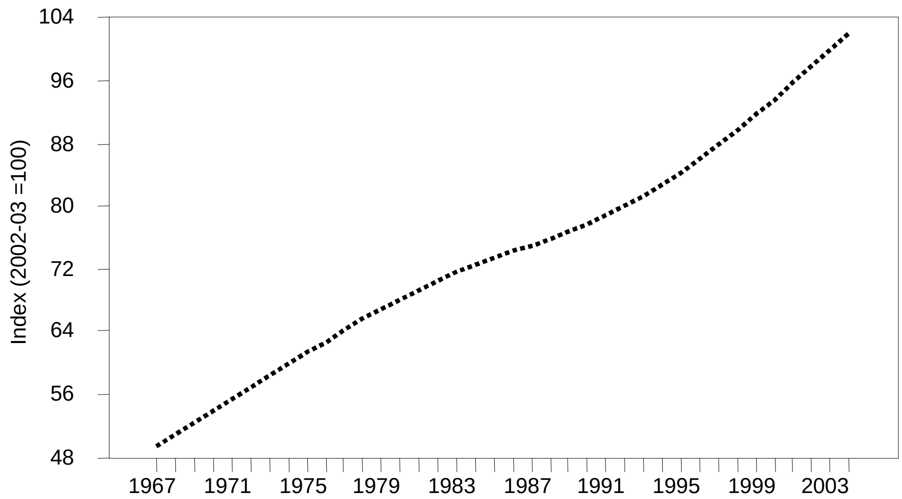
To avoid these consistency problems, this study has used the existing ABS National Accounts approach to the measurement of GDP — with its underlying assumptions — but also looked at the implications of different productivity growth projections.

5 The ABS' National Accounts measure of labour productivity for the whole economy for the last 25 years averaged about 0.5 per cent per year less than for the market sector.

What does history tell us?

The last forty year span of labour productivity (based on GDP per hour for the whole economy) reveals several shifts in long-run trends (figure 4.1), with a slowdown evident in the 1980s and an acceleration during the 1990s (hence the 'miracle' decade).

Figure 4.1 **Labour productivity,1966-67 to 2003-04**
Index of GDP per employee hour worked[a]



a The labour productivity series has been smoothed by a Hodrick-Prescott filter, so that growth rates can be calculated for any period without being affected by cyclical variations.

Data sources: Commission estimates; ABS (*National Accounts*, Cat. no. 5204.0).

Based on cyclically-adjusted data (table 4.1), the long-term growth rate from 1966-67 to 2003-04 is 1.78 per cent per annum — very close to the long-run value of 1.75 per cent used in the Intergenerational Report. This rate is 0.3 percentage points below the vigorous productivity growth apparent over the period from 1992-93 to 2003-04, but about 0.5 percentage points above the sluggish performance from 1985-86 to 1992-93, when growth was 1.27 per cent per year.[6]

[6] These results are for economy-wide output per hour worked, and should not be confused with figures for the market sector (which comprises about two-thirds of total output).

Table 4.1 **Labour productivity growth rates, 1966-67 to 2003-04**

Market and non-market sector, Australia[a]

Period	*Compound growth rate (unsmoothed series)*	*Trend growth rate (unsmoothed series)*	*Trend growth rate (smoothed series)*
	%	%	%
Peak to peak			
1969-70 to 1978-79	2.23	2.32	2.38
1978-79 to 1985-86	1.63	1.66	1.49
1985-86 to 1992-93	1.10	1.02	1.27
1992-93 to 1998-99	2.21	2.18	2.02
1998-99 to 2003-04	1.84	1.89	2.12
1992-93 to 2003-04	2.05	2.18	2.09
1969-70 to 1992-93	1.70	1.68	1.71
1969-70 to 2003-04	1.81	1.70	1.71
Entire time period (non-peaks)			
1966-67 to 2003-04	..	..	1.78

a In order to avoid biases associated with the influences of the business cycle, peaks in GDP per hour worked were identified by smoothing the data using a Hodrick-Prescott filter and forming the ratio of the smoothed to the unsmoothed data. However, it should be emphasised that it is too early to determine whether the end year (2003-04) will be the peak in the latest cycle. It should also be noted that these peaks are not the same as those identified by the ABS using market sector data (and a slightly different smoothing technique). Growth rates were then calculated on the unsmoothed data across the identified peaks (the first two columns). The third column represents trend growth rates calculated across various periods using the smoothed data. This method can also — with caution — be applied to non-peak to non-peak periods, since the influence of the business cycle is significantly reduced. This enables an assessment of an even longer run productivity growth rate — as shown in the last row of the table. The trend growth rates for both columns 2 and 3 were calculated by regressing the natural log of the relevant productivity measure against a time trend using Ordinary Least Squares.

Source: ABS (*National Accounts*, Cat. no. 5204.0 and 5206.0).

In deciding on a range of likely future outcomes, the past acts as a check. For example, it would be difficult to justify averages for the next 40 years lower or higher than the extremes of the last 40 years. The Commission has accordingly assumed a range of 1.45 to 2.05 per cent as being useful for this study. The upper bound matches the strong productivity growth of the 1990s, while the lower bound provides approximate symmetry around the long-term average of around 1.75 per cent.[7] Box 4.1 sets out some of the circumstances that may be associated with higher or lower productivity outcomes.

[7] A complementary approach is to work backwards and calculate the 'minimum' productivity growth rate in order that the level of real output per capita is maintained, despite the impacts of ageing. For example, in the case of New Zealand, Guest et al. (2003) estimate a labour productivity growth rate of 0.27 per cent would suffice.

Box 4.1 **The scope for sustaining recent productivity growth**

The strong, sustained Australian productivity performance since the early 1990s has prompted examination of the factors that lay behind it and the scope for maintaining it. Four aspects are often highlighted. First, there are likely to be further gains from the diffusion ICTs. ICTs are a source of significant capital deepening effects. For example, the innovative use of ICTs played a key role in the uplift in productivity in the wholesale trade sector, which was a major contributor to Australia's productivity surge. As a general purpose technology, there should be further scope for ongoing user adaptation. In addition, ICTs may enhance the ability for older workers to remain in the workforce by way of a reduction in physical demands and enhancement of flexibility in job change.

Second, Australia appears to be below the levels of productivity achieved in some other OECD countries. For example, in terms of GDP per hour worked, in 2002, Australia was at 83 per cent of the US level, up from 76 per cent in 1990, but only slightly above the 1950 relativity. Notwithstanding qualifications about international productivity measurement and the feasibility of a relatively small economy to achieve US benchmarks, this suggests the scope for productivity catch-up.

Third, forecast increases in education levels (human capital) are expected to be beneficial to productivity growth. Increases in education levels should directly increase the level of productivity of workers. There may also be implications for the rate of capital accumulation, technology absorption and technology advancement, labour supply participation and fertility. However, at some point, the returns to education may begin to diminish.

Fourth, as identified in the recent review of National Competition Policy (PC 2004b), governments have scope to implement further reforms that could stimulate productivity.

While the above factors may strengthen productivity growth, there may be some challenges facing Australia that could undermine productivity growth. For example, salinity, droughts and climate change could dampen agricultural performance, with sizeable effects on other sectors. Externally, global ageing is expected to slow growth in output in many advanced economies, and may have damaging impacts on global entrepreneurship and innovation. This could reduce demand for Australian goods and services (with possible scale effects) and slow the growth in the value of foreign technological spillovers that have been an important source of past productivity growth.

The baseline productivity assumption should be viewed as a useful starting point for this exercise, matching that of the Intergenerational Report and consistent with the long-run historical trend. It should not be seen as the Commission's *forecast* of Australia's future productivity growth.

4.4 Relative productivity of current workers

A common view is that an individual's productivity rises until some middle age peak, after which it begins to decline. The basis for this view is largely two-fold. First, the physical and cognitive effects of ageing mean, on average, 70 year olds are less capable at certain tasks than when they were 35 years old. Second, human capital theory predicts that productivity increases with experience, at least in the early years, while education and training rates diminish after some middle age peak, such that skills depreciate.

A counter view is that there is no decline in productivity in later years, nor are older workers any less productive than younger contemporaries (box 4.2). The claim is that any decrements in physical and cognitive capacities are relatively small during working years and, even when they do occur, do not materially undermine performance in most tasks. In addition, it is sometimes claimed that certain attributes of older workers, such as greater experience, less absenteeism and lower job turnover, make older workers of comparable (or greater) value to employers than younger workers.

In light of these divergent views, it is important to obtain an objective assessment of the actual impacts of ageing on productivity. Measuring the relative productivity of current workers of different age is challenging. Three broad approaches have been tried:

- examining the age profile of worker characteristics that may be related to productivity — for example, education, training, job turnover and absenteeism;
- using the economy-wide cross sectional pattern of earnings across age groups; and
- econometrically estimating the relationship between age of workers and their productivity, using large samples of diverse workers — in one case, covering almost three million concurrent workers.

Box 4.2 **The positive view — age does not affect productivity**

The research … indicates that there is strong support for a finding that an ageing workforce is not necessarily linked to lower productivity. Improving health and higher levels of educational attainment for older workers are associated with the maintenance or improvement of productivity. Certainly there is no overwhelming support for suggesting workers' productivity declines with age. (DEWR 2003, p. 5)

'The overall finding from more than 100 research investigations is that there is no significant difference between the job performance of older and younger workers.' (Warr 1994 p. 309)

'There are only small declines in reaction time and physical strength and almost all research into the productivity of older workers has shown it to compare quite favourably with that of other workers from other age groups … precisely because of seniority.' (HREOC 1999, p. 16)

'The bulk of the evidence (Reid (1989), McNaught & Henderson (1990), Encel (1992), Salthouse (1994) and Waldman and Avalio (1986) suggest productivity declines little with age, and that in many applications (notably work involving intellectual skills) productivity may rise with age.' (Access Economics 2001)

'… all the research evidence suggests older workers are just as productive, trustworthy, stable and conscientious and as adaptable to change as younger workers.' (NSW Anti-discrimination Board 2004)

'A number of factors have contributed to the decline in labour marker participation by those aged 55 and over. They include … discriminatory attitudes towards older workers, based largely on myths about their supposed inability to be efficient and productive workers.' (South Australian Government, sub. 23, Background Paper on Employment and Older People, p. 4)

Worker characteristics and age

A popular approach to assessing the relationship between productivity and age is to examine, one at a time, the age pattern of certain worker characteristics that may be expected to have a bearing on individuals' productivity. The Commission has examined several characteristics in some detail.

The gerontological evidence reveals some decline in capabilities

Disciplines such as industrial gerontology and applied psychology have intensively examined changes with age in physical and cognitive capacities (including traits such as reasoning speed, numerical and verbal capabilities, problem solving and memory recall). The general picture that emerges is that some capacities decline from some stage in adulthood (Skirbeck 2003).

It is less clear what effect this has on work performance.

- It is likely that the effects depend upon the nature of the task and the role of experience in compensating for what in practice, are slow and subtle changes in capacities. Warr (1994), for example, concluded that experience can compensate in some tasks, but not others.
- The impact on economy-wide productivity of biological ageing may also be muted if workers, when confronted with decline in certain biological capacities, leave the workforce or change to jobs in which those capacities are not important.[8]
- There is also some evidence suggesting that targeted training programs may soften or halt age-related decline (Skirbeck 2003, p.5).

Older workers tend to be less educated and less trained

Historically, the average education attainment level of older workers has been much lower than for younger contemporaries. Educational differences play a key role in job and wage differences between older and younger workers and would be expected to at least partly explain statistical differences in average worker productivity across age groups.

The incidence of training is significantly lower among older workers (Wooden et al. 2001). This could reflect the benefits and costs to employers of training older workers. For example, the period over which an employer can obtain a return from training is lower for workers close to retirement. However, some commentators question whether employers misperceive the benefits and costs of training older workers.

Two skills which may be important for productivity in a modern society, literacy and computer skills, are lower among older workers, even after accounting for education differences between age groups (Miller and Mulvey 1997; OECD 1998).

Staying and moving around — patterns of worker mobility

Long service with an organisation (tenure) — commonly seen as an indicator of certain worker qualities — is much more prevalent among older workers. This is partly an artefact because, clearly, younger workers under, say 40 years of age, have had less scope for 20 years of service. Nonetheless, longer experience with an organisation increases the likelihood of better performance, *if* the job entails firm- specific skills and knowledge.[9]

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[8] Both the Queensland Government (sub. 17, p. 27) and Victorian Government (sub. 29, p. 42) also came to the view that the effects of biological ageing and experience tend to work in opposite directions.

