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Links Between Literacy and Numeracy Skills and Labour Market Outcomes

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The paper utilised a confidentialised unit record file (CURF), accessed from the Australian Bureau of Statistics (ABS) via its Remote Access Data Laboratory (RADL). The findings and views reported in this paper, however, are those of the author and should not be attributed to either the ABS or the Productivity Commission.

Abbreviations

ABS	Australian Bureau of Statistics
ALLS	Adult Literacy and Lifeskills Survey (2006)
COAG	Council of Australian Governments
COB	Country of birth
CURF	Confidentialised Unit Record File
DPC	Department of Premier and Cabinet (Victoria)
IALS	International Adult Literacy Survey
NAPLAN	National Assessment Plan — Literacy and Numeracy
NRA	National Reform Agenda
OECD	Organisation for Economic Co-Operation and Development
OLS	Ordinary Least Squares
ppt	percentage points
RADL	Remote Access Data Laboratory
SAL	Survey of Aspects of Literacy (1996)
UNESCO	United Nations Educational, Scientific and Cultural Organization
VET	Vocational Education and Training

Key points

- Literacy and numeracy skills are key components of human capital, which is an important driver of economic growth.
- This paper utilises data from a 2006 survey on the literacy and numeracy skills of the Australian adult population. Analysis reveals that literacy and numeracy skills:
  - for nearly half of the population were assessed at either levels 1 (the lowest level) or 2, both of which are below the minimum level deemed necessary to participate in a knowledge-based economy (level 3).
  - vary according to a number of factors, and were generally highest for people who had either undertaken higher levels of education, were born in an English speaking country or were of prime working age (20–44 years old).
- Models were used to estimate the effect of improved literacy and numeracy skills on the probability of labour force participation and on wages.
- Results confirm previous research in the human capital literature — that improving literacy and numeracy skills has a positive, statistically significant effect on labour market outcomes.
- More specifically, it was estimated that an improvement in literacy and numeracy skills from level 1 to level 3 would:
  - increase the likelihood of labour force participation by about 15 percentage points for women and about 5 percentage points for men
  - increase hourly wage rates by about 25 and 30 per cent for women and men respectively.
- Improving educational attainment was also estimated to have a positive, statistically significant effect on labour force participation and on wages.
  - However, once literacy and numeracy skills were controlled for, the effect of increasing educational attainment on labour force participation and on wages was reduced. Some of the benefit occurs because more highly educated people tend to have higher literacy and numeracy skills.
- Literacy and numeracy skills are developed through education, but they can also be enhanced in other ways.
  - Understanding the factors that influence literacy and numeracy skills is important and could be further explored with the data used in this paper.

1 Introduction

Governments in Australia are interested in ways to improve human capital. For example, improving human capital is a key stream of the Council of Australian Government's (COAG's) National Reform Agenda (NRA).

Human capital refers to the set of attributes that individuals possess, including knowledge, skills, work experience, health and intangible characteristics such as motivation. Human capital may be acquired, or enhanced, through formal education or training, and by other, informal means (for example, through the experiences of undertaking daily activities at home or at the workplace).

There are many potential benefits from improving human capital that governments have identified. The Victorian Government stated:

> … a healthy and skilled population will secure a strong national economy through increased workforce participation and productivity, and will provide all Australians with the opportunity to participate fully and actively in our economy and society (DPC 2007, p. 6)

The Treasury's second intergenerational report stated:

> The level of an individual's educational attainment and skills is a key determinant of their participation in the labour force. Improving educational attainment and skills also contributes to lifting productivity. (Australian Government 2007, p. 13 overview)

From a macroeconomic perspective, improving human capital can address potential skill and labour supply shortages by offsetting the expected decline in labour force participation as the population ages (Australian Government 2007).

Literacy and numeracy skills are one component of a person's human capital, and the focus of research in this paper. While raising educational attainment has been a longstanding goal of governments, more recently governments have focussed their attention on improving literacy and numeracy outcomes. For example, the Victorian Government's plan to improve literacy and numeracy skills aims to 'increase the proportion of young people meeting basic literacy and numeracy standards, and improve overall levels of achievement' (DPC 2007, p. 15). To assist with achieving this goal, the National Assessment Plan — Literacy and Numeracy (NAPLAN) has been established, which includes reporting results on the literacy and numeracy levels of students in years 3, 5, 7 and 9, and how they have changed over time. The second year of results (for 2009) was recently released (MCEECDYA 2010).

Improving the literacy and numeracy skills of students, particularly at younger ages, is considered to be an important way to develop the skills necessary for people to work and to function in society at later years in their lives (DPC 2007). However, there has been relatively little research in Australia focussing on the links between literacy and numeracy skills and labour market outcomes.

1.1 Background and previous research

In 2006, the Productivity Commission reported on the potential economic and fiscal benefits that could arise from implementing the NRA (PC 2006a), including from its human capital stream, which is devoted to reforms aimed at improving educational and training outcomes, health and workforce incentives.

At the time of estimating the benefits of these reforms, the Commission indicated that it would continue research in this area, as some of the estimated benefits were based on information that was 'unavoidably incomplete, fragmented and speculative' (Laplagne, Glover and Shomos 2007, p. 3). Subsequent research by the Commission to fill these gaps has examined the effect of increasing educational attainment and health on labour force participation (Laplagne, Glover and Shomos 2007) and on wages (Forbes, Barker and Turner 2010).

This research, and most other literature, has used educational attainment as an indicator of skills or human capital. Key findings are that raising educational attainment is associated with a greater likelihood of labour force participation and higher wages. Theoretically, greater education is likely to enhance the skills used for work, which will make people more productive and more likely to participate in the workforce, all else equal.[1]

However, measures of educational attainment may not accurately reflect a person's literacy and numeracy skills (chapter 2). As a result, previous research does not provide much information on the types of skills that actually comprise a person's human capital (including literacy and numeracy). Furthermore, there is not much information regarding how important literacy and numeracy skills (which might be obtained through education, be an innate characteristic of an individual or be acquired through life experience) are for labour market outcomes.

[1] Other factors that influence participation and productivity (for example, innate ability or motivation) might also induce a person to undertake more education.

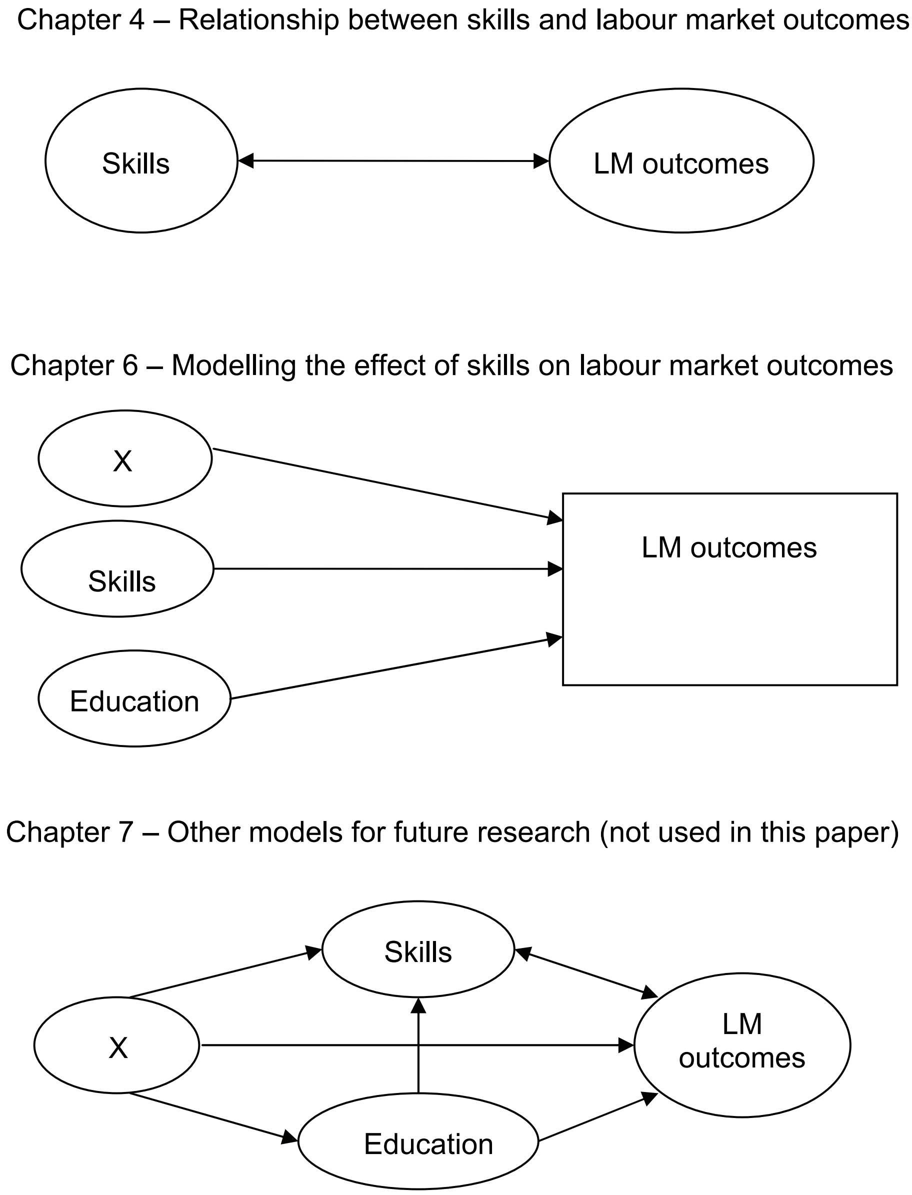
1.2 Aim of the paper and analytical approach

This study makes use of recent (2006) data that include direct measures of functional literacy and numeracy. These data are used to analyse the links between literacy and numeracy skills and labour market outcomes of the Australian adult population. The survey (described in chapter 2) is the most recently available of its scope — it contains objective tests of literacy and numeracy (as well as measures of educational attainment and labour market outcomes), and covers the Australian population aged 15–74 years.

The empirical analysis first considers how literacy and numeracy skills vary by demographic groups (chapter 3) and labour market outcomes (chapter 4). This analysis does not control for other factors that affect labour market outcomes. To address this, econometric models are used to formally estimate the effect of literacy and numeracy skills on labour force participation and wages (chapter 6). A depiction of the empirical analysis is presented in figure 1.1.

Econometric models account for the effects of educational attainment and other factors — denoted by X in figure 1.1 — that are also likely to affect labour market outcomes (for example, age and health). The modelling approach used in this paper does have some limitations. It did not control for the possibility that participation affects literacy and numeracy skills, or that innate ability (which cannot be measured from the survey data) and other factors might also jointly affect skill development and labour market outcomes. Thus there are possible extensions to the modelling that can be done. Models that could be used in further research are identified in chapter 7 and elsewhere in the report.

Figure 1.1 **Modelling the relationship between literacy and numeracy and labour market outcomes**



The paper contributes to the literature by using recent *Australian* data to estimate the effects of improving literacy and numeracy skills on the above labour market outcomes.[2] A key finding is that, regardless of people's educational attainment, improving their literacy and numeracy skills has a significant positive effect on

[2] To the author's knowledge, only Barrett (2009) has used the 2006 Australian data to estimate the effect of literacy and numeracy skills on wages.

labour market outcomes. The findings in this paper are consistent with studies for other countries. For example, Green and Riddell (2001) found a positive effect of literacy on the earnings of Canadian adults. Dougherty (2003) found that numeracy has a positive effect on earnings for workers in the United States. Chapple and Maré (2000) found that literacy has a positive effect on labour market participation and earnings for both men and women in New Zealand.

The estimates from this paper can be drawn upon by policy makers to help evaluate the potential benefits of reforms that aim to improve literacy and numeracy outcomes. As mentioned above, governments have recently set goals for the proportion of students achieving basic literacy and numeracy standards. The results from this paper can help quantify the effect that achieving such targets would have on overall labour force participation and wages (although the analysis does not consider how reaching such targets might be achieved in practice).

Care must be taken when applying the results. For example, it might be difficult to raise the skills of all persons with low literacy and numeracy to the highest level because of personal characteristics such as innate ability or motivation.

Results also show that the effect of increasing educational attainment on labour market outcomes is lower, once skills are controlled for. That is, the effect of education on labour market outcomes may be overstated in models that do not control for the underlying skills individuals possess — some of the benefit occurs because people with higher education tend to have higher skills. (Although education is likely to help develop a person's literacy and numeracy skills.)

The outline of the rest of this paper is as follows. Definitions of literacy and numeracy, and the survey data used in the analysis, are presented in chapter 2. An analysis of how literacy and numeracy skills vary by demographic group is in chapter 3. In chapter 4, the links between literacy and numeracy skills and labour market outcomes are examined using cross-tabulations. A description of the data and variables used in econometric analyses is set out in chapter 5. The results from econometric modelling of the effects of literacy and numeracy skills on labour force participation and on wages are presented in chapter 6. Finally, chapter 7 contains a summary and areas for further research.

2 Defining and measuring literacy and numeracy

This chapter presents the definitions of literacy and numeracy and the survey data used in the analysis. The links between human capital and literacy and numeracy, and how they relate to labour market outcomes are discussed in section 2.1. Sections 2.2 to 2.4 describe various theories and definitions of literacy and numeracy, and how they can be incorporated into a human capital framework. Finally, section 2.5 describes the preferred definition of literacy and numeracy and the survey data used in the analysis.

2.1 Literacy and numeracy as an element of human capital

'Human capital' refers to the set of attributes that makes it possible for people to contribute to production (including knowledge, skills, experience, health and intangible characteristics such as motivation). Human capital is a key determinant of an individual's productivity (which can be used to proxy wages) and of participation.

Previous Commission research for Australia indicates that people with higher levels of education earn higher wages (Forbes, Barker and Turner 2010) and are more likely to be in the labour market (Laplagne, Glover and Shomos 2007). Part of the reason for more highly educated people having better labour market outcomes is that they are likely to have higher literacy and numeracy skills than less educated people. However, literacy and numeracy are only two elements of the contribution that education makes to human capital. Furthermore, literacy and numeracy skills may be obtained through schooling, but can also be obtained from other, informal, means or they may reflect a person's innate learning ability. Thus, schooling is not a perfect measure of literacy and numeracy skills. There are many definitions of literacy and numeracy, which are described below.

2.2 The formal or abstract approach to literacy and numeracy

Definitions of literacy have 'changed over time in parallel with changes in our society, economy, and culture' (Kirsch 2001, p. 4). Historically, people were recognised as 'literate' if they could sign their name. Later definitions classified people as either 'literate' or 'illiterate', depending on whether they were able to read and write (Boudard and Jones 2003). Over time widespread education increased the number of people who were able to read and write, and more sophisticated skills were required to function in an advanced society. This made the dichotomous definition of people as 'literate' or 'illiterate' less useful for policy makers.

One definition of literacy and numeracy — the 'formal' or 'abstract' definition — relates skills to schooling. For example, Boudard and Jones (2003) state that UNESCO defines 'literate' people as those who have completed four or five years of schooling.

Measurement and reporting

Under this formal definition, literacy and numeracy is measured as years of education completed. Although this approach is attractive due to the ease of data collection, the number of years a person has spent in school is likely to be an imperfect measure of literacy and numeracy. For example, literacy and numeracy skills appear to increase at a slower rate as more education is undertaken (chapter 3). Different endowments of skills and motivation, and variations in the quality of teaching, mean that people obtain different returns from a given amount of education. More naturally gifted or more diligent students are likely to have higher levels of literacy and numeracy skills than other students with the same level of education whose natural ability or work ethic is lower. Likewise, two identical students with the same level of educational attainment could have different levels of literacy and numeracy if one benefited from a higher standard of teaching.

People's occupations have also been used as a proxy for literacy. This requires reliable data on the level of literacy required to perform particular jobs, which may not accurately reflect people's literacy. For example, a person with high literacy skills may work in a job that does not require those skills. The jobs available in an economy reflect a much wider array of influences than the human capital available.

This has implications for modelling the effect of skills (as proxied by occupation) on wages. Chiswick and Miller (2007) estimated that the returns to earnings from a highly skilled worker being in an occupation which does not use those skills are lower than if that worker was in a job requiring the use of those skills.

For the above reasons, the formal definition of literacy is likely to be only a partial reflection of literacy and numeracy skills as a component of human capital.

2.3 The functional approach to literacy and numeracy

'Functional' literacy and numeracy is a concept that relates literacy and numeracy to people's ability to engage in certain activities and participate in society (including, but not limited to, the labour market). There are a range of definitions of functional literacy and numeracy, but they share a number of common elements:

- a focus on knowledge and skills
- skills must be relevant to the culture or group to which the individual belongs
- literacy and numeracy are seen as tools that enable people to achieve their goals.

