Who works beyond the 'standard' retirement age and why?

AUSTRALIAN NATIONAL UNIVERSITY

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About the research

Who works beyond the 'standard' retirement age and why?

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One of the challenges facing Australia's labour supply today is its ageing population. As observed in the Australian Government's 2010 intergenerational report, in the future there will be fewer workers to support retirees and young dependents. With life expectancy increasing, and with adjustments to public policy aimed at encouraging older workers to stay in the workforce, the decisions people make about retirement are changing. It is therefore useful to consider who works beyond the 'standard' retirement age—defined by the authors as 65 years—and why.

This report describes the characteristics of those who continue to work beyond the age of 65 and examines how the skill requirements of their jobs and their remuneration change over time.

Key messages

- Two groups of workers, in terms of their educational qualifications, are more likely to remain working beyond the age of 65 years—the most-educated and the least-educated.
- Workers with vocational skills tend to retire around the standard retirement age. After standard retirement age the labour force participation rate of those with vocational qualifications declines more than for workers with higher and lower educational levels.
- Educational attainment is a strong predictor of wage levels among older workers, more so than document literacy and literacy use.

The finding that the most-educated and the least-educated are the ones to remain working beyond age 65 years probably reflects two of the components that make work attractive—remuneration and job satisfaction. The most-educated tend to have more interesting jobs with high wage levels. By contrast, the least-educated have significantly lower lifetime incomes and may well be working to maintain living standards. The policy implications are that retirement income policies matter, as do policies such as flexible work arrangements that make work more satisfying.

Tom Karmel
Managing Director, NCVER

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Executive summary

Australia will experience substantial demographic change over the coming decades as a consequence of low fertility rates in the recent past and increasing life expectancy. The extent to which these changes will affect economic and social conditions will depend, among other factors, on the ability of older workers to continue working. As a result of the increasing life expectancy and changes to public policies that extend the age at which public pensions are available, individuals may find they need to work to older ages than they had envisaged. Against this background, this study investigates which types of workers, in the last ten years, continued in employment beyond the 'standard' retirement age and explores some of the reasons why they might have been motivated to do so. The analysis uses data from the 1996 Survey of Aspects of Literacy (SAL) and the 2006 Adult Literacy and Life Skills (ALLS) Survey.

Although the definition of the 'standard' retirement age varies substantially across occupations and industries, our analysis compares workers younger than age 65 (observed in 1996) with workers who remain employed beyond the age of 65 (observed in 2006). This allows us to see which groups of workers remain employed in terms of their skill and education levels and how the skill requirements of their jobs and their remuneration change over time. The findings give us some sense of whether older workers remain in the labour force through choice or necessity and could be useful for informing policies that may be necessary to encourage labour force participation at older ages.

This study consists of two broad components. One component provides information about skills, education levels, remuneration and other relevant characteristics (such as occupation and size of employer) of workers who continue to work beyond the standard retirement age. The second component involves regression analysis, which allows us to examine the factors that are relevant in explaining labour force participation. Particular attention is paid to the skills of workers who work beyond the standard retirement age and the skills that are required in their jobs.

The comparison of the two adult literacy surveys permits an examination of changes over time for specific birth cohorts, allowing us to estimate ageing effects on their labour force participation. Both include information on skill requirements, employment status, individual literacy skills and earnings of people up to age 74 years. Although the two surveys are based on different samples and do not allow longitudinal analysis, they enable us to compare two cohorts of workers younger than age 65 in 1996 (aged 45–54 and 55–64) with a survey undertaken ten years later (where the cohorts are aged 55–64 and 65–74, respectively) to investigate the types of workers who remain employed in terms of skills and skill requirements at work, their education levels and remuneration and other factors.

Our analysis pays particular attention to the extent to which worker skills and the skill requirements in their jobs affect their retirement decisions. In addition, we investigate where in the 1996 wage distribution the workers who remained employed in 2006 came from (that is, whether they were predominantly from the top of the distribution or from lower down the distribution). Using estimates from a wage regression model, we can predict the wages of workers in 1996, given the characteristics of persons who work beyond the standard retirement age in 2006. Specifically, we may compare the resulting *counterfactual* distribution with the actual wage distribution in 1996 to draw inferences about the original position of workers in the wage distribution, given that they have the same characteristics as persons who work beyond age 65 years in 2006. The findings derived

from this analysis provide information about the self-selection process of workers into employment beyond the 'standard' retirement age.

The major findings and their implications are highlighted in the points below:

Labour supply determinants:

- ✧ Labour force participation rates were around 80% for the population aged 15–54 years and substantially lower for older individuals. The overall labour force participation rate of 65 to 74-year-olds in 2006 was 14%.
- ✧ The increase in overall labour force participation between 1996 and 2006 may be attributed predominantly to an increase among women.
- ✧ A substantial part of the labour force population without post-school qualifications remains employed beyond age 65 years. The share of workers with vocational qualifications within the birth cohort 1932–41 declined between 1996 and 2006, while the proportion of employed persons with a university degree increased.
- ✧ Older workers appear to be relatively well matched to their jobs. Their skills are slightly below average and they tend to work in jobs with relatively low skill requirements.
- ✧ Self-assessed skills may matter more for retirement decisions than actual skills. This was especially apparent in females, as those who remain employed consider themselves as high-skilled even though this might not actually be the case.
- ✧ Differences in individual skills and skill requirements over time and across birth cohorts are rather small.
- ✧ An increase in individual literacy increases the propensity to participate in the labour force, although the increase slows down at the higher literacy levels.
- ✧ After controlling for relevant characteristics, gender differences in labour force participation remain highly significant.
- ✧ Educational attainment is positively associated with labour force participation.

Wage determinants:

- ✧ Older workers are less likely to be full-time employed than younger workers, which affects weekly wages:
  - The share of male workers employed full-time in the birth cohorts 1932–41 declined from 87.0% in 1996 to 58.9% in 2006.
  - The corresponding share of female workers employed full-time dropped from 37.2% to 23.1% over the same period.
- ✧ Wages of highly educated workers who remain employed beyond age 65 years are higher than those of younger age groups.
- ✧ The regression results provide evidence for a strong relationship between education and wages. In addition, even after controlling for relevant observable characteristics, a gender wage gap of about 30% may be observed.

Self-selection of older workers into employment:

- ✧ Positive self-selection of full-time employed workers aged 55–64 years into full-time employment beyond age 65 is evident in the comparison of wage distributions from 1996 and 2006. Workers who continued in employment had higher wages.
- ✧ The most-educated and least-educated groups of workers are more likely to remain employed beyond age 65 years than other groups. Nevertheless, in general there is evidence of positive selection of workers beyond age 65 years into part-time employment as well as full-time employment.

Introduction

Australia will experience substantial demographic changes over the coming decades, induced by low fertility rates in the recent past and increasing life expectancy. The extent to which these changes will affect economic and social conditions will depend, among other factors, on the ability of older workers to continue working. As a consequence of the increasing life expectancy and changes to public policies that extend the age at which public pensions are available, individuals may find they need to work to older ages than they had envisaged. Against this background, this study investigates which types of workers, in the recent past, continued in employment beyond the 'standard' retirement age and looks indirectly at some of the reasons why they might have been motivated to do so.

Although what might be viewed as 'the standard' retirement age varies substantially across occupations and industries, our analysis focuses on a comparison of workers aged below 65 years and workers aged 65 years or above. Hence, when talking about 'the standard' retirement age, we mean age 65 years. We impose this restriction for several reasons. Firstly, most workers who retire early face reduced superannuation payments compared with their age 65 entitlements, that is, the age of 65 is still considered as the 'standard' retirement age for most workers in terms of both public and private pension entitlements, although many workers depart from this standard by retiring early. While the ages at which men and women are eligible for public pensions are in the process of changing in Australia, age 65 was the relevant age for males and the age towards which female eligibility was moving during the timeframe covered by the data used in the analysis that follows. Secondly, working beyond the age of 65 is (still) relatively uncommon—our findings reveal that labour force participation rates of 55 to 64-year-old workers are above 60%, while less than 20% of the population aged 65–74 years participates in the labour force. Unfortunately, data limitations prevent us from considering occupation- or industry-specific retirement norms.

This study focuses on a comparison between cohorts of workers younger than age 65 (observed in 1996) and workers from the same birth cohorts who remained employed beyond the age of 65 (observed in 2006). This allows us to see which groups of workers remain employed in terms of their skill and education levels and how the skill requirements of their jobs and their remuneration change over time. The findings will give us a better sense of why older workers remain in the labour force.

The analysis consists of two broad components. The first component involves a descriptive analysis of the skills, education levels, remuneration and other relevant characteristics (such as occupation, size of employer and so on) of workers who continue to work beyond the standard retirement age. The second component involves regression analysis, which allows us to investigate the factors that are relevant in explaining labour force participation. Particular attention is paid to the observed skills of workers who work beyond the standard retirement age relative to the skills that are required in their jobs.

We use two surveys conducted by the Australian Bureau of Statistics (ABS) ten years apart in our empirical analysis. These surveys permit an examination of changes over time for specific birth cohorts, allowing us to estimate ageing effects on their labour force participation. Specifically, the analysis uses data from the 1996 Survey of Aspects of Literacy (SAL) and the 2006 Adult Literacy and Life Skills (ALLS) Survey. The former was a household-based survey of Australians that collected information about current and previous labour market participation of people up to age

74 years and their current income, along with information about the literacy skills of individuals and the extent to which these skills were used in their jobs. The second source of data, the Adult Literacy and Life Skills Survey, was undertaken in 2006 by the ABS. For the purposes of this research, it can be treated as a later replication of the Survey of Aspects of Literacy Survey, with similar survey size, design features and overlapping questions. Although the two surveys are based on different samples of the population and therefore do not allow a longitudinal analysis, they enable us to compare the experiences of two cohorts of workers younger than age 65 in 1996 (aged 45–54 and 55–64, respectively) with the experiences of members of the same birth cohorts ten years later (where the cohorts are aged 55–64 and 65–74) to investigate the types of workers who remain employed in terms of skills and skill requirements at work, education levels, remuneration and other characteristics.

Our empirical analysis departs from more standard analyses of labour supply among individuals around retirement age, which typically investigate the effects of variations in old age assistance (Friedberg 1999) or the role of social security provision (Rust & Phelan 1997; Tanner 1998; Boersch-Supan 2000; Coile & Gruber 2000; and see Blundell & MaCurdy 1999 for a detailed discussion of this literature). Less is known about the extent to which worker skills and the skill requirements of their jobs affect their retirement decisions, although we may expect that older workers are more likely to retire if they begin to become less productive (Bartel & Sicherman 1993; Friedberg 2003; Schleife 2006; Biagi, Cavapozzi & Miniaci 2007). At the same time, if human capital and technology are complementary, technological change may favour more experienced (and older) workers, because of their high level of accumulated human capital (Weinberg 2004; Biagi, Cavapozzi & Miniaci 2007). Those who have invested more in their human capital may also need to work longer to recoup their investment. Consequently, the effect of skills and skill requirements at work on retirement decisions is mainly an empirical issue.

In addition to the analysis of a labour supply model, we investigate where the workers who remained employed in 2006 came from (that is, whether they were predominantly from the top of the 1996 wage distribution or from lower down the distribution). Using estimates from a wage regression model, we can predict the wages of workers in 1996, given the characteristics of persons who worked beyond the standard retirement age in 2006. Specifically, we can compare the resulting *counterfactual* distribution with the actual wage distribution in 1996 to draw inferences about the position of workers in the earlier wage distribution, given that they have the same characteristics as persons who work beyond age 65 years in 2006 (DiNardo, Fortin & Lemieux 1996 provide a detailed discussion of this approach). The findings derived from this analysis provide information about the self-selection process of workers into employment beyond the 'standard' retirement age.

The next chapter describes the data used for the analysis, while later chapters provide evidence on the determinants of labour force participation and wages and discuss the self-selection process of older workers into employment beyond the standard retirement age. A final chapter summarises the results and points to their implications.

Description of the data

The analysis uses information from two comparable surveys of one person from Australian households conducted in 1996 and 2006 by the Australian Bureau of Statistics, the Survey of Aspects of Literacy and the Adult Literacy and Life Skills Survey, both undertaken as part of international projects as described below.

Survey of Aspects of Literacy, 1996

The Survey of Aspects of Literacy was a national survey designed to measure certain aspects of the literacy and numeracy skills of Australians. Personal interviews were carried out over a nine-week period between May 1996 and July 1996. The sample consists of 9302 respondents aged 15 to 74 years living in private dwellings, but excluded persons living in remote and sparsely settled areas. The data includes information about the literacy and numeracy skills of individuals that are deemed necessary to use printed material typically found at work, at home, and in the community (ABS 1997a, 1997b). The survey was part of an international project led by Statistics Canada called the International Adult Literacy Survey (IALS).[1]

There were two major components to the survey:

- Self-assessed reports were given by individuals of their reading, writing and basic mathematical skills for the needs of daily life and their main job.
  - Respondents were asked a series of questions to obtain background socio-demographic information (such as age and gender).
  - Respondents were asked to rate their reading, writing and basic mathematical skills.
  - Information was collected about the frequency with which respondents undertook selected literacy and numeracy activities in daily life and at work, and about their English and other language skills.
- An objective, test-based assessment of literacy and numeracy skills was applied, with respondents asked to undertake a set of tasks.
  - Each respondent was asked to complete six relatively simple literacy-related tasks.
  - Those who completed two or more of these correctly were then given 46 additional tasks, drawn from a pool of 108, using commonplace examples of printed material and which required varying degrees of comprehension and arithmetic skills.