[9] The South Australian Government (sub. 23, Background paper on Employment and Older People, p. 5) expressed concern about a huge potential loss of corporate memory in the public

However, some empirical evidence suggests that, on average, earnings and productivity increase little, if at all, beyond about 10 years tenure.

Job turnover is much lower among older workers. From an employer's perspective, low turnover should reduce hiring and training costs. On the other hand, from an economy-wide perspective, low turnover may impede the diffusion of knowledge and the efficient matching of employers and employees (Jovanovic 1979). Ilmukannus et al. (1999) found empirical support for a positive relationship between firm productivity and turnover in Finland manufacturing.

Older workers are probably less healthy

The probability of poorer health and disability clearly increases with age among the *population.* There is less comprehensive evidence on the prevalence of poorer health and disability among different age groups in the *workforce*, but most of what is available suggests ill-health rises with age.

That said, it is likely that differences in health status by age in the workforce are less marked than differences between age groups in the population generally, because people with particularly poor health are more likely to be unemployed or to exit the labour force.

Somewhat paradoxically, surveys reveal lower than average sick leave *incidence* rates for the oldest workers. To some extent, this reflects greater use of sick leave for family reasons by younger workers. In any case, sick leave incidence is only one part of the health productivity story, as it does not capture the impacts of chronic conditions on performance while at work. Nor does it consider the duration of sick leave, which may also vary by age. For example, the total duration of leave on workers' compensation, as a proportion of total hours worked by age cohorts, was highest for workers over 50 years.[10]

But overall absences from work are lower for the old

Surveys find that the incidence rate for all forms of absences (approved and unapproved leave) is slightly lower among older workers. However, the pattern, duration and forewarning of absences, and the nature of the work (such as team- based versus individual work), are probably also important in determining whether such absences have significant productivity effects. The age dimension of these aspects is unknown.

sector over the next 10 years — about 18 per cent of the current workforce is expected to retire by 2011.

10 New cases accepted in 2000-01 involving at least one weeks absence.

Ageing will add to team diversity

Increasingly, the view is put that a more age-diverse workforce enhances business performance (and productivity). For instance:

- age diversity is said to yield greater team problem-solving abilities; and
- businesses with older workers are predicted to more likely attract, and be better able to, service older customers, who will become increasingly representative in an ageing society.[11]

However, the effects on firm performance of age-diverse teams are still unclear. Gibbons and Waldman (1999) discuss the large sociology literature on this issue. Moreover, two empirical economic studies did not find a benefit from customer age matching or age-diverse teams.[12]

The characteristics of the old are changing

Some of the characteristics of older workers may change in a way that affects their average productivity and overall productivity growth rates:

- future cohorts of the old will have educational levels much closer to those of younger cohorts, reducing productivity disparities by age;
- the health profile of older workers may improve due to less exposure to, or better treatment of, illnesses (reflecting changes in the occupational mix of jobs, new health technologies and improved Occupational Health and Safety practices), also raising average productivity levels; and
- average labour participation rates at older ages are likely to rise (chapter 3). While there may well be significant personal and output benefits from such increases, the 'new' older workers are likely to have lower skills and poorer health status than older workers already in employment — depressing average labour productivity levels.[13] Of course,

[11] Access Economics (2001, p. 9) state 'the productivity of employees can be turbo-charged by the advantages of matching [the age of] an organisations customer base'. It identified examples such as hardware and music shops where customer demographics are matched by staffing.

[12] Leonard and Levine (2003) used a sample from 800 retail stores employing over 70 000 individuals. They found that race and gender diversity did not predict sales or sales growth, but that age diversity predicted low sales. There was little benefit to employers from 'matching' except when the customers do not speak English. Hamilton et al. (2004) studied the productivity of workers in a garment plant that had shifted from individual piece rate payments to team piece rate payment. They found that teams with greater diversity in age were less productive, while teams with greater diversity in worker abilities were more productive, as were teams composed of one ethnicity (Hispanic in this case).

[13] Bryant et al. (2004) assumed differences in the productivity of 'new' and existing workers in estimating the GDP effect of higher participation rates in New Zealand, on the basis that survey

there is still a gain to output from their involvement, but it should not be assumed to be as great as other older workers more strongly attached to the labour market.

On the whole, it is likely that the gains from the first two effects will dominate the third. Consequently, average disparities in productivity of older and middle-aged workers may decline over time.

Summing up

The productivity of *individual* workers is determined by a host of characteristics — for example, education and skills, experience, motivation, inherent intellectual and physical capabilities, their team work and personality. Some of the worker characteristics most important for productivity performance — such as cognitive and physical functioning — decline after some age. That age varies enormously by the individual, and, in many cases, will occur largely after retirement. There are offsetting advantages with age too, and compensation strategies that are likely to ameliorate ageing effects. Nevertheless, the evidence on changes in worker characteristics and age is consistent with *some* decline in *average* labour productivity levels after middle age. (As shown below, this finding is reinforced by data on productivity and wages.) The disparity between older and middle-aged workers may reduce in the future.

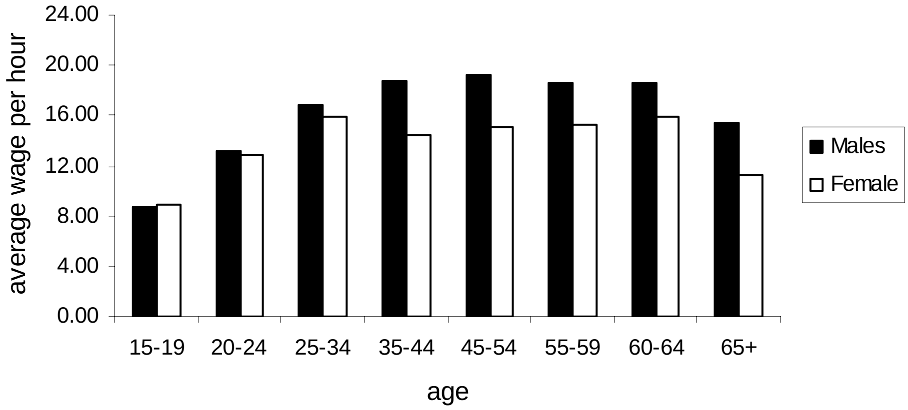
The emphases on 'some' and 'average' are important. First, it is far from clear whether the productivity effects are large (as discussed below). Second, while averages matter, for an assessment of the effect of ageing on economy-wide productivity, they are irrelevant to judgments about the suitability of older people for jobs. Age is a very poor predictor of ability or productivity. Many older people will have superior performance to younger people.

Cross sectional earnings as a proxy for workers' relative productivity

As noted above, Gruen and Garbutt (2003) used the recent economy-wide, cross-sectional age pattern of wages per hour as an estimate of the relative productivity across age and gender cohorts (figure 4.2). Several submissions also suggested this as a possible approach (including Queensland Government, sub. 17, p. 28 and Nigel Fitzpatrick, sub. 31).

evidence showed that people who are not currently employed differ systematically from people who are currently employed in ways that affect hours and productivity — for example, those currently not employed are more likely to have young children, and lower education. They used estimates of average wages for people not in employment (by age and sex) which are about 65 to 75 per cent of the average for those currently employed.

Figure 4.2 **Average wages by age and gender, 1999-2000**



Data source: Gruen and Garbutt (2003, figure 7).

It is important to dispel any possible misunderstandings about the productivity interpretations of this wage pattern. It does not measure a typical individual's lifetime pattern of earnings: indeed, longitudinal data typically shows that individual's (hourly) earnings largely rise with age. Rather it reveals that among current workers, the youngest and oldest are on average in lower-paid jobs, whatever the reasons.

It could reasonably be expected that wages broadly reflect the scarcity value to society of employing labour in those activities — and so figure 4.2 may provide an adequate proxy for present day relative productivity differences for the current age structure (with their given other worker characteristics). The use of the wages profile as a proxy for productivity differences between age groups also has the attraction of providing evidence encompassing the entire paid employment sector.

However, actual productivity in the future may not exactly match this wage profile for two reasons:

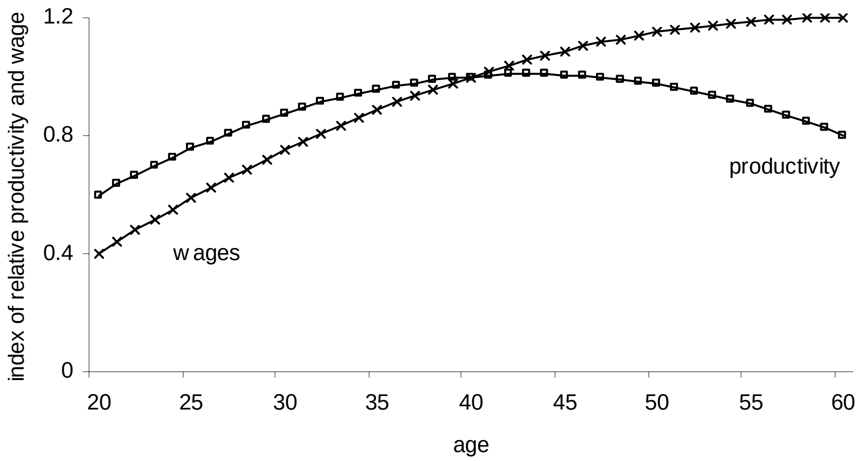
- relative wages of older workers may be higher in the future, reflecting changes in education profiles;[14] and
- there is evidence (using large sample studies) that, on average, younger workers tend to be paid less than their marginal productivity and older workers more.[15] Accordingly,

[14] Though, against this, Borland and Wilkins (1996) found that the hump shaped age-earnings profile for full time male employees (in their main job) changed very little between 1975 and 1994, despite changes over the period in educational attainment rates across age groups. But changes in other factors may make it hard to identify an education effect.

[15] For example, Medoff and Abraham (1980), Kotlikoff and Gokhale (1992), Haegeland and Klette (1999), Crepon et al. (2002), Ilmakunnas and Maliranta (2002), Ilmakunnas et al. (2004).

the wages profile above may underestimate the productivity decline associated with age and overestimate the productivity gain made as young people gain experience (figure 4.3).

Figure 4.3 **Empirical cross section productivity-wage patterns**



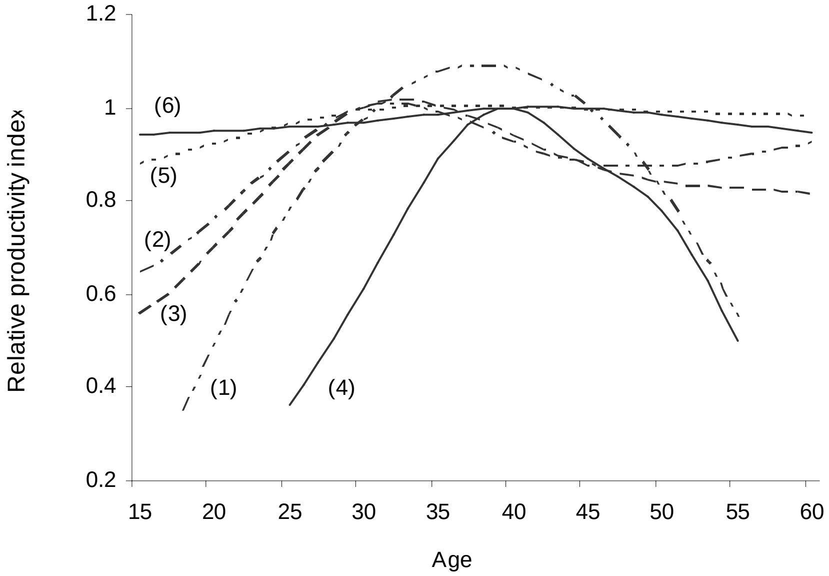
Statistical estimates of differences in worker productivity between age groups

The age distribution of wages reflects factors like education, occupation and industry, as well as those factors directly associated with the biological impacts of ageing. In order to just consider the direct effects, several studies of worker productivity control for measurable differences between age groups in their underlying characteristics (such as education, firm tenure and plant vintage).