For example, the International Adult Literacy Survey (IALS) defines literacy as:

> … the ability to understand and employ printed information in daily activities, at home, at work and in the community — to achieve one's goals, and to develop one's knowledge and potential. (OECD 2000, p. 10)

Functional definitions of literacy and numeracy are consistent with the human capital approach to labour market outcomes. That approach regards literacy and numeracy as skills or attributes that contribute to an individual's ability to participate in the labour market and to be productive. Broadly speaking, someone who has a high level of functional literacy or numeracy is likely to be more productive than someone who has a low level of functional literacy (or numeracy).

Measurement and reporting

Functional literacy and numeracy emphasises the ability to use information to achieve one's goals and to engage in one's community. This means that functional literacy and numeracy cannot be accurately measured using years of education. Instead, tests, assessment centres and self-assessment are used to gauge how well people can understand and use information that is presented in a way that mimics some of the ways people use literacy and numeracy skills in their daily lives — for example, reading bus timetables, instruction manuals and newspaper articles.

Formal testing

Formal testing has been used for a long time to assess literacy and numeracy. An early example is the reporting in the early twentieth century of test results expressed in terms of the grade level at which a person could read (Kirsch 2001). Although these kinds of tests gave an indication of a person's reading skill level, according to Kirsch (2001, p. 5) such tests tended to gloss over 'the multifaceted nature of literacy'.

More recently, researchers have developed testing procedures to gauge how well people can use literacy and numeracy skills to achieve their goals and to function in their communities. For example, the IALS required people to identify the maximum dosage on a medicine label or extract information from a newspaper article.

Literacy and numeracy tests can be administered to large samples to determine the skill level of the population. The tests can be augmented with questions that provide other information relevant to human capital (including education) and labour market and demographic characteristics. This enables researchers to investigate the links between literacy and numeracy and the labour market.

Assessment centres

Assessment centres go beyond the scope of literacy and numeracy tests. Rather than answering questions, people are faced with real-life problems (or simulations) in specialised centres where an effort is made to present tasks in their relevant contexts. As such, Allen and van der Velden (2005, p. 7) state that this method is the 'gold standard' against which other measures should be judged. However, using assessment centres is also costly and difficult to administer to large samples.

Individual self-assessment

Individual self-assessment involves asking people about their functional level of literacy and numeracy (for example, asking people to rate their ability to carry out tasks such as reading a newspaper). Alternatively, individuals can be asked to rate their literacy and numeracy against a scale.

Allen and van der Velden list a range of advantages of self-assessment procedures:

> … they are relatively easy to administer to large samples, can be administered simultaneously in different locations, provide responses that are easily quantifiable and thus analyzable, are relatively inexpensive to produce and administer, and can be administered in any or all of a number of different ways, such as personal or telephone interviews, and questionnaire distributed by regular mail, email, or via the internet (Allen and van der Velden 2005, p. 11)

The main disadvantage with self-assessment is the potential for measurement error. People may over or understate their level of literacy and numeracy skills in order to appear 'normal' (Allen and van der Velden 2005). Other sources of measurement error arise because there is no objective scale for people to rate themselves against. For example, people may be asked if they regard their literacy skills as 'poor', 'average' or 'high'. Responses to this question could be based on people's own backgrounds, experiences and requirements for literacy skills.

2.4 Social and cultural approaches to literacy and numeracy

The social and cultural approach claims that literacy is dependent on context:

> If literacy is conceptualised as social practice rather than as an individualised, self contained action, and is thus likely to differ from context to context, then it follows that there can be no such thing as a single, universal literacy but rather multiple literacies. (Lonsdale and McCurry 2004, p. 26)

This approach to literacy and numeracy questions the appropriateness of testing and benchmarking literacy and policies that focus on specific sets of skills — such as vocational competencies — because the skills required to function in a society are dependent on context. Although this approach may lead to a more pluralistic and inclusive set of definitions of literacy, the implications for research and policy making are unclear. It does suggest, however, that care should be taken in cross-country comparisons of skills.

Measurement

Social and cultural views of literacy caution against using tests to determine people's level of literacy. Stripped of context, literacy tests do not measure literacy as such, but rather a specific form of 'test literacy' — the ability to answer the type of questions that appear on literacy tests. As such, these tests are merely another indicator of true 'literacy' (Hamilton and Barton 2000).

Hamilton and Barton (2000) are critical of the use of literacy and numeracy tests for international comparisons because test developers seek to identify a 'common cultural core of test items which elicit a similar pattern of response across all cultures and language groups' (p. 382). Hamilton and Barton (2000) argue that, because tests seek to strip literacy of its cultural context, they cannot be regarded as true measures of how people use literacy in their daily lives.

Ethnographic studies

Ethnographic studies involve observing how people use literacy and numeracy in their daily lives. For example, Zevenbergen and Zevenbergen (2004) followed 19 people in their work for a minimum of three days, and followed this up with interviews. (An example of a person using daily life skills was a retail worker using mental arithmetic to work out correct change to give.)

These studies have the advantage of observing how people use literacy and numeracy skills in contexts that they are familiar with. However, they are expensive to carry out and unlikely to provide useful data for analysing the labour market effects of literacy and numeracy.

2.5 The Adult Literacy and Lifeskills Survey (2006)

In this paper, the functional definition of literacy and numeracy is used. That definition is consistent with the human capital approach to literacy and numeracy.

Functional measures of literacy and numeracy give a more sophisticated view of people’s abilities than proxy measures (such as years of schooling) used in the formal approach. Although years of schooling is a measure of an input into the education system, literacy and numeracy skills directly measure educational outcomes (Osberg 2000). Furthermore, while people’s highest level of educational attainment or years of education remains largely unchanged over the course of their lives, their actual skills may vary at different points in time, depending on how they are used in daily activities.

Compared with the social and cultural approach, the functional definition of literacy and numeracy is easier to measure, making it more useful for the empirical analysis in this paper.

Functional literacy and numeracy skills of the Australian population were obtained from the Adult Literacy and Lifeskills Survey (ALLS) for 2006. It is only the second survey of its kind for Australia. The first survey, for 1996, contained survey data that were highly aggregated, which restricted its use in exploring links between skills and labour market outcomes. The ALLS includes information for almost 10 000 survey respondents, covering the population aged 15 to 74. Each respondent is assigned a test score for various literacy and numeracy skills. There is also information for each person’s labour market status, education and income.

Literacy and numeracy skills measured in the ALLS

The ALLS measures several 'domains' of literacy and numeracy, which relate to the different types of skills necessary to function in a modern society. These are:

- document literacy — knowledge and skills required to locate and use information contained in various formats including job applications, payroll forms, transportation schedules, maps, tables and charts
- prose literacy — knowledge and skills needed to understand and use various kinds of information from text including editorials, news stories, brochures and instruction manuals
- numeracy — knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations
- problem solving — goal-directed thinking action in situations for which no routine solution procedure is available
- health literacy — 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.

Each skill domain is measured in two different ways.

First, based on test responses, each skill is measured on a continuous scale ranging from 0 to 500. Each person is located along this continuum, with those people who have poorer literacy or numeracy obtaining a lower rating than those who have higher literacy and numeracy skills.

Each skill is then converted into a discrete skill level, ranging from level 1 (the lowest skill level) to level 5[1] (the highest skill level). Using document literacy, an example of how levels 1 to 5 are constructed from the values in the 500 point index is provided in box 2.1. An explanation of how a person's capabilities differ according to each skill level is also provided.

1 An exception is for the problem solving domain, for which there are only four skill levels.

Box 2.1 **How document literacy levels are defined in the ALLS**

Level 1 (Test score = 0–225)

Tasks in this level tend to require the respondent either to locate a piece of information based on a literal match or to enter information from personal knowledge onto a document. Little, if any, distracting information is present.

Level 2 (Test score = 226–275)

Tasks in this level are more varied than those in Level 1. Some require the respondents to match a single piece of information; however, several distractors may be present, or the match may require low-level inferences. Tasks in this level may also ask the respondent to cycle through information in a document or to integrate information from various parts of a document.

Level 3 (Test score = 276–325)

Some tasks in this level require the respondent to integrate multiple pieces of information from one or more documents. Others ask respondents to cycle through rather complex tables or graphs which contain information that is irrelevant or inappropriate to the task.

Level 4 (Test score = 326–375)

Tasks in this level, like those at the previous levels, ask respondents to perform multiple-feature matches, cycle through documents, and integrate information; however, they require a greater degree of inferencing. Many of these tasks require respondents to provide numerous responses but do not designate how many responses are needed. Conditional information is also present in the document tasks at this level and must be taken into account by the respondent.

Level 5 (Test score = 376–500)

Tasks in this level require the respondent to search through complex displays that contain multiple distractors, to make high-level text-based inferences, and to use specialised knowledge.

Source: ABS (2006).

In the descriptive analysis in this paper (chapters 3 and 4), both the continuous and discrete skill measures are used when presenting results. The econometric analyses (chapters 5 and 6) uses only the discrete skill level, because these skill levels have more interpretable definitions than the continuous variable. For example, level 3 is regarded by the survey developers as the ‘minimum required for individuals to meet the complex demands of everyday life and work in the emerging knowledge-based economy’ (ABS 2006, p. 5).

For the analysis in this paper (and as the ABS has done in their summary publication), level 4 and level 5 are grouped together (when using the discrete measure) because few people were assessed at level 5.

The various literacy and numeracy skills are highly correlated. More than 70 per cent of the population reported the same document literacy and numeracy skill level (bold numbers in table 2.1). A similar pattern occurs for correlations between other skill variables in the survey.

Table 2.1 **Correlation between document literacy and numeracy**

Per cent of population

	Numeracy				
Document literacy	Level 1	Level 2	Level 3	Level 4/5	Total
Level 1	**14.78**	1.67	0.05	0.00	16.50
Level 2	5.36	**19.39**	3.72	0.00	28.48
Level 3	0.17	9.78	**24.19**	3.93	38.07
Level 4/5	0.00	0.07	5.19	**11.70**	16.95
Total	20.31	30.91	33.15	15.63	100.00

Source: Productivity Commission estimates based on the ALLS (2006).

As well as test scores, the ALLS also has subjective measures of literacy and numeracy skills. For example, respondents were asked to rate their ability to use their reading, writing and mathematical skills at work as being either ‘good’, ‘very good’ or ‘poor’. As noted above, self-assessed indicators of functional literacy and numeracy have potential measurement errors. Furthermore, Finnie and Meng (2005) showed that objective measures of skill consistently gave a better explanation of labour market outcomes (employment and income) than subjective measures did. For these reasons, only the objective test scores of literacy and numeracy skills are used in this paper (for both descriptive and econometric analyses).

3 A profile of literacy and numeracy skills in Australia

In this section, the literacy and numeracy skills of Australia's population in 2006 are explored using the ALLS data. Comparisons are also made over time and with other countries. Following this, the literacy and numeracy skills of specific demographic groups are described.

3.1 Australian literacy and numeracy skills compared over time and with other countries

Australian literacy and numeracy skills in 2006

As noted in chapter 2, there is a strong correlation across the different types of skills assessed. Looking at each skill type, up to half of those people surveyed in 2006 (44–50 per cent) had low (level 1 or 2) prose literacy, document literacy or numeracy and almost 70 per cent had low problem solving skills (table 3.1). About one third of the population had level 3 skills for each type of skill (except problem solving).

Table 3.1 **Distribution of skill levels for working age respondents[a]**
By skill type, 2006

	Skill level (per cent of population)				
Skill type	*1*	*2*	*1 and 2*	*3*	*4/5*
Prose	14.5	29.0	43.5	38.8	17.7
Document	15.5	28.0	43.5	37.1	19.4
Numeracy	19.7	30.0	49.7	32.8	17.5
Problem solving	32.1	35.7	67.8	26.3	5.9

a Working age respondents are persons aged 15–65.

Source: ABS (2006).

The above information suggests that a substantial proportion (almost 50 per cent) of working age Australians have 'low' skills, which is in contrast with 2009 NAPLAN results that reported about 90 per cent of students met basic literacy and numeracy standards. The discrepancy between the NAPLAN test results and the ALLS may be, in part, due to the different age brackets for people tested under NAPLAN (students in years 3, 5, 7 and 9) and the ALLS, which was conducted for persons aged 15–74. More likely, however, is that the NAPLAN tests and the ALLS have different interpretations of the benchmark regarding 'basic' or 'minimum' skill levels.

The COAG Reform Council provides some useful guidance on how to interpret these benchmarks. It states that NAPLAN is designed to measure student performance in meeting the 'minimum standards' of literacy and numeracy, whereas the ALLS measures the proportion of working age Australians with a 'proficient standard' of literacy and numeracy to effectively participate in society (COAG Reform Council 2009, p. 47). Thus, while some students may have only level 1 or level 2 literacy and numeracy in the ALLS, they may still meet the minimum standard of literacy and numeracy under the NAPLAN definition.

Did Australian literacy and numeracy skills increase over the previous decade?

Of the five skills measured in the ALLS (2006), only prose and document literacy are directly comparable with the Survey of Aspects of Literacy (SAL) for 1996. Problem solving and health are new dimensions, while numeracy has been expanded.

There were small, but statistically significant, changes in both prose and document literacy between 1996 and 2006 (ABS 2006). There was a statistically significant decrease in the proportion of people with level 1 prose and document literacy. This corresponded with an increase in the proportion of people with level 2 prose and document literacy between 1996 and 2006.

Level 1 and level 2 are considered to be below the level required to function in daily activities, including work. When looking at skill levels 1 and 2 combined, the proportion of people with low (level 1 or level 2) prose literacy decreased slightly, from 47.4 per cent in 1996 to 46.4 per cent in 2006. Similarly, the proportion of people with level 1 or 2 document literacy decreased from 47.9 per cent in 1996 to 46.8 per cent in 2006.[1]

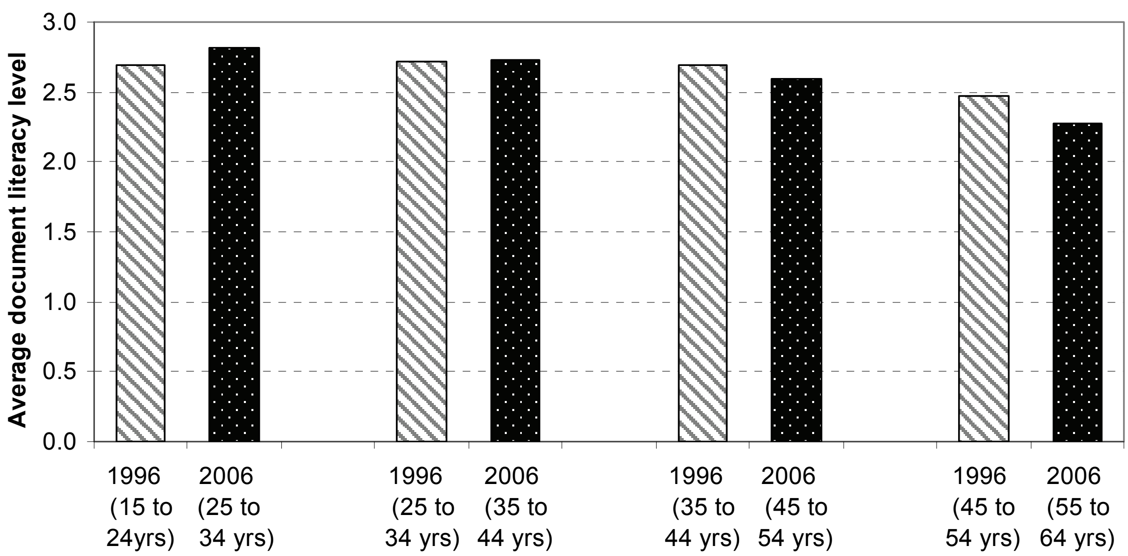
[1] These figures are from the ABS (2006) summary publication, which reported level 1 and level 2 skills separately. It is not known whether the changes are statistically significant.

Although the ALLS and the SAL can be used to examine changes over time, the two surveys are not longitudinal in design (which would require the *same* respondents to be re-interviewed). However, the cohort analysis presented below is a reasonable measure of the change over time in the populations the two surveys represent. To follow how skills of the population have changed over time, a particular age group (spanning 10 years) in 1996 has been compared with a 10-year older age group in 2006.

The synthetic cohort analysis (depicted in figure 3.1), shows that there was lower document literacy for age groups 35–54 in 1996 (who were aged 45–64 in 2006) and higher literacy for those aged 15–24 in 1996 (aged 25–34 in 2006). Determining how skills vary according to age and over time is difficult. Cohort effects and period effects can all influence skill development (Willms and Murray 2007). However, these results give support to a hypothesis of skill depreciation with age and are also consistent with a hypothesis of general skill improvement in the population over time, perhaps because younger people are now undertaking more education. (These are discussed in more detail below.)