The data from this survey include three objective skill measures:

- *Document literacy*: the effective use of information contained in materials such as tables, schedules, charts, graphs and maps.
- *Prose literacy*: the skills required to understand and use information from various kinds of prose texts, including texts from newspapers, magazines and brochures.

[1] The questionnaire and task booklets were administered in English and people with poor English language were excluded from the survey. This might have excluded some migrants, and possibly Indigenous Australians. Since remote and very remote areas were excluded from the sampling frame, a significant proportion of Indigenous population was excluded from the survey as well.

- *Quantitative literacy*: the ability to perform arithmetic operations using numbers contained in printed texts or documents. This is a very narrow measure of the numeracy skills of individuals.

These survey data further contain variables that capture labour force participation and personal income from wages, salary or self-employment, which will be used as dependent variables in our various empirical analyses.

Adult Literacy and Life Skills Survey, 2006

The Adult Literacy and Life Skills Survey was conducted in Australia as part of an international study coordinated by Statistics Canada and the Organisation for Economic Co-operation and Development (OECD).[2] Personal interviews were carried out from July 2006 to January 2007 in private dwellings throughout non-remote areas of Australia. The sample consists of 8988 respondents aged 15 to 74 years.

The survey is divided into two sections:

- A background questionnaire was administered and included individual and household information such as general demographic information, linguistic information, parental information, labour force activities, literacy and numeracy practices in daily life and at work, frequency of reading and writing activities, participation in education and learning, social capital and wellbeing, information and communication technology, personal and household income.
- After the background questionnaire, each respondent was asked to complete a set of six basic questions. Only respondents who correctly answered a minimum of three questions of this basic component moved onto a main component, consisting of three blocks designed to measure (ABS 2006):
  - *Document literacy*: the efficient use of information contained in various formats, including job applications, payroll forms, transportation schedules, maps, tables and charts.
  - *Prose literacy*: the knowledge and skills required to understand and use information from various kinds of narrative texts, including texts from newspapers, magazines and brochures.
  - *Numeracy*: the ability to effectively manage and respond to the mathematical demands of diverse situations.
  - *Problem-solving*: goal-directed thinking and the ability to act in situations for which no routine solution is available.
  - *Health literacy*: the knowledge and skills required to understand and use information relating to health issues such as drugs and alcohol, disease prevention and treatment, safety and accident prevention, first aid, emergencies and staying healthy.

Like the Survey of Aspects of Literacy, individuals also provided self-assessments of their English reading and writing skills for the needs of daily life and of their main job.

The Adult Literacy and Life Skills Survey also includes variables denoting labour force participation and personal income. The following section provides a more detailed description of these variables, which we will use as dependent variables in our various empirical analyses.

Labour force participation and wages

As stated above, the empirical analysis of this study aims to investigate the factors that determine the labour force participation and wages of older workers. While the construction of a measure of labour force participation is straightforward—both surveys include information on individual

[2] The OECD (2005) provides an international comparison of participation in adult education and training, using data from the International Adult Literacy Survey. The results point to substantial differences in participation patterns among countries, suggesting that differences in adult learning policy matter. In this report, we concentrate on education and training patterns in Australia, which were not addressed by the OECD report.

labour force status (that is, employed, unemployed or not in labour force)—the generation of a suitable wage measure is more challenging. In particular, two problems have to be addressed. First, instead of a continuous wage measure, the data provide only the decile of the distribution in which wages or income lie. The use of such a non-linear wage measure complicates the empirical analysis and the interpretation of the results. Second, instead of hourly wages, only weekly wages are observed in the data. We would have preferred to use hourly wages in our empirical analysis because different groups of workers (such as male and female workers) do not work the same number of hours per week.

To address the first problem, we estimate interval regression models. Interval regression models account for the non-linear nature of our wage variable (that is, the fact that we only observe wage intervals in our data) and allow a linear prediction of wages for a given set of individual-specific characteristics (Cameron & Trivedi 2005). Thus, we can use the interval regression parameter estimates to predict wage measures on a continuous scale. We use this continuous scale in our empirical analysis to facilitate the interpretation of our results. Separate interval regression models are estimated for male and female workers who report that employee income is their main source of income. This sample restriction is necessary because the income measure available in 2006 could also include pension income. By imposing the restriction, we ensure that employee income is the major source of income for all workers in the sample. In-sample and out-of-sample predictions are performed to construct a wage measure for all workers.

The second problem mentioned above is attributable to the limited labour supply information provided in the data. Specifically, instead of the number of weekly working hours, only broad categories of hours worked are reported. Since this limitation prevents us from analysing hourly wages, our empirical analysis focuses predominantly on predicted weekly wages of full-time employed persons (that is, persons who work at least 35 hours per week).

Table 1 contains the means and standard deviations of labour force participation and predicted weekly wages of male and female workers of both surveys. The numbers reveal that labour force participation of younger workers (cohorts of people born between 1952 and 1991) has remained relatively stable over time, while labour force participation among older workers (birth cohorts 1942–51, 1932–41 and 1922–31) declined substantially. In both years, the labour force participation rate of persons aged 65 and above (that is, the birth cohort 1922–31 in 1996 and the birth cohort 1932–41 in 2006) was below 20%.

The numbers further show that labour force participation rates of males are substantially higher than those of females. However, the gender gap in labour force participation has declined over time. Specifically, while the overall labour force participation rate of males was 18.5 percentage points higher than that of females in 1996, the difference in labour force participation has decreased to 13.7 percentage points in 2006. Table 1 further includes the means and standard deviations of predicted weekly wages of employed and non-employed persons. To allow a comparison of wages over time, we present real rather than nominal wage rates, that is, nominal wages were deflated by the consumer price index provided by the ABS.[3] The numbers reveal that real wages have increased considerably between 1996 and 2006. Moreover, a substantial gender wage gap may be observed in both years. However, it should be noted that this result may partly be attributed to gender differences in the number of hours worked per week (although later analysis restricted to full-time workers also exhibits a gender wage gap).

[3] The consumer price index is a weighted average of eight Australian capital cities observed in June 1996 and June 2006. Real wages are measured in 2006 dollars.

Table 1 Labour force participation and predicted weekly wages for all workers, 1996 and 2006

	Mean value by gender and year			
	1996		2006	
	Males	*Females*	*Males*	*Females*
Labour force participation (in %)				
Birth cohort 1952–91	89.5	72.7	89.3	76.6
(35–44 years in 1996 and 45–54 years in 2006)	(30.7)	(44.6)	(31.0)	(42.3)
Birth cohort 1942–51	90.8	70.2	72.6	52.3
(45–54 years in 1996 and 55–64 years in 2006)	(28.9)	(45.8)	(44.6)	(50.0)
Birth cohort 1932–41	63.6	34.4	18.7	9.5
(55–64 years in 1996 and 65–74 years in 2006)	(48.1)	(47.6)	(39.1)	(29.3)
Birth cohort 1922–31	12.3	5.9		
(65–74 years in 1996)	(32.9)	(23.6)		
Total	**79.8**	**61.3**	**80.3**	**66.6**
	(40.2)	**(48.7)**	**(39.8)**	**(47.2)**
Number of observations	4261	5038	4162	4826
Predicted weekly wages (in real 2006 AUD)				
Birth cohort 1952–91	637	426	906	663
	(188)	(178)	(286)	(278)
Birth cohort 1942–51	681	382	854	601
	(147)	(165)	(249)	(277)
Birth cohort 1932–41	661	349	747	564
	(152)	(164)	(301)	(216)
Birth cohort 1922–31	531	304		
	(195)	(144)		
Total	**647**	**411**	**896**	**654**
	(178)	**(176)**	**(283)**	**(278)**
Number of observations	3034	2781	3128	2977

Notes: Weighted numbers based on weights provided by ABS. Standard deviations in parentheses.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Job task measures and individual skills

Since we expect that both wages and retirement decisions depend on individual skills and skill requirements at work, we developed two types of scales based on the information available in the two data sets:

- ✧ measures of job tasks
- ✧ measures of individual literacy.

Ryan and Sinning (2009) provide a detailed description of the construction of these measures and analyse the relationship between workers' skills and skill requirements of their jobs in Australia, paying particular attention to older workers. Measures of job tasks reflect reports by individuals of the frequency with which they undertook literacy and numeracy tasks at work. Respondents in both surveys were asked a partially overlapping set of questions about the literacy and numeracy tasks they undertook at work. These included, for example, how often they wrote 'reports or articles', or 'letters or memos', or how often they filled in forms such as 'bills, invoices or budgets', or how often they calculated 'prices, costs or budgets'. Ryan and Sinning (2009) provide a detailed description of the empirical approach that was applied to generate the job task measures.

The individual skill measures utilised in the empirical analysis here include document literacy and numeracy (using scales contained in the data) as well as self-assessed skills (based on a scale we

develop).[4] We place all the scales developed onto a 0–500 range, consistent with the literacy and numeracy scales provided in the ABS data.

While the measures of individual literacy in the 2006 data contain both an underlying, continuous score on a 0–500 range and a summary indicator in the form of a five-point scale (with known thresholds from the underlying scale), the literacy skill levels of the 1996 survey were only published in Australia on the same summary five-point scale used in 2006. To overcome this problem, a continuous scale is imputed for 1996, given the observed five-point scale scores of individuals and a set of other relevant characteristics.[5]

Table 2 Descriptive statistics—measures of job tasks and individual literacy, 1996 and 2006

	Mean value by gender and year			
	1996		2006	
	Males	*Females*	*Males*	*Females*
Measures of job tasks				
Literacy use	288.5	262.5	295.7	294.7
	(152.6)	(144.4)	(138.1)	(129.4)
Numeracy use	270.7	208.4	302.9	264.9
	(149.7)	(140.5)	(129.9)	(132.1)
Measures of individual literacy				
Document literacy	283.2	286.0	285.0	286.8
	(57.8)	(54.0)	(54.8)	(50.1)
Prose literacy	280.3	291.7	279.3	289.9
	(56.8)	(53.9)	(51.9)	(48.1)
Numeracy			283.9	274.9
			(57.5)	(53.3)
Self-assessed skills	383.9	387.1	384.1	418.7
	(81.5)	(74.7)	(109.2)	(95.7)
Number of observations	3034	2781	3128	2977

Notes: Weighted numbers based on weights provided by ABS. Standard deviations in parentheses.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Table 2 includes the means and standard deviations of job task and individual literacy measures for male and female workers of both surveys. All measures range on a 0–500 scale. The numbers reveal that the average literacy use of males and females in their jobs has increased between 1996 and 2006, with the increase appearing to be more substantial for employed females. There also appears to be a substantial increase in average numeracy use. The table also contains summary estimates of the individual skill scales, which indicate that the difference in document literacy between male and female workers is relatively small. The measure shows little change between 1996 and 2006.[6] Moreover, numeracy skills of male workers (only observed in 2006) are higher than those of female

[4] Since the relationship between literacy skills and literacy use at work seems to be very similar for document and prose literacy (Ryan & Sinning 2009), the report includes only the results for document literacy.

[5] Technically, we impute missing wage information by regression-based multiple imputation. The main idea of multiple imputation is to replace missing values by estimates derived from a regression of the outcome measure on a set of explanatory variables. To simulate the sampling distribution of the missing values appropriately, each missing value is replaced by five generated values that are imputed by the process of randomly drawing a residual five times to obtain five different imputations referred to as 'implicates'. Due to the generation of more imputed values, this procedure improves the approximation to the true sampling distribution. In practice, the average of these values is calculated to produce the best estimate of what the results would have been if the missing data had been observed (Rubin 1987).

[6] This is consistent with the published data in ABS (2008). Table 16 of ABS (2008) contains a comparison of the prose and document literacy levels of employed people in the two surveys on the five-point scale. The distributions in the two surveys show no obvious change.

workers.[7] While self-assessed skills of men and women do not differ substantially in 1996, men report considerably lower skill levels than women in 2006. The experience of individuals from the specific birth cohorts of interest in this paper in relation to these various measures of skill levels and their usage is described in the following chapter.

[7] The quantitative literacy domain, derived from the 1996 survey, cannot be compared with the expanded measure of adult numeracy of the 2006 survey (ABS 2006). For that reason, this report only considers the measure of the 2006 survey.

Labour supply determinants

This chapter contains an analysis of the determinants of labour force participation. It focuses on:

- the role of demographic factors
- the role of educational attainment
- the role of individual skills
- the relative importance of these factors in explaining labour force participation.

Particular attention is paid to the comparison of workers aged 45–54 and 55–64 years in 1996 with workers aged 55–64 and 65–74 years in 2006.

As noted in the introduction, since there are reasons why the effect of skills and skill requirements at work might operate in different directions on retirement decisions, their exact impact is largely an empirical issue. From a classical economic theoretical perspective on modelling retirement decisions, individuals choose whether or not to retire by comparing the present value of the streams of benefits and costs associated with the two situations (Lazaer 1986; Lumsdaine & Mitchell 1999). Within this framework, retirement decisions depend on preferences for leisure, actual and expected levels of labour income, pension benefits, pension tax contributions and health conditions, as well as bargaining within households and the conditions facing other members of the household, including their financial position and health.

Empirical evidence on retirement behaviour indicates that individuals usually retire at around the standard age of eligibility, with some retirement taking place earlier—given that early retirement is allowed (Blundell, Meghir & Smith 2002; Tanner 1998). In addition, empirical studies have shown that institutional details of the social security system are highly relevant (see, for example, Coile & Gruber 2000, 2001). In Australia, studies such as Merrilees (1982, 1983) and O'Brien (2001) have looked at the availability of war service and disability pensions in encouraging males to leave the labour force prior to the standard retirement age. Miller (1983) and Woodland (1987) analysed the effect that wealth levels have on retirement intentions and the associated decision to cease working. Theoretical analysis of the impact of the Superannuation Guarantee on retirement behaviour suggests it is likely to induce more early retirement (Freebairn 2004; Atkinson & Creedy 1997).