The results (figure 4.4) from these large scale cross-sectional studies point to a robust inverted U-shape pattern between productivity and age. The estimated peak occurs around 35 to 40 years. The average rate of decline after the peak, until age 55, ranges from about 0.1 to 3 per cent per year. In most cases, the oldest workers were still more productive than the youngest workers.

For a survey of theories of divergence in wages and productivity, at a point in time, (Hutchens 1989). Such theories include those based on firm specific human capital and incentive wages.

Figure 4.4 **Estimated relative productivity across age groups**[a]



a The vertical axis compares the average productivity of groups of workers of different age in index form. The most productive age group has a productivity index of one. All other age groups have lower indices. For example an age group with an index of 0.8 is 20 per cent less productive than the peak age group. The studies did not estimate a continuous function, as above. Rather there were discrete point estimates for broad age groups (for example 25 to 34 years). For the purposes of graphical illustration, the Commission used a spline function to fit a smooth curve to the discrete point estimates of each study. For example, if the productivity index estimate was 1.0 for an age group ranging from 15 to 24 years and 1.5 for the age group 25 to 34 years then the midpoint of the age group was taken as representative and a smooth, continuous curve fitted, subject to the constraint that it passed through the given estimates at the midpoint age.

Data sources: (series 1) Haegeland and Klette (1999), table 5 (manufacturing). (series 2) Crepon et al. (2002), table 4 (manufacturing). (series 3) Crepon et al. (2002), table 4 (non-manufacturing). (series 4) Ilmakunnas et al (1999), figure 2, profile 5 (manufacturing). (series 5) Ilmakunnas and Marilantra (2002), table 2, model A-G (manufacturing). (series 6) Ilumakunnas and Marilantra (2002), table 3, model E (business sector).

The variability in the estimated age patterns makes it difficult to choose a representative pattern for modelling purposes.[16] However, a consistent finding is that, after controlling for *measurable* differences in worker characteristics, average productivity levels are highest for middle aged workers. (The disparity in actual productivity between the older age group and other age groups will be greater than those shown in figure 4.4. This is because older workers in the samples have lower education and work in older plants, which are themselves associated with lower productivity levels.)

[16] Note that differences in the estimated age patterns in figure 4.4 could be due to genuine differences in relative productivity patterns of workers between the samples. It could also be due to differences between the models. For example, education is not measured the same in each study – Haegeland and Klette measure years of schooling, divided into four groups, and Ilmakunnas while Maliranta identify eight groups of education attainment. Notwithstanding, the same general inverted U-shape pattern emerges.

Are there differences in the productivity-age pattern across sectors?

From an economy-wide modelling perspective, it is also relevant whether the productivity-age pattern is the same across all sectors. Only two of the studies illustrated in figure 4.4 compared samples of manufacturing and non-manufacturing workers and the results provide no basis for assuming significant sectoral differences in the age pattern of productivity of workers.[17]

Is the productivity-age pattern different for males and females?

Finally, since chapter 3 estimates future labour participation rates by gender as well as age we should consider whether the relative productivity-age patterns is the same within the male and female sub-groups. The broad evidence suggests that, qualitatively, similar profiles apply.[18]

Summing up the links between ageing and worker productivity

Although the evidence suggests there are differences in average productivity levels across age cohorts and genders, there are two arguments in favour of ignoring these in the base case projections:

- experimental estimates that take account of variations in productivity levels between age groups did not make a big difference to aggregate projections, a result confirmed in analysis by the Queensland Government (sub. 17, p. 28).[19] The main reason for this is that age distribution of employment shifts away from younger (less productive) workers, largely offsetting the small adverse effects of productivity decline among older workers (figure 4.5). The ageing effects may well be even smaller if future increases in the educational attainment and health status of older workers reduce existing disparities between old and middle-aged workers; and

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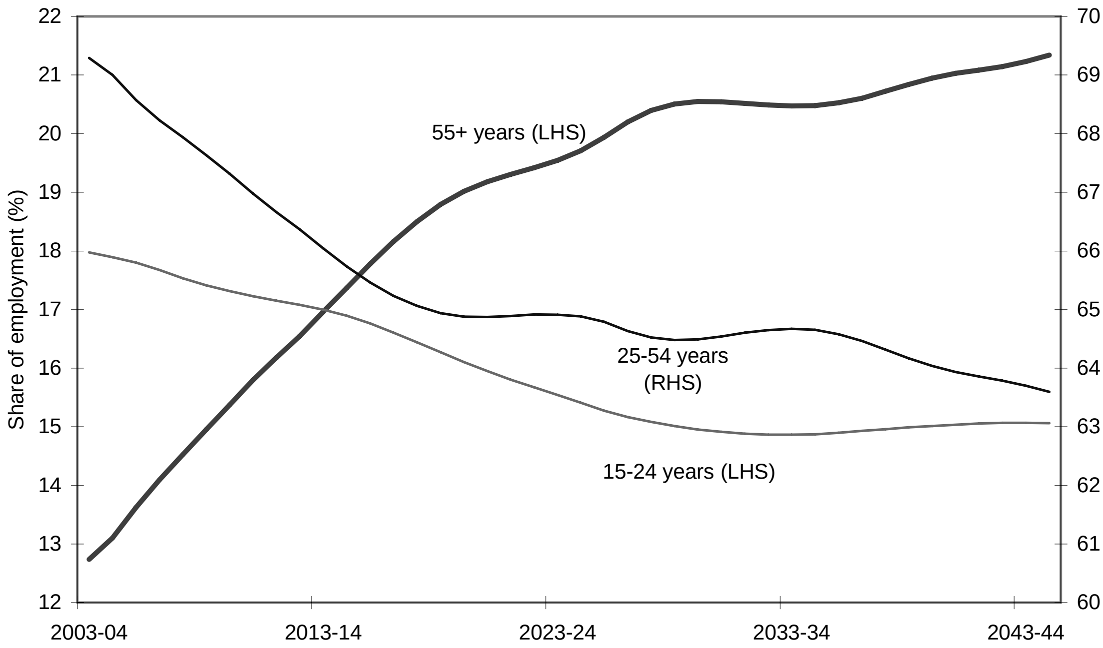
[17] It is incorrect to compare the 'flattish' profile for the business sector (line 6 in figure 4.4) with the highly curved profiles for manufacturing (such as lines 1 and 4) because they are different studies with different models. A more valid approach is to compare manufacturing and non-manufacturing samples of workers from the same country, for the same period using the same model and estimation technique.

[18] For example, Crepon et al. (2002) estimate the age-productivity differential between the peak and oldest workers, in manufacturing, to range from 5 to 17 per cent for males and from 2 to 14 per cent for females. In non-manufacturing, the age differential ranges from 5 to 24 per cent for males and 14 to 27 per cent for females.

[19] The Queensland Government found a small effect from relaxing the assumption of equal levels of productivity. It calculated that the long term average annual productivity growth rate would be 0.05 per cent per year *higher* than otherwise, under its medium participation scenario, if productivity levels by age and gender conformed to the profile of average weekly earnings in 1997.

Figure 4.5 **The age distribution of employment**
2003-04 to 2044-45



Data source: Commission estimates.

- it simplifies the analysis and enables other experiments about the effects of productivity on ageing to be conducted more readily (as in chapter 13).

Accordingly, the Commission has assumed equal productivity levels across age groups in the base case, as in the Intergenerational Report and the Access Economics models used by State governments. Nevertheless, the effects on aggregate productivity growth and output per capita of relaxing this assumption are examined in chapter 5 (box 5.1).

4.5 Capital deepening, technical progress and ageing

Section 4.4 examined the potential effect of a change in the age structure of the workforce on the average quality of direct labour inputs. This section examines the implications of demographic change on the other components that determine labour productivity growth:

- the capital to labour ratio (capital deepening); and
- ‘technical progress’ or multi-factor productivity.

Global demographic effects on savings and investment

Investment in capital has to be funded from savings. Since Australia is an open economy, the relevant pool of savings is a global one. This then raises the question of the capacity for continued strong long-run inward investment flows into Australia. Among other things, this depends on:

- global demographic trends; and
- the effects of global ageing on labour supply growth, investment demand, and lifecycle savings and consumption behaviour.

The first is straightforward in qualitative terms. There are clear signs that the shift to older age structures is not an Australian, nor even a developed country, peculiarity. China, for example, is expected to experience profound population ageing over the next half century. However, for empirical purposes, the precise timing, nature and extent of population ageing matters. For instance, it matters whether the ageing arises from reduced fertility or increased longevity, since life cycle savings theory suggests that different savings responses should ensue.[20]

The second issue is more complex:

- while the aged run down superannuation assets and tend to liquidate fungible assets, such as bank deposits, during retirement, they often do not draw down illiquid assets, like housing (though this may change in the future — chapter 10). The effects on the household savings rate, properly measured, are therefore muted (and sometimes ambiguous). In any case, the precise effect on savings at any time depends on the particular consumption-savings behaviour of different age groups and changes in the global age structure;
- public savings are expected to decline because of the effects of ageing populations on government expenditure and revenue (though many countries are expected to reform public retirement pension arrangements and/or take other actions to limit the increase in public debt as a consequence of ageing);[21] and

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[20] On the issue of timing, Tosun (2001) estimated that living standards of both the developed countries (as a group) and developing countries (as a group) are higher than otherwise if ageing occurs earlier in the developing countries than in the base case.

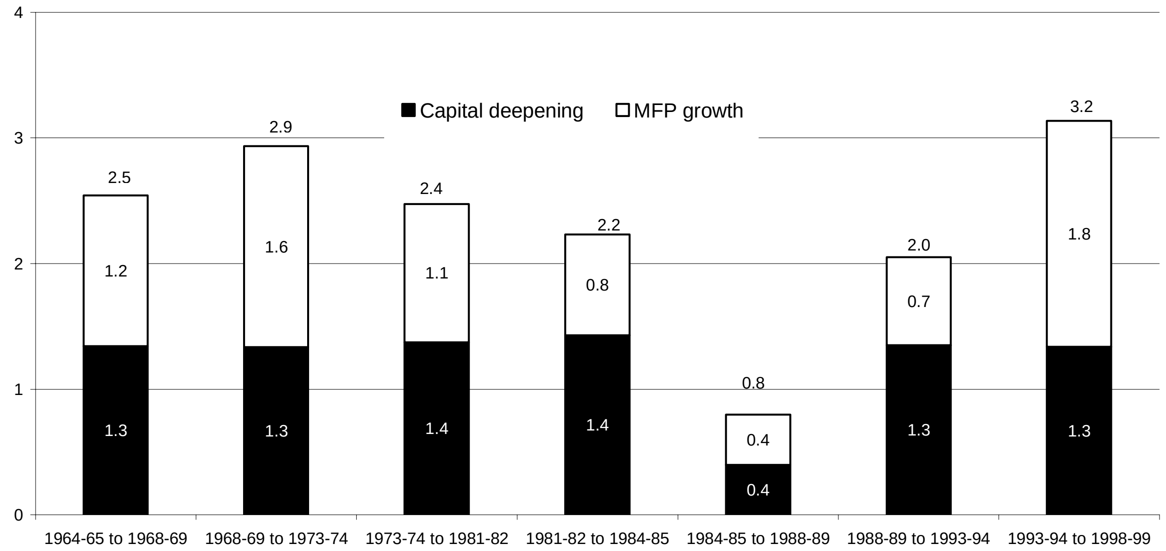
[21] A number of empirical studies allow for some fiscal policy response over the long term in order to limit budgetary impacts of ageing, though budget positions still worsen somewhat. Some models even allow fiscal expenditure to be responsive (endogenous) to changes in the median voter age, reflecting evidence that people of different age have different attitudes/preferences for government expenditure and vote so as to increase the chances their preferences will be fulfilled — Auerbach and Kotlikoff (1992) comment that 'one of the greatest unknowns is how the political process will change as an increasing fraction of the voting population becomes elderly'.

- the amount of capital required to achieve the desired capital-labour ratio will fall as the growth of the labour supply slows. At given factor prices, this depresses investment demand.

Several studies have attempted to unravel the forces at work, using multi-region, general equilibrium models, intended to capture the differential impacts across countries and the important linkages between countries.[22] Some of these analyses suggest higher world interest rates (and therefore lower investment levels). This occurs because, even while investment requirements are lower with ageing, existing national savings are lower still, creating an excess demand for investment. Some results also point to large swings in current account balances and an increase in the ‘intensity’ of world capital flows. However, as noted by the Queensland Government (sub. 17, p. 29), the collective findings from global modelling are not clear cut from the perspective of Australia. This points to the importance of using sensitivity analysis for productivity growth rates when projecting the impacts of ageing.