Figure 3.1 **Document literacy and age cohorts**

1996 and 2006



Data source: Productivity Commission estimates based on the ALLS (2006) and the SAL (1996).

How did Australia's literacy and numeracy skills compare with other countries?

The ALLS was conducted as part of a wider, international survey (IALS). There are seven countries for which the 2006 Australian data can be compared. Norway had the smallest proportion of people with skill levels 1 or 2 for prose literacy, document literacy and problem solving (table 3.2). Switzerland had the smallest proportion of people with numeracy levels 1 and 2. Italy had the largest proportion of people with skill levels 1 and 2 across all four measures. (Health literacy results are not available.)

Table 3.2 **International comparisons of low literacy**

Per cent of population aged 16–65 with skill levels 1 or 2

Country	*Prose*	*Document*	*Numeracy*	*Problem solving*
Australia	43.5	43.5	49.7	67.8
Bermuda	38.1	46.1	54.1	69.9
Canada	41.9	42.6	49.8	68.5
Italy	79.5	80.6	80.2	90.6
Norway	34.1	32.4	40.2	60.8
Switzerland	52.2	49.0	39.3	66.1
United States	52.6	52.5	58.6	**na**

na not applicable.

Source: ABS (2006).

Australia was ranked fourth on prose literacy, with Norway, Bermuda and Canada having lower rates of prose literacy level 1 or 2. Australia was ranked third on document literacy, with Norway, and Canada having lower rates of document literacy level 1 or 2. For numeracy and problem solving literacy, Australia was ranked third behind Norway and Switzerland.

3.2 How do skills vary across demographic groups?

The analysis above has shown that Australia ranked in the middle compared with the selected countries. However, there were many people deemed to have skills below those required for day-to-day living and working, based on the standard set by the survey designers. This section looks more closely at which groups of people have higher and lower skill levels.

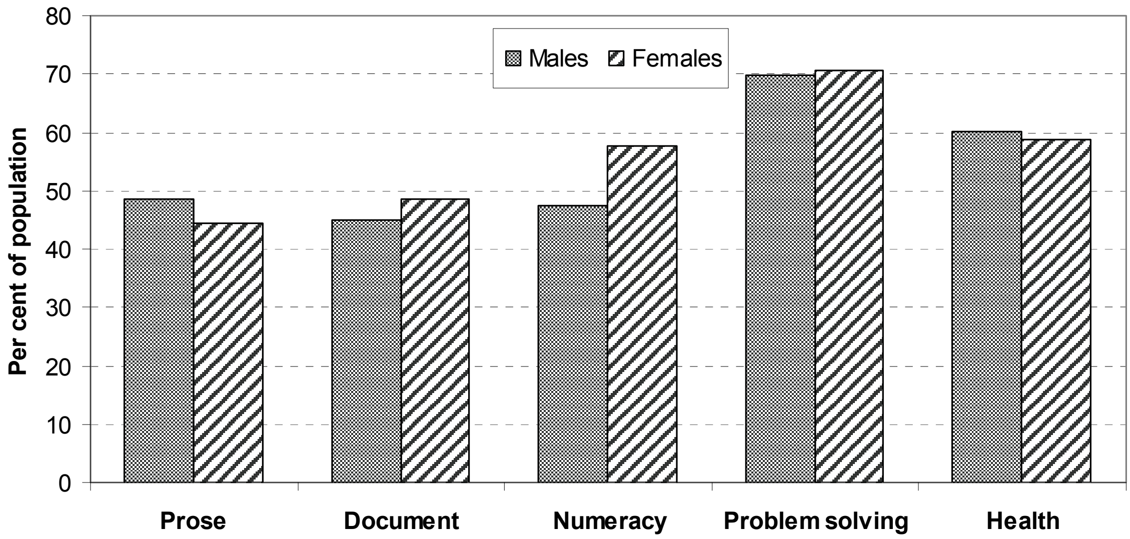
Literacy and numeracy skills vary between men and women

The distribution of people with high and low literacy and numeracy skills varies depending on the particular type of literacy and numeracy being assessed and according to gender. The main differences in particular types of literacy and numeracy between genders (figure 3.2) are:

- females have lower levels of numeracy than males (58 per cent of females were assessed at skill level 1 or 2, compared with 48 per cent for males)
- males have lower prose literacy skills, compared with females
- females have lower levels of document literacy than males.

These differences hold for most age groups (all ages in the case of numeracy) and are consistent with previously observed patterns for other countries (Statistics Canada and OECD, 2005).

Figure 3.2 **Proportion of people with literacy level 1 or 2, by sex**
2006

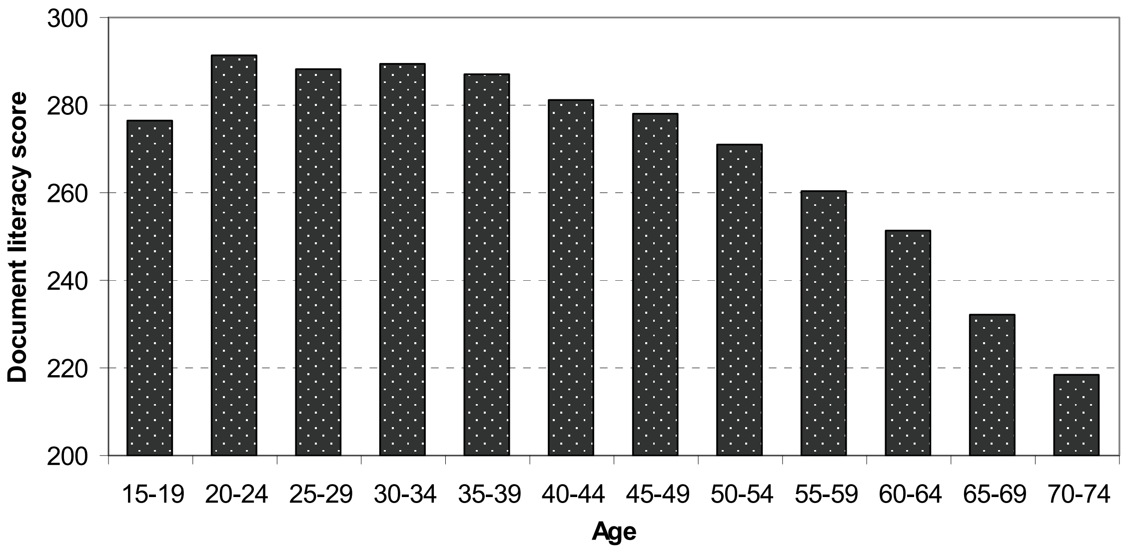


Data source: ABS (2006).

Literacy and numeracy skills decrease with age

Statistics Canada and OECD (2005, p. 43) state ‘Skills can be acquired, developed, maintained and lost over the lifespan, making the relationship between skills and age complex’. At the aggregate level, an examination of skills according to age suggests that skills of older people are lower than younger people. Using document literacy as an example, skills are highest for 20–24 year olds, as indicated in figure 3.3. Skills appear to decrease as people age. This observation also is apparent with other skill types, and occurs across countries.

Figure 3.3 **Document literacy score, by age**



Data source: Productivity Commission estimates based on the ALLS (2006).

A number of possible explanations for this observation are discussed below:

1. Age and up-skilling.

Up-skilling can include formal, and non-formal up-skilling. Formal up-skilling refers to participation in a course that leads towards a certificate, diploma or degree, whereas non-formal up-skilling does not lead towards a certificate, degree or diploma (Satherly and Lawes 2008). As most people undertake formal education until the age of about 20–24, their skills might increase until that age because skill levels increase with higher levels of education. Depending on their literacy engagement after this age, people may maintain, enhance or experience a depreciation in their skills during late and middle age (Willms and Murray 2007). On average, people undertake less formal or non-formal education as they get older, which may explain, in part, the lower skill level of older persons.

2. Labour force withdrawal and skill depreciation.

The pattern of skills decreasing as people age (from about the ages of 40–44 onwards) might reflect that older people withdraw from the labour force and do not actively use their literacy and numeracy skills, thereby lending to a depreciation in them.

3. Cohort effects.

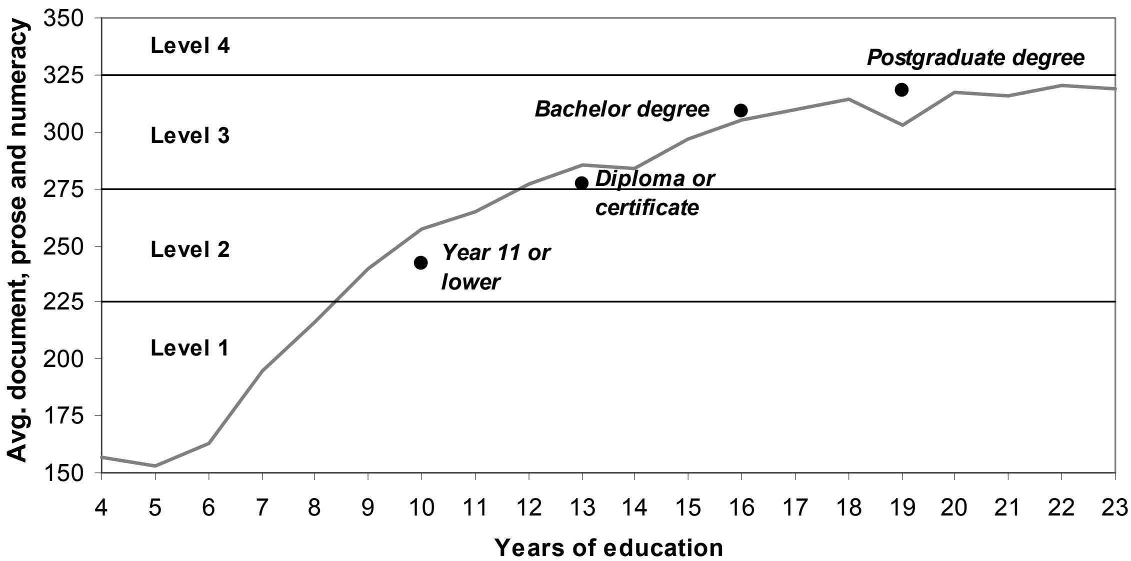
The quality and quantity of education provided to younger people today might be better than it was at the time when older people obtained their education. If this were the case, then it would be expected that younger people would have higher skill levels compared with other people, all else equal. (This is explored in more detail below.)

People with more education have higher literacy and numeracy skills

"In most societies, a principal and widely accepted goal of the educational system is to produce a population able to read, write and count' (Statistics Canada and OECD 2005, p. 60). Therefore, it is not surprising that a large body of empirical research shows that higher educational attainment is associated with higher skills.

Figure 3.4 shows the average literacy and numeracy skills for people in Australia, by years of education undertaken (grey line) and qualification (dot points, with average years to complete). Skills appear to increase with the number of years of education undertaken, but at a decreasing rate.

Figure 3.4 **Literacy and numeracy score[a], by years of formal education and highest qualification**
2006



[a] The literacy and numeracy test score is an average of document, prose, numeracy and problem solving skill indexes. Four years of education includes all people who acquired up to four years of education. 23 years of education indicates people who may have taken 23, or more, years of education.

Data source: Productivity Commission estimates based on the ALLS (2006).

Undertaking more years of education may not improve skills in the same way for all people. Some individuals may take more time to complete a qualification than others (for instance, if they repeat year 12, or if they change courses at university). Higher educational attainment is associated with higher skills. However, people with year 12 or a degree or higher both have, on average, level 3 skills. Undertaking more years of education than required for a degree does not lead to a noticeable increase in skills.

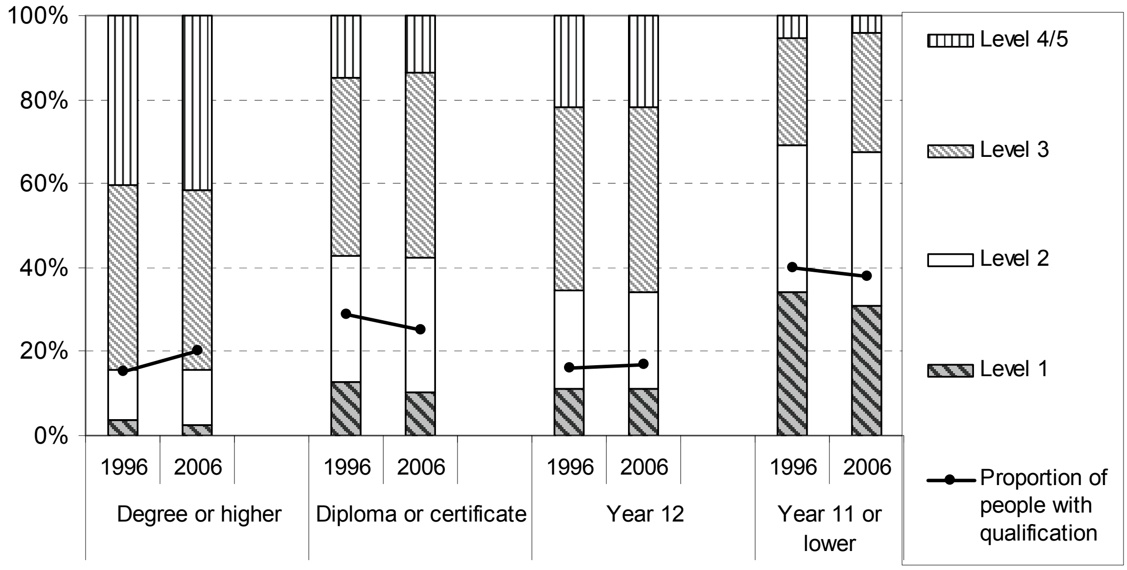
These results might reflect that early years of education (primary and secondary school) primarily serve to improve basic skills needed for day-to-day functioning, whereas higher education (for example, VET or university) is tailored to more vocational or job-specific skills, which do not have a noticeable impact on functional literacy and numeracy.

In this respect, it might also be useful to examine information from the NAPLAN results to develop an understanding of skill deficiencies in the formative years of a person's education. (This, and other areas for further research, are mentioned in chapter 7.)

Returns to education were unchanged in the past decade, but people are more highly qualified

It was mentioned above that an education cohort effect might explain the increase in skills between 1996 and 2006. To examine this, the distribution of document literacy skill levels by qualification, for both 1996 and 2006, is shown in figure 3.5. Higher qualifications are associated with higher skill levels — the proportion of people with level 4 or 5 document literacy is much higher for those with a degree compared with other levels of education.

Figure 3.5 **Distribution of document literacy skills and qualifications**
1996 and 2006



Data source: Productivity Commission estimates based on the ALLS (2006) and the SAL (1996).

For the same qualification, the proportion of people with document literacy above level 2 did not change much between 1996 and 2006. This suggests that any cohort effect from a change in the *quality* of education (between 1996 and 2006) is small. However, there was a shift in the proportion of people with higher levels of education (depicted by the lines in figure 3.5). For example, 20 per cent of the population held a degree in 2006 compared with 15 per cent in 1996. So there is an education cohort effect — an increase in the *quantity* of education taken — that might partly explain the overall increase in skills between 1996 and 2006.

Skills of immigrants compared with Australian born people

A number of overseas studies have shown that skills vary according to country of birth and, for immigrants, vary according to their time of arrival. Satherly, Lawes and Sok (2008) found that, for both the United States and New Zealand, native born people had higher skills than immigrants. In the United States, recently arrived immigrants (those who arrived within five years at the time of the survey) had higher skills than established immigrants (those who arrived more than five years ago), but the opposite was the case for immigrants in New Zealand.

The skills of immigrants by both country of birth and time of arrival can also be explored for Australia using data from the ALLS.