Empirical evidence on the consequences of retirement decisions for labour force participation in Australia (Borland 2005) suggests that:

- The employment rate for the population aged 55 years and above is lower than for those aged 25–54 years.
- Older workers are more likely to be employed part-time.
- The proportion of the older population in the labour force and employed declined from the mid-1970s to the mid-1980s and increased afterwards.
- The decrease in employment rates for older workers in the 1970s and 1980s was primarily due to declining employment for males aged 55 to 64 years.
- The growth in employment of older workers from the mid-1980s onwards has been mainly due to increases in employment of females aged 45–54 years.

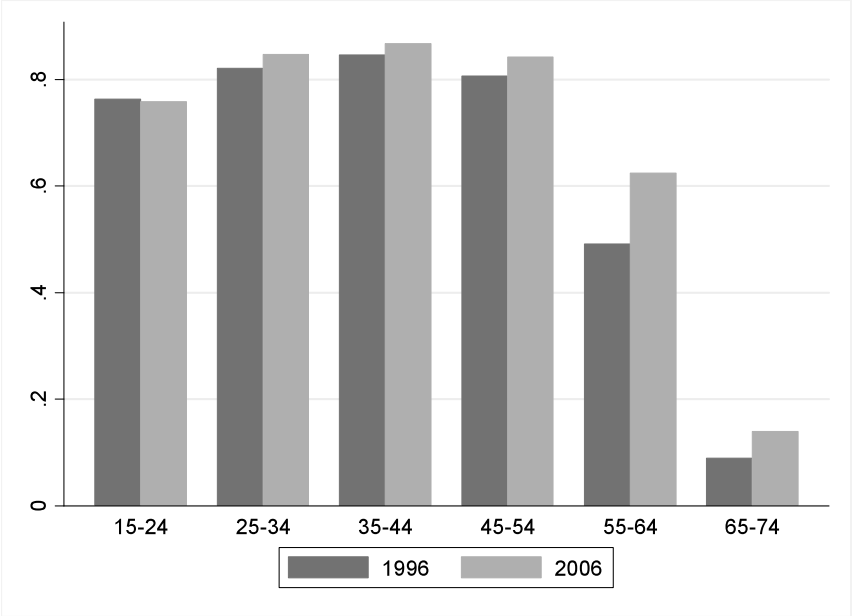
The analysis that follows is designed to assess, first, whether these phenomena are present in the data analysed here, and then what more can be learned from examination of the additional role played by skills and their usage in the determination of labour supply among older workers.

The role of demographic factors

Age

From a theoretical perspective, retirement decisions are usually analysed using a dynamic model of labour supply. In this model, consumers make labour supply decisions over the 'life cycle', taking into account that their flow of income undergoes both permanent and transitory shocks. Figure 1 highlights how labour supply decisions change as people age. Labour force participation rates were around 80% for the population aged 15–54 years both in 1996 and 2006. The rates are substantially lower for individuals older than 55 years. Specifically, only 49.1% of the population aged 55–64 years and 8.9% of the population aged 65–74 years were employed in 1996. These rates increased over time, so that labour force participation rates in 2006 were 62.4% for 55 to 64-years-olds and 14.0% for 65 to 74-year-olds.

Figure 1 Labour force participation by year and age



Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Figure 1 reveals a considerable decline in labour force participation among the population aged 55 years and above. However, labour force participation rates of older persons have increased over time, possibly reflecting the overall increase in life expectancy.[8] Interestingly, the labour supply rates observed in 2006 suggest that about 20% of the adult population at any age do not work, a further 20% of the population chooses early retirement (prior to age 65), 45% retire around age 65, while nearly 15% of the population aged 65–74 years continue in employment. Consequently, given the increase in labour force participation rates of persons aged 55 years and above and the relative increase in the population share of persons above 65 years, the number of workers who continue in employment beyond age 65 years is likely to exceed the number of early retirees in a few years. However, future labour force participation rates of older persons will reflect more than demographic

[8] According to ABS (2007), life expectancy at birth has improved by 6.0 years for males and 4.1 years for females over the past 20 years.

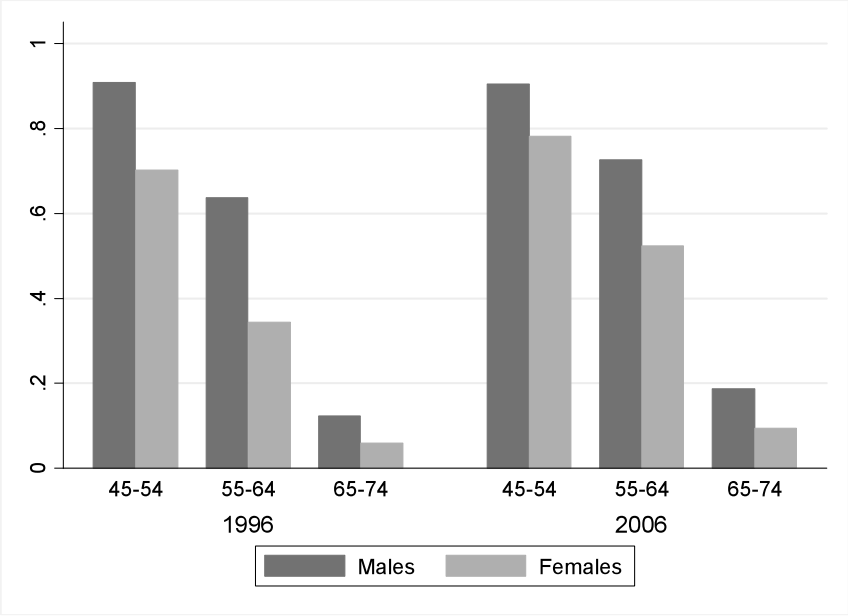
aspects. Labour market conditions and policies as well as pension benefits, pension tax contributions and health conditions will also influence the future retirement decisions of older workers.

Gender

When analysing labour force participation, it is important to distinguish between men and women. Labour force participation rates of women are typically lower than those of men. Studies on female labour supply provide evidence of a strong increase in female labour force participation over time in most developed economies (Killingsworth & Heckman 1986), while male rates show long-term aggregate declines. Figure 2 provides evidence for a substantial increase between 1996 and 2006 in the labour force participation of women. While the rate of employed women aged 45–54 years has increased only moderately from 70.2% in 1996 to 78.1% in 2006, the labour force participation rate of women aged 55–64 years rose substantially from 34.4% in 1996 to 52.3% in 2006. Moreover, the share of women who continued in employment beyond the age of 65 years rose from 5.9% in 1996 to 9.4% in 2006. Over the same period, labour force participation rates of men remained relatively stable and even declined for those aged 45–54 years, from 90.7% in 1996 to 90.4% in 2006.

These numbers reveal that the increase in overall labour force participation rates arose predominantly because of the increase in employed women. Consequently, figure 2 highlights the relevance of taking differences between men and women into account when analysing dynamics in labour force participation.

Figure 2 Labour force participation by gender, year and age



Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Educational attainment

We now turn to look at the educational levels of workers who continue in employment beyond age 65 years. From a theoretical perspective, it is difficult to predict which types of workers (in terms of education) remain employed beyond age 65 years. Highly educated workers may find it more attractive to remain employed in old age than less-educated workers, in terms of the relative employment conditions they face, or if they need to recoup their investment in education. At the same time, less-educated workers (such as manual workers) are more likely to face physical limitations that do not allow them to remain in their jobs in old age. In this case, we would expect labour force participation rates to increase with educational attainment. Alternatively, their higher

lifetime incomes may enable highly educated workers to retire early, while some less-educated workers may be forced to remain employed beyond age 65 to secure a desired level of consumption after retirement. In this case, labour force participation rates may remain high among less-educated persons.

Table 3 Share of labour force participants by educational attainment and birth cohort, 1996 and 2006

	Mean value by gender and year			
	1996		2006	
	Males	*Females*	*Males*	*Females*
Year 12 and below (in %)				
Birth cohort 1952–91	48.8	52.5	47.0	47.5
	(50.0)	(50.0)	(49.9)	(49.9)
Birth cohort 1942–51	41.7	50.1	40.4	54.5
	(49.3)	(50.0)	(49.1)	(49.9)
Birth cohort 1932–41	42.6	61.0	45.9	46.7
	(49.5)	(48.9)	(50.1)	(50.3)
Birth cohort 1922–31	54.7	48.4		
	(50.2)	(50.7)		
Total	46.9	52.5	46.1	48.3
	(49.9)	(49.9)	(49.9)	(50.0)
Vocational qualification (in %)				
Birth cohort 1952–91	36.7	30.5	30.6	26.4
	(48.2)	(46.1)	(46.1)	(44.1)
Birth cohort 1942–51	42.8	33.1	36.8	23.9
	(49.5)	(47.1)	(48.3)	(42.7)
Birth cohort 1932–41	42.6	26.6	35.7	25.7
	(49.5)	(44.3)	(48.2)	(44.1)
Birth cohort 1922–31	21.4	39.0		
	(41.3)	(49.5)		
Total	38.2	30.9	31.5	26.1
	(48.6)	(46.2)	(46.5)	(43.9)
Bachelor degree or higher (in %)				
Birth cohort 1952–91	14.5	17.0	22.4	26.0
	(35.3)	(37.6)	(41.7)	(43.9)
Birth cohort 1942–51	15.5	16.9	22.8	21.5
	(36.2)	(37.5)	(42.0)	(41.2)
Birth cohort 1932–41	14.8	12.5	18.3	27.5
	(35.6)	(33.1)	(38.9)	(45.0)
Birth cohort 1922–31	23.9	12.6		
	(43.0)	(33.7)		
Total	14.9	16.7	22.4	25.5
	(35.6)	(37.3)	(41.7)	(43.6)
Number of observations	3299	2981	3251	3112

Notes: Weighted numbers based on weights provided by ABS. Standard deviations in parentheses.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Table 3 contains the share of labour force participants by educational attainment and birth cohort in 1996 and 2006. The numbers reveal that the overall share of male and female labour force participants without vocational qualifications or a university degree has slightly declined over time. However, while the proportion without post-school qualifications within the birth cohort 1932–1941 (that is, the 55 to 64-year-olds in 1996 and the 65 to 74-year-olds in 2006) has fallen over time for females, an increase in this proportion of males from 42.6% in 1996 to 45.9% in 2006 is

apparent. This suggests that a substantial part of the labour force population without post-school qualifications remains employed beyond age 65 years. These numbers are consistent with some share of this population being forced to stay employed to fund consumption beyond the standard retirement age.

Table 3 further suggests that the share of males and females with vocational qualifications declined among these age groups between the two surveys. This decline is particularly strong for males. Specifically, the overall share of male labour force participants with vocational qualifications declined from 38.2% in 1996 to 31.5% in 2006. Over the same period, the corresponding share of female labour force participants has declined from 30.9% to 26.1%.

The numbers in table 3 show that the decline in the share of labour force participants with vocational qualifications was taken up by the share of persons who hold a university degree. Specifically, while the overall share of male labour force participants with a university degree increased from 14.9% to 22.4% between 1996 and 2006, the share of female labour force participants increased from 16.7% to 25.5%. Within the birth cohort 1932–41, the increase was even more substantial for females. The share of highly educated female labour force participants of this birth cohort increased from 12.5% to 27.5%. These numbers indicate that a large proportion of workers who remain employed beyond age 65 years come from the pool of highly educated persons. The strong increase in the share of labour force participants with a university degree reflects the large proportion of more highly educated women who continue to work.

Skills and skill requirements at work

It seems likely that labour force participation in old age does not only depend on educational attainment, but also on the extent to which workers have the opportunity to apply their skills at work. OECD (2005) contains an analysis of skills mismatch using literacy skills and literacy use at work across those countries involved in the first wave of the Adult Literacy and Life Skills Survey, drawing on the analysis of Krahn and Lowe (1998) of the earlier International Adult Literacy Survey. It used the five-point scale to group respondents into two skill level categories (1 and 2: low skill, versus 3 to 5: high skill) and split usage into above and below median categories. This provided a four-way classification that made it possible to compare the match of workers to jobs across countries. In general, about 60% of workers were well matched—either high-literacy-skill workers to jobs with high requirements, or low-skill workers to low-requirement jobs. The balance was of workers with either skill surpluses or deficits. In most countries, more workers had surplus literacy skills than were in deficit. The same seems to be true in Australia. Using the same approach, Ryan and Sinning (2009) find that about 60% of workers appear to be well matched, with 26% of workers with good literacy skills but in low-use jobs and 13% of workers with low skills in high-use jobs.

To gain a better understanding of the relationship between individual skills and labour force participation, we focus on the investigation of individual literacy and self-assessed skill measures of workers. Table 4 includes these measures of workers by birth cohort in 1996 and 2006. The numbers reveal that individual literacy measures of workers remain remarkably stable over time. However, some heterogeneity across birth cohorts and gender may be observed. Specifically, while overall document literacy of male and female workers does not vary considerably over the period 1996 to 2006, a decline may be observed for male workers within the birth cohort 1932–41, suggesting that skills of male workers who remain employed beyond age 65 years are below average (and that skills may deteriorate with age). This result is in line with the numbers presented in table 3, which provide evidence for a relatively large share of less-educated workers who continue to work in old age. At the same time, document literacy of female workers within the birth cohort 1932–41 increases over time, suggesting that women are more likely to remain employed beyond age 65 if they are highly educated.