That said, past trends in capital deepening in Australia do not portend a crisis in investment because of ageing. There have been large changes in global capital markets over the past 40 years and significant changes in Australia’s (and global) demographic structure. Yet, in the past 40 years, the contribution of capital deepening to Australia’s labour productivity growth has been remarkably stable over productivity cycles (figure 4.6).

Figure 4.6 **Components of labour productivity growth, 1964-65 to 1998-99**
ABS productivity cycles for the market sector



Source: PC (2003).

22 For example, Masson and Tryon (1991), Turner et al. (1998), Brooks (2000) and Guest and McDonald (2004).

The effects of ageing on technical progress

A major underlying reason for labour productivity growth is 'technical progress' in its broadest sense — better ways of doing things — whether in people's heads, new institutional structures, or embodied in capital. Some see this as the prime route by which ageing affects labour productivity (Feyrer 2002).

Ageing could affect technical progress in several ways:

- on the negative side, an older population may be inherently less creative and less entrepreneurial, or their depreciating skills may create impediments to the adoption and diffusion of new knowledge;
- on the positive side, a slowdown in the rate of labour supply growth might create incentives for labour saving innovation.[23] Other forces — such as fiscal pressures facing governments in areas such as health and aged care — might also prompt better ways of doing things.

The potential links between ageing and technical progress are not well understood.

Age of inventors and entrepreneurs

If productivity growth is driven by innovation, then the ages at which workers are generating and implementing new ideas may be important. Creative output in science and invention varies substantially by age, with the peak generally between ages 30 and 40.[24] Thus, slower growth in the absolute number of younger people may reduce the pace of major creative breakthroughs.

For most countries, however, idea *adoption* may be more relevant than idea creation. Entrepreneurial activity is one way in which new technologies are introduced into the economy. While it is possible that older people may have greater access to capital for starting their own businesses (and are generally believed to have better skills and understanding of the target industry through experience), some evidence suggests that entrepreneurial activity is higher among younger people. For example, Feyrer (2002) notes that the median age of Chief Executive Officers (CEOs) of the 500 fastest growing companies in the US was 42 years in a 2001 survey (compared with 56 years for Fortune 500 CEOs). He also noted that Zacharakis et al. (1999) found that the majority of those

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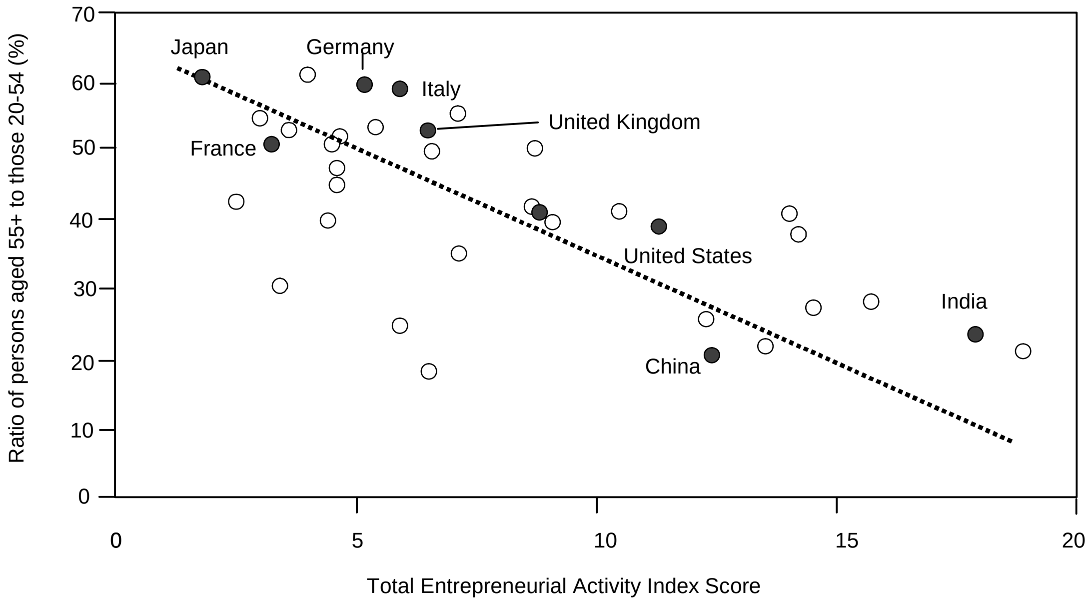
23 Aside from innovation effects, a slow down in the rate of labour supply growth may also stimulate capital deepening and the out-sourcing of labour intensive activities to labour 'rich' countries.

24 Lehman (1953) is often cited as evidence. A more recent study (reported by the *Canberra Times*, 17 July 2003, p.19) was said to have found that two-thirds of 280 eminent scientists had made their most significant contributions before their mid-30s.

involved in a sample of ‘start-up’ companies across ten OECD countries were aged 25 to 44 years. Schieber (2003) found a negative relationship between a measure of entrepreneurial activity and ageing (figure 4.7). On the other hand, the Queensland Government (sub. 17, p. 30) pointed out that many new products and services are brought to market by large firms, which obscures the link between entrepreneurial activity and individual demographics.

Figure 4.7 **Ageing and entrepreneurship**

Ratio of persons aged 55+ to those 20-54 by Entrepreneurial Activity Index Score



Data source: Schieber (2003).

Labour scarcity as a spur to innovation

A well-known saying is that ‘necessity is the mother of invention’. Greenspan (2003) noted that economic historians have argued that one reason the United States surpassed Great Britain in the early nineteenth century as the leader in technological invention was its relative scarcity of labour. As supporting evidence he pointed out that:

> … patent records of this period show that innovation did respond to economic incentives and that the scarcity of labour clearly provided incentives to develop new methods of production.

Empirical studies of cross country economic growth have consistently found a statistically significant negative association between annual labour force growth and annual labour productivity growth — the estimates suggest that a one per cent per annum slowdown in labour supply growth is correlated with an increase of about 0.5 per cent per year in labour productivity growth (as cited by Gruen and Garbutt 2003, p. 29). Correlation need not imply causation, though Romer (1987) argued that incentives to generate labour-saving forms of knowledge are likely to be stronger when labour force growth is slower. Were the relationship valid, the projected slow growth in annual labour supply relative to the past (chapter 3) would imply an addition to present labour productivity growth rates of around 0.5 per cent.

However, in the Commission's judgment, there is insufficient basis to project radical improvements to labour productivity of this extent when the evidence about the direction of causality or even the mechanism at work is unsubstantiated.[25]

Industry structure considerations

The implications of demographic change for economy-wide growth in labour productivity could, in principle, be more closely assessed by examining:

- the differential impacts of ageing across industries; and
- any shifts in the structure of industries arising from ageing (as raised by the Queensland Government, (sub. 17, p. 31).

Industries differ in their age composition, labour intensity, scope for technical change and existing productivity levels. This suggests that ageing may have differential effects on productivity across industries.

The Department of Industry, Tourism and Resources (ITR) (sub. 33) examined differences across broad industry groupings in age, gender, skill and working hours profiles, in order to more clearly draw out the labour input implications of a decline in the growth in the overall workforce. For example, it identified that future mining growth is expected to come mainly from capital investment. On the other hand, cultural and recreational services have exhibited low labour productivity and are relatively labour intensive.[26]

As noted above, ageing may also have implications for capital deepening and technical progress. Thus, while mining is unlikely to be constrained by labour shortages, it may face greater obstacles to growth if interest rates or capital flows are adversely affected by global ageing.

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[25] Others have adopted a similarly position (for example, Turner et al. 1998; Guest and McDonald 2004; and Byrant 2003, p. 13).

[26] The department noted that accommodation, cafes and restaurants; and cultural and recreational services exhibit low labour productivity, suggesting the potential of some special challenges in a tightening labour market. However, it also observed that these two industries display relatively high levels of part-time and female employment. These two characteristics may indicate a potential to raise labour input through lifting average hours worked by existing employees. It noted that scope for this may depend, in part, on the (dis)incentives arising from the interaction between the welfare and tax systems and employer workplace flexibility.

As well as influencing labour and capital inputs — with differential impacts on industries and their growth prospects — ageing will also have profound impacts on the composition of demand (technical paper 11), particularly increasing growth in health care and other ageing-related services. The productivity of the these sectors is poorly measured — but there clearly could be potential for ageing to have aggregate productivity effects through industry/demand compositional change.

In sum, a disaggregated industry approach offers scope for a better understanding of the economy-wide effects on productivity of ageing, but as yet, does not give precise guidance to any economy-wide impacts.

4.6 Convergence or divergence in State productivity growth?

Another issue is whether the same long-term average labour productivity growth rates should be assumed for each State. Average labour productivity growth rates since 1984-85 show some differences across jurisdictions (table 4.2).

Table 4.2 **State and Territory average labour productivity growth**
1984-85 to 2002-03, All sectors

	1984-85 to 2002-03	*1984-85 to 1989-90*	*1989-90 to 1993-94*	*1993-94 to 2002-03*
	per cent per year	per cent per year	per cent per year	per cent per year
NSW	1.6	0.8	1.3	2.1
VIC	1.6	-0.2	2.0	2.4
QLD	1.4	-0.1	2.0	2.0
SA	1.5	1.2	0.3	2.2
WA	2.1	1.3	2.2	2.6
Tas	1.1	-0.6	1.9	1.8
NT	2.1	2.4	0.5	2.8
ACT	1.5	2.1	0.4	1.6
Australia	**1.5**	**0.2**	**1.6**	**2.2**

Source: Commission estimates using ABS (DX data 2004, GSP by State) and ABS (labour force super-table 2004, hours worked by State).

Some of this variation is likely to be due to statistical errors, random differences in supply and demand shocks that may not persist, or to structural and policy differences between jurisdictions.[27] The cyclical movements of productivity appear to be similar for all jurisdictions (figure 4.8), suggesting some common economic

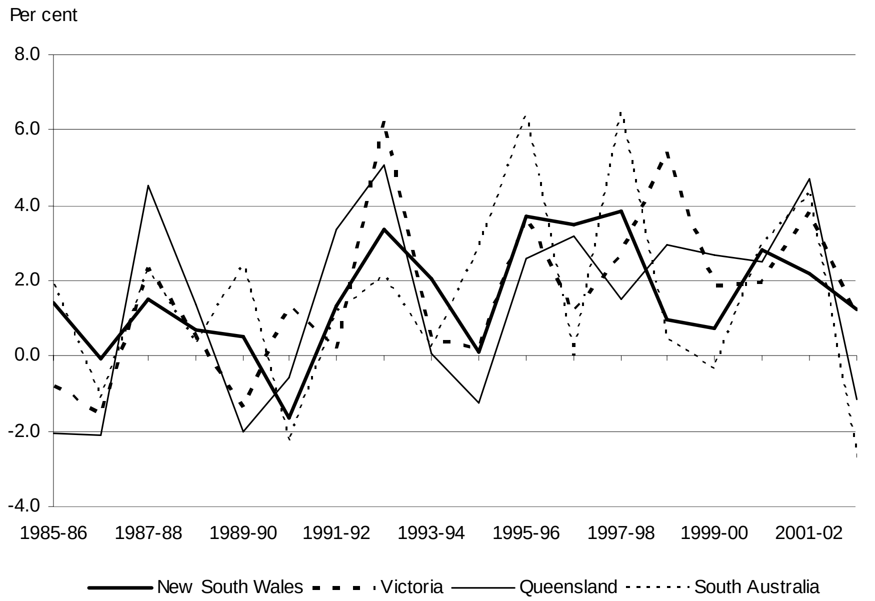
[27] The Victorian Government (sub. 29, p. 42) stated that ‘productivity growth can be influenced by state policy levers, particularly in education and training, research and development,

drivers of productivity growth. But it is also clear that rankings in productivity growth are highly volatile from year to year.