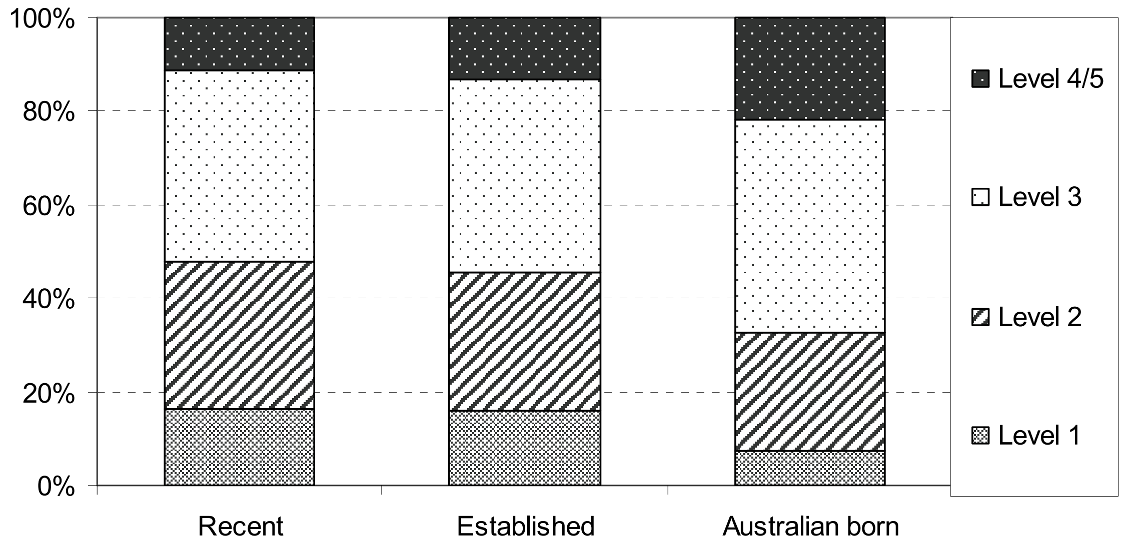
Skills of immigrants do not vary by period of time they have been in Australia

Recent immigrants are, on average, 31 years old, whereas established immigrants are 48 years old. (Australian born people were 40 years old, on average, in 2006). As shown above, there is evidence indicating that older people have lower literacy and numeracy skills than younger people. Therefore, the skills of recent immigrants, established immigrants and Australian born people were compared for only 20–44 year olds. This age group was chosen because, after these ages, skill levels decrease noticeably. The sample size for this group is still large enough to make reliable judgements.

After controlling for age, there is not much difference between the prose literacy skills of recent immigrants and established immigrants (figure 3.6). Thus, the period of time immigrants have spent in Australia does not appear to influence their skill levels. However, compared with the Australian born population, the skills of all immigrants are lower (even after controlling for age).

Figure 3.6 **Prose literacy, by period of time immigrant has been in Australia[a]**

20–44 year olds



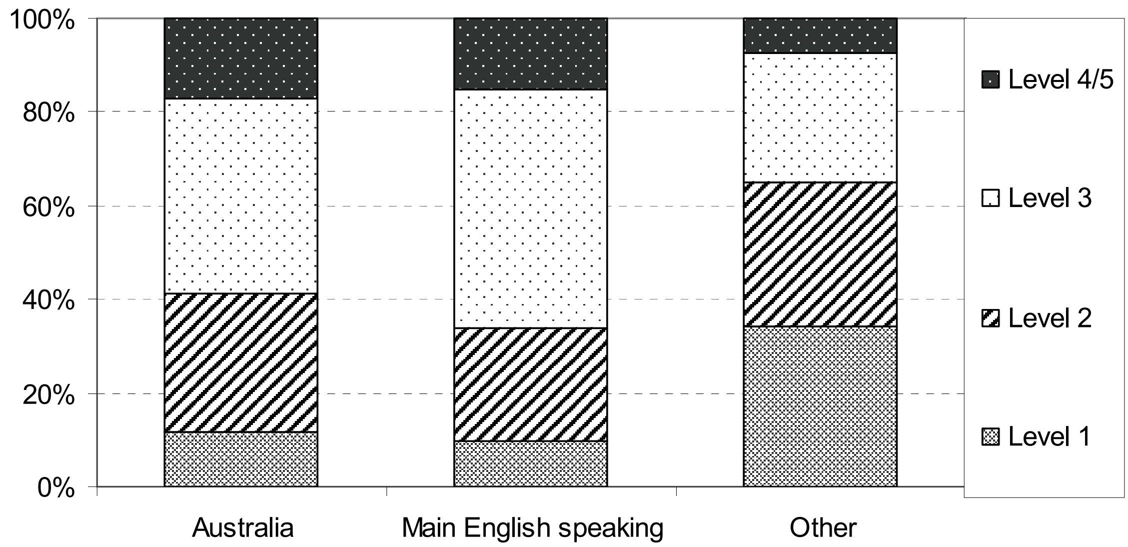
[a] A ‘recent’ immigrant is defined as having arrived in Australia within five years of the date the survey was undertaken, while an ‘established’ immigrant is someone who arrived more than five years from when the survey was undertaken.

Data source: Productivity Commission estimates based on the ALLS (2006).

People born in a non-English speaking country tend to have lower skills

The skills of immigrants vary significantly, according to their country of birth. In particular, immigrants born in countries the ABS defines as a main English speaking country (including the United States, United Kingdom, Canada and South Africa) have much higher average literacy and numeracy skills than immigrants from other (mainly non-English speaking) countries. That is not unexpected, because the tests were conducted in English. The literacy and numeracy skills of immigrants from English speaking countries are higher than those of Australian born people as a whole (figure 3.7). Immigrants from main English speaking countries comprise about 36 per cent of all immigrants.

Figure 3.7 **Prose literacy, by country of birth[a]**



[a] Main English speaking countries are defined by the ABS as the United States, Canada, South Africa, New Zealand, Republic of Ireland and the United Kingdom.

Data source: Productivity Commission estimates based on the ALLS (2006).

Variations in immigrants' skills might be influenced by the quality of schooling in the country of origin. The ALLS also has data on where a person obtained their highest educational qualification.

It was found that people who obtained their qualification from a non-English speaking country tended to have lower skills compared with those with a qualification from an English speaking country. This finding is consistent with a study comparing results from a range of countries for which data were available:

> Education credentials do not necessarily translate into functional levels of literacy, numeracy and problem solving skills in the official language(s) of the host country.

> This is especially the case if the credentials were attained abroad in a language other than that used in the host country. (Statistics Canada and OECD 2005, p. 209)

Having an English speaking background not only affects literacy and numeracy skills, but also labour market outcomes. For example, the Commission (PC 2006b) found earnings of immigrants to be positively related to their English speaking ability, after controlling for factors such as educational attainment. The effect of non-English speaking background on labour market outcomes is explored in more detail in the econometric analysis presented in chapter 6.

4 Literacy and numeracy skills and labour market outcomes

Chapter 3 considered how literacy and numeracy skills vary across different demographic groups. It was shown that some groups had much lower literacy and numeracy skills than others, suggesting there is some potential to raise the skills of those groups of people. This chapter considers the relationship between literacy and numeracy skills and labour market outcomes, to help identify the potential benefits from improving literacy and numeracy. Specifically, the relationship between literacy and numeracy skills and the following labour market outcomes are explored: labour force participation; occupation; and income. It will be shown that people who have higher literacy and numeracy skills generally have much better labour market outcomes than those with lower skills.

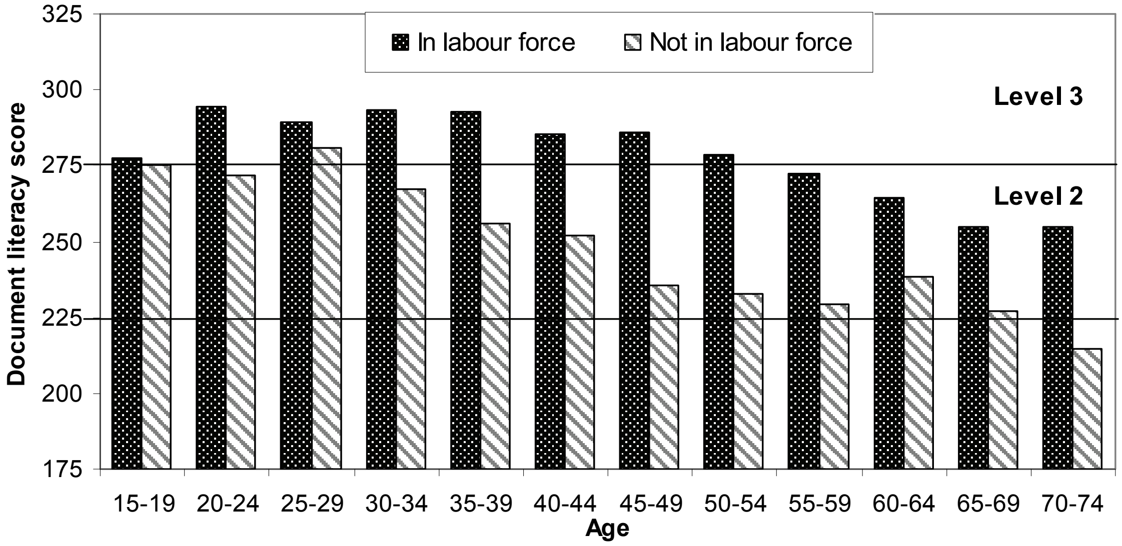
4.1 Literacy and numeracy skills and labour force participation

While participation depends on a range of factors, including the presence of children (Cai 2010), for most people having higher human capital (including literacy and numeracy) will encourage greater labour force participation. People with higher functional literacy and numeracy skills are likely to achieve greater returns from working than lower skilled people. Therefore, the higher people's skills are, the more likely they are to participate in the labour force, all else equal.

For various age groups, the document literacy test score according to labour force status is presented in figure 4.1. (While the results presented in figures 4.1 and 4.2 are for document literacy, a similar pattern emerges for other skill types measured in the ALLS.) A few observations can be made. Those in the labour force have higher document literacy than those who are not in the labour force. This holds across all age groups.

The difference between document literacy of those in and those not in the labour force varies with age — the difference is smaller for younger people (aged less than 30) compared with older people. Labour force participation might affect skills if working utilises and maintains a person's skills. If that were the case, the results might reflect that older people have been out of work for a longer period, so their skills might have decreased compared with younger workers.

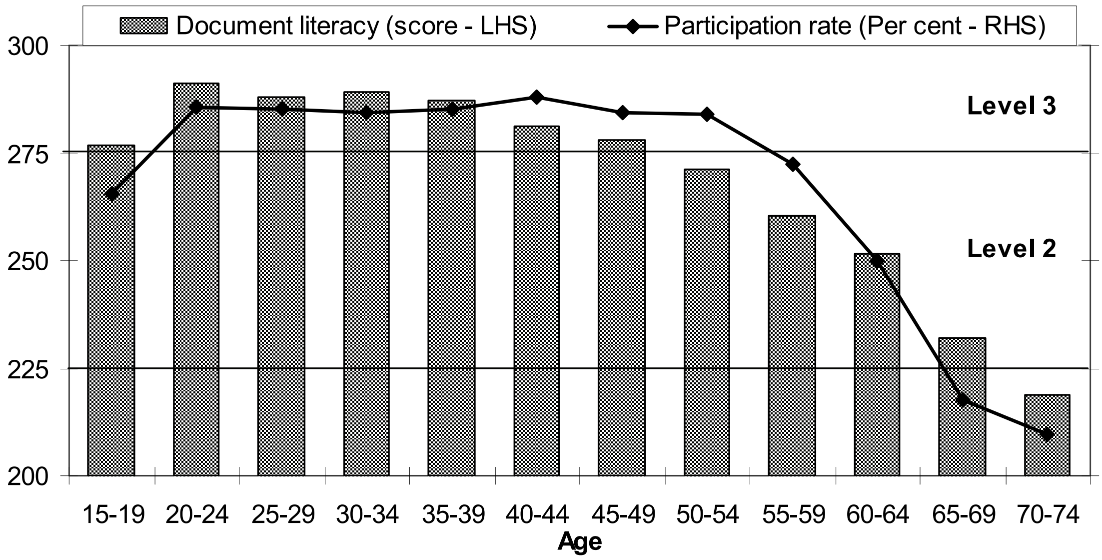
Figure 4.1 **Document literacy score, by labour force status and age**



Data source: Productivity Commission estimates based on the ALLS (2006).

Another way this can be examined is to look at skills and the participation rate. There is a strong correlation between the labour force participation rate and document literacy (figure 4.2). This gives some support to the idea that people's skills decline if they do not participate in the workforce. (However, as shown previously, literacy and numeracy skills decline with age, regardless of labour force status.)

Figure 4.2 **Document literacy, by participation and age**



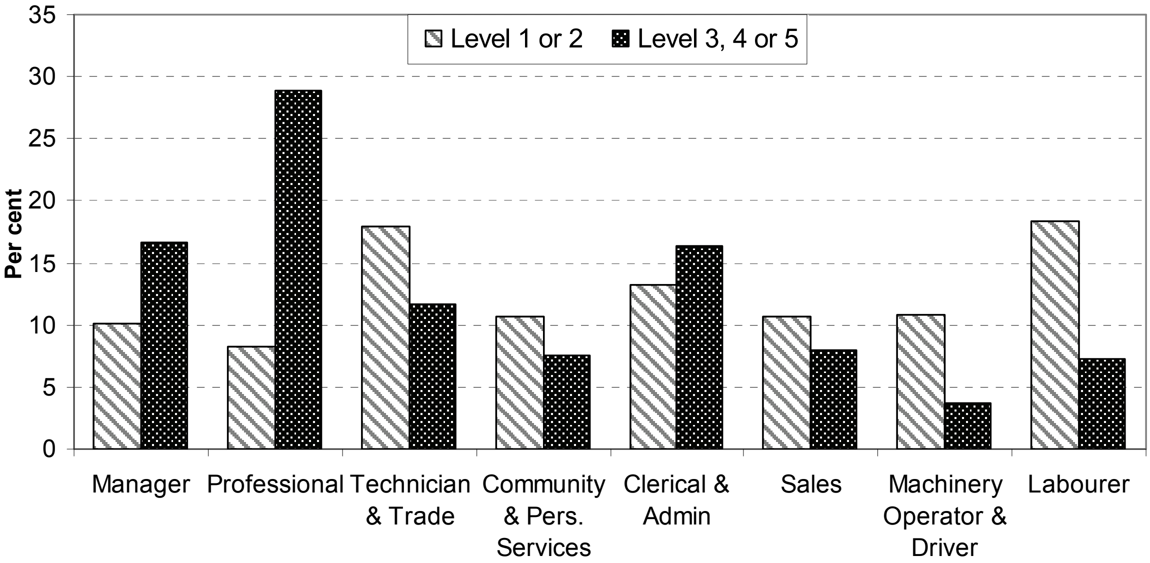
Data source: Productivity Commission estimates based on the ALLS (2006).

4.2 Literacy and numeracy skills and occupation

It would be expected that, all else equal, people who have high literacy and numeracy skills are likely to be employed in professions that require the use of those skills.

Occupational data in the ALLS showed that, for those people with an average document literacy, prose literacy and numeracy skill level of 3 or more, most were employed as professionals, managers, and clerical and administrative workers respectively (figure 4.3). They were least represented as machinery operators/drivers and labourers. Conversely, people with skill level 1 or 2 were most likely to be employed as labourers and technicians/trade workers.

Figure 4.3 **Occupational distribution, by average skill level**[a]

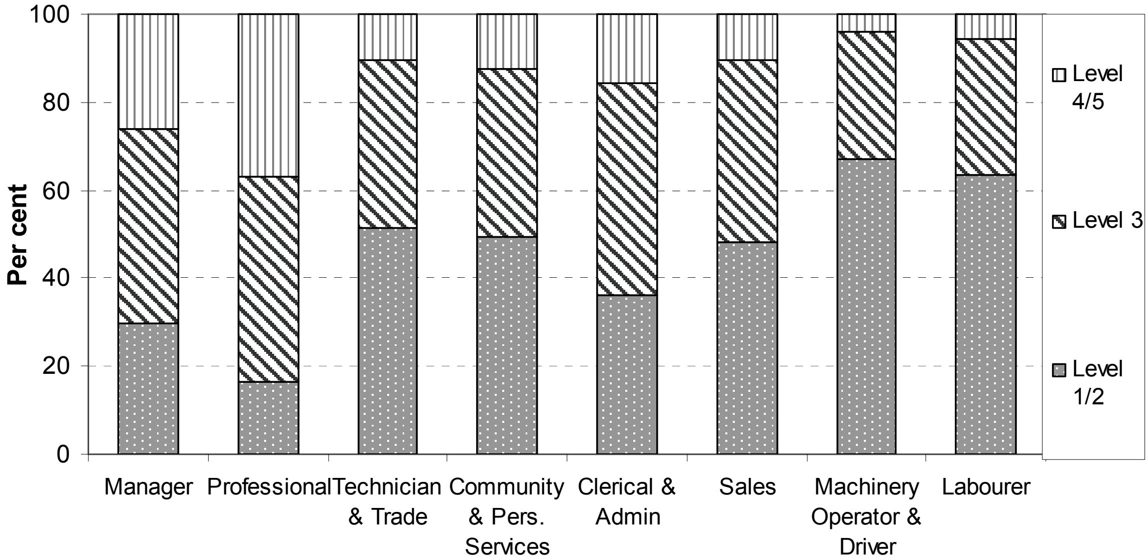


[a] Average skill level is equal to the average test score for document literacy, prose literacy and numeracy (scale 0-500), converted to the equivalent level (as measured by the ABS — see chapter 2).