The numbers for self-assessed skills provided at the bottom of table 4 show a substantial increase for female workers of the birth cohort 1932–41. While, overall, self-assessed skills of male workers

of this birth cohort have remained stable between 1996 and 2006, the skill measure of female workers has increased from 387.1 in 1996 to 418.7 in 2006. These numbers indicate that self-assessed skills appear to be more important for retirement decisions than actual skills. In particular, female workers seem to remain employed beyond age 65 years because they consider themselves as high-skilled (which may not necessarily be the case).

Table 4 Individual literacy of all workers by birth cohort, 1996 and 2006

	Mean value by gender and year			
	1996		2006	
	Males	*Females*	*Males*	*Females*
Document literacy				
Birth cohort 1952–91	287.8	292.6	288.0	290.1
	(55.2)	(49.8)	(53.2)	(48.9)
Birth cohort 1942–51	277.8	274.0	271.9	266.5
	(60.9)	(59.4)	(59.7)	(53.2)
Birth cohort 1932–41	263.3	256.4	251.2	261.8
	(64.0)	(61.0)	(57.1)	(48.8)
Birth cohort 1922–31	267.7	247.7		
	(60.1)	(59.0)		
Total	**283.2**	**286.0**	**285.0**	**286.8**
	(57.8)	**(54.0)**	**(54.8)**	**(50.1)**
Self-assessed skills				
Birth cohort 1952–91	387.5	389.4	385.0	417.7
	(77.7)	(71.5)	(108.2)	(96.1)
Birth cohort 1942–51	371.7	381.9	381.9	424.7
	(89.7)	(80.1)	(113.1)	(91.5)
Birth cohort 1932–41	383.1	379.6	363.0	426.5
	(89.0)	(88.7)	(118.6)	(105.1)
Birth cohort 1922–31	390.8	377.9		
	(72.0)	(81.5)		
Total	**383.9**	**387.1**	**384.1**	**418.7**
	(81.5)	**(74.7)**	**(109.2)**	**(95.7)**
Number of observations	3034	2781	3128	2977

Notes: Weighted numbers based on weights provided by ABS. Standard deviations in parentheses.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Finally, table 5 includes the job task measures of workers by birth cohort in 1996 and 2006. Overall, these measures have increased considerably over time. However, the numbers also suggest that older workers are typically matched to jobs with relatively low literacy and numeracy requirements. Moreover, the job task measures have remained relatively stable for male workers and increased substantially for female workers of the birth cohort 1932–41. These findings are in line with the high proportion of highly educated female workers who remain employed beyond age 65 years (table 3) and the increase in the measure of document literacy and self-assessed skills for female workers (table 4). Overall, older workers appear to be relatively well matched since their skills are slightly below average, while they tend to work in jobs with relatively low-skill requirements. This result confirms the findings of Ryan and Sinning (2009), who conclude that there was no reason to be particularly concerned about the misallocation of older workers to their jobs, since the match of workers with skills to jobs that required them appeared no worse than was the case for younger workers.

Table 5 Job task measures of all workers by birth cohort, 1996 and 2006

	Mean value by gender and year			
	1996		2006	
	Males	*Females*	*Males*	*Females*
Literacy use				
Birth cohort 1952–91	285.0	265.1	296.7	296.1
	(150.4)	(143.2)	(137.4)	(129.4)
Birth cohort 1942–51	307.3	270.2	292.3	288.3
	(154.4)	(147.7)	(140.7)	(129.0)
Birth cohort 1932–41	278.5	225.6	278.1	267.8
	(162.1)	(141.5)	(148.0)	(128.6)
Birth cohort 1922–31	248.4	169.1		
	(147.0)	(124.9)		
Total	**288.5**	**262.5**	**295.7**	**294.7**
	(152.6)	**(144.4)**	**(138.1)**	**(129.4)**
Numeracy use				
Birth cohort 1952–91	270.4	215.2	306.5	268.9
	(150.7)	(140.0)	(129.0)	(131.1)
Birth cohort 1942–51	282.5	196.7	288.0	241.7
	(145.6)	(140.1)	(133.6)	(137.5)
Birth cohort 1932–41	253.8	175.3	261.5	216.4
	(148.5)	(141.4)	(130.7)	(116.1)
Birth cohort 1922–31	217.2	172.2		
	(150.3)	(128.8)		
Total	**270.7**	**208.4**	**302.9**	**264.9**
	(149.7)	**(140.5)**	**(129.9)**	**(132.1)**
Number of observations	3034	2781	3128	2977

Notes: Weighted numbers based on weights provided by ABS. Standard deviations in parentheses.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Regression analysis

So far, we have discussed several factors that are relevant in explaining the labour force participation of older people. We have found that gender differences in labour force participation are considerable, but that female labour force participation has increased substantially over time. We have also shown that many workers who remain employed beyond age 65 years are highly educated, although their skills (and skill requirements) are below average. To investigate whether these relationships remain when other determinants of labour force participation are taken into account, it is necessary to estimate a multivariate regression model. The estimates of such a model can answer a number of important questions, such as:

- ✧ Do the differences in labour force participation propensities between men and women remain substantial?
- ✧ Does the relationship between educational attainment and labour force participation remain once individual skills are taken into account?
- ✧ Are the estimated effects common across birth cohorts?

To answer these questions, a linear probability model is estimated. Since substantial differences exist between 1996 and 2006, the model is estimated separately for the two years. Furthermore, the sample is restricted to the birth cohorts 1932–51. These are the birth cohorts aged 45–64 years in 1996 and 55–74 years in 2006. Since we are particularly interested in differences between workers aged below 65 years and workers age 65 years and above, we estimate a fully interacted model which includes an

indicator variable for the birth cohorts 1932–41 (that is, the workers aged 55–64 years in 1996 and 65–74 years in 2006) and interaction terms between this indicator variable and all other explanatory variables of the model. Specifically, the following regression equation is estimated separately for 1996 and 2006 (all explanatory variables have an associated parameter that we estimate):[9]

$$
\begin{aligned}
\text{Labour force participation} = {} & \text{intercept} \\
& + \text{document literacy} + \text{document literacy squared} \\
& + \text{female indicator} \\
& + \text{highest level of education indicators} \\
& + \text{birth cohort indicator} \\
& + \text{interaction of all variables with birth cohort indicator} \\
& + \text{residuals}
\end{aligned}
$$

The estimates obtained from this model do not only permit inferences about changes in the relevance of labour supply determinants over time, but also about differences between birth cohorts. Table 6 shows the estimates of the linear probability models. The first two columns report the estimates for 1996, while the last two columns include the results for 2006.

In general, variables are interpreted to have a significant effect on the dependent variable of a regression equation where their t-value (parameter estimate/standard error) exceeds 1.96. The parameters on such variables are said to be statistically different from zero at the 95% level. Using this criterion, the coefficients on individual literacy can be considered significantly different from zero in 1996 for the birth cohorts 1942–51, while the coefficients of document literacy are insignificant. The significant coefficients have the expected signs that describe a quadratic relationship between document literacy and labour force participation, that is, they indicate that an increase in individual literacy increases the propensity to participate in the labour force, but has less of an effect at higher literacy levels than it does at lower levels. Since the estimates are influenced strongly by the way in which the model is specified, it is necessary to take a closer look at all variables that were included in the regression equation:

- *Intercept*: the intercept denotes a constructed level of labour force participation for a hypothetical observation, given that all variables of the model are equal to zero. Since some of the variables in the regression model are different from zero for all observations, an economic interpretation of the intercept is not possible.
- *Female indicator*. after controlling for relevant determinants, gender differences in labour force participation remain highly significant in both years, with female participation of the order of 15.8–18.1% lower than male participation.
- *Highest level of* education: the coefficients on the indicator variables for the highest level of education of individuals suggest that education is positively associated with labour force participation. Compared with the reference group (that is, the group of persons with education below Year 12), all coefficients are positively associated with labour force participation (although the coefficients are not always significant), suggesting that the propensity to participate in the labour force increases with education. It is the estimated effect of these variables that are affected most by the inclusion of the document literacy skill variables. When the skill variables are excluded, the estimated parameters are about twice the size of those reported in table 6. Hence, while the relationship between educational attainment and labour force participation remains once individual skills are taken into account, the estimated magnitude of the relationship is substantially smaller.

[9] Although the numbers in table 4 suggest that self-assessed skills seem to matter more for retirement decisions than actual skills, we include a measure of actual rather than self-assessed skills in our regression equation because self-assessed skills turned out to be highly correlated with the highest level of education.

✧ *Birth cohort indicator.* the coefficient of the birth cohort indicator is insignificant in both years, suggesting that differences in labour force participation between the birth cohorts 1932–41 and 1942–51 are not significant after relevant determinants are considered. Nevertheless, there are real differences in participation between the cohorts, but much of the difference is captured in the regression equation by the document literacy skill interaction variables. If these are excluded, the cohort indicator is negative, large and statistically significant in both years.

Table 6 Determinants of labour force participation

	Birth cohort 1932–41			
	1996		2006	
	Estimate	*t-value*	*Estimate*	*t-value*
Intercept	0.165	0.90	0.231	1.44
Document literacy				
Document literacy	0.004	2.97	0.002	1.31
Document literacy squared/10 000	-0.057	-2.22	-0.003	-0.10
Female				
Female	-0.181	-8.06	-0.158	-5.70
Highest level of education				
Year 11 and below (reference group)				
Year 12	0.094	2.46	0.028	0.52
Certificate, advanced diploma/diploma	0.089	3.15	0.082	2.41
Bachelor degree or higher	0.114	3.28	0.162	4.04
Birth cohort 1932–41				
Birth cohort 1932–41	0.060	0.22	-0.166	-0.84
Interaction terms:				
Document literacy				
Document literacy	-0.003	-1.26	-0.002	-1.01
Document literacy squared/10 000	0.064	1.46	0.024	0.58
Female				
Female	-0.076	-1.91	0.077	2.05
Highest level of education				
Year 11 and below (reference group)				
Year 12	-0.108	-1.53	0.088	1.00
Certificate, advanced diploma/diploma	-0.072	-1.48	-0.052	-1.14
Bachelor degree or higher	0.045	0.66	-0.025	-0.36
F-value	61.49		116.47	
Number of observations	2718		2631	

Notes: Weighted linear regression based on weights provided by ABS.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

✧ *Interaction terms:* to investigate differences in the effects of the determinants of labour force participation between birth cohorts, the birth cohort indicator is interacted with all other explanatory variables of the model. The estimates of the interaction terms indicate that the effects of almost all variables are the same for the birth cohorts 1932–41 and 1942–51. Only the effect of the female indicator is significantly positive in 2006, suggesting that gender differences in labour force participation have declined between the age cohorts, 55–64 years and 65–74 years. This result is in line with figure 1, which suggests that the small gender gap in labour force participation is a result of the relatively small proportion of labour force participants above age 65 years.

Summary

This chapter has investigated the determinants of labour supply among older persons. A number of well-known features about labour force participation are reflected in the data used here: that it declines with age and is higher among males and those with more education. We find these patterns are evident even when we take account of the literacy skills of individuals, both observed and self-reported skills. In the next chapter, we consider the role of these same factors in the determinants of individual wages among older workers, including those beyond age 65 years.

Wage determinants

This chapter contains an analysis of the determinants of wages. It concentrates on:

- the role of labour supply
- the role of demographic factors
- the role of educational attainment and occupation
- the extent to which these factors determine wages.

From a theoretical perspective, workers choose their retirement age based on the discounted value of lifetime income (that is, the total present value of the remaining lifetime). If a worker delays retirement, the present value of the remaining income increases. Most of this increase comes from additional earnings, while the increase in lifetime pension benefits is rather small. Since earnings have a substantial impact on increases in lifetime income (and consequently the choice of retirement age), this chapter investigates the determinants of wages among older workers. To draw inferences about changes over time and across birth cohorts, we compare workers aged 45–54 and 55–64 years in 1996 with workers aged 55–64 and 65–74 years in 2006. The findings derived from the empirical analysis of wages will give us a better sense of the types of workers who remain employed beyond age 65 years. Our empirical analysis investigates a number of relevant wage determinants, such as labour supply, skills and skill requirements at work and education.

The role of labour supply

Empirical analyses of wage determinants typically consider hourly wages, because labour supply patterns may differ considerably across groups and change over time. However, instead of hourly wages, only weekly wages are released in the available data. Moreover, instead of the number of weekly working hours, only broad categories of hours worked are available. Since this limitation prevents us from analysing hourly wages, our empirical analysis focuses predominantly on the weekly wages of full-time employed workers (that is, persons who work at least 35 hours per week), but also includes comparisons of full- and part-time employed workers.

Table 7 contains the proportion of full-time employed workers by birth cohort in 1996 and 2006 (since the proportions of full- and part-time workers always add up to 100%, part-time employed labour force participants are not reported separately). The numbers reveal that older workers are less likely to be employed full-time than younger workers. Specifically, the share of full-time employed male workers in the birth cohort 1932–41 declined from 87.0% in 1996 to 58.9% in 2006. The corresponding share of female workers dropped from 37.2% to 23.1% over the same period. Compared with younger birth cohorts, the decline in the proportion of workers employed full-time who remained employed beyond age 65 years is substantial. In particular, the decline in the proportion of male workers employed full-time in the younger 1942–51 birth cohort was only 11.6 percentage points, while the share of female workers employed full-time decreased by 0.4 percentage points.