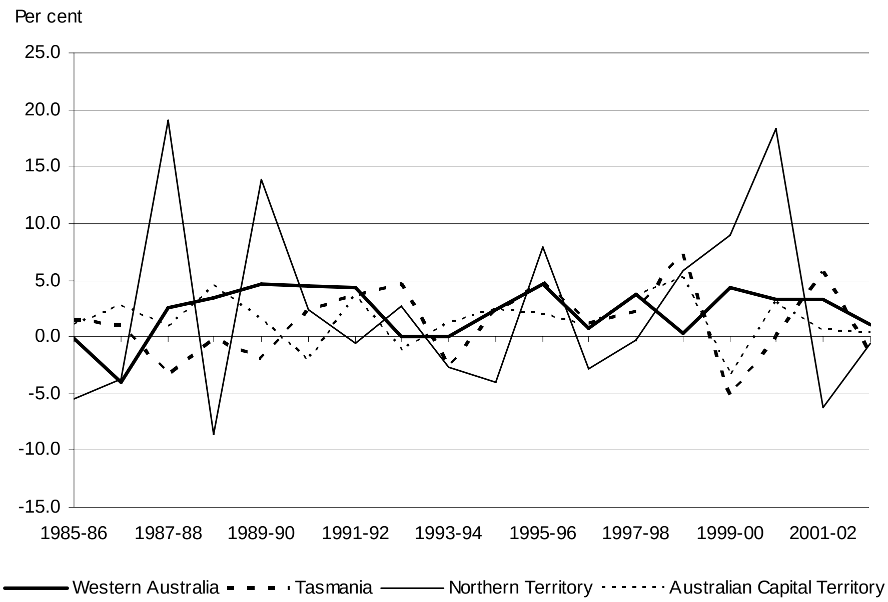
infrastructure investment, and in legal and institutional arrangements such as natural resource allocation frameworks and a regulatory framework that fosters competition and innovation.'

Figure 4.8 **Annual labour productivity growth, 1984-85 to 2002-03**

New South Wales, Victoria, Queensland and South Australia



Western Australia, Tasmania, Northern Territory and the ACT



Data source:, ABS (DX data 2004, GSP by State; labour force super-table 2004, hours worked by State); Commission estimates.

The neoclassical model of economic growth suggests there would be long-run convergence in interstate per capita income *levels* (and labour productivity levels). In turn, this implies that economies with lower levels grow faster, and vice versa, until a steady state in which all economies trend towards the same productivity growth rate.[28] Nguyen et al. (2003) found no empirical evidence that labour productivity *levels* across the six Australian states either converged or diverged between 1984-85 and 1998-99 — meaning *growth* rates were neither positively nor negatively correlated with initial levels, as suggested by the neoclassical model. There was some evidence that the dispersion in the levels of labour productivity had increased. However, if mining was excluded (which underpins some of the high average growth in the period for Western Australia) there was no statistically significant increase or decrease in the dispersion of levels. Bodman et al. (2003) found evidence of a tendency towards stable gaps between productivity *levels* across the six states for the same period — which is consistent with similar cross-State productivity *growth* rates.

In the absence of evidence to the contrary, the simplest characterisation of inter-state productivity is appropriate. Accordingly, in the Commission's projections, average long-term productivity growth rates have been assumed to be the same for each jurisdiction.[29]

[28] In the neoclassical model, the process of convergence is driven by increases in the rate of investment in poorer economies (capital deepening), because developing economies face a higher return to capital, until their capital-labour ratio and the return to capital is equalised with that of higher income economies. Lower income economies also have the opportunity to absorb the latest technologies available in higher income economies. The convergence hypothesis is usually used in relation to countries. Within Australia we could expect less differences between States in the relative price of capital to labour and in technologies, compared with cross country samples, in which case interstate differences in labour productivity growth must be due more to other factors such as industry mix and policy environments, which are not subject to 'natural' convergence.

[29] Moreover, assuming otherwise is problematic — aside from the difficulty of how they may diverge, compounding of different rates may result in unrealistic differences in income levels as well as possibly complicating the central focus on the effects of ageing on government budgets.

14 Consolidating the effects of human capital reform

Key points

- Analysis of the potential impacts of the human capital substreams of health promotion and disease prevention, education and training and work incentives, suggests that full implementation of the NRA could significantly increase workforce participation and productivity.
- Consolidation of the potential impacts of the NRA human capital substreams indicates that, by 2030:
  - workforce participation potentially could increase by around 8 per cent (or 4.9 percentage points) to 64 per cent — roughly offsetting the impact of ageing over this period. However, the new workers would tend to be less productive on average, than baseline workers; and
  - labour productivity of baseline workers could increase by around 2 per cent (or 1 percentage point). Employability of projected workforce participants would also be enhanced.
- With these changes, effective labour inputs could be around 8 per cent higher, than otherwise by 2030.
- Disaggregation of national changes suggests that projected impacts vary across the States and Territories, because some outcome objectives affect specific age–sex groups and jurisdictions have different demographic structures.
  - The projections are exploratory and conditional on numerous assumptions about likely population growth, demographic change and the impacts potentially available from the full implementation of the NRA human capital stream.

This chapter brings together the 'building blocks' developed in the preceding chapters on the scope to achieve, and the estimated effects of achieving fully, outcome objectives for the human capital substreams.

To recap, international comparisons indicate that there is scope to improve Australia's workforce participation and productivity (chapter 10). This 'first-take' is supported by subsequent analyses that estimate the scope for improvement from:

- more effective health promotion and disease prevention (chapter 11);

- initiatives targeting early childhood development, literacy and numeracy, transitions from school to work or study, and adult learning (chapter 12); and
- changes to the work incentives environment (chapter 13).

14.1 Consolidating the human capital substreams

The human capital stream of the NRA reflects an ambitious partnership by governments to enhance workforce participation and productivity. As participating governments are yet to settle on specific reforms, the assessment of the potential for change must occur within a heavily qualified framework. That said, the investigations in preceding chapters suggest that the indicative outcomes agreed for health, education and training, and work incentives could lead to an increase in workforce participation, albeit with varying impacts on productivity.

To arrive at a consolidated effect, it is necessary to account for interactions within and across the substreams and to contend with their divergent maturation periods. For example, the impact of changing work incentives could be observed relatively quickly, whereas changes to early childhood development might not be manifest for a generation.

Interactions *within* substreams generally have been reconciled in chapters 11−13. They include co-morbidities between chronic diseases that might lead to double counting and hence inflate the effect of health initiatives. Interactions *across* substreams are more problematic, as some groups might be targeted by more than one human capital outcome objective. In addition, it is possible that particular (as yet unspecified) reforms could spill over to other groups (refer appendix C). For example, changes to workforce incentives to encourage disability support recipients into work also might liberate their carers to participate (more) in the workforce.

The presence of such interactions and spillovers mean that the consolidated outcome for workforce participation and productivity might be greater, equal to, or less than that implied by adding the projected substream outcomes. Of course, adding the substream outcomes itself might involve double counting (overestimation), in which case failure to quantify the presence of positive spillovers (underestimation) would be a countervailing influence. Given the inherent problems associated with trying to account for these factors, the consolidated impacts in this chapter, in the first instance, build on the estimated effects from each substream.

The chapter applies a demographic model to compare, by 2030, a *baseline* outcome for workforce participation and productivity that assumes no human capital reforms, with an outer envelope that incorporates the potential impacts of these reforms (see box 14.1). By projecting potential outcomes 25 years ahead, the analysis takes account of the substantial lags that are likely to occur between the implementation of any human capital reforms and the impact of those reforms on the broader economy. A 25 year horizon should capture sufficiently the effect of meeting the outcome objectives, with the possible exception of those relating to early childhood — these initiatives would probably require a longer time frame.[1]

Box 14.1 Demographic and labour modelling framework

The potential effects of achieving outcome objectives are measured by comparing two scenarios using a demographic model — a 'business-as-usual' baseline and a scenario where human capital objectives are assumed to be achieved.

The demographic model, developed for the report *Economic Implications of an Ageing Australia* (PC 2005f), projects future population size and structure and incorporates labour market assumptions for projecting labour supply and productivity. Although the labour market is not modelled, the parameters can be interpreted as providing plausible outcomes that might arise from a full modelling of economic behaviour in the labour market.

The current implementation of the model uses a standard set of assumptions drawn from PC (2005f, chapters 2–4) for the baseline:

- 'medium' life expectancy;
- fertility is stable at current levels; and
- net migration is fixed at 115 000 immigrants per year with an unchanging age–sex structure.

The labour market parameters are based on recent trends.

Significantly, to the extent that human capital stream objectives are achieved, this will occur against a backdrop of prospective demographic changes — most notably population ageing — that are expected to cause a decline in participation in paid employment, potentially reducing economic growth.

The chapter initially considers potential changes in workforce participation (section 14.2). As workforce participation is silent on employment outcomes, it is informative to also estimate the likely hours worked by additional participants and baseline workers (section 14.3). Similarly, estimates of the potential changes in labour productivity take account of the relative effects of NRA-induced improvements in health and education on the productivity of additional participants and of baseline workers, respectively (section 14.4).

[1] This issue is explored in chapter 12, which discusses the potential participation and productivity effects of achieving NRA outcome objectives for education and training in 40 years time.

Having projected the effects on total hours (quantity) and on productivity (quality), it is possible to estimate the impact of achieving the human capital agenda on 'effective' labour supply (section 14.5). This section also explores the distribution of changes between States and Territories, taking into account projections of jurisdictions' demographic structure 25 years hence. A summary of the consolidated impacts on labour supply and productivity potentially available is presented in section 14.6. Appendix C describes the experimental framework used in this study.

A note of caution

In common with many other aspects of this study, the estimated impacts of achieving the human capital outcomes are experimental. They need to be interpreted with care, having regard to the underlying assumptions. In particular:

- projections of how the workforce might evolve over the next 25 years require assumptions about trends in population growth, international and inter-regional migration, education, health and other social factors;
- the potential impacts on workforce participation and productivity assume that labour market responses to potential changes in human capital will be similar in 25 years to behavioural responses today;
- the projections fully attribute deviations from the baseline to the achievement of the human capital objectives and do not separately quantify any complementary role that the market might play in responding to the labour supply implications of an ageing population — for example, participation might increase as a result of behavioural responses to changed work preferences, individual imperatives and market incentives;
- the projections abstract from possible changes in the economy, such as compositional shifts or movements in the terms of trade; and
- the disaggregation to the State and Territory level assumes that changes within jurisdictions are determined in line with national changes, after accounting for each jurisdiction's different demographic profiles.

Accordingly, the projections reported in this chapter, and in particular those relating to the States and Territories, should be interpreted with care.

Finally, it is important to reiterate that a robust assessment of policy initiatives associated with the human capital stream would need to consider workforce participation and productivity outcomes within a wider cost–benefit framework (chapter 10).

14.2 Workforce participation

By 2030, possible improvements in health, education and training and work incentives associated with the NRA are projected to give rise to higher participation rates, relative to what would otherwise occur. The estimated outer-envelope impacts of the individual human capital substreams (chapters 11−13) indicate that, in terms of workforce participation, changes to work incentives (+4 percentage points) are likely to dominate the effects of meeting outcome objectives, compared with reform in health (+0.6 percentage points) and education (+0.7 percentage points).[2]

The work incentives substream is of a fundamentally different nature to the health and education substreams for two reasons:

- whereas improved health and education outcomes bear directly on the human capital attributes of the population, changes to work incentives do not; and
- the impacts from changing work incentives can arise relatively quickly (chapter 13), whereas achieving the health and education outcome objectives would require longer lead times.

Despite these differences, the substreams are complementary. A work incentives environment that is more conducive to higher participation outcomes needs to be underpinned by a more responsive — that is, healthier and more educated — population. For example, inducing people on the disability support pension (DSP) to participate in the workforce might require a greater call on health-related services. To support participation, additional training and re-training might also be required.

Potential improvements to workforce incentives (chapter 13) could lower impediments to paid work for some groups and provide positive incentives to others. Such initiatives have the potential to increase participation by 4.0 percentage points, with most of the increase likely to come from older men and women (42 per cent). The remainder could be fairly evenly split between women (aged 25–44) and DSP recipients.

The projected 0.6 percentage point increase in participation attributed to health initiatives derives primarily from preventing or improving the treatment of mental health and type 2 diabetes (chapter 11). Beyond this, improvements in health promotion or early interventions could further increase life expectancy (through reduced mortality rates).

Achieving NRA educational outcomes might potentially increase participation by nearly 0.7 percentage points (chapter 12). Literacy and numeracy and transition from school programs might improve educational attainment, especially for women, eventually increasing workforce participation. However, these programs might also reduce

[2] The individual substream estimates do not take account of consolidation issues (refer text).

participation among younger age groups (15–19 and 20–24 year olds) as they remain in education longer and attain higher formal qualifications before entering the workforce.