Data source: Productivity Commission estimates based on the ALLS (2006).

Within each occupation, the proportion of people with average literacy and numeracy skill levels 1 or 2, level 3 and levels 4 or 5 are shown in figure 4.4. Fewer than 30 per cent of managers had low (level 1 or 2) literacy and numeracy skills. In contrast, about two-thirds of machinery operators/drivers and labourers had level 1 or 2 literacy and numeracy skills.

Figure 4.4 **Skill distribution, by occupation**



[a] Average skill level is equal to the average test score for document literacy, prose literacy and numeracy (scale 0-500), converted to the equivalent level (as measured by the ABS — see chapter 2).

Data source: Productivity Commission estimates based on the ALLS (2006).

The ALLS also has information on whether people agree that their reading, writing and maths skills are good enough to perform their job. Using this information, it appears that there is a greater return from improving the literacy and numeracy skills of lower skilled workers than higher skilled workers. For example, about 15 per cent of workers with level 1 numeracy stated that their maths skills were not good enough to do their job (compared with about 5 per cent of workers with skill level 2 and just one per cent of workers with level 3 numeracy). Thus, the economic payoff from improving workers' skills — that is, having a more capable/effective workforce –— would be larger from improving workers' skills from level 1 to level 2 compared with further improvements of relatively high-skilled workers.

4.3 Literacy and numeracy skills and income

Understanding the links between literacy and numeracy skills and income/wages is important, because wages can be used to measure productivity (Forbes, Barker and Turner 2010).

Factors explaining the relationship between literacy and numeracy skills and income

Marks (2008) outlined demand, supply and institutional factors that explain how higher education and skills may lead to higher wages, as discussed below.

Supply-side

Individuals invest in education and training to improve their skills. Employees with higher skills (obtained through education) are expected to be more productive and can earn higher wages than less-skilled workers, all else equal.

Demand-side

Employers may view a person's educational qualification as a signal that a worker is more productive than others, and offer higher wages. As Leigh (2008) notes, if education is merely a credential then it would signal ability, without raising productivity.

Institutional factors

In Australia, many professional and technical occupations have pay rates linked to qualifications. For example, industrial award structures specify that wage rates for workers with certain qualifications are higher than wage rates for unqualified workers.

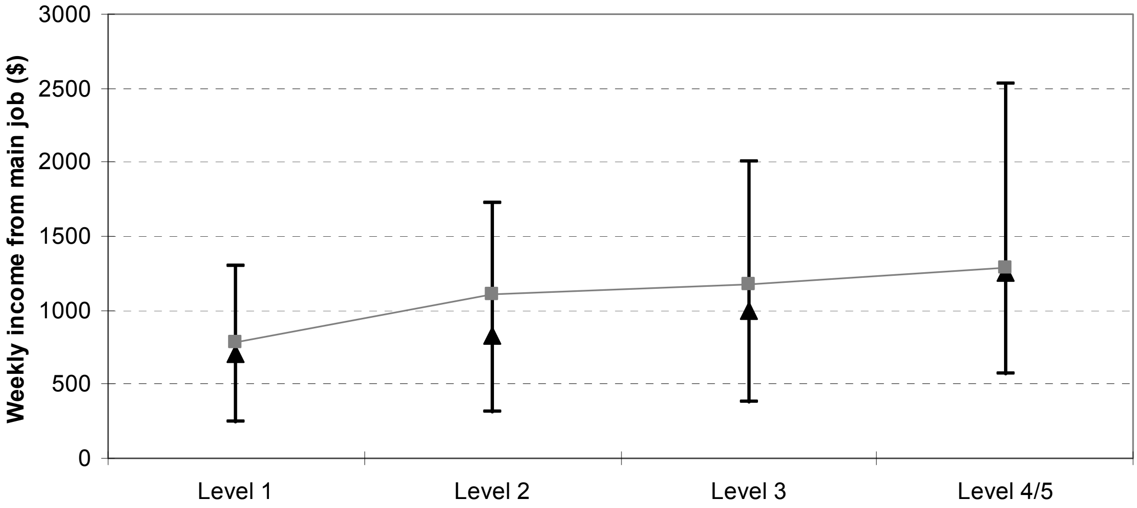
Empirical relationship between literacy and numeracy skills and income

The ALLS data supports the theoretical relationship set out above — people with higher skills earn more than people with lower skills. On average, weekly income is higher for more highly skilled workers (figures 4.5 and 4.6 for men and women, respectively).

For men, there is a larger increase in income from moving from skill level 1 to level 2, compared with increases in income from moving at level 2 to level 3 (or level 3 to level 4/5).

For women, the opposite occurs, with the largest increase in average weekly income occurring in moving from skill level 3 to level 4/5.

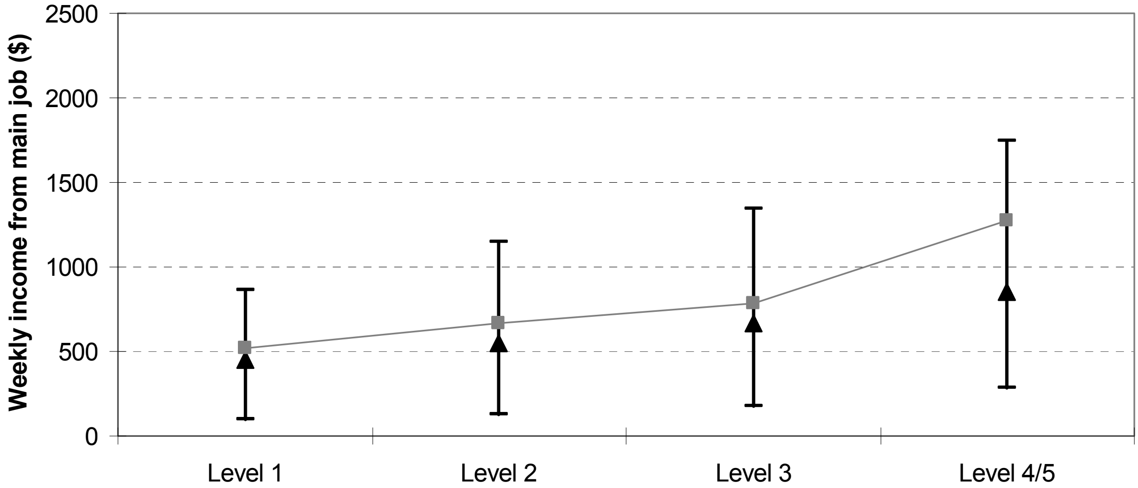
Figure 4.5 **Male weekly income distribution,[a] by average skill level[b]**
15–64 year olds



[a] Average weekly income is shown by the grey squares. Bars show the average income range between the tenth and ninetieth deciles. The triangles are median income points. [b] Average skill level is equal to the average test score for document literacy, prose literacy and numeracy (scale 0-500), converted to the equivalent level (as measured by the ABS — see chapter 2).

Data source: Productivity Commission estimates based on the ALLS (2006).

Figure 4.6 **Female weekly income distribution[a], by average skill level[b]**
15–64 year olds



[a] Average weekly income is shown by the grey squares. The black bars show the average income range between the tenth and ninetieth deciles. The triangles are median income points. [b] Average skill level is equal to the average test score for document literacy, prose literacy and numeracy (scale 0-500), converted to the equivalent level (as measured by the ABS — see chapter 2).

Data source: Productivity Commission estimates based on the ALLS (2006).

However, these results are only for weekly earnings, and do not capture the differing amounts of hours worked by men and women, or hours worked across the skill distribution. The average hourly wage rate for a worker with skill level 1 is about 60 per cent of that earned by a worker with skill level 4/5 (table 4.1). For men, hourly wage rates increase at each skill level, but the largest increase in hourly wages occurs at the higher end of the skill distribution. This is the opposite for women, although the result for skill level 2 should be treated with caution (see note b in table 4.1).

Table 4.1 **Wage rate, by average skill level**[a]

Dollars per hour in main job, 25–64 year olds

	Males	*Females*	*Total*
Level 1	22.13	16.87	19.69
Level 2	24.69	30.71[b]	26.63
Level 3	30.21	26.54	26.82
Level 4/5	36.64	27.51	32.23

[a] Average skill level is equal to the average test score for document literacy, prose literacy and numeracy (scale 0-500), converted to the equivalent level (as measured by the ABS — see chapter 2). Results are survey weighted. [b] Estimate had a very large standard error compared with other estimates, and should be treated with caution.

Source: Productivity Commission estimates based on the ALLS (2006).

5 Econometric method and variable construction

The analysis in chapter 4 highlighted that people with higher literacy and numeracy skills are more likely to participate in the workforce, be employed in more highly skilled jobs and earn more, compared with people who have lower skills.

In chapter 3 it was suggested that people's skills vary according to demographic factors such as country of birth, age, gender and educational attainment. These and other individual characteristics are also likely to affect labour market outcomes, so cross-tabulations (between skills and labour market outcomes) will not accurately predict how much an improvement in literacy and numeracy skills can improve labour market outcomes. In this section of the report, multivariate econometric models are presented which control for demographic factors to estimate the effect of literacy and numeracy skills on the following labour market outcomes:

- labour force participation
- wages.

Following this, a description of the variables used in the econometric analyses is presented. Modelling results are reported in chapter 6.

5.1 Econometric models of labour force participation and wages

Econometric models of labour force participation and wages can help answer the following research questions:

- What is the effect of increasing literacy and numeracy skills on participation/wages, holding other factors (including education) constant?
- Do models of participation that use only proxy measures of skills accurately measure the effect of human capital on participation and wages?
- How important are literacy and numeracy skills, relative to other indicators of human capital (for example, education and labour market experience) in raising labour force participation and wages?

- Does the impact of literacy and numeracy skills on participation or wages vary along different points of the skill distribution, and are there differences between genders?

The framework used in the analysis draws upon approaches used by other researchers including Chiswick, Lee and Miller (2003) for labour force participation and Barrett (2009) for wages. Both of those papers used Australian data, allowing for comparisons with the results in this paper.

Estimating the effect of literacy and numeracy skills on labour force participation

Two models of labour force participation are estimated, using a similar approach to Chiswick, Lee and Miller (2003). In the first instance, a 'traditional' human capital model is estimated. That model assumes that labour force participation is a function of education and potential labour market experience. The model[1] takes the form:

$$LFP = \alpha_0 + \alpha_1 ED + \alpha_2 X + \varepsilon \qquad (1)$$

where: LFP = labour force participation (0 or 1)

ED is a vector of educational attainment variables (section 5.2)

and X is a vector of variables representing factors likely to affect participation (including age, marital status, children — see output in appendix B for full list).

In this specification, education is an indicative measure of a person's skill level. Such an assumption might be valid under the 'formal' or 'abstract' approach to literacy and numeracy, which assumes that years of education is a good measure of a person's skills (chapter 2).

The functional approach to literacy and numeracy — which is consistent with a human capital framework — suggests that literacy and numeracy are only loosely correlated with education. The empirical analysis presented in chapter 3 supported this framework. Education may enhance literacy and numeracy skills, but it may also be important for developing other skills relevant for work — for example, affective skills of cooperation and perseverance (Chiswick, Lee and Miller 2003).

[1] In their analysis, Chiswick, Lee and Miller (2003) used potential labour market experience as a control variable. Age is used here, but in practice both are highly correlated as potential labour market experience is defined as age minus years of education minus 5.

Therefore, estimating the effect of education *and* skills on participation separately gives additional insight that traditional human capital models do not. In particular, inclusion of the skills variable allows us to estimate the:

- effect that education has on participation, after controlling for differences in people's functional skills
- relative importance of the various skills needed in the workplace (for example, functional literacy and numeracy skills and other skills that education provides).

Therefore, a second model of participation is estimated, which explicitly controls for functional literacy and numeracy skills:

$$LFP = \beta_0 + \beta_1 ED + \beta_2 LitNum + \beta_3 X + \varepsilon \qquad (2)$$

where: *LitNum* = Literacy and numeracy skill level (explained in section 5.2).

In this specification, the coefficient β_2 measures the effect of improving literacy and numeracy skills on participation. Education is modelled as having a direct effect on participation (β_1). However, education might also *indirectly* effect participation, if undertaking more education leads to greater skills. Education is likely to improve literacy and numeracy skills, but those skills may also be developed, or enhanced, outside of the school sector. Equation 2 does not distinguish how skills are developed.

The two models above are estimated because important findings can be obtained by comparing results. If education is a good proxy for skills, then inclusion of the skills variable (in equation 2) should not add to the explanatory power of the model. Furthermore, it may cause collinearity problems — either the literacy and numeracy skill variable, or education variable, would not be significant. If, however, literacy and numeracy skills are influenced by education (but they are not the same) then both variables would be significant (in equation 2). The magnitude of the education coefficient would diminish if education influences literacy and numeracy, with education now a measure of the effect from other skills that education provides on the likelihood of participation.

Participation is a binary variable (1 if in the labour force, 0 otherwise). The demographic factors X are based on those commonly found in the literature (see model results in appendix B for those variables used in the analysis, and a description of each variable in appendix A).

Previous research has used logit and probit models to estimate labour force participation. Greene (2008) states that there is no theoretical reason to prefer one model over the other. In the analysis here, the labour force participation equations were estimated with a probit and logit model. Results were very similar, and therefore are reported only for the probit model of labour force participation (presented in chapter 6 and appendix B). The probit model was chosen for consistency — as explained below, it was also used as a first step in some of the wages models estimated.

Ability bias may affect results

A problem commonly identified in the human capital literature 'is that higher ability individuals may systematically choose more schooling, leading to an upward bias in the estimated return to schooling' (Hanushek and Zhang 2006, p. 2). Put another way, models that do not explicitly control for ability may overestimate the return to education — people who undertake more education may choose to do so because they have higher ability than those people who do not undertake education.

The inclusion of a skills measure may partly reduce this ability bias, as people with higher ability are likely to have higher skills. However, as Barrett (2009, p. 6) notes, the literacy and numeracy tests 'drew on cognitive skills typically used in daily activities, hence the emphasis on ALLS measuring *skills* of daily living, rather than underlying abilities or potential'. Insofar as the education and skills variables used in the analysis do not adequately capture a person's innate ability, motivation or potential, then the results may be biased upwards.

There is likely to be some ability bias in the results. People with higher ability are more likely to increase their education which, in turn, is likely to increase their skills more than otherwise. Ability bias can be controlled for by following individuals and their skill development over time. However, because the ALLS data are cross-sectional, they cannot be used to control for underlying ability.[2]

The potential problem of ability bias, in practice, might not have a material effect on the results. Laplagne, Glover and Shomos (2007) used a panel model of labour force participation (which accounts for unobserved factors such as ability) and estimated that having a degree increased the likelihood of participation for females by 20 percentage points compared with a female who only had year 11 or lower education. This compared with a 16 percentage point increase when estimated with a standard model. The differences in model results were smaller when estimated for males, and smaller again when estimated for other qualifications (because the impact of other qualifications on participation is smaller than from having a degree). Therefore, any ability bias present in the data is unlikely to change the qualitative findings.

2 Ability bias may also affect results for the wages model presented below.

Estimating the effect of literacy and numeracy skills on wages

To estimate the effect of literacy and numeracy skills on wages, a model developed by Mincer (1974) is used, where wages are modelled as a function of human capital variables including potential experience in the labour market and education. That model takes the form:

$$\text{Log}(W) = \alpha_0 + \alpha_1 ED + \alpha_2 EXP + \alpha_3 EXP^2 + \alpha_4 X + u \tag{3}$$

where: W is the hourly wage rate

ED is a vector of educational attainment measures

EXP is potential work experience

and X is a vector of variables likely to affect wages (see output results in appendix B for full list).

This model is analogous to equation 1, used to estimate the effect of education on participation. Like that model, equation 3 is then re-estimated to include the effect of functional literacy and numeracy skills:

$$\text{Log}(W) = \beta_0 + \beta_1 ED + \beta_2 LitNum + \beta_3 EXP + \beta_4 EXP^2 + \beta_5 X + u \tag{4}$$

where: $LitNum$ is a measure of literacy and numeracy skills (defined above).

If workers with higher functional skills are likely to earn higher wages regardless of their level of education then in equation 3, which only examines the effect of education and income, the observed effect of education on income will reflect the effect of both education *and* skills (Leigh 2008). Including a variable for functional literacy and numeray skills (equation 4) enables the effect of these skills to be estimated separately from education. Therefore, the addition of the skills variable is expected to reduce the coefficient for education (because skills are now modelled separately).

Sample selection bias and the Heckman model

Sample selection bias can arise if the group of observations for which a model is estimated is not taken from a random sample. In the wages model, the hourly wage rate is the dependent variable. However, wage rates are only observed for people who are employed. As people who are employed tend to have characteristics different to those who are not in the labour force or unemployed, excluding these groups results in a non-random sample being used, which may bias results.