Table 7 Proportion of full-time employed workers by birth cohort, 1996 and 2006

	Mean value by gender and year			
	1996		2006	
	Males	*Females*	*Males*	*Females*
Full-time employed (in %)				
Birth cohort 1952–91	85.3	52.8	85.5	51.9
	(35.4)	(49.9)	(35.2)	(50.0)
Birth cohort 1942–51	91.8	48.1	80.2	47.7
	(27.5)	(50.0)	(39.9)	(50.0)
Birth cohort 1932–41	87.0	37.2	58.9	23.1
	(33.7)	(48.5)	(49.5)	(42.5)
Birth cohort 1922–31	38.5	18.5		
	(49.1)	(39.4)		
Total	**86.1**	**50.5**	**84.2**	**51.0**
	(34.6)	**(50.0)**	**(36.5)**	**(50.0)**
Number of observations	3034	2781	3128	2977

Notes: Weighted numbers based on weights provided by ABS. Standard deviations in parentheses.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

The relationship between weekly working hours and wages is presented in table 8. The numbers typically show an increase in average weekly wages with higher working hours. Since variations within the group of full-time employed workers (that is, those who work 35 hours or more) are relatively small, we may consider predicted weekly wages of full-time employed workers rather than hourly wages in our empirical analysis. The numbers further suggest that overall wages of workers who remain employed beyond age 65 years are slightly lower than those of workers aged 55–64 years. This result seems to be driven by compositional differences in hours worked, since the wages within the hours categories are quite similar.

Table 8 Predicted weekly wages of all workers by age, 2006

	Predicted weekly wages by age		
	45–54 years	55–64 years	65–74 years
Worked 1–15 hours	392	424	486
	(148)	(169)	(181)
Worked 16–24 hours	413	425	432
	(163)	(171)	(141)
Worked 25–34 hours	413	402	526
	(164)	(170)	(226)
Worked 35–39 hours	862	849	900
	(176)	(160)	(200)
Worked 40 hours	917	893	916
	(179)	(171)	(208)
Worked 41–48 hours	951	927	960
	(174)	(163)	(201)
Worked 48 hours and more	965	945	930
	(176)	(181)	(185)
Total	**792**	**737**	**679**
	(287)	**(289)**	**(290)**
Number of observations	1378	908	148

Notes: Weighted numbers based on weights provided by ABS. Standard deviations in parentheses.

Source: ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

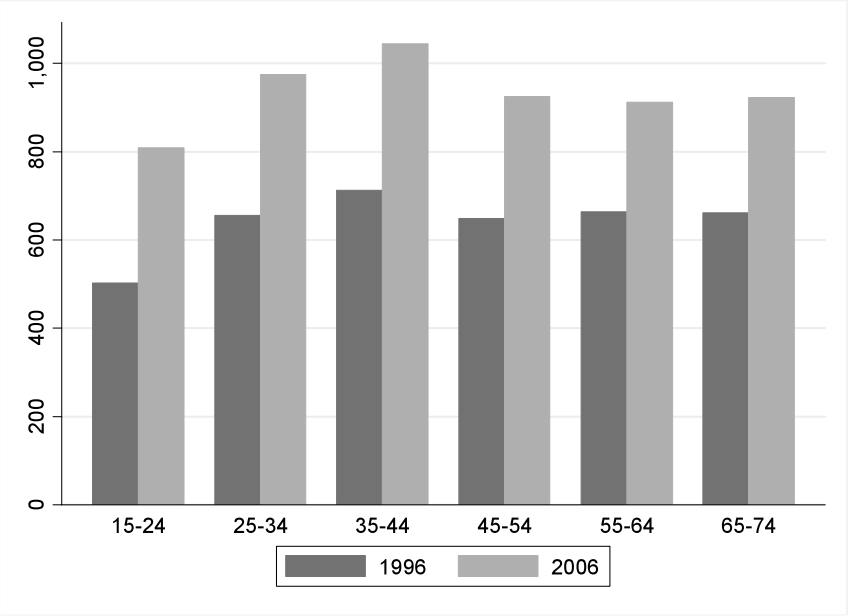
The role of demographic factors

Age

Demographic factors play a major role in explaining variation in wage levels. It is well known that older workers earn higher wages than younger workers because they are typically more experienced (Becker 1964; Mincer 1974). However, the relationship between wages and age is not linear. Instead, wages typically increase during the working life at a declining rate. Moreover, empirical studies provide evidence of a (relatively small) decline in wages for older workers.

Figure 3 presents the relationship between predicted weekly wages of full-time employed workers by year and age. The numbers provide evidence for higher wage levels among mature workers than younger workers. In particular, average weekly wages of full-time employed persons aged 15–24 years in 1996 amounted to $503 (in $2006), while the corresponding wage rate was $656 for workers aged 25–34. Average wages of workers aged 35–44 years were about $713. In 2006, average full-time wages were $809 for workers aged 15–24 years and $1045 for workers aged 35–44 years. Consistent with the economic literature, there is evidence of a small wage decline for older workers. Specifically, average wages of full-time workers aged 45–54 years were around $648 in 1996 and $925 in 2006. Beyond this age, however, average full-time wages remain relatively constant. Since wages of individuals typically fall in these older age ranges, our result suggests that more highly paid individuals seem to remain full-time employed.

Figure 3 Predicted weekly wages of full-time employed workers by year and age

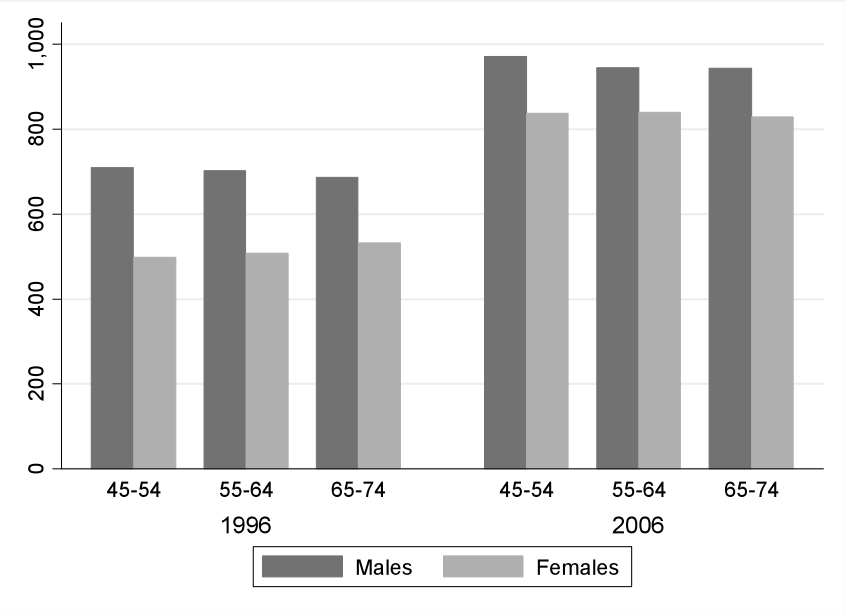


Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Gender

Gender differences in average weekly wages of full-time employed workers are presented in figure 4, which reveals substantial wage gaps between male and female workers across all age groups in both surveys. Moreover, there is very little difference in the average wages received by full-time workers for each gender across the different age ranges in the two surveys. However, we know from table 7 that the proportions employed full-time do vary substantially across these age ranges. At the same time, average wages of female workers remain relatively stable across age groups, at about $840. Overall, these results demonstrate that wages of workers who remain employed full-time beyond age 65 years receive relatively high wages (if wages fall for individuals as they age), suggesting that a selection of full-time employed older workers into high-wage jobs takes place.

Figure 4 Predicted weekly wages of full-time employed workers by gender, year and age



Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Educational attainment and occupation

As outlined above, human capital accumulation plays a major role in predicting wages. Table 9 presents the average weekly wages of full-time employed workers by education in 2006. The numbers show that highly educated workers from different age groups earn higher wages than less-educated workers. Although the numbers are consistent with figure 3, they reveal substantial heterogeneity with regard to education. Most importantly, wages of highly educated workers who remain employed beyond age 65 years are higher than those of younger age groups, indicating that highly educated older workers might select themselves into high-wage jobs, while an intermediate selection of less-educated older workers seems to takes place. These results suggest that highly educated workers are more likely to remain employed beyond age 65 years if they receive relatively high wages. At the same time, less-educated workers are more likely to work beyond age 65 years if they receive (at least) the same wage rate as comparable workers aged 55–64 years.

The numbers in table 10 reveal that wages of full-time employed workers differ considerably across occupations. Moreover, while differences within occupations are relatively small when comparing workers aged 45–54 years with those aged 55–64 years, a more heterogeneous pattern may be observed when looking at workers who remain employed beyond age 65 years.

Table 9 Predicted weekly wages of full-time employed workers by highest educational attainment and age, 2006

	Labour force participation by age		
	45–54 years	55–64 years	65–74 years
Postgraduate degree, graduate diploma/graduate certificate	1119	1112	1235
	(148)	(151)	(45)
Bachelor degree	1051	1061	1179
	(156)	(147)	(51)
Advanced diploma/diploma	973	952	1039
	(172)	(166)	(145)
Certificate	880	869	855
	(147)	(139)	(127)
Year 12 or below	836	820	828
	(142)	(128)	(142)
Total	**926**	**905**	**925**
	(181)	**(175)**	**(194)**
Number of observations	1022	596	66

Notes: Weighted numbers based on weights provided by ABS. Standard deviations in parentheses.
Source: ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Table 10 Predicted weekly wages of full-time employed workers by occupation and age, 2006

	Labour force participation by age		
	45–54 years	55–64 years	65–74 years
Managers	1039	1023	989
	(110)	(121)	(104)
Professionals	1139	1138	1163
	(109)	(110)	(115)
Technicians and trades workers	902	900	953
	(102)	(105)	(105)
Community and personal service workers	789	775	789
	(92)	(106)	(171)
Clerical and administrative workers	703	708	651
	(99)	(82)	(89)
Sales workers	877	864	799
	(86)	(84)	(123)
Machinery operators and drivers	870	877	913
	(118)	(104)	(25)
Labourers	722	735	705
	(73)	(85)	(37)
Total	**926**	**905**	**925**
	(181)	**(175)**	**(194)**
Number of observations	1022	596	66

Notes: Weighted numbers based on weights provided by ABS. Standard deviation in parentheses.
Source: ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

While average wages of 65 to 74-year-old workers are lower than those of 55 to 64-year-old workers in some occupations (such as managers, clerical and administrative workers, sales workers and labourers), they tend to be higher or about equal in other occupations (professionals, technicians and trades workers, community and personal service workers, machinery operators and drivers). Overall, the numbers highlight the relevance of considering differences between

occupations when analysing wage determinants. These differences will be taken into account in the following empirical analysis.

Regression analysis

In the following, a multivariate linear regression model is estimated to investigate the determinants of wages. To examine changes over time and differences between birth cohorts, the model is estimated separately for the years 1996 and 2006 and the birth cohorts 1932–41 and 1942–51. Specifically, a regression model of the following form is considered (all explanatory variables have an associated model parameter):

$$
\begin{aligned}
\ln(\text{Wages}) = {} & \text{intercept} \\
& + \text{full-time employment indicator} \\
& + \text{literacy use and literacy use squared} \\
& + \text{document literacy + document literacy squared} \\
& + \text{female indicator} \\
& + \text{highest level of education indicators} \\
& + \text{employer size indicator} \\
& + \text{occupation indicators} \\
& + \text{industry indicators} \\
& + \text{residuals}
\end{aligned}
$$

Table 11 includes the estimates for the birth cohorts 1932–41 for the years 1996 and 2006. As in the last chapter, variables are interpreted to have a significant effect on the dependent variable of a regression equation where their t-value (parameter estimate/standard error) exceeds 1.96. The parameters on such variables are said to be statistically different from zero at the 95% level.

Given this interpretation, the estimates show that wage differences between full-time employed workers and part-time employed workers (which constitute the reference group) are significantly different from each other, even after controlling for other explanatory variables. The estimates further suggest that both skill use and document literacy have no significant influence on wages for these age groups. At the same time, it is important to note that our model also controls for the highest level of education, which is likely to be correlated with skills and skill requirements at work to some extent.

The coefficients of the highest level of education provide evidence for a strong relationship between education and wages. Moreover, the indicator variable for female workers is significantly negative, suggesting that average wages of female workers in 1996 were 33.3% lower than those of male workers, even after controlling for relevant observable characteristics. In 2006, this gap has declined to 28.9%.[10] Finally, the size of the employer has no significant effect on wages in both years.

[10] Since the we use the logarithm of wages as dependent variable in our regression, the marginal effects of the parameter estimates b are given by: m(b) = exp(b)—1. Consequently the marginal effects of the female indicator are m(-0.405) = exp(-0.405)—1 = –0.333 = –33.3% and m(-0.341) = exp(-0.341)—1 = –-0.289= –28.9%, respectively.