Collectively, the analysis suggests that such policies could raise the aggregate participation rate by 2030 to around 63 per cent of the working-age population compared with around 59 per cent in the absence of these initiatives (table 14.1). This suggests that achieving NRA outcome objectives could roughly offset the negative participation rate effects of population ageing.

Table 14.1 **Participation rate projections, 2030**

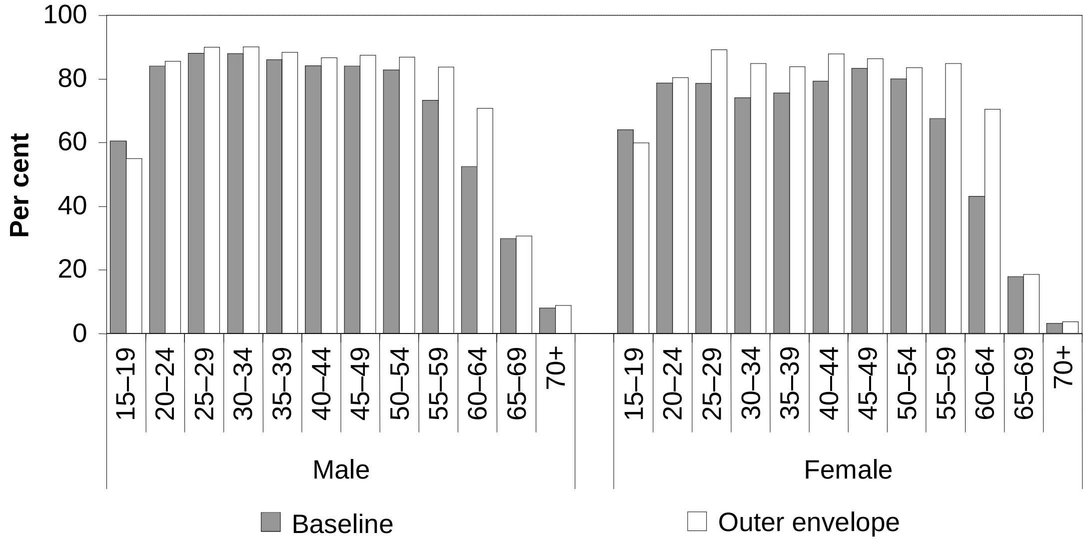
	2005	*Baseline 2030*	*Outer envelope 2030*	*Deviation*[a]
	%	%	%	% point
Male	71.6	62.8	66.1	3.3
Female	55.6	54.9	61.5	6.6
Persons	63.5[b]	58.8	63.7	4.9[c]

[a] Difference between outer envelope and baseline in 2030. [b] This participation rate is a projection from the demographic model and differs from the OECD outcome presented in chapter 10. This small variability in level does not pose a difficulty because it is the deviation from the baseline owing to NRA that is important. [c] The deviation in the participation rate is a consolidated projection that differs from the sum of estimates from chapters 11–13 as it takes into account the various adjustments (such as reduced mortality) noted in the text.

Source: Productivity Commission estimates.

Reflecting the targeting of specific groups in the population and the potential effects on participation varying between these groups, the benefits available from the implementation of the NRA are also likely to vary by population group (figure 14.1). Consistent with the sectoral analyses there is a projected increase in participation rates for all cohorts — except 15–19 year olds due to an increase in their number remaining at school. The largest increases are projected for people aged 55–64 and women aged 25–44 — the groups judged to be potentially most affected by the implementation of the NRA with respect to workforce participation.

Figure 14.1 **Participation rate projections by cohort, 2030[a]**



a Consolidated outer-envelope effect for human capital outcome objectives. Substream results are not shown due to the complexity of any interactions and spillovers that might exist between and within the cohorts.

Source: Productivity Commission estimates.

14.3 Hours worked

Workforce participation is a measure that relates to a state of being employed or of seeking employment. Given the skills profile of certain groups currently not in the workforce (chapter 13), not all of the additional people who choose to participate are likely to find work and hence contribute to labour inputs — conventionally measured as hours worked. And, those who do find employment would likely work fewer hours on average than incumbent workers (see below). Consequently, the effects of potential improvements in human capital on unemployment (indicated by the unemployment rate) and average hours per worker are important.

Potential impacts on the unemployment rate

The aggregate unemployment rate is influenced by many factors, including general economic conditions, labour market regulations, quality of labour and willingness to seek out employment. In the baseline for this study, unemployment rates for most age–sex groups are assumed to decline between 2005 and 2030. This reflects the view that, with an ageing population and the resultant 'scaling down' of the working age population:

- employers are likely to seek out additional workers; and

- as employment becomes more attractive, some who would otherwise be outside of the workforce opt for employment.

With implementation of the NRA, two influences affect aggregate unemployment. First, additional participants are assumed to have a greater propensity to be unemployed than baseline participants.[3] Second, and conversely, NRA-induced improvements to the health and educational status of baseline participants are assumed to act to improve their employment outcomes.

In the current analysis, the latter effect more than offsets the former so that, on balance, by 2030, the unemployment rate might potentially be 0.6 percentage points lower than the baseline. These projections abstract from any short-term cyclical variations in economic conditions and the level of unemployment.

Potential impacts on average hours per worker

Additional workers are assumed to work fewer hours than baseline workers of the same age and sex.[4] Therefore, it is also likely that achievement of the NRA human capital objectives would lower the estimated *average* hours worked per employee. In relation to this, a primary influence would be that additional workers potentially joining the workforce are concentrated in age–sex cohorts that tend to work part time, such as women aged 25–44 and older workers (chapter 13).

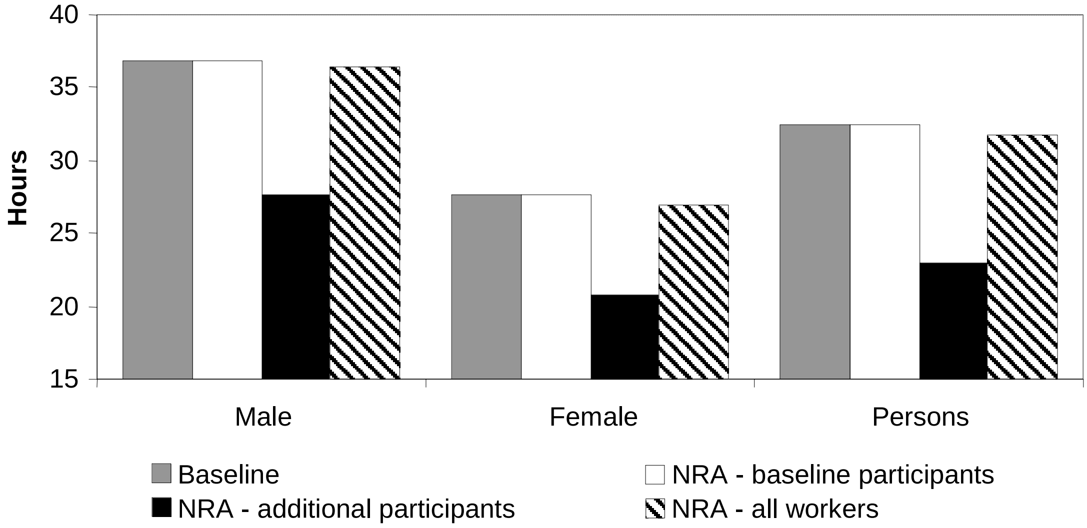
In addition, the average hours of baseline participants might vary from the status quo as a result of NRA-induced improvements in health and education. For example, potential improvements in health and education outcomes might increase the proportion of workers that seek to work full time. However, while recognising this in-principle potential, the information available to this study has not formally enabled the inclusion of this effect in the analysis. However, the analysis assumes that baseline participants could potentially increase *total hours worked* — by 0.7 per cent — as a result of the 0.6 percentage point decrease in the unemployment rate noted above.

3 After adjusting for increased employment rates due to improvements in health and education, additional participants are assumed to be 2.5 per cent less likely to be employed than baseline participants of the same age and sex.

4 There are two factors contributing to hours worked by additional workers. First, additional workers are assumed to be 30 per cent less likely to work full time than their baseline counterparts. Second, whether full time or part time, additional workers are assumed to work 15 per cent fewer hours than their baseline counterparts.

By 2030, average hours *per worker* potentially could decline by 2.3 per cent from 32.5 to 31.7 hours per week (figure 14.2).

Figure 14.2 **Potential impact on average hours worked per worker, 2030**



Source: Productivity Commission estimates.

Potential impacts on hours worked per capita

Hours worked per capita is a useful summary measure of labour utilisation, accounting for participation rates, unemployment rates and average hours per worker in a single estimate. It is also a good indicator of dependency since it takes account of actual employment and hours worked, rather than just the changing age structure of the population.

By 2030, paid hours worked per capita per week potentially could increase from 15.0 in the baseline to 16.0 as a result of improvements in health, education and training and changes to work incentives. Overall, the projected number of hours worked per capita aligns roughly with the current (2005) level — that is, 16.0 hours of paid work per capita per week.

14.4 Labour productivity

Changes in human capital can influence average labour productivity in two main ways.[5] First, the productivity of additional workers might differ from that of the rest of the workforce. In other words, if the average additional worker is less productive than the average baseline worker, average labour productivity could fall (other things remaining equal). Second, the productivity of the baseline workers might increase as a result of better health and education outcomes.

Average productivity of additional workers

Most of the potential to lift workforce participation arises from possible changes associated with the work incentives substream. The health and education substreams are projected to have a modest impact on the productivity of additional workers, but with a more pronounced effect on baseline workers (see next section).

The additional workers from the work incentives substream are likely to be less productive, on average, than baseline workers. This assessment reflects the likelihood that the additional workers would come from groups that would generally find it harder to get a job than incumbent workers. As noted in chapter 13, people not in the workforce tend to have lower educational attainment than their employed counterparts.

Considerations bearing on additional participants having lower average productivity than the baseline workforce are likely to include the following:

- Older men and women who might be induced to (or choose to remain in) the workforce as a result of changed work incentives could well include lower-earning, and hence lower productivity, individuals less able to fund a retirement lifestyle (chapter 13).
- DSP recipients who might enter the workforce are likely to be people with mild disabilities or low skill levels, some of whom tend to have lower productivity than other workers in the baseline workforce of the same age and sex (chapter 13).
- Health initiatives are likely to induce some additional participants, mostly due to improved mental health outcomes. These additional workers are, however, likely to have lower 'at-work' effectiveness (chapter 11).

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[5] Achieving outer-envelope outcomes in human capital might also change multi-factor productivity growth. For example, improvements in education outcomes might increase the rate of innovation, and/or the rate of adoption of new technologies, ultimately flowing through to higher overall multi-factor productivity growth in the economy. Also, changes in the composition of the economy might shift the composition of the workforce to industries with higher productivity, or open up access to greater economies of scope and scale. These effects are not addressed in the demographic modelling. A more sophisticated modelling framework would be required to capture the full flow-on effects of such changes.

This does not, however, mean that all additional workers will be less productive than incumbent workers. Relevant considerations include the following:

- Professionals who re-enter the workforce might be more productive than the average baseline worker.
- It is likely that many women who might choose to return to the workforce as a result of improved childcare arrangements could have relatively high productivity (chapter 13).
- Education and training initiatives might increase the average productivity of potential additional workers — although they might still have lower average levels of education and productivity relative to those already in the workforce.

The overall impact of additional workers on labour productivity depends on two factors.

First, each substream chapter has assessed the relative productivity of additional participants *from that substream*:

- additional participants from improved health promotion and disease prevention are likely to be 80 per cent as productive as baseline workers (chapter 11);
- additional participants from improved education and training are assumed to be equally as productive as baseline workers of the same age (chapter 12); and
- a productivity ratio of 75 per cent was adopted for additional workers as a result of changed work incentives (chapter 13) — the same ratio used in the study of the implications of ageing (PC 2005f).

Second, the overall impact on labour productivity also depends on the age–sex structure of the additional participants from each substream. To account for this, the relativities from the chapters are converted to relativities comparing 'average with average' — that is, the average productivity of additional participants compared with the average productivity of all baseline workers.