A large literature has evolved to address this potential problem, and a common approach is to run a two-step model, first developed by Heckman (1979).

Conceptually, a 'selection equation' is first estimated for labour force participation, which has a binary outcome (1 or 0). An 'inverse Mills' ratio is estimated from this equation, and incorporated into a second equation — the earnings equation — as a correction term. A 'selection effect' is present if the two error terms from each equation are correlated. By including the correction term, coefficients are adjusted to take account of the selection effect.

In this paper, wage models were first estimated using ordinary least squares (OLS) on the sample of employed persons only. Next, Heckman models were used to estimate a selection equation (on all persons), and a wage equation (for employed persons). The selection equation uses a probit model specification for labour force participation. Although results showed no evidence of a sample selection error, the Heckman model results are presented in chapter 6 as the preferred estimates. For completeness, both the Heckman and standard OLS model results are presented in full (appendix B). The model results were very similar between the OLS and Heckman models.

5.2 Variables used in the analysis

This section describes how the main variables of interest used in the analysis were constructed. Appendix A contains a full list of variables used in all models, including their mean and standard deviations.

Labour force participation

Participation is treated as a binary variable, taking the value 1 for persons in the labour force (employed and unemployed persons) and 0 otherwise.

Wages

Wages are estimated using a measure of the hourly wage rate. The hourly wage rate is defined as weekly income divided by number of hours worked per week.

There are two income measures in the survey data that can be used. One is income from all sources (including government allowances). Another is based on income from a person's main job only. Similarly, hours worked are reported for a person's main job only, and for all jobs. In the analysis, the hourly wage rate is obtained using the income and hours data pertaining to a person's main job only.

Explanatory variables

Explanatory variables are those commonly found in the labour supply literature. Only the human capital variables are described in detail below, as it is the effect of those variables on participation and wages that is the primary focus of this paper.

Literacy and numeracy skills

There are five different skills formally tested for in the ALLS. In addition, there are subjective measures of skills, but these were not used in the analysis (chapter 2).

There are two broad approaches to account for skills in the modelling.

First, a separate variable could be included for various skills (for example, document literacy, prose literacy, and numeracy test scores). However, there is a strong correlation between each skill variable (table 2.1) and there may be collinearity problems if all are included. In their analysis, Chiswick, Lee and Miller (2003) found that only one or two variables were needed to obtain most of the model's explanatory power. A problem with that approach, however, is that it is difficult to determine which skill(s) should be included and which should not.

A second approach is to construct an index of literacy and numeracy skills by combining the measures that are in the survey. A disadvantage with this approach is that combining the variables makes it difficult to isolate the effect of numeracy from, say, prose literacy on labour market outcomes.

The aim of this paper is to identify the effect of overall functional literacy and numeracy skills on labour market outcomes, and not necessarily the effect of particular components within these functional skills. Therefore, the second approach is the one chosen in the analysis. This method has also been used by others (Barrett 2009; Green and Riddell 2001; Hanushek and Zhang 2006), primarily because the skills are highly correlated with each other.

A single skill variable capturing a person's literacy and numeracy skills was constructed as follows:

1. The principal component of the document literacy, prose literacy and numeracy test scores (0–500) was estimated. The indicator of problem solving skill was not included in estimation as it is not a measure of functional literacy or numeracy.

Furthermore, it is only aggregated to four levels, so it cannot be converted into a skill level 1 to 5 in the same way the other variables are assigned a skill level (see point 4 below).

2. The first principal component (which accounted for about 96 per cent of variation and had almost equal weights for each of the three test scores) was used to weight each of the three skills above (see table 5.1 for principal component analysis). The second and third principal components were not used, as their additional explanatory power was negligible, and the different signs on the weights made their interpretation difficult.
3. The resulting test score was re-indexed to a scale of one to 500, by dividing the aggregate test score by the sum of the principal component weights.
4. The test score was converted into five categorical levels, using the same interval points as in the ABS survey.
5. The following binary variables were also created:
   (a) Skill level 2 = 1 if skill level 2, 0 otherwise
   (b) Skill level 3 = 1 if skill level 3, 0 otherwise
   (c) Skill level 4/5 = 1 if skill level 4 or 5, 0 otherwise

Table 5.1 **Principal component analysis for skills variable**

Type of literacy	*Component 1*	*Component 2*	*Component 3*	*Proportion explained*	*Cumulative*
Document literacy	0.5818	-0.2618	-0.7701	0.9604	0.9604
Prose literacy	0.5721	0.8047	0.1586	0.0289	0.9894
Numeracy	0.5782	-0.5328	0.6179	0.0106	1.0000

Source: Productivity Commission estimates based on the ALLS (2006).

In each model that was estimated, either the continuous literacy and numeracy measure (defined in point 3) was used, or the binary variables (defined in point 5) were used. The continuous measure has the benefit of providing more data points, while the skill levels approach provides a more meaningful interpretation of what is being estimated. For example, with only skill level 1 excluded from the model, the coefficient for skill level 3 estimates the effect of increasing functional literacy and numeracy skills from level 1 (representing a person with the lowest level of literacy/numeracy) to level 3 — the minimum level required for a person to effectively participate in the workforce.

The preferred approach in the analysis, and presented in chapter 6, was to use the skill level variables. (However, full estimation output using a continuous skill variable can also be found in appendix B.) The resulting vector of skill variables (defined as *LitNum* in section 5.1) should be interpreted as measuring overall functional literacy and numeracy (as defined in chapter 2). Barrett (2009) and others have also said that this variable can be interpreted as measuring cognitive skills.

Education

Four categories of educational attainment were used: Year 11 or lower; Year 12; Diploma or Certificate; and Degree or higher. These were aggregated from more detailed levels of education reported in the survey (table 5.2). Years of education was not used because, as discussed above and in other studies, the time taken to complete a course of study can vary significantly among individuals.

Year 11 or lower is the benchmark from which the effects of the other three categories of highest education level were estimated and compared. As such, Year 11 or lower does not appear in the modelling results presented in chapter 6.

Table 5.2 **Educational attainment variables used in the modelling**

Survey data response	*Aggregated educational level of attainment*
Postgraduate degree	Degree or higher
Graduate Diploma/Graduate Certificate	Degree or higher
Bachelor Degree	Degree or higher
Advanced Diploma/Diploma	Diploma/Certificate
Certificate III/IV	Diploma/Certificate
Certificate I/II	Year 11 or lower
Certificate not further defined	Year 11 or lower
Year 12	Year 12
Year 11	Year 11 or lower
Year 10	Year 11 or lower
Year 9	Year 11 or lower
Year 8 or below including never attended school	Year 11 or lower

Source: Based on the ALLS (2006).

The particular education levels were chosen because they were also used to analyse the effects of education (and health) on labour force participation by Laplagne, Glover and Shomos (2007) and on wages by Forbes, Barker and Turner (2010). Therefore, modelling results can be compared with the results from those papers.

5.3 Estimation sample

Each model was estimated separately for males and females. This was done for a number of reasons. The decision to participate is likely to vary according to sex —

females typically work less after the birth of a child. Thus, the impact of some variables on participation and wages is likely to differ for men and women.

In particular, the effect of education on the likelihood of participation and on wages has been shown to vary in its magnitude for men and women (Laplagne, Glover and Shomos 2007; Forbes, Barker and Turner 2010). Thus, for the variables of interest in this analysis — education and literacy — it is useful to examine their effects on men and women separately.

The sample was restricted to 25–64 year olds. Educational attainment is a variable of interest, and was estimated using indicators for highest level of educational attainment a person has completed. As many people under 25 might not have completed their highest level of education (Leigh 2008), they were excluded from the analysis. Similarly, people aged 65 and over were excluded as the majority of that group would have reached pensionable age.

Unweighted data were used in estimation. Models were estimated with Stata, and processed using the ABS's Remote Access Data Laboratory (RADL).

In the next chapter, results from the econometric models above are presented. (Full estimation output is in appendix B.)

6 Modelling results

In this section of the paper, econometric results for the models of labour force participation and wages are presented. The focus of the results is for the marginal effects of education and literacy and numeracy skills on labour force participation and wages. Full estimation output (including coefficients and marginal effects for all variables) is in appendix B.

6.1 Labour force participation results

Section 5.1 set out two models of labour force participation — one which included literacy and numeracy skills (equation 2) and one which did not include those skills (equation 1). Econometric results from those models are presented below. As explained in chapter 5, the literacy and numeracy variable should be interpreted as measuring people's overall functional literacy and numeracy skills — not a specific type of literacy or numeracy.

Effects of education for different model specifications

The marginal effects[1] of educational attainment for equation 1 (does not control for literacy and numeracy skills) are presented in table 6.1.

Table 6.1 **Marginal effects of education[a] on participation in different model structures**

	Men		*Women*	
Explanatory variable	*Education only (Equation 1)*	*With skills (Equation 2)*	*Education only (Equation 1)*	*With skills (Equation 2)*
Year 12	1.56	-0.01	8.13***	5.65***
Diploma/Cert	4.07***	2.93***	13.08***	10.53***
Degree	5.20***	2.78**	19.11***	14.90***

[a] Education levels are compared with a base level of year 11 or lower educational attainment.

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Tables B.1 and B.2.

[1] All marginal effect estimates are calculated at the mean of the variable under consideration.

Those results are of the expected sign, and consistent with other studies. The marginal effects on participation from having a degree relative to having year 11 or lower education were estimated to be 5.2 percentage points and 19.1 percentage points for men and women respectively. These compare with results from a multinomial logit model estimated by Laplagne, Glover and Shomos (2007) of 8.6 percentage points and 19.7 percentage points for men and women respectively.

As explained in chapter 5, if education and skills are synonymous (equation 1), then there would be collinearity problems when equation 2 is estimated — either the skills or the education variables may be insignificant. Table 6.1 shows the marginal effects for educational attainment when skills are included in the model (equation 2). Compared with results from equation 1, it can be seen that marginal effects are reduced by about one quarter when skills are included. These results imply that a 'traditional' model of human capital, which uses education only to proxy skills, might overestimate the direct effect of education on participation. Put another way, about one quarter of the effect education has on participation (in traditional human capital models) occurs because the more highly educated are also more highly skilled. (Education may improve literacy and numeracy skills, but those skills can also be obtained from other means. The model does not examine the factors affecting skills.)

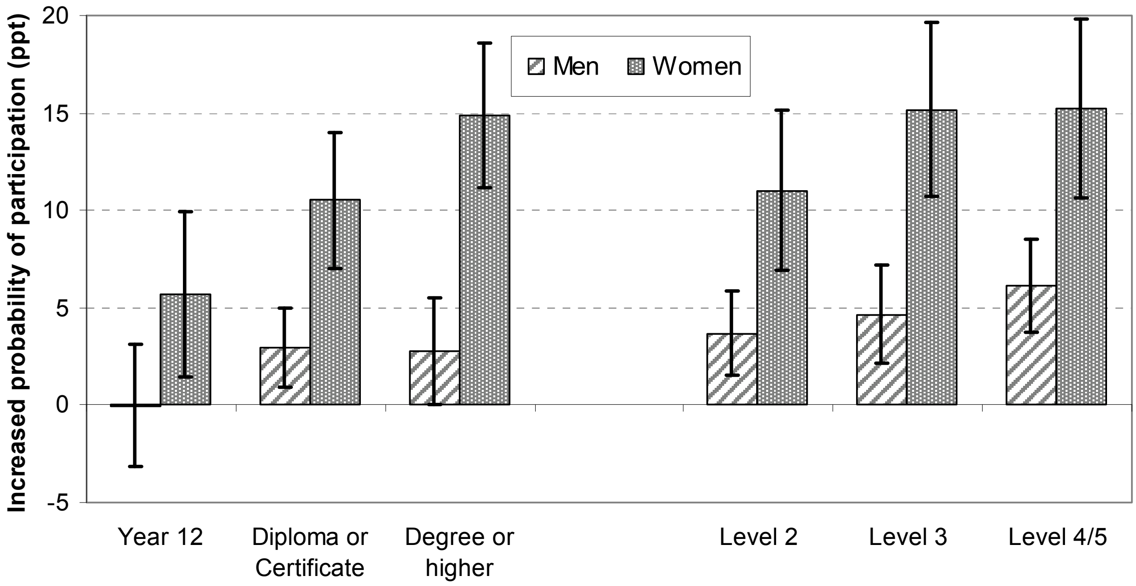
As will be shown below, the marginal effects for all of the skills variables (and most of the education variables) are statistically significant in equation 2. Furthermore, the explanatory power of the model was improved (by about 1 percentage point, for both men and women) when the functional literacy and numeracy skills variable was included in estimation. Therefore, a model which assumes that education may *enhance* functional literacy and numeracy, but is not a direct substitute for those skills, is the more appropriate specification.

Effects of literacy and numeracy skills on participation

In the analysis below, the focus turns to how skills affect participation, so results are presented only for equation 2. Figure 6.1 presents the marginal effects of skills (and educational attainment) on labour force participation.

Figure 6.1 **Marginal effects of education and skills on participation**

Educational attainment relative to year 11 or lower, literacy and numeracy skills relative to level 1[a]



[a] Bars show the 95 per cent confidence interval for the marginal effects, which were calculated at the mean. If, for a given variable, the bars overlap, then those estimates are not statistically different at the 5 per cent level of confidence. If a bar reaches the horizontal axis, that marginal effect is not statistically significant at the 5 per cent level of confidence.

Data source: Tables B.1 and B.2.

The following observations regarding literacy and numeracy skills can be made:

- Improving functional literacy and numeracy from level 1 to level 2 or above has a positive, and statistically significant, impact on labour force participation, for both men and women.
- The increase in participation that occurs from improving these skills is greater for women than for men (consistent with the effects of greater education, and likely to occur because of the higher participation rate for men).
- There is only weak evidence that the effect (on participation) from an improvement in literacy and numeracy skills varies along the skill distribution, with differences between genders.
  - For women an increase in skills from level 1 to level 2 raises participation by 11 percentage points. Raising skills from level 1 to level 3 (or level 4/5) raises participation by about 15 percentage points. Thus, the largest *additional* increase in participation occurs from improving lower skilled

workers' functional literacy and numeracy.[2] (Note, however, that the marginal effect of increasing skills from level 1 to level 2 is not statistically different than from increasing skills from level 1 to level 3).

– For men, an improvement in skills from level 1 to level 2 raises participation by almost 4 percentage points, and from level 1 to level 4/5 raises participation by about 6 percentage points. So, there is a more even effect on participation from improving skills along the distribution for men than there is for women.

Compared with raising educational attainment, improving people's skills leads to a relatively large increase in participation. For example, raising skills from level 1 to level 2 has a larger effect on participation than from increasing educational attainment from year 11 or lower to year 12 or a diploma/certificate (and a larger effect than from raising educational attainment to a degree for men). To put that into context, the time taken to complete a degree or higher is roughly seven years longer than the time taken to complete year 11 or lower (figure 3.4).

The joint effect from improving education and improving literacy and numeracy skills was not formally estimated in the models (this would require an interactive term for education and skills to be included). However, the results indicate that having higher education *and* greater literacy and numeracy skills is likely to lead to the largest increases in participation. For example, if a person has low skills and low education, then increasing education increases the likelihood of participation. The likelihood of participating is increased further if the person also increases his or her literacy and numeracy skills. It is likely that education does improve skills, so the cumulative effect of increasing education is likely to be greater than the predicted estimate for education alone.

The effects of education and skills were robust to different model specifications. For example, years of education was used as an alternative to educational attainment, and the continuous literacy/numeracy skill test score (0–500) was used in other variations of the models presented here. The key results did not change. In particular, the effect of improving skills on participation was stronger for women than for men, and statistically significant across all models.

Results for literacy and numeracy skills are also consistent with other studies. Chiswick, Lee and Miller (2003) found that document literacy and (self-assessed)

[2] Strictly speaking, the effect on participation from increasing skills from level 3 to level 4/5 is not the difference between the marginal effects of skill levels 3 and 4/5 presented in figure 6.1. That would require re-estimating the model with level 3 as the base skill level. Alternative models, with different skill level bases, were estimated for comparison and gave similar results to the differences in marginal effects between skill levels above.

mathematical ability both had a positive and statistically significant effect on participation, using 1996 Australian data. They also found the direct effect of education to be overestimated (by up to 50 per cent) if skills are not controlled for.

Other results

A number of other explanatory variables were included in the estimation. This section briefly reports some of those results (appendix B contains full estimation output).