Table 11 Wage determinants, birth cohorts 1932–41

	1996		2006	
	Estimate	t-value	Estimate	t-value
Intercept	5.682	35.87	5.752	42.02
Full-time employed				
Full-time employed	0.658	28.09	0.624	38.06
Literacy use				
Literacy use	0.001	1.04	0.001	1.62
Literacy use squared/10 000	-0.002	-0.73	-0.003	-1.45
Document literacy				
Document literacy	0.002	1.26	0.001	1.26
Document literacy squared/10 000	-0.021	-0.94	-0.020	-1.05
Female				
Female	-0.405	-16.24	-0.341	-25.44
Highest level of education				
Year 11 and below (reference group)				
Year 12	0.052	2.21	0.024	1.43
Certificate, advanced diploma/diploma	0.048	2.48	0.021	1.81
Bachelor degree or higher	0.094	2.57	0.124	5.41
Employer size				
< 500 (reference group)				
500 and over	-0.022	-1.06	-0.004	-0.34
F-value	139.25		277.67	

Notes: Number of observations: 1996: 514; 2006: 1177. Weighted linear regression based on weights provided by ABS. The regression model further includes occupation and industry indicators.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

To gain a better understanding of differences between the birth cohorts 1932–41 and 1942–51 in 1996 and 2006, separate regression models were estimated for the birth cohort 1942–51. The estimates of these models, which are presented in table 12, suggest that differences in the effects of the wage determinants between the birth cohorts are rather small. Only the quadratic relationship between wages and literacy use at work is significant for the birth cohorts 1942–51 in 2006, indicating that skill requirements at work increase wages at the declining rate. The coefficients of the remaining variables show little variation between different sub-samples, suggesting that the returns to the explanatory variables are similar across birth cohorts.

Table 12 Wage determinants, birth cohorts 1942–51

	1996		2006	
	Estimate	t-value	Estimate	t-value
Intercept	6.558	29.33	6.282	87.77
Full-time employed				
Full-time employed	0.679	19.69	0.708	56.99
Literacy use				
Literacy use	0.001	0.28	0.001	2.23
Literacy use squared/10 000	0.001	0.02	-0.006	-2.42
Document literacy				
Document literacy	-0.003	-1.49	-0.001	-0.85
Document literacy squared/10 000	0.059	1.52	0.009	0.81
Female				
Female	-0.071	-2.00	-0.179	-14.56
Highest level of education				
Year 11 and below (reference group)				
Year 12	-0.034	-0.82	0.001	0.04
Certificate, advanced diploma/diploma	0.009	0.18	0.061	5.11
Bachelor degree or higher	0.042	0.98	0.131	8.12
Employer size				
< 500 (reference group)				
500 and over	0.050	1.35	0.010	0.94
F-value	113.28		327.91	

Notes: Number of observations: 1996: 148; 2006: 908. Weighted linear regression based on weights provided by ABS. The regression model further includes occupation and industry indicators.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Summary

This chapter examined the determinants of wages, paying particular attention to older persons and their observed skill levels and the extent to which they utilise their skills in their jobs. While standard variables affect wages the way they do for other workers, so that wages increase with education and hours worked and are higher for males, we find little effect of observed skills and their utilisation on wages for this group of older workers. In the next chapter, we aim to establish how individuals who remain working beyond age 65 years might differ in important ways from those who do not.

Self-selection of older workers into employment

So far, we have examined the determinants of labour force participation and the remuneration of older workers. Our findings suggest that highly educated older workers seem to select themselves into high-wage jobs (that is, they are more likely to remain full-time employed beyond age 65 years if they receive relatively high wages), while some selection of less-educated older workers also seems to take place (that is, they are more likely to work beyond age 65 years if they receive (at least) the same wage rate as comparable workers aged 55–64 years).

In this chapter, we investigate which types of workers select themselves into employment beyond age 65 years. Specifically, we would like to know where in the wage distribution the workers came from (that is, whether they used to be at the top or lower down the distribution before they turned 65 years). This will give us a better sense of why workers remain employed in old age. Since the self-selection of older workers in full-time employment may be very different from the self-selection process into part-time employment, full- and part-time employed workers will be considered separately.

Table 13 includes summary statistics for the birth cohorts 1942–51 (that is, the group of workers aged 45–54 years in 1996 and 55–64 years in 2006) and 1932–41 (that is, the group of workers aged 55–64 years in 1996 and 65–74 years in 2006). The numbers in table 13 show that younger workers are more likely to be employed full-time than older workers. In particular, a selection into part-time employment may be observed for workers who remain employed beyond age 65 years. Moreover, older male workers are more likely to remain in the labour force than older female workers.

While average skills do not change substantially over time, a slight increase in skill requirements may be observed for the birth cohorts 1932–41. Moreover, the numbers point to substantial differences in the proportion of highly educated workers below and above 65 years. Specifically, while the share of workers without a post-school qualification remains relatively stable over time (that is, it declines slightly from 48.4% to 46.4%), we observe a decline in the proportion of workers with vocational qualifications (from 37.6% to 32.0%) and, correspondingly, an increase in the proportion of workers with a university degree (from 14.0% to 21.6%). These numbers suggest that a positive selection of workers into employment beyond age 65 has taken place with regard to education. Finally, the share of workers in large firms dropped considerably over time within each birth cohort.

Based on the worker characteristics reported in table 13, we are able to investigate where in the 1996 wage distribution of their birth cohort the workers who remained employed in 2006 came from (that is, whether they were predominantly from the top of the distribution—which would suggest that financial factors are not the main reason for their continuing in work—or from lower down the distribution). To draw inferences about the original position of workers in their cohort's wage distribution, we can calculate the *counterfactual* wage distribution, using the empirical approach proposed by DiNardo, Fortin and Lemieux (1996). The counterfactual wage distribution is the distribution that would have prevailed if workers from the cohort in 1996 had the same characteristics (that is, literacy and numeracy use, document literacy, gender, education, employer size, occupation and industry) as workers from that cohort who remained employed beyond age 65 years in 2006. Intuitively, this involves matching the characteristics of those employed in 2006 to those most like them in the 1996 sample and estimating the wage distribution of this matched group. A comparison of this distribution with the actual wage distribution in 1996 provides useful

information about the selection of persons who were employed in 1996 into retirement or further employment in 2006.

Table 13 Summary statistics for those employed

	1996		2006	
	Mean	Standard deviation	Mean	Standard deviation
Birth cohort 1942–51	*Age group 45–54 years*		*Age group 55–64 years*	
Full-time employed				
Full-time employed	0.731	0.444	0.665	0.472
Literacy use				
Literacy use	291.3	152.5	290.5	135.8
Document literacy				
Document literacy	276.2	60.2	269.6	57.1
Female				
Female	0.429	0.495	0.421	0.494
Highest level of education				
Year 11 and below	0.340	0.474	0.387	0.487
Year 12	0.107	0.309	0.075	0.264
Certificate, advanced diploma/diploma	0.389	0.488	0.315	0.465
Bachelor degree or higher	0.163	0.370	0.223	0.417
Employer size				
500 and over	0.320	0.467	0.256	0.437
N	1177		908	
Birth cohort 1932–41	*Age group 55–64 years*		*Age group 65–74 years*	
Full-time employed				
Full-time employed	0.688	0.464	0.465	0.500
Literacy use				
Literacy use	259.2	156.8	274.5	141.2
Document literacy				
Document literacy	260.8	63.0	254.8	54.5
Female				
Female	0.365	0.482	0.348	0.478
Highest level of education				
Year 11 and below	0.399	0.490	0.371	0.485
Year 12	0.085	0.280	0.093	0.291
Certificate, advanced diploma/diploma	0.376	0.485	0.320	0.468
Bachelor degree or higher	0.140	0.347	0.216	0.413
Employer size				
500 and over	0.276	0.447	0.126	0.333
N	514		148	

Notes: Weighted numbers based on weights provided by ABS.

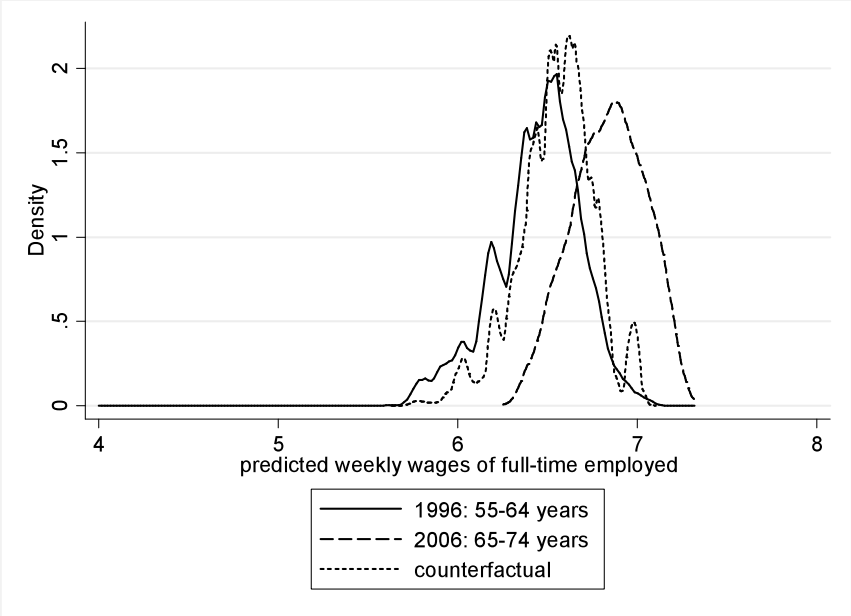
Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Counterfactual wage distribution

The actual and counterfactual wage distributions of full-time employed labour force participants are presented in figure 5. While the actual wage distributions refer to the age groups 55–64 years in 1996 and 65–74 years in 2006, the counterfactual distribution is the distribution of 65 to 74-year-old workers that would have prevailed in 2006 if workers were paid according to 1996 wage rates. The wage distributions provide evidence for a substantial increase in real wages between 1996 and

2006. Moreover, a comparison of the 1996 wage distribution with the counterfactual wage distribution provides evidence of positive selection of workers who remained employed beyond age 65 years in 2006, since the counterfactual distribution lies to the right of the 1996 wage distribution, so that workers of the birth cohort 1932–41 who continued in employment in 2006 had somewhat higher wages than the entire set of workers in 1996.

Figure 5 Actual and counterfactual wages of full-time workers



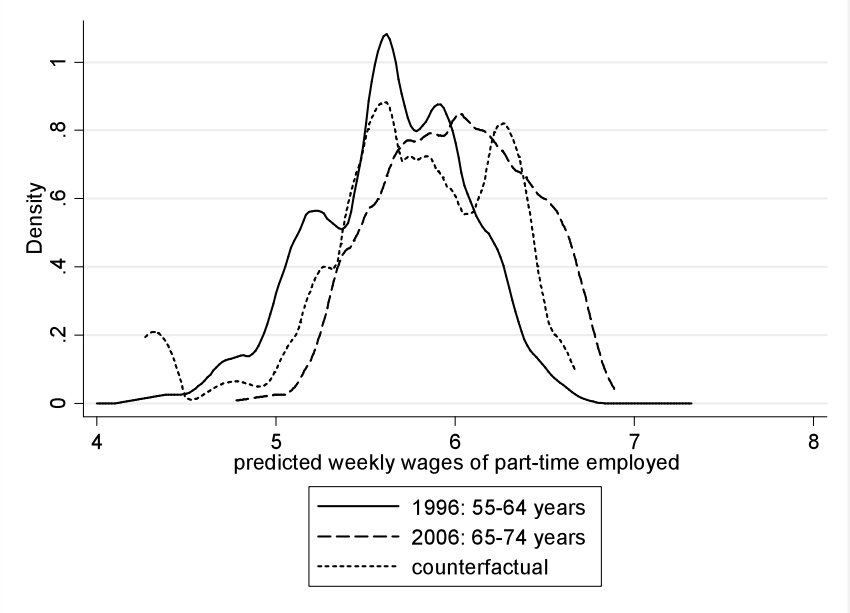
Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

The increase in the proportion of workers with a university degree and the decline in the share of workers with vocational qualifications (table 13) led to small positive selection from the pool of formerly full-time employed workers of the same birth cohort. In addition, the large proportion of workers without a post-school qualification (table 13) indicates that many workers might be forced to work beyond age 65 years to finance their consumption after retirement.

To account for differences in the wage distributions between full- and part-time employed workers, we consider part-time employed workers separately. Figure 6 includes the actual and counterfactual wage distributions of part-time workers. The counterfactual wage distribution in figure 6 suggests that a positive selection of workers into part-time employment beyond age 65 years has taken place (that is, workers who continue in part-time employment beyond age 65 years in 2006 are those who would have earned relatively high wages in 1996).

Several factors may be responsible for the positive self-selection process of older workers into part-time employment. Firstly, the numbers in table 13 suggest that many full-time employed workers remain part-time employed beyond age 65 years. As a result, the pool of part-time employed workers aged 65–74 years in 2006 is very different from the pool of part-time workers aged 55–64 years in 1996. Secondly, table 13 provides evidence for an increase in the proportion of older workers with university degrees, indicating a positive selection of workers into employment beyond age 65 years with regard to education. Given the strong relationship between education and wages, it seems likely that a large part of the positive self-selection observed in figure 6 may be attributed to educational attainment. Finally, economic theory suggests that the optimal retirement age does not only depend on wages and social security benefits, but also on individual preferences. If highly educated persons are more motivated to remain part-time employed beyond age 65 years, positive self-selection into part-time employment takes place.

Figure 6 Actual and counterfactual wages of part-time workers



Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0; ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Summary

This chapter investigated the actual and counterfactual wage distributions of members of the same birth cohort at two different points in time to investigate why older workers remain in the labour force. We find evidence of positive self-selection of full-time employed workers aged 55–64 years into full-time employment beyond age 65. Specifically, more highly educated workers remain employed beyond age 65 years than less-educated workers. In addition, a positive selection of workers beyond age 65 years into part-time employment is also observed.

Conclusions and implications

Australia will experience substantial demographic changes over the coming decades as a result of low fertility rates in the recent past and increasing life expectancy. The extent to which these changes will affect economic and social conditions will depend, among other factors, on the ability of older workers to continue working. As a consequence of the increasing life expectancy, individuals may find they need to work in old age to supplement public pensions and finance consumption after retirement. Against this background, this study investigated which types of workers continue in employment beyond the 'standard' retirement age and why.