Most additional workers are concentrated in older age groups. Older workers tend to be more productive, because they often tend to have more work experience, and work in more highly paid occupations. For example, although additional male workers aged 55–64 are significantly less productive than baseline male workers aged 55–64, the former are only slightly less productive than the *average* baseline worker across all age–sex groups.

Thus, when all of these considerations are taken into account, the average additional worker is assumed to be 90 per cent as productive on average as baseline workers — a productivity discount of 10 per cent.

Effect on the baseline workers

In the baseline, it is assumed that the productivity of workers will increase by 1.75 per cent per year, on average (chapter 10). This reflects a combination of increasing multi-factor productivity and capital deepening. Achievement of this increase implies ongoing improvements in the level of educational attainment and an ongoing improvement in the capacity of the workforce to employ higher levels of increasingly sophisticated capital equipment. For this study, it is implicit that the NRA does not diminish the capacity of the education and training system to support such change, but rather that it adds to the Australian economy's capacity to increase labour productivity through additional targeted reforms. Reforms targeting disadvantaged groups might also be considered to have broader social merit.

At the margin, NRA health initiatives are likely to further improve the productivity of baseline workers (chapter 11). Among the chronic diseases considered, mental health conditions and cancer account for most of the productivity losses that might be recouped via achievement of the health promotion and disease prevention objectives. Thus, NRA potentially could contribute to increase the productivity of baseline workers above levels that might otherwise be attained.

Improved educational attainment is also projected to increase productivity, at the margin (chapter 12). The largest effects are likely to stem from literacy and numeracy programs, which are assumed to increase the proportion of young people going to university. Initiatives designed to improve transitions from school are assumed to increase the proportion of young people continuing their education within the VET system. Combined with adult education, these programs might also increase the productivity of those already in the workforce.[6]

By 2030, projected improvements in health and education outcomes are estimated to increase the productivity of all cohorts, except for people aged 65 and over, who were not assessed in this part of the study. Possible improvements in education account for more than 75 per cent of the projected increase in productivity for people aged 15–34. For people aged 35–64, possible improvements in health outcomes account for most of the projected increase in productivity.

Overall, it is projected that achievement of the NRA human capital outcome objectives could result in the productivity of baseline workers being almost 2 per cent higher than otherwise.[7]

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[6] Improvements to work incentives (chapter 13) are targeted at those not in the workforce in the baseline, so these initiatives are assumed not to affect productivity of baseline workers.

[7] This is a weighted average of the cohort specific increases in productivity shown in appendix C, table C.2.

Potential impacts on overall labour productivity

The lower potential productivity of additional participants is likely to be more than offset be the potential positive effect on the productivity of baseline workers. By 2030, average labour productivity could potentially increase by 1.3 per cent as a result of the human capital stream of the NRA.

Although not insignificant, this potential improvement should be considered in context — over 25 years, labour productivity is assumed to rise by 54 per cent in the absence of the NRA.

14.5 Implications for States and Territories

The guidelines for this study specify that 'to the extent possible, the analysis should separately identify the potential economic benefits derived by each of the States and Territories from the NRA…'. Liaison with the States and Territories during the course of this study reinforced the need to take account of jurisdictional differences (particularly demographic variations — box 14.2) when projecting the impacts of achieving a consolidated NRA outer-envelope outcome. By necessity, the approach adopted was 'tops-down' — that is, the national results were disaggregated to the State and Territory level.

It is apparent from the data cited in box 14.1 that the States and Territories have different participation rates, largely reflecting their different demographic structures. It follows that the distribution of NRA-induced changes between the States and Territories is likely to vary because some human capital reforms focus on specific age–sex cohorts and each jurisdiction has a different demographic structure. In particular, the largest projected effects on participation are projected for older age groups.

Box 14.2 **Accounting for age in State and Territory participation rates**

The table shows that participation rates for 2004-05 vary by State and Territory. These divergences are moderated once participation rates are standardised for age.

	Unit	*NSW*	*Vic*	*Qld*	*SA*	*WA*	*Tas*	*NT*	*ACT*	*Aust*
Participation rate	%	62.5	64.2	65.8	61.7	66.5	59.3	69.3	72.0	64.2
Age-standardised participation rate[8]	%	62.9	64.3	65.2	63.6	65.4	61.1	63.0	68.6	64.2

In each jurisdiction, the age structure explains some or all of the difference between the national participation rate and each jurisdiction's participation rate. The analysis indicated that:

- over the past 25 years, the age-standardised participation rates of Victoria, Queensland, South Australia and the Northern Territory have been roughly equal to the national rate, but in New South Wales it is around a percentage point lower;
- the age-standardised participation rates in the ACT and Western Australia are higher than the national rate — this indicates that actual participation rates are higher than each jurisdiction's age structure might suggest; and
- the age-standardised participation rate in Tasmania is lower than the average — this indicates that factors other than age are important in the Tasmanian labour market. Thus, the 'tops-down' disaggregation might overstate Tasmania's participation rate (but not necessarily the potential for improvement).

Apart from the age structure of the population, a jurisdiction's age-standardised participation rate might differ from the national rate for a number of reasons. First, natural, physical and human capital endowments might differ and thereby affect the labour market opportunities people face. Second, the industry structure, opportunities for part-time work and 'family friendly' workplaces might play a role, particularly in relation to female participation rates. Third, people might move to another jurisdiction specifically to work. This is probably a significant reason for the higher participation in the ACT relative to other jurisdictions. Finally, other social and behavioural differences might also play a role.

Divergences between the national and a jurisdiction's age-standardised participation rate might suggest greater scope for improvement, or that underlying factors make it difficult to increase participation in that jurisdiction. Moreover, because differences between age-standardised participation rates and the national rate might change over 25 years, it is difficult to determine whether the *change* in participation potentially available under NRA will be larger or smaller than that suggested by the disaggregation to the State and Territory level determined in line with national changes.

Source: Productivity Commission estimates based on ABS (*Labour Force, Australia, Detailed – Electronic Delivery*, Mar 2006, Cat. no. 6291.0.55.001).

8 Age-standardised participation rates were calculated by applying State-specific participation rates to national population shares.

The estimated effects of human capital reforms on participation rates and hours worked for each jurisdiction are shown in table 14.2. (The projected 8.4 per cent increase in the Australian participation rate is equivalent to the 4.9 *percentage point* increase described in section 14.2.)

Table 14.2 **Estimated potential impacts on participation and hours worked, increase relative to baseline, 2030**

	NSW	*Vic*	*Qld*	*SA*	*WA*	*Tas*	*NT*	*ACT*	*Aust*
	%	%	%	%	%	%	%	%	%
Participation rate	8.4	8.4	8.4	8.7	8.4	8.9	7.3	7.8	8.4
Total hours worked	6.6	6.6	6.7	6.9	6.6	7.0	5.8	6.2	6.6

Source: Productivity Commission estimates.

Over the projection period (2005–2030), South Australia and Tasmania have older populations than the other jurisdictions. These States' older populations mean that their baseline participation rates are projected to be correspondingly lower than those for the other States and Territories. However, reforms targeting older workers might have a larger relative effect in these two States.

The projected effects on hours worked follow a similar pattern to the projected effects on participation rates. South Australia and Tasmania are projected to experience higher than average increases in hours worked, due to an older population. The two Territories are projected to have smaller increases, as both have a relatively young population (particularly the Northern Territory).

Average labour productivity is projected to increase in all jurisdictions (table 14.3). The jurisdiction with the largest potential increase in hours worked, Tasmania, also has the smallest potential increase in labour productivity. The two Territories, with smaller than average potential increases in hours worked, have larger than average potential increases in labour productivity.

Table 14.3 **Estimated potential impacts on labour productivity and effective hours, increase relative to baseline, 2030**

	NSW	*Vic*	*Qld*	*SA*	*WA*	*Tas*	*NT*	*ACT*	*Aust*
	%	%	%	%	%	%	%	%	%
Labour productivity[a]	1.3	1.3	1.3	1.3	1.3	1.2	1.5	1.4	1.3
Effective hours of labour	8.0	8.0	8.0	8.2	8.0	8.4	7.4	7.7	8.0

a Labour productivity measures output per hour worked.

Source: Productivity Commission estimates.

A jurisdiction's productivity effect can be different to the average for two reasons:

- jurisdictions with the largest potential increase in hours source those hours mainly from additional workers, who are assumed to be less productive on average; and
- the potential increase in labour productivity of baseline workers is smaller for older age groups — jurisdictions with older populations therefore have smaller potential productivity gains for baseline workers (and vice versa).

Each reason explains roughly half of the difference between the national average and the increases in labour productivity in Tasmania, the Northern Territory and the Australian Capital Territory.

Combining the projected effects on participation, hours and productivity, the overall effects on 'effective' labour supply are also presented in table 14.3. In parallel with the potential effect on participation and hours, the potential increase in effective labour supply is largest in the two jurisdictions with older populations, South Australia and Tasmania. The two Territories, and the Northern Territory in particular, are projected to have smaller increases, again, because of their younger populations.

14.6 Summary of direct impacts

The consolidated analysis of the potential effects of reforms within the human capital stream of the NRA suggests that there is scope for:

- increases in aggregate participation potentially sufficient to offset the participation rate effects of population ageing;
- an expansion in hours worked, primarily owing to the increased workforce participation of people in target groups but also because of improved employment prospects for baseline participants;
- increases in overall labour productivity (output per hour worked) because of the projected improvements in the health and education of baseline workers; and
- increases in effective labour supply after taking account of changes in hours worked and the increase in labour productivity.

The changes canvassed are broadly in line with the bounds suggested by international comparisons (chapter 10). Nevertheless, the analysis also shows that the changes are sensitive to the demographic structure of the population and assumptions made about the potential for higher participation and productivity in each population group. To summarise the results of this study, the analysis is disaggregated into changes associated with additional participants and baseline participants (table 14.4).

The increase in effective labour supply arises mainly from additional workforce participants (5.4 per cent), notwithstanding that they work fewer hours on average than baseline participants.[9] It is also likely that there will be a small contribution to increased labour supply owing to baseline participants becoming more employable as they benefit from more education and improved health.

Table 14.4 Decomposition of potential impacts of improvements in human capital, change relative to baseline, 2030[a]

	Additional participants	*Baseline participants*
	%	%
Participation rate	8.4	0
Employment rate	..	0.6
Average hours per worker	-2.3	..
Labour productivity[b]	-0.6	1.9
Effective labour inputs	5.4	2.5

.. Approximately zero. [a] The decomposition presented in this table is used to illuminate the 'drivers' of the potential impacts of improvements in human capital. The results in the two columns are not strictly separable because they flow from a 'set' of potential changes that do not always target one group or the other. [b] Output per hour worked.

Source: Productivity Commission estimates.

In a similar vein, the tendency of additional participants to lower average productivity might be offset by the improved productivity of baseline participants as a result of better health and education.

The projected effects of this overall increase in labour supply and productivity for the States and Territories is presented in table 14.5 — again decomposed by additional and baseline participants. The disaggregation to the State and Territory level assumes that changes are determined in line with national changes, after accounting for their different demographic profiles, but do not account for other factors (see box 14.1). They therefore should be interpreted with additional care.

In sum, the potential changes in human capital outcomes, if realised, could substantially offset the effect of ageing in terms of hours worked in paid employment per capita. This represents a significant increase in hours in paid employment per capita relative to the baseline projections and potentially would contribute to a significant increase in measured production and consumption, other things remaining equal.

[9] The additional 'survivors' resulting from improved life expectancy also increase the size of the workforce, but because of their older age structure, dampen the increase in the participation rate.