In chapter 3, it was shown that skills vary according to country of birth. The models estimated include explanatory variables for being born in either a main English speaking country, or a non-English speaking[3] country, relative to being born in Australia. Being born in a non-English speaking country had a negative effect on female participation (it reduced the likelihood of participation by 10 percentage points in equation 1). However, the negative effect reduced markedly once skills were controlled for (to minus 5 percentage points in equation 2). These results demonstrate that the negative effect on participation from being born in a non-English speaking country is overestimated in ‘traditional’ models (which do not include skills). It is the lower literacy and numeracy skills that people from a non-English speaking background have that, in part, explains their lower participation.

Most of the other explanatory variables were statistically significant, and of the expected sign. Being married and having at least one child aged 0–4 or 5–14 had a negative effect on female participation. Mothers are more likely to spend time out of the labour force to care for younger children rather than older children, because looking after younger children is more time-intensive (Birch 2005). Recent empirical research for Australia (Cai 2010) also supports this theory. High levels of physical and mental health both had a positive effect on participation, for both men and women, consistent with results from previous Commission research (Laplagne, Glover and Shomos 2007).

6.2 Wages model results

In this section, results from the wages models are presented. As was done for the participation models, the effects of education in both wages models are presented first, before the focus turns to the effect of literacy and numeracy skills on wages.

[3] Some countries included in this definition may be English speaking. However, the vast majority of countries are non-English speaking.

Effects of education for different model specifications

Marginal effects of educational attainment on wages are presented in table 6.2. Based on equation 3, it was found that improving educational attainment had a large, statistically significant effect on wages. For example, increasing education from year 11 or lower to a degree increased hourly wages by about 60 per cent. This is larger than other estimates in the literature, although the marginal effect from increasing education from year 11 or lower to year 12 or a diploma/certificate was much smaller (between 11 and 18 per cent). All education effects were statistically significant.

The estimated marginal effects for educational attainment for equation 4 (controlling for skills) were lower than those that were obtained for equation 3 (table 6.2). This pattern is the same which occurred for the labour force participation model. The estimated marginal effects for education were reduced by about half for men, and by a lesser amount for women.

The effect of increasing schooling to year 12 (relative to year 11 or lower) was not statistically significant in equation 4. That is, raising education from year 11 to year 12 is not predicted to have any effect on hourly wages (unless skills are also improved by undertaking that education).

Table 6.2 **Marginal effects of education[a] on hourly wages in different model structures**

	Men		*Women*	
Explanatory variable	*Education only (Equation 3)*	*With skills (Equation 4)*	*Education only (Equation 3)*	*With skills (Equation 4)*
Degree	59.58***	34.21***	61.05***	49.42***
Diploma/Cert	17.65***	9.77***	13.76***	10.28**
Year 12	15.35***	5.18	10.97**	7.24

a Marginal effects measure the percentage increase in hourly wages from increasing education from year 11 or lower to the education levels estimated.

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Table B.9.

Therefore, like the participation model, wage models which only use education may overstate the direct effect of education on hourly wages. Some of the expected increase in hourly wages occurs because more highly educated people also have higher literacy and numeracy skills.

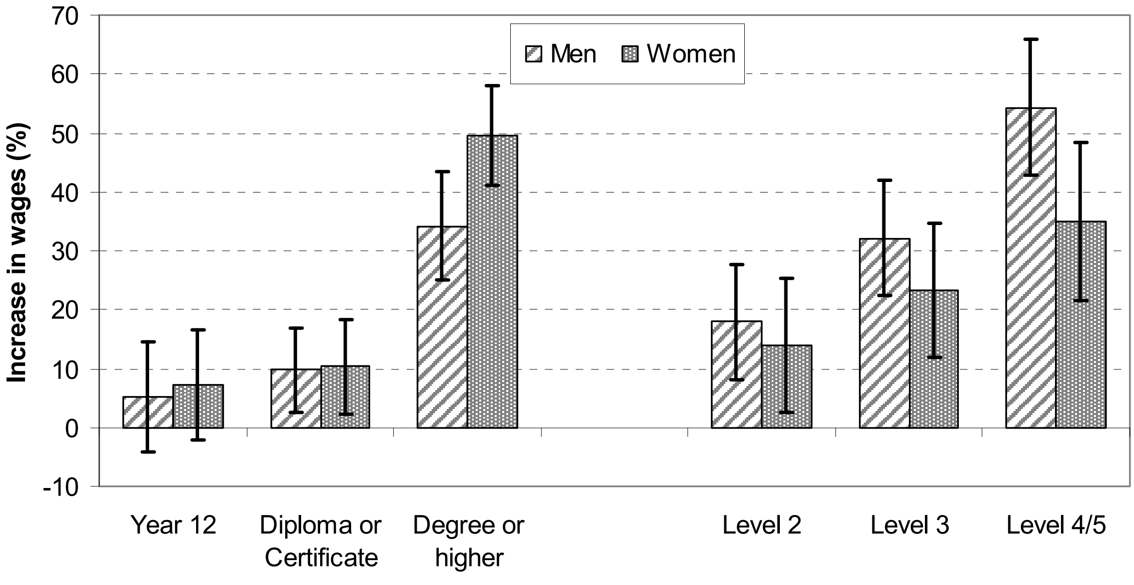
Like the participation model above, ability bias might also affect the results presented for the wages models. A number of studies have attempted to address this issue. Data on twins has been used by Ashenfelter and Kreuger (1994) for the United States and Miller, Mulvey and Martin (1995) for Australia. Those studies 'reveal that there is little evidence of upward bias in the typical OLS estimate of the return to education' (Miller, Mulvey and Martin 1995, p. 597). This arises because any upward bias is largely offset by measurement error, which has a downward bias on results.

More recently, Leigh and Ryan (2008) estimated returns to education using various natural experiment techniques to control for ability bias. Their returns to education were higher than from studies using twins, and the authors attribute this to having better measures of income and schooling. Their results suggest that about 10 to 40 per cent of the return to schooling in standard OLS regressions may be due to ability bias.

Effects of literacy and numeracy skills on wages

Equation 4 models the effects of both education, and literacy and numeracy skills, on wages. Marginal effects are presented in figure 6.2.

Figure 6.2 **Marginal effects of education and skills on wages**
Educational attainment relative to year 11 or lower, literacy and numeracy skills relative to level 1[a]



[a] Bars show the 95 per cent confidence interval for the marginal effects, which were calculated at the mean. If, for a given variable, the bars overlap, then those estimates are not statistically different at the 5 per cent level of confidence. If a bar reaches the horizontal axis, that marginal effect is not statistically significant at the 5 per cent level of confidence.

Data source: Table B.9.

The following observations regarding the effect of improving functional literacy and numeracy skills on wages can be made:

- Increasing skills from level 1 to level 2 or above had a positive and statistically significant effect on wages, for both men and women.
- Increasing skills has a larger impact on returns to wages for men compared with women. This is in contrast to the effect that skills had on the likelihood of participation for men and women.
- The effect of increasing skills on wages varies more along the skill distribution for men than it does for women.[4]
  - For men, increasing skills from level 1 to level 3 increases wages by 32 per cent, (14 percentage points more than from increasing skills from level 1 to level 2). However, an increase in skills from level 1 to level 4 or 5 raises wages by 54 per cent (a difference of 22 percentage points compared with raising skills from level 1 to level 3). Furthermore, the increase in wages from increasing skills from level 1 to level 2 is significantly different than from increasing skills to level 4 or level 5.
  - For women, the additional increase in wages is roughly 10 per cent from increasing skills from level 1 to level 2, compared with increasing skills from level 1 to level 3. The additional increase from improving skills to level 4 or 5 (compared with level 3) is also about 10 per cent. Furthermore, there is no statistical difference from improving skills from level 1 to level 2 compared with increasing them to any other level.

Results were robust to various model specifications (for example, when literacy and numeracy was estimated as a continuous variable).

In a similar analysis using the ALLS data, Barrett (2009) considered how the returns to skills vary along different points of the wage distribution. He found that the return to skills is uniform across the wage distribution.

Finnie and Meng (2007) found that not only do skills benefit individuals at the top and bottom ends of the labour market, but that the effect of literacy and numeracy skills on labour market success is just as important as education. 'Indeed, in some cases, the effects of functional literacy appear to be substantially greater than the number of years of education' (Finnie and Meng 2007, p. 10). Likewise, the model

[4] Strictly speaking, the effect on wages from increasing skills from level 3 to level 4/5 is not the difference between the marginal effects of skill levels 3 and 4/5 presented in figure 6.2. That would require re-estimating the model with level 3 as the base skill level. However, alternative models, with different skill level bases, were also estimated for comparison and gave similar results to the differences in marginal effects between skill levels above.

results above suggest that improving skills has a larger impact on wages than improving education, particularly for men. For men, increasing skills from level 1 to level 4/5 has a larger effect on wages than from increasing education from year 11 to any of the other higher levels of educational attainment modelled. Even smaller improvements in skills for men (from level 1 to 2) have twice the impact on wages than from increasing educational attainment from year 11 to year 12 or to a diploma/certificate (although differences are not statistically different from one another). For women, increasing educational attainment to a degree or higher (from year 11 or lower) had a larger effect than improving literacy and numeracy skills. This could reflect that education acts as a stronger signalling device (of motivation or expectations at work) for women, compared with men.

Other model results

Potential labour market experience was included as a control variable in the wages equations. The results for equation 3 show that additional years of experience increase hourly wages, but at a decreasing rate (see appendix B for results). The magnitude of the effect of the experience variables was largely unaffected by including the skills variable (in equation 4), consistent with other results for Australia (Barrett 2009) and results for Canada (Green and Riddell 2002). This indicates that work experience might not improve literacy and numeracy skills. Descriptive analysis in chapters 3 and 4 suggested that literacy and numeracy skills might deteriorate once a person exits the workforce. Therefore, it may be the case that literacy and numeracy skills are developed prior to entering the workforce, but are maintained (and not enhanced) by using them in the workplace. They may deteriorate after leaving work, or may deteriorate due to other factors. This would be a useful area to explore in future research.

Being born in a non-English speaking country was estimated to have a negative impact on wages. However, as in the participation model, once literacy and numeracy skills were controlled for, the negative effect was lessened (by about 25–50 per cent, depending on sex). Again, this highlights that human capital models which do not explicitly control for skills overstate the effect of being born in a non-English speaking country — some of the effect occurs because this group has lower (English) literacy and numeracy skills.

Most other explanatory variables are of the expected sign. Of those that are statistically significant, better mental or physical health, residing in the city, and being married (for men only) had a positive impact on hourly wage rates.

Working part-time had a negative impact on wages of men and a positive impact for women, but was not statistically significant in either case. In contrast, a recent study of the Australian labour market showed that there was a wage premium from working part-time for both men and women (Booth and Wood 2008).

6.3 Summary of modelling results

The econometric modelling results in this chapter have highlighted that improving functional literacy and numeracy skills has a large and statistically significant effect on labour force participation and hourly wages.

The estimated benefits of education, after controlling for functional skills, were reduced but still significant. Thus, education develops other skills used in the workplace, and may act as a signal to employers that people with higher education have higher human capital.

The above findings suggest that both educational qualifications and functional skills are valued in the labour force. The modelling did not formally estimate the impact of factors likely to affect functional skills.

Green and Riddell (2001) estimated a joint model of skills, education and wages. They found education to be a strong factor explaining literacy and numeracy skills. However, formal education is usually undertaken prior to entering the workforce. Although education is likely to improve younger persons' skills, people who are older and already working can also improve their functional skills. Understanding the determinants of a person's literacy and numeracy skills, and how they can be improved (or maintained) at different stages of the life cycle, would be a good area for further research. The above analysis indicates that work experience might not improve functional literacy and numeracy skills. However, only a crude measure of work experience was used. The ALLS also has information on how often a person uses various skills in the workplace, and at home. Identifying whether using skills at work improves functional skills would be a good first step in understanding ways to improve the skills of older workers.

7 Concluding remarks

In this paper, the links between literacy and numeracy skills and labour market outcomes were examined using recent Australian data. The motivation for the project has arisen from growing policy interest on the impact that literacy and numeracy skills have on key labour market outcomes. As mentioned in chapter 1, governments are committed to improving literacy and numeracy outcomes of the population, as this component of human capital is seen as crucial to raising productivity and participation.

A summary of the key findings from the empirical analysis in this paper and how they can be used by policy makers is presented below. Areas for further research are also mentioned.

7.1 Summary of findings

A profile of Australian's functional literacy and numeracy skills in 2006 showed that skills typically:

- decrease with age
- are higher for more educated people
- are lower for people born in a non-English speaking country.

Skills were also shown to be important for labour market outcomes — people with higher skills are more likely to participate in the labour force, be employed in higher-skilled occupations, and earn more, compared to people with lower skills.

Econometric models were used to formally estimate the effect of functional literacy and numeracy skills on labour force participation and on hourly wages (which is an indicator of productivity).

Modelling results should be used with caution. There may be unobserved characteristics which influence education and skills. People with greater motivation, potential or innate ability are more likely to undertake education, meaning that the effects of education might be overstated. Although the addition of the skill variable used in this paper might capture more accurately people's skills (and other unobserved factors that education does not), it might not capture motivation or innate ability. If that were the case, there may be some upward bias in the results meaning that they should be regarded as an upper estimate of the benefits from improving literacy and numeracy skills on labour market outcomes.

Notwithstanding those limitations, the qualitative conclusions from this research are likely to remain unchanged.

Model results showed that education has a positive effect on labour market participation and wages. Education is likely to improve a person's human capital, of which literacy and numeracy is one component. Once literacy and numeracy skills were controlled for, the effect of greater education on labour market outcomes was reduced, but it was still positive for most levels of attainment. This suggests that schooling develops skills other than functional literacy and numeracy, which are also rewarded in the labour market. Such skills may be vocational or job-specific.

Increasing literacy and numeracy skills had a positive, statistically significant effect on both labour force participation and hourly wages. Thus, from a policy perspective, if people's literacy and numeracy skills can be improved, then they will tend to achieve better labour market outcomes.

As stated above, a person's innate ability or motivation could affect his or her skill development. Thus, in practice, it might be difficult for a person with low literacy and numeracy to move to the highest skill level. Nevertheless, it is possible to increase the literacy and numeracy skills for the population as a whole.

Theory, and analysis of the data, both suggest that education is one factor likely to affect skills. However, the analysis also showed that education and skills are not perfectly correlated. Other studies have found 'the development and maintenance of cognitive skills is more complex than simply attending school or achieving a certificate of completion, and that education does not "fix" skill levels for life' (Statistics Canada and OECD 2005, p. 60). Modelling results supported this view, showing that, even after controlling for educational attainment, increasing people's skills will lead to higher wages and increased labour force participation.

Therefore, understanding factors other than education which affect literacy and numeracy is of importance, and could be an area for further research. Using Canadian data, Willms and Murray (2007) found that people's engagement in *general* literacy activities at work and at home have a stronger influence on skill development, compared with engagement in *technical* literacy practices at work.

Other findings may also be of interest. For example, the effect of literacy and numeracy skills was different for men and women — improving skills had a larger impact on participation for women than for men, but had a larger impact on hourly wage rates for men compared with women.

Returns to skills also varied slightly along the distribution of lower and higher skilled workers. Raising the skills of lower-skilled people had a larger effect on increasing participation, compared with further improving high-skilled workers' ability.

Compared with raising educational attainment, most of the results showed that there was a larger payoff to labour market outcomes from improving skills.

Finally, an important finding from the research was that people born in a non-English speaking country were much more likely to have lower functional skills than people born in Australia or a main English speaking country. This was the case regardless of a person's educational attainment. Thus, improving language proficiency is paramount to enhancing the functional skills and, in turn, the labour market outcomes for that group. The empirical results support the findings of previous Commission research on migration, which found that 'English language proficiency is significantly related to migrant labour market success and performance' (PC 2006b, p. 172).

7.2 Future research areas

Modelling results highlighted that education and functional literacy and numeracy skills have a positive effect on labour force participation and on wages. Estimates were based on standard econometric models often used in the literature, but they could be further refined using more sophisticated techniques. Although the qualitative conclusions are likely to remain unchanged, further research could be useful for policy makers if they wanted a more precise estimate of the effect of literacy and numeracy skills (and education) on labour market outcomes.

There are many different model specifications that could be used. Some of these are mentioned below.

1. Hours worked. The effect of skills on participation could be estimated using 'hours worked' as the dependent variable instead of participation. Alternatively, a multinomial logit could be used to model participation (that is, the states of labour force status could be expanded to include people unemployed, working part-time, or working full-time).
2. Simultaneous equations. In the descriptive analysis, there was some evidence that people who are out of the labour force might experience skill deterioration. If participation does affect skills, then there is reverse causality. To account for

this, a simultaneous equations model could be estimated with participation and literacy and numeracy skills jointly estimated. Using this model would help shed light on the direction of causality regarding skills and participation for people in the workforce nearing retirement age, which is likely to be of policy interest in the future.