The findings drawn from the analysis include:

- *Labour supply determinants*: labour force participation rates were around 80% for the population aged 15–54 years and substantially lower for older individuals. The overall labour force participation rate of 65 to 74-year-olds in 2006 was 14%. The increase in overall labour force participation between 1996 and 2006 may be attributed predominantly to an increase among women. A substantial part of the labour force population without post-school qualifications remains employed beyond age 65 years. While the share of workers with a vocational qualification within the birth cohort 1932–41 declined between 1996 and 2006, the proportion of employed persons with university degree increased.
- *Older workers relatively well matched to their jobs*: their skills are slightly below average and they tend to work in jobs with relatively low skill requirements. Self-assessed skills may matter more for retirement decisions than actual skills. Differences in individual skills and skill requirements over time and across birth cohorts are rather small. An increase in individual literacy increases the propensity to participate in the labour force, but the effect is smaller at high literacy levels. After controlling for relevant characteristics, gender differences in labour force participation remain highly significant. Educational attainment is positively associated with labour force participation. Older workers are less likely to be employed full-time than younger workers: the share of male workers employed full-time in the cohort born 1932–41 declined from 87.0% in 1996 (when they were aged 55–64 years) to 58.9% in 2006. The corresponding share of female workers employed full-time dropped from 37.2% to 23.1% over the same period.
- *Wage determinants*: the wages of highly educated workers who remain employed beyond age 65 years are no lower than those of younger age groups. The regression results provide evidence for a strong relationship between education and wages that is not affected by the inclusion of literacy skills or their usage at work. Even after controlling for relevant observable characteristics, a gender wage gap of about 30% may be observed among older workers.
- *Self-selection of older workers who remain in employment*: positive self-selection of full-time employed workers aged 55–64 years who remain in full-time employment beyond age 65 is apparent across the wage distribution. As already noted, more highly educated workers are more likely to remain employed beyond age 65 years than less-educated workers, which also results in positive selection of workers beyond age 65 years into part-time employment.

The empirical analysis in this paper indicates that two groups of workers, in terms of their educational qualifications, are more likely to remain working beyond the standard retirement age—the most-educated and least-educated groups of workers. For the former group, it seems likely this is a matter of choice, since they appear to be quite well paid to do so. It is less clear what drives the least-educated to remain working, but since their lifetime incomes are lower than other groups, it seems likely that the necessity of maintaining (relatively low) living standards for as long as possible

may play a part. Public policies designed to encourage individuals to provide for themselves in retirement need to be kept under review to ensure they promote this behaviour across the entire income distribution.

One group with lower rates of continuation in employment beyond age 65 years are those with vocational education qualifications. Whether this says something about the kinds of jobs those workers have up to age 65 or their attitudes towards work or the conditions of their private superannuation arrangements is not clear from the data. Other types of data, such as the longitudinal data provided in the Household, Income and Labour Dynamics in Australia survey, may help disentangle these kinds of effects. Knowledge of the relative roles of these factors would allow the development of public policies designed to encourage participation beyond age 65 years among this group.

References

ABS (Australian Bureau of Statistics) 1997a, *Aspects of literacy: Assessed skill levels Australia 1996*, cat.no.4228.0, ABS, Canberra.

——1997b, *Aspects of literacy: Profiles and perceptions, Australia, 1996*, cat.no.4226.0, ABS, Canberra.

——2006, *Adult Literacy and Life Skills Survey: User guide*, cat.no.4228.0.55.002, ABS, Canberra.

——2007, *Deaths*, cat.no.3302.0, ABS, Canberra.

——2008, *Adult Literacy and Life Skills Survey: Summary results*, cat.no.4228.0, ABS, Canberra.

Atkinson, ME & Creedy, J 1997, 'The choice of early retirement age and the Australian superannuation', *Australian Journal of Labour Economics,* vol.1, no.1, pp.1–23.

Bartel, A & Sicherman, N 1993, 'Technological change and retirement decisions of older workers', *Journal of Labor Economics*, vol.11, no.1, pp.162–83.

Biagi, F, Cavapozzi, D & Miniaci, R 2007, 'Technology, skills and retirement', working paper no.42, Dipartimento di Scienze Economiche M. Fanno, University of Padova.

Becker, GS 1964, *Human capital: A theoretical and empirical analysis, with special reference to education,* University of Chicago Press, Chicago.

Blundell, R & MaCurdy, T 1999, 'Labor supply: A review of alternative approaches', in *Handbook of Labor Economics, vol. IIIA*, eds O Ashenfelter & D Card, North-Holland, Amsterdam, pp.1559–695.

Blundell, R, Meghir, C & Smith, S 2002, 'Pension incentives and the pattern of early retirement', *Economic Journal*, vol.112, pp.153–70.

Boersch-Supan, A 2000, 'Incentive effects of social security on labor force participation: Evidence in Germany and across Europe', *Journal of Public Economics*, vol.78, pp.25–49.

Borland, J 2005, 'Transitions to retirement: A review', *Melbourne Institute Working Paper Series*, no.3/05.

Cameron, AC & Trivedi, PK 2005, *Microeconometrics: Methods and applications*, Cambridge University Press, New York.

Coile, C & Gruber, J 2000, 'Social security and retirement', working paper no. 2000–11, Center for Retirement Research, Boston College.

——2001, 'The effect of social security on retirement in the US', in *Social security programs and retirement around the world: Micro-estimation*, National Bureau of Economic Research (NBER), Washington, DC, pp.691–730.

DiNardo, J, Fortin, N & Lemieux, T 1996, 'Labor market institutions and the distribution of wages, 1973–1992: A semiparametric analysis', *Econometrica*, vol.64, pp.1001–44.

Freebairn, J 2004, 'Some long-run labour market effects of the superannuation guarantee', *Australian Economic Review,* vol.37, no.2, pp.191–97.

Friedberg, L 1999, 'The effect of old age assistance on retirement', *Journal of Public Economics*, vol.71, pp.213–32.

——2003, 'The impact of technological change on older workers: Evidence from data on computer use', *Industrial and Labor Relations Review*, vol.56, no.3, pp.511–29.

Killingsworth, MR & Heckman, JJ 1986, 'Female labor supply: A survey', in *Handbook of labor economics, vol.I*, eds O Ashenfelter & R Layard, North-Holland, Amsterdam, pp.103–204.

Krahn, H & Lowe, GS 1998, *Literacy utilization in Canadian workplaces*, Statistics Canada and Human Resources Development Canada, Ottawa and Hull.

Lazear, EP 1986, 'Retirement from the labor force', in *Handbook of labor economics, vol.I*, eds O Ashenfelter & R Layard, North-Holland, Amsterdam, pp. 305–55.

Lumsdaine, R & Mitchell, O 1999, 'New developments in the economics of retirements', in *Handbook of labor economics, vol. III*, eds O Ashenfelter & D Card, North-Holland, Amsterdam, pp. 3261–308.

Merrilees, W 1982, 'The mass exodus of the older men from the labour force: An exploratory analysis', *Australian Bulletin of Labour,* vol.8, no.2, pp.81–94.

——1983, 'Pension benefits and the decline in elderly male labour force participation', *Economic Record,* vol.59, no.166, pp.260–70.

Miller, P 1983, 'On explanations of declining labour force participation among older males', Discussion paper no.74, Centre for Economic Policy Research, Australian National University.

Mincer, J 1974, *Schooling, experience and earnings*, National Bureau of Economic Research (NBER), New York.

O'Brien, M 2001, 'Older male labour force participation: The role of social security and hidden unemployment', *Australian Journal of Labour Economics,* vol.4, pp.206–23.

OECD (Organisation for Economic Co-operation and Development) 2005, *Learning a living: First results of the Adult Literacy and Life Skills Survey*, OECD, Paris.
Rubin, DB 1987, *Multiple imputation for nonresponse in surveys*, John Wiley Sons, New York.
Rust, J & Phelan, C 1997, 'How social security and medicare affect retirement behavior in a world of incomplete markets', *Econometrica*, vol.65, no.4, pp.781–832.
Ryan, C & Sinning, M 2009, *Skill matches and job requirements*, NCVER, Adelaide.
Schleife, K 2006, 'Computer use and employment status of older workers: An analysis based on individual data', *Labour*, vol.20, no.2, pp.325–48.
Tanner, S 1998, 'The dynamics of male retirement behaviour', *Fiscal Studies*, vol.19, no.2, pp.175–96.
Weinberg, BA 2004, 'Experience and technology adoption', *IZA Discussion Paper*, no.1051.
Woodland, AD 1987, 'Determinants of the Labour Force Status of the Aged <http://ideas.repec.org/a/bla/ecorec/v63y1987i181p97-114.html> ', *The Economic Record* <http://ideas.repec.org/s/bla/ecorec.html>, vol.63, no.181, pp.97–114.

Appendix 1
Definition of variables

The following table provides a description of the variables that were used in the empirical analysis of the report. A detailed description of the generated job task and literacy use measures used in the report can be found in the support document to the report *Skill matches and job requirements* (Ryan & Sinning 2009).

Table A1 Description of variables

Variable	
Person ID	Person ID
Year	Year indicator
Weight	Person weight
Labour force participation	Indicator variable for labour force status 'employed'
Weekly wages	Weekly gross income (in real 2006 AUD), 1996: Personal income from wages, salary or self-employment; 2006: Personal gross income.
Hours worked	Number of hours usually worked per week, [1] Worked 1–15 hours in main job, [2] Worked 16–24 hours in main job, [3] Worked 25–34 hours in main job, [4] Worked 35–39 hours in main job, [5] Worked 40 hours in main job, [6] Worked 41–48 hours in main job, [7] Worked 49 hours and over in main job.
Literacy use at work (0–500)	Literacy use at work (generated scale), 1996: (i) How often reports or articles were written in main job, (ii) How often letters or memos were written in main job, (iii) How often directions or instructions for any products were used in main job, (iv) How often manuals or reference books were read or used in the main job, (v) How often reports, articles, magazines or journals were read or used in main job, (vi) How often letters or memos were read or used in main job; 'At least once a week': 2, 'Less than once a week': 1, 'Never : 0; 2006: (i) How often reads letters, memos or emails, (ii) How often reads or uses reports, articles, magazines or journals, (iii) How often reads or uses manuals or reference books including catalogues, (iv) How often writes or fills in letters, memos or emails, (v) How often writes or fills in reports, articles, magazines or journals, (vi) How often writes or fills in manuals or reference books including catalogues; 'At least once a week': 2, 'Less than once a week': 1, 'Never': 0; Scale takes on values from 0–500.
Numeracy use at work (0–500)	Numeracy use at work (generated scale), 1996: (i) How often arithmetic was used in main job to work out prices, costs or budgets, (ii) How often arithmetic was used in main job to measure or estimate the size or weight of objects, (iii) How often forms such as bills, invoices or budgets were filled out in main job, (iv) How often bills, invoices, spreadsheets or budget tables were read or used in main job, (v) How often diagrams or plans were read or used in main job; 'At least once a week': 2, 'Less than once a week': 1, 'Never': 0; 2006: (i) How often calculates prices, costs or budgets, (ii) How often measures or estimates the size or weight of objects, (iii) How often writes or fills in bills, invoices, spreadsheets or budget tables, (iv) How often reads or uses bills, invoices, spreadsheets or budget tables, (v) How often reads or uses diagrams or plans; 'At least once a week': 2, 'Less than once a week': 1, 'Never': 0
Skills (0–500)	Self-assessed skills (generated scale), 1996: Self-perception of (i) English reading skills for the needs of main job, (ii) English writing skills for the needs of main job, (iii) English reading skills for the needs of daily life, (iv) English writing skills for the needs of daily life; 'Poor': 0, 'Good or moderate': 1, 'Excellent': 2; 2006: (i) Has reading skills in English to do main job well, (ii) Has writing skills in English to do main job well, (iii) Self-perception of English reading skills for daily life, (iv) Self-perception of English writing skills for daily life; (i)–(ii): 'Disagree/Strongly disagree': 0, 'Agree': 1, 'Strongly agree': 2, (iii)–(iv): 'Poor': 0, 'Good or moderate': 1, 'Excellent': 2; Scale takes on values from 0–500.