Table 14.5 **Estimated potential impacts of improvements in human capital, change relative to baseline, 2030[a]**

	NSW	*Vic*	*Qld*	*SA*	*WA*	*Tas*	*NT*	*ACT*	*Aust*
	%	%	%	%	%	%	%	%	%
Additional participants									
Participation rate	8.37	8.41	8.41	8.71	8.36	8.92	7.25	7.81	8.40
Employment rate	0.05	0.05	0.06	0.06	0.06	0.07	0.06	0.06	0.06
Average hours	-2.27	-2.29	-2.27	-2.37	-2.27	-2.41	-1.94	-2.11	-2.28
Labour productivity[b]	-0.57	-0.57	-0.57	-0.59	-0.57	-0.60	-0.50	-0.53	-0.57
Total effective hours	*5.36*	*5.39*	*5.41*	*5.57*	*5.37*	*5.72*	*4.70*	*5.03*	*5.39*
Baseline participants									
Participation rate	–	–	–	–	–	–	–	–	–
Employment rate	0.62	0.62	0.62	0.62	0.62	0.63	0.58	0.59	0.62
Average hours	..	..	..	..	..	..	..	..	..
Labour productivity[b]	1.89	1.89	1.89	1.87	1.89	1.86	1.97	1.92	1.89
Total effective hours	*2.51*	*2.52*	*2.52*	*2.50*	*2.51*	*2.50*	*2.54*	*2.52*	*2.51*
Total									
Participation rate	8.37	8.41	8.41	8.71	8.36	8.92	7.25	7.81	8.40
Employment rate	0.67	0.67	0.68	0.68	0.67	0.70	0.63	0.65	0.67
Average hours	-2.27	-2.29	-2.27	-2.37	-2.27	-2.41	-1.95	-2.11	-2.28
Labour productivity[b]	1.31	1.31	1.31	1.27	1.31	1.24	1.45	1.37	1.31
Total effective hours	*8.01*	*8.04*	*8.06*	*8.21*	*8.01*	*8.36*	*7.36*	*7.67*	*8.03*

– Not applicable. .. Approximately zero. [a] The decomposition presented in this table is used to illuminate the 'drivers' of the potential impacts of improvements in human capital. The results for additional and baseline participants are not strictly separable, because they flow from a 'set' of potential changes that do not always target one group or the other. [b] Output per hour worked

Source: Productivity Commission estimates.

Owing to continuing increases in average lifespan, the demographic modelling used in this study projects that the baseline population in 2030 will be around 2.7 per cent larger than would be the case with no change in life expectancy. Actions under the NRA — such as measures to arrest the incidence of chronic disease — would be consistent with the achievement of this anticipated change in the baseline population.

It is also possible that actions under the NRA might lead to an increase in life expectancy above that anticipated in the baseline — for example, by delaying mortality for certain targeted groups. But, in the absence of a detailed assessment of all factors determining the baseline, it was not possible to specify the full extent of any such NRA-induced 'additional survivors' in 2030.

That said, the analysis undertaken in this study suggests that the influence of such increased longevity could lead to the population being larger than otherwise in 2030 — preliminary estimates suggest around 1 per cent of the projected baseline population.

E The productivity of outsiders

As noted in appendix D, the value of GDP forgone through male economic inactivity is best measured as equivalent to the *gain* in output from achieving a realistic rate of re-engagement. A key part of measuring this gain is the productivity in workplaces of men who would have otherwise been outside the labour force (outsiders). Given the traits of men out of the workplace, it can be expected that these productivities are lower than existing male workers.

The theoretical framework developed by Frijters and Gregory (2006) provides a useful *initial* conceptual framework for considering the productivities of the responsive group — men currently not at work, but who would be employed under the counterfactual. In this model, the productivity of workers is equal to their potential market wages. Frijters and Gregory suggest that inactive males are outside the labour force because they have average productivities (p) that are either:

(a) at or below the minimum wage (w_{min}), so that the average productivity of this group is $w_{min}(1-\varepsilon)$ where ε is the extent to which their effective productivity falls below that at the minimum wage; or

(b) somewhat above the minimum wage, $w_{min}(1+\upsilon)$, but where welfare benefits or other incentive mechanisms are sufficiently high to dissuade participation. υ is the extent to which their effective productivity is above that at the minimum wage.[1] For example, policies that have encouraged early retirement by educated men involve high productivity workers.

The ratio (r) of the labour productivity of new labour market entrants (p) to that of the average labour productivity of existing workers (p_{av}) accordingly depends on the weighted average of these groups:

$$r = \frac{p}{p_{av}} = \frac{s \times w_{min}(1-\varepsilon) + (1-s) \times w_{min}(1+\upsilon)}{p_{av}}$$

where s is the share of the responsive group that are in (a) and ε or υ are the extent to which average potential wages deviate from the minimum wage for the (a) and (b) groups

[1] This case may be apt for males, but it is notably less so for women, who are often outside the labour market for reasons separate from those in (a) or (b).

respectively. If s = 0.5 and $\varepsilon = \upsilon$, then $r = w_{min}/p_{av}$, which was the assumption applied by the Victorian Department of Treasury and Finance (2005) in a future modelling exercise.[2]

There are several possibilities for measures of minimum wages.

- Federal minimum wages are given statutory recognition for many workers. In 2006, the ratio of Federal minimum adult full-time wages ($484.60) to average full-time male ordinary-time wages ($1101.2)[3] was about 44 per cent.[4]
- The ABS provides data on the earning distribution of various groups. The 10th percentile provides a reasonable measure of the bottom group of wage earners. In 2004 — the latest year for which data are available — the 10th percentile was $576 for full-time male non-managerial employees relative to average earnings for this group of $974.9 or a ratio of just below 60 per cent.

But given uncertainty, it is important to consider scenarios in which s, ε and υ have values different from those assumed above.[5] For example, were s, ε or υ equal to 0.3, 0.1 and 0.25 respectively, then $r = 1.15\, w_{min}/p_{av}= 50$ per cent using Federal minimum wages as the value of w_{min}.

A more complex approach is based on estimating expected wages as a function of the characteristics of people (education, experience, age, occupation). Such wage equations need to be adjusted[6] for the fact that wages are only observed for the employed, which can bias the estimates. When adjusted, it is then possible to use these equations to infer the wages of people, were they to commence working, who are currently outside the labour force. As part of analysis undertaken for assessing the benefits of the National Reform Agenda, the Commission used wage equations estimated by Breusch and Gray (2004) to estimate the wage effects of re-integrating people outside the labour force. Relative wages then provide an indicator of relative productivities. Across several age-sex cohorts, the average hourly productivity of new entrants was around three-quarters of existing workers.

Bryant et al. (2004) use a similar approach to estimate the productivity differential for new entrants in New Zealand using a wage equation estimated by Kalb and Scutella 2003. For males aged over 20 years, this suggests relative productivities, between around 65 and 70 per cent (figure E.1).

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2 With the ratio being around 0.5.

3 Based on ABS, *Average Weekly Earnings, Australia,* Cat. No. 6302.0.

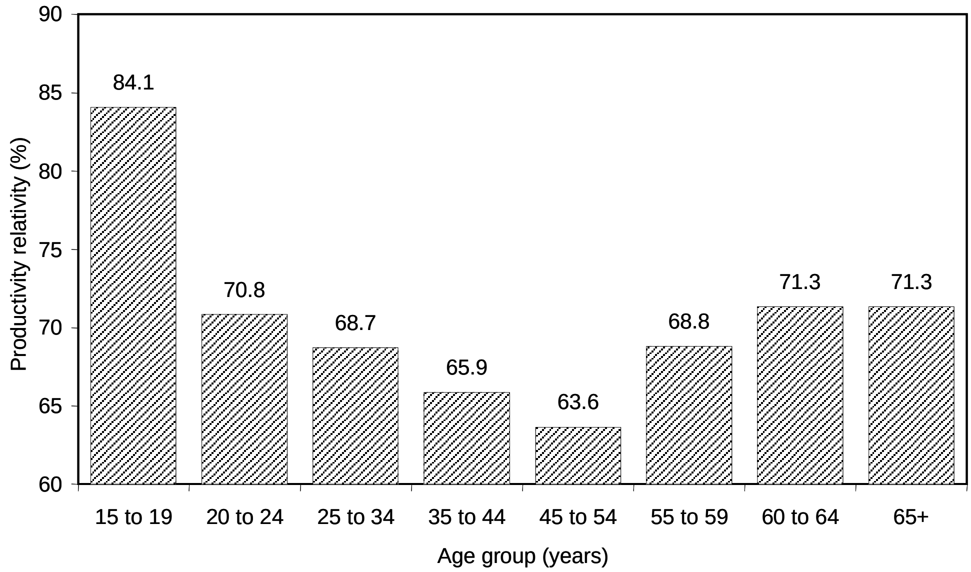
4 The Victorian Department of Treasury and Finance study (2005) also used the assumption of $r= w_{min}/p_{av}$, but found a ratio of 50 per cent.

5 Reflecting this uncertainty, Frijters and Gregory find little evidence about the value of s, ε or υ.

6 Using Heckman selection bias adjustments.

Figure E.1 **Implied productivity relativities by age between newcomers and existing workers**

Males, New Zealand



Data source: Bryant et al. (2004).

There are three potential problems in using Breusch and Gray (2004), Kalb and Scutella (2003) or similar wage equations to infer productivities of 'outsiders' were they to get jobs, with opposing biases.

Unobserved characteristics

First, the wage equations of Breusch and Gray (2004) and Kalb and Scutella (2003) exclude some characteristics that may be particularly relevant for assessing the productivities of some key groups of males who are outside the labour force. They exclude:

- health/disability status, which, all other things being equal, is associated with lower productivity. Some idea of the magnitude of those effects is given by Cai (2006), who examined wages of people by their health status using the HILDA survey. This is relevant to the issue of re-integrating men with disabilities into employment. The results, corrected for the effects of wages on health, suggest that Australian men in poor or fair health earn wages around 20 per cent less than men with good or better health.[7] This effect would further decrease the average productivity of new entrants compared with existing workers; and

[7] Cai reports that people in good or better health earn a premium of 24 per cent higher than those with poor or fair health. That ratio is inverted to give the 20 per cent figure.

- other variables that are likely to be associated with working, but that are hard to observe, such as motivation, adaptability, social skills, and inherent ability. These are also likely to affect wages and productivity.

People don't stay the same

Second, the results shown in figure E.1 above (and implied by the conceptual framework used by Frijters and Gregory (2006)) are based on the supposition that existing inactive males have the same traits when re-integrated into the labour market. This assumption is imperfect. As emphasised in appendix D, the counterfactual used to estimate forgone output associated with the currently economically inactive is based on optimal policy (one that equates the marginal benefits of re-engagement with the marginal costs). That counterfactual will undoubtedly involve a range of policy initiatives, some of which rely on changing the characteristics of those presently outside the labour force (such as improved education when young, preventative health strategies and so on). This has several effects.

- Productivities of outsiders when integrated into the labour force are higher than they would be otherwise.
- Policies aimed at reducing inactivity rates of some groups in the future do so by increasing wages and productivity of these groups *throughout* their working life. So, for example, if under current policy, someone were to be in the workforce for 20 years, and then leave for the remaining 30 years, then a reform that increases workforce life to 25 years not only generates output gains during the additional five years of work, but the productivity of the first 20 years. This positive effect will show up in factor (10) in the model shown in appendix D.

Only some outsiders can realistically become insiders

Outsiders are a highly heterogeneous group. For example, one dimension of this is the expected duration of economic inactivity. Men outside the labour force comprise those with:

(a) long expected durations outside the labour force (those with long-term health conditions, disabilities and retirees); and

(b) those with short and medium durations (leisure activities when young, education, childcare).

It could be expected that group (b) are intrinsically more productive than (a), but that proposed policy changes are (for males) not aiming to increase their labour participation. Indeed, policy will, to some extent, convert some insiders to outsiders in this category by increasing educational attainment rates. Accordingly, it would be desirable to exclude this group from the calculation of relative productivities.

Policy is principally aimed at those with long expected durations of inactivity, who face more enduring obstacles to work. But it is unrealistic to assume that all of group (a) outsiders could become insiders. For example, those with extremely serious barriers, such as with a profound disability, are much less likely to enter the labour force. Consequently, the group of policy-relevant outsiders are likely to be the more employable subset of outsiders within (a). These will have higher average productivity rates than group (a) as a whole, but lower than group (b).

This heterogeneity suggests that even when good estimates of wage equations are available, it is difficult to work out the appropriate productivity relativities unless the groups of outsiders targeted by policy can be clearly identified.

The assumption used in this paper

All of the various conceptual and modelling approaches described above have weaknesses, which increases the uncertainty about the appropriate parameter to use for the relative productivity of outsiders versus insiders. This paper uses a ratio of 70 per cent as a reasonable guide to this relativity, but applies sensitivity analysis when calculating implications for forgone output. Were the study to include women — as is the case in the Commission's analysis of the National Reform Agenda — a higher ratio would be employed because the available evidence suggests that female outsiders have characteristics that make them more closely akin to insiders.[8]

8 This is confirmed using the data from Bryant et al. (2004), which show much lower productivity disadvantages for female outsiders compared with insiders for most ages.