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Variable	
Document literacy 1–5	Document literacy, level 1–5
Prose literacy 1–5	Prose literacy, level 1–5
Numeracy 1–5	Numeracy levels 1–5
Document literacy 1–5 (0–500)	Document literacy, continuous measure 1–5 (0–500)
Prose literacy 1–5 (0–500)	Prose literacy, continuous measure 1–5 (0–500)
Numeracy 1–5 (0–500)	Numeracy 1–5 (0–500)
Age	Five-year age ranges
Birth cohort	Identifier for individuals from common birth cohorts in each survey
Sex	Male or female
Full-time employed	Indicator variable for full-time employment
Employer size	Employer size; number of persons employed at the location of the individuals'
Educational attainment (ASCED 2006)	Highest level of completed schooling or post-school qualification; the following categories were used for 2006: [1] Year 8 or below, [2] Year 9, [3] Year 10, [4] Year 11, [5] Year 12, [6] Certificate I/II, [7] Certificate III/IV, [8] Advanced diploma/diploma, [9] Bachelor degree, [10] Postgraduate degree, graduate diploma/graduate certificate
Educational attainment	Highest level of completed schooling or post-school qualification; the following categories could be used in 1996 and 2006: [1] 1996: Has not completed highest level of secondary school available/Never attended school; 2006: Level not determined /Year 8 or below including never attended school/Year 9–11, [2] 1996: Completed highest level of secondary school available; 2006: Year 12, [3] 1996: Basic vocational qualifications; 2006: Certificate I/II/certificate not further defined, [4] 1996: Skilled vocational qualifications; 2006 Certificate III/IV, [5] 1996: Associate diploma/undergraduate diploma; 2006: Advanced diploma/diploma, [6] 1996: Bachelor degree; 2006: Bachelor degree, [7] 1996: Postgraduate diploma/higher degree; 2006: Postgraduate degree, Graduate diploma/graduate certificate
Occupation (ANZSCO 2006)	Occupation of main job; the following categories were used in 2006: [1] Labourers, [2] Machinery operators and drivers, [3] Sales workers, [4] Clerical and administrative workers, [5] Community and personal service workers, [6] Technicians and trades workers, [7] Professionals, [8] Managers
Occupation	Occupation of main job; the following categories could be used in 1996 and 2006: [1] Managers and administrators, [2] Professionals, [3] Para-professionals, [4] Clerks, [5] Salespersons and personal service workers, [6] Craft and related trades workers, [7] Plant and machine operators, and Drivers, [8] Other
Industry	Industry of main job; the following categories could be used in 1996 and 2006: [1] Agriculture, forestry and fishing, [2] Mining, [3] Manufacturing, [4] Electricity, Gas and water supply, [5] Construction, [6] Wholesale trade, [7] Retail trade, [8] Accommodation, cafes and restaurants, [9] Transport and storage, [10] Communication services, [11] Finance and insurance services, [12] Property and business services, [13] Government administration and defence, [14] Education, [15] Health and community services, [16] Cultural and recreational services, [17] Other

Appendix 2
Descriptive statistics

Table A2 Descriptive statistics, 1996

Variable	Mean	Standard deviation	Minimum	Maximum
Labour force participation	0.683	0.464	0	1
Weekly wages	532.50	225.35	1.20	1304.77
Hours worked				
1–15	0.094	0.292	0	1
16–24	0.061	0.239	0	1
25–34	0.055	0.229	0	1
35–39	0.132	0.339	0	1
40	0.114	0.318	0	1
41–48	0.074	0.262	0	1
49 and above	0.151	0.358	0	1
Job task measures				
Literacy use	257.3	103.0	0	500
Numeracy use	248.5	90.1	0	500
Individual literacy measures				
Document literacy	268.6	60.5	0	500
Prose literacy	270.4	60.4	0	500
Self-assessed skills	288.2	114.6	0	500
Age				
Age 15–19 years	0.057	0.232	0	1
Age 20– 24 years	0.081	0.274	0	1
Age 25–29 years	0.104	0.305	0	1
Age 30–34 years	0.116	0.321	0	1
Age 35–39 years	0.122	0.328	0	1
Age 40–44 years	0.097	0.297	0	1
Age 45–49 years	0.091	0.288	0	1
Age 50–54 years	0.072	0.259	0	1
Age 55–59 years	0.065	0.248	0	1
Age 60–64 years	0.063	0.243	0	1
Age 65–69 years	0.065	0.247	0	1
Age 70–74 years	0.059	0.237	0	1
Gender				
Male	0.458	0.498	0	1
Female	0.541	0.498	0	1
Industry				
Agriculture, forestry and fishing	0.314	0.464	0	1
Mining	0.033	0.180	0	1
Manufacturing	0.008	0.089	0	1
Electricity, gas and water supply	0.086	0.281	0	1
Construction	0.005	0.076	0	1

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Variable	Mean	Standard deviation	Minimum	Maximum
Wholesale trade	0.044	0.206	0	1
Retail trade	0.031	0.173	0	1
Accommodation, cafes and restaurants	0.097	0.297	0	1
Transport and storage	0.029	0.168	0	1
Communication services	0.027	0.164	0	1
Finance and insurance services	0.012	0.111	0	1
Property and business services	0.022	0.147	0	1
Government administration and defence	0.066	0.249	0	1
Education	0.041	0.198	0	1
Health and community services	0.055	0.228	0	1
Cultural and recreational services	0.072	0.259	0	1
Other	0.018	0.136	0	1
Full-time employment	0.472	0.499	0	1
Employer size				
Less than 20	0.268	0.443	0	1
20–99	0.094	0.293	0	1
100–499	0.071	0.257	0	1
500 and over	0.250	0.433	0	1
State				
New South Wales	0.226	0.418	0	1
Victoria	0.209	0.406	0	1
Queensland	0.170	0.376	0	1
South Australia	0.118	0.322	0	1
Western Australia	0.138	0.345	0	1
Other	0.137	0.344	0	1

Notes: This table includes descriptive statistics (unweighted numbers) of the sample that was used in the empirical analysis of the report. Number of observations: 8990.

Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0.

Table A3 Descriptive statistics, 2006

Variable	Mean	Standard deviation	Minimum	Maximum
Labour force participation	0.689	0.462	0	1
Weekly wages	800.26	310.01	21.85	1572.28
Hours worked				
1–15	0.074	0.263	0	1
16–24	0.061	0.241	0	1
25–34	0.065	0.247	0	1
35–39	0.128	0.334	0	1
40	0.115	0.319	0	1
41–48	0.080	0.272	0	1
49 and above	0.162	0.368	0	1
Job task measures				
Literacy use	263.1	116.5	0	500
Numeracy use	261.1	95.7	0	500
Individual literacy measures				
Document literacy	274.5	68.3	0	500
Prose literacy	275.0	64.7	0	500
Self-assessed skills	343.2	108.8	0	500
Age				
Age 15–19 years	0.041	0.199	0	1
Age 20–24 years	0.066	0.249	0	1
Age 25–29 years	0.082	0.275	0	1
Age 30–34 years	0.100	0.301	0	1
Age 35–39 years	0.109	0.311	0	1
Age 40–44 years	0.104	0.306	0	1
Age 45–49 years	0.102	0.303	0	1
Age 50–54 years	0.090	0.287	0	1
Age 55–59 years	0.089	0.285	0	1
Age 60–64 years	0.081	0.274	0	1
Age 65–69 years	0.064	0.245	0	1
Age 70–74 years	0.065	0.247	0	1
Gender				
Male	0.471	0.499	0	1
Female	0.528	0.499	0	1
Level of highest educational attainment (ASCED)				
Postgraduate degree, graduate diploma/graduate certificate	0.067	0.250	0	1
Bachelor degree	0.148	0.355	0	1
Advanced diploma/diploma	0.091	0.288	0	1
Certificate III/IV	0.169	0.375	0	1
Certificate I/II	0.018	0.133	0	1
Year 12	0.149	0.356	0	1
Year 11	0.065	0.246	0	1
Year 10	0.156	0.362	0	1
Year 9	0.055	0.229	0	1
Year 8 or below	0.079	0.270	0	1

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Variable	Mean	Standard deviation	Minimum	Maximum
Occupation of main job (ANZSCO 2006)				
Managers	0.208	0.406	0	1
Professionals	0.121	0.326	0	1
Technicians and trades workers	0.171	0.377	0	1
Community and personal service workers	0.112	0.315	0	1
Clerical and administrative workers	0.068	0.251	0	1
Sales workers	0.126	0.332	0	1
Machinery operators and drivers	0.061	0.240	0	1
Labourers	0.046	0.210	0	1
Industry				
Agriculture, forestry and fishing	0.208	0.406	0	1
Mining	0.032	0.176	0	1
Manufacturing	0.012	0.109	0	1
Electricity, gas and water supply	0.075	0.263	0	1
Construction	0.007	0.087	0	1
Wholesale trade	0.065	0.248	0	1
Retail trade	0.029	0.168	0	1
Accommodation, cafes and restaurants	0.084	0.277	0	1
Transport and storage	0.047	0.212	0	1
Communication services	0.034	0.183	0	1
Finance and insurance services	0.015	0.124	0	1
Property and business services	0.028	0.165	0	1
Government administration and defence	0.014	0.119	0	1
Education	0.061	0.240	0	1
Health and community services	0.063	0.243	0	1
Cultural and recreational services	0.084	0.277	0	1
Other	0.015	0.122	0	1
Full-time employment	0.486	0.499	0	1
Employer size				
Fewer than 20	0.218	0.413	0	1
20–99	0.112	0.315	0	1
100–499	0.083	0.277	0	1
500 and over	0.278	0.448	0	1
State				
New South Wales	0.217	0.412	0	1
Victoria	0.192	0.394	0	1
Queensland	0.181	0.385	0	1
South Australia	0.121	0.326	0	1
Western Australia	0.139	0.346	0	1
Other	0.147	0.354	0	1

Notes: This table includes descriptive statistics (unweighted numbers) of the sample that was used in the empirical analysis of the report. Number of observations: 7862.

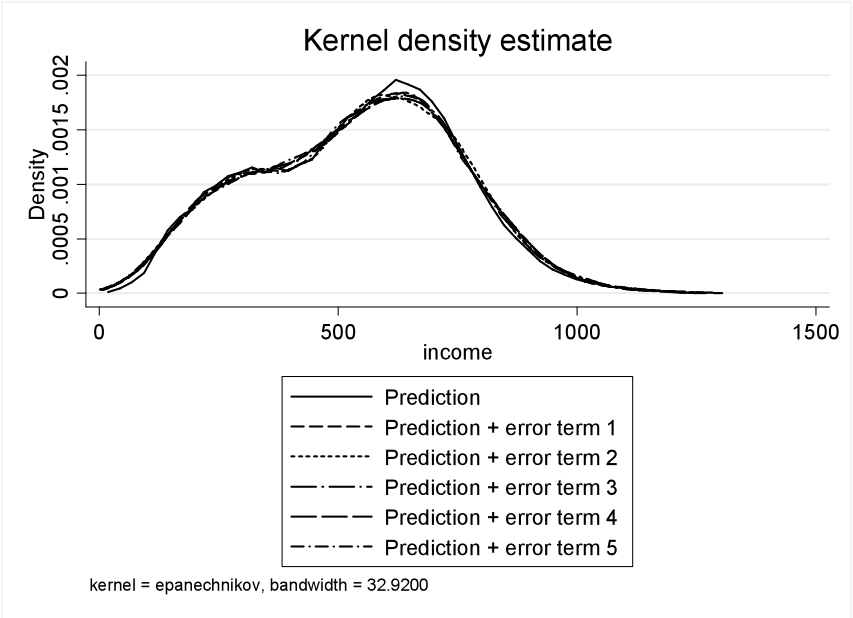
Source: ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

Appendix 3
Multiple imputation of wages

Instead of a linear wage measure, only wage ranges for ten deciles of the wage distribution may be observed in the data. To account for the resulting nonlinear nature of the wage variable, interval regression models were estimated. The estimates derived from these models were used to predict continuous measures of weekly wages. The predictions are typically obtained by regression-based multiple imputation. The main idea of multiple imputation is to replace missing values by estimates derived from a regression of the outcome measure on a set of explanatory variables. To simulate the sampling distribution of the missing values appropriately, each missing value is replaced by five generated values that are imputed by the process of randomly drawing a residual five times to obtain five different imputations, referred to as 'implicates'. Due to the generation of more imputed values, this procedure improves the approximation to the true sampling distribution.

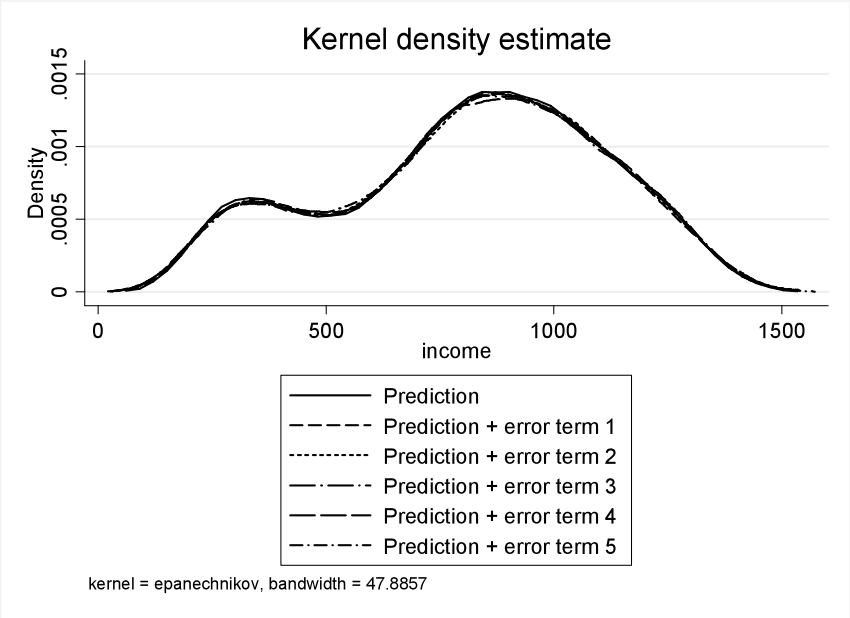
Figures A1 and A2 present the predicted wage distributions for 1996 and 2006. In practice, the average of these values is calculated to produce the best estimate of what the results would have been if the missing data had been observed (Rubin 1987). An accepted procedure for estimating the imputation variance using plausible values is to measure the variance of the five different values by a weighted average of 'between' and 'within' variances. ABS (2006) provides a more detailed description of this approach.

Figure A1 Imputed wages, 1996



Source: ABS, Survey of Aspects of Literacy, Australia, Basic Confidentialised Unit Record File, 1996, 4228.0.

Figure A2 Imputed wages, 2006



Source: ABS, Adult Literacy and Life Skills Survey, Australia, Basic Confidentialised Unit Record File, 2006, 4228.0.

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