3. Three-stage least squares. Literacy and numeracy skills are influenced by many factors, including education, engagement in reading and writing activities at work or home, English speaking background and parents' education levels. Models could be estimated to examine which factors are more important for skill development. For example, Green and Riddell (2001) used a three-stage least squares model to jointly estimate wages, education and skills for Canada. Understanding the factors affecting literacy and numeracy skills, and how those skills can be improved at different stages of the life cycle would also be important. Thus the modelling could be done for different age groups.

The econometric models in this paper can also be used to examine other links between literacy and numeracy skills and labour market outcomes.

For example, separate marginal effects were estimated for increasing educational attainment and literacy and numeracy skills. These marginal effects are interpreted as the effect of changing one variable, holding all others constant. For example, the estimated marginal effect of improving education assumes that a person's skill level is held constant. In practice, greater educational attainment is associated with higher skills (chapter 3). Therefore, a more realistic estimate of improving educational attainment for a person with relatively low education and low literacy and numeracy skills might consider the impact of improving both education *and* literacy and numeracy. This could be incorporated with an interactive term for literacy and numeracy skills and education.

Finally, although the focus of this report was to look at *overall* functional literacy and numeracy, the skill variable could be replaced and the effects of different types of literacy or numeracy could be estimated in isolation. Using data for the United States, Dougherty (2003) found that the effect of numeracy on earnings is much larger than that of literacy.

A Descriptive statistics

This appendix lists the variables used in the econometric models. The sample was restricted to 25–64 year old persons.

Table A.1 contains a description of all the variables, and their means and standard errors.

Table A.1 **Variable definition and descriptive statistics**

Variable	*Description*	*Mean*	*Std. Error*
Labour force	1 if in labour force, 0 otherwise	0.7728	
Log wage	Log of hourly wage rate x 100	234.3692	1.8906
Degree or higher	1 if degree or higher, 0 otherwise	0.2411	
Diploma/certificate	1 if diploma/certificate, 0 otherwise	0.2743	
Year 12	1 if year 12, 0 otherwise	0.1347	
Skill level 2	1 if skill level 2, 0 otherwise	0.2849	
Skill level 3	1 if skill level 3, 0 otherwise	0.3991	
Skill level 4/5	1 if skill level 4/5, 0 otherwise	0.1695	
Lives in city	1 if lives in city, 0 otherwise	0.5895	
Married	1 if married, 0 otherwise	0.6122	
Child 0–4	1 if child aged 0–4, 0 otherwise	0.1602	
Child 5–14	1 if child aged 5–14, 0 otherwise	0.2672	
Child 15–24	1 if child aged 15–24, 0 otherwise	0.0878	
Age	Age (years)	44.1943	0.1345
Age squared	Age squared/100	20.7588	0.1205
Age cubed	Age cubed/10 000	10.2670	0.0851
Experience	Potential work experience (years)	26.3904	0.1490
Experience squared	Potential work experience squared	8.4703	0.0827
Physical health	SF12 physical health score (1–100)	49.8385	0.1175
Mental health	SF12 mental health score (1–100)	50.6485	0.1165
Pension recipient	1 if receives any pension excluding disability and Department of Veteran Affairs (DVA) service pension, 0 otherwise	0.0102	
Part-time	1 if works part-time, 0 otherwise	0.2127	
COB – English speaking (not Aus)	1 if born in English speaking country (not Australia), 0 otherwise	0.1239	
COB – other	1 if born in non-English speaking country, 0 otherwise	0.1531	
Number of observations		*6785*	

Source: Productivity Commission estimates based on the ALLS (2006).

B Estimation output

This appendix contains output from all of the models estimated, including those models presented in chapter 6. As explained in chapter 5, each model was estimated separately for men and women, with the sample population being 25–64 year old persons.

B.1 Labour force participation model

Equations 1 and 2 (presented in section 6.1) were estimated using a probit model of labour force participation. The two states are either being in the labour force (employed or unemployed) or not in the labour force. Models were estimated with two specifications for functional literacy and numeracy skills. In the first instance, discrete skill levels were first estimated (results using this approach were presented in chapter 6). An alternative specification, with the continuous test score, was also used. Selected output from both of these models is presented below.

Participation model results with skill levels

The probit labour force participation model results for equations 1 and 2 are presented for men and women in tables B.1 and B.2 respectively. Results include coefficients and goodness of fit measures. Tables B.1 and B.2 also contain the associated marginal effects for key variables of interest.

Marginal effects for all models were calculated at the mean (using the ‘mfx’ command in Stata). This method was chosen, rather than calculating the average marginal effect, because that command is not available in the version of Stata run through RADL. In either case, previous literature does not indicate any strong preference for choosing a particular method when estimating marginal effects.

Table B.1 **Participation model results for men, skill levels**

Variable	*Equation 1*	*Equation 2*
Log likelihood	*-863.6*	*-854.4*
Pseudo R squared	*0.2979*	*0.3054*
Number of observations	*3154*	*3154*
Coefficients		
LitNum Skill level 2	–	0.2934***
LitNum Skill level 3	–	0.3575***
LitNum Skill level 4 and 5	–	0.5730***
Degree or higher	0.4397***	0.2195*
Diploma/Certificate	0.3118***	0.2239***
Year 12	0.1188	-0.0010
Age	0.1898***	0.1858***
Age squared	-0.2503***	-0.2452***
Married	0.5010***	0.4780***
Child 0–4	-0.0489	-0.0522
Child 5–14	-0.1365	-0.1327
Child 15–24	0.3619**	0.3527**
Lives in city	-0.0285	-0.0285
COB – English speaking (not Aus)	0.1792*	0.1424
COB – Other	-0.0406	0.0671
Physical health	0.0420***	0.0406***
Mental health	0.0214***	0.0210***
Constant	-5.4808***	-5.5340***
Marginal effects	**ppt**	**ppt**
LitNum Skill level 2	–	3.69***
LitNum Skill level 3	–	4.67***
LitNum Skill level 4 and 5	–	6.16***
Degree or higher	5.20***	2.78**
Diploma/Certificate	4.07***	2.93***
Year 12	1.56	-0.01
COB – English speaking (not Aus)	2.28*	1.82
COB – Other	-0.58	0.89

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

Table B.2 **Participation model results for women, skill levels**

Variable	*Equation 1*	*Equation 2*
Log likelihood	*-1755.0*	*-1732.9*
Pseudo R squared	*0.1803*	*0.1906*
Number of observations	*3631*	*3631*
Coefficients		
LitNum Skill level 2		0.3744***
LitNum Skill level 3		0.5030***
LitNum Skill level 4 and 5		0.5743***
Degree or higher	0.7012***	0.5284***
Diploma/Certificate	0.4609***	0.3637***
Year 12	0.2796***	0.1901**
Age	-0.3115**	-0.3093**
Age squared	0.9027***	0.8980***
Age cubed[a]	-0.8361***	-0.8305***
Married	-0.0752	-0.0921*
Child 0–4	-0.5852***	-0.6051***
Child 5–14	-0.2406***	-0.2435***
Child 15–24	0.0178	0.0159
Lives in city	-0.0349	-0.0223
COB – English speaking (not Aus)	0.0952	0.0985
COB – Other	-0.3028***	-0.1579**
Physical health	0.0306***	0.0290***
Mental health	0.0154***	0.0142***
Constant	1.9685	1.7111
Marginal effects	**ppt**	**ppt**
LitNum Skill level 2		11.03***
LitNum Skill level 3		15.17***
LitNum Skill level 4 and 5		15.25***
Degree or higher	19.11***	14.90***
Diploma/Certificate	13.08***	10.53***
Year 12	8.13***	5.65***
COB – English speaking (not Aus)	2.91	3.00
COB – Other	-10.12***	-5.12**

a A cubed age term was used for females, because it gave a better fit to the female age profile compared with only using a squared term.

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

Participation model results with continuous skills variable

The probit labour force participation model was also estimated using the continuous skills variable (test score 1–500) rather than with skill levels (1, 2, 3 and 4/5). Other variables used in estimation remained unchanged. Selected marginal effects for equation 2 with the continuous skills variable are presented for men and women in table B.3.

The results confirm that higher literacy and numeracy has a positive effect on participation. The effect is larger for women (about three times greater than the effect for men, broadly in line with results using skill levels). The marginal effect of other variables of interest (education and country of birth) are also very similar to those results obtained with models using skill levels (those results are reported under equation 2 in tables B.1 and B.2 for men and women, respectively).

Table B.3 **Participation model results, continuous skills variable**
Equation 2

Variable	*Men*	*Women*
Log likelihood	*-853.0*	*-1729.35*
Pseudo R squared	*0.3065*	*0.1922*
Number of observations	*3154*	*3631*
Marginal effects	**ppt**	**ppt**
Literacy/Numeracy score[a]	0.05***	0.13***
Degree or higher	2.40*	13.24***
Diploma/Certificate	2.69**	10.00***
Year 12	-0.30	5.12**
COB – English speaking (not Aus)	1.82	2.97
COB – Other	1.29	-3.35

[a] The marginal effect for literacy/numeracy represents the increase in probability of labour force participation for an additional one point in a person's literacy/numeracy test score (which can be between 1 and 500).

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

B.2 Wages model results

Wages models for equations 3 and 4 were estimated using standard OLS and with a Heckman selection model. Results from both of those models are reported below. The dependent variable is the natural logarithm of the hourly wage rate.

For comparison, wages model results using a continuous skills variable are also presented at the end of this section.

OLS hourly wages model results

Wages model results using OLS (for employed persons only) are reported for men and women in tables B.4 and B.5 respectively.

Table B.4 **OLS wages model results for men**

Variable	*Equation 3*	*Equation 4*
Adjusted R squared	*0.0842*	*0.1079*
Number of observations	*2407*	*2407*
Coefficients		
Lives in city	0.0850***	0.0844***
Married	0.1211***	0.1021***
Experience	0.0215***	0.0195***
Experience squared	-0.0338***	-0.0278***
Degree or higher	0.4685***	0.2952***
Diploma or certificate	0.1630***	0.0936***
Year 12	0.1430**	0.0506
LitNum Skill level 2		0.1648***
LitNum Skill level 3		0.2786***
LitNum Skill level 4 and 5		0.4334***
Physical health	0.0041**	0.0033*
Mental health	0.0015	0.0016
COB – English speaking (not Aus)	0.0254	0.0202
COB – Other	-0.1552***	-0.0698*
Works part-time	-0.0693	-0.0620
Constant	2.3439***	2.2139***

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

Table B.5 **OLS wages model results for women**

Variable	*Equation 3*	*Equation 4*
Adjusted R squared	*0.0926*	*0.1015*
Number of observations	*2244*	*2244*
Coefficients		
Lives in city	0.0604**	0.0597**
Married	0.0553*	0.0473*
Experience	0.0112**	0.0099*
Experience squared	-0.0158	-0.0111
Degree or higher	0.4783***	0.4030***
Diploma or certificate	0.1300***	0.0988**
Year 12	0.1059**	0.0713
LitNum Skill level 2		0.1295**
LitNum Skill level 3		0.2086***
LitNum Skill level 4 and 5		0.2999***
Physical health	0.0072***	0.0066***
Mental health	0.0036**	0.0033**
COB – English speaking (not Aus)	0.0410	0.0427
COB – Other	-0.2221***	-0.1626***
Works part-time	0.0213	0.0250
Constant	2.1140***	2.0077***

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

Marginal effects

Marginal effects in an OLS model are equivalent to the corresponding coefficients. However, the dependent variable used in the wages model was the logarithm of the hourly wage. The marginal effects had to be converted to obtain a percentage growth rate in wages from a percentage change in the explanatory variable. Thornton and Inness (1989) show that the estimated marginal effect when the dependent variable is in logarithmic form needs to be converted with the following formula:

$$\%\Delta Wages = X.\ e^{\beta} - 1$$

where β is the estimated marginal effect, and X is the unit change in the dependent variable. For a binary variable, X is 1. Therefore, the education and skills marginal effects in tables B.4 and B.5 were converted using the following formula:

$$\%\Delta Wages = e^{\beta} - 1$$

The marginal effects for the OLS wages models (for both men and women) are presented in table B.6.

Table B.6 **Marginal effects of selected variables in OLS wages models**

Variable	*Equation 3 (Education only)*		*Equation 4 (With skills)*	
	Men	*Women*	*Men*	*Women*
Degree or higher	59.75***	61.34***	34.34***	49.63***
Diploma or certificate	17.71***	13.88***	9.81***	10.39**
Year 12	15.37***	11.17**	5.19	7.39
Skill level 2			17.92***	13.82**
Skill level 3			32.13***	23.19***
Skill level 4/5			54.25***	34.97***
COB – English speaking (not Aus)	2.57	4.18	2.04	4.36
COB – Other	-14.38***	-19.92***	-6.74*	-15.01***

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

Heckman model results

In this section, a description of the Heckman model that was used to estimate the wages models is provided below. Following that, estimation results for the wages models (outlined in section 6.2) are presented.

Heckman model specification

A formal representation of the Heckman model is presented below.

The following selection equation is first estimated:

$\mathrm{Prob}(L = 1 \mid Z) = \Phi(Z\gamma)$

where: L = 1 if in labour force, and 0 otherwise

Z is a vector of explanatory variables,

and γ includes parameters to be estimated.

Z includes the education variables, skill variables (for equation 4) and other demographic variables (those estimated for the labour force participation models).

A second (wage) equation, is then estimated:

$w^* = X\beta + u_1$

where: w^* is a wage offer, which is only observed if a respondent is working.

The conditional wage, given a person works is then:

$$E[w \mid X, L = 1] = X\beta + E[u \mid X, L = 1]$$

$$E[w \mid X, L = 1] = X\beta + \rho\sigma_u\lambda(Z\gamma)$$

where: ρ = correlation between error terms in the first and second equations

σ_u = standard deviation of u

λ = inverse mills ratio.

The above equation can be rewritten as:

$$E[w \mid X, L = 1] = X\beta + c\lambda(Z\gamma)$$

where: $c = \rho\sigma_u$

The value of c (the coefficient of λ), can be tested to see if it is statistically different from zero. If it is, there is a 'selection effect' present. By controlling for this, wage model estimates are unbiased. However, there was no statistically significant effect (see below), meaning that sample selection bias is not a problem according to the model results. A problem in estimating Heckman models like the above is finding relevant 'instruments' — variables that affect participation, but which do not influence wages. The variables specifically used as instruments (that is, in the participation equation only) were: having a child aged 0–4; child aged 5–14; child aged 15–24; age (including squared and cubed terms).

Estimation output

The coefficient estimates for equations 3 and 4 are presented in tables B.7 and B.8 for men and women respectively. These results include explanatory variables used in both the selection and wage equations.

Table B.7 **Heckman wages model results for men**

Variable	*Equation 3*	*Equation 4*
Selection equation		
Lives in city	-0.0463	-0.0467
Married	0.5433***	0.5219***
Age	0.1744***	0.1683***
Age squared	-0.2304***	-0.2230***
Degree or higher	0.5022***	0.2611**
Diploma or certificate	0.4117***	0.3148***
Year 12	0.2124**	0.0824
LitNum Skill level 2		0.3020***
LitNum Skill level 3		0.3601***
LitNum Skill level 4 and 5		0.6250***
Physical health	0.0404***	0.0388***
Mental health	0.0232***	0.0227***
COB – English speaking (not Aus)	0.1625	0.1351
COB – Other	-0.1779*	-0.0594
Child 0–4	-0.0106	-0.0119
Child 5–14	-0.1200	-0.1181
Child 15–24	0.2526*	0.2359
Constant	-5.5131***	-5.5195***
Wage equation		
Lives in city	0.0847***	0.0841***
Married	0.1249***	0.1056***
Experience	0.0220***	0.0200***
Experience squared	-0.0352***	-0.0291***
Degree or higher	0.4706***	0.2960***
Diploma or certificate	0.1654***	0.0953***
Year 12	0.1443***	0.0511
LitNum Skill level 2		0.1673***
LitNum Skill level 3		0.2813***
LitNum Skill level 4 and 5		0.4371***
Physical health	0.0045**	0.0036*
Mental health	0.0017	0.0017
COB – English speaking (not Aus)	0.0261	0.0208
COB – Other	-0.1563***	-0.0702*
Works part-time	-0.0696	-0.0623
Constant	2.3040***	2.1745***
Lambda	*0.0238*	*2.3155*
Log likelihood	*-3322.4*	*-3278.1*

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

Table B.8 **Heckman wages model results for women**

Variable	*Equation 3*	*Equation 4*
Selection equation		
Lives in city	-0.0061	0.0033
Married	0.0110	-0.0084
Age	-0.3467***	-0.3486***
Age squared	0.9635***	0.9678***
Age cubed	-0.8647***	-0.8645***
Degree or higher	0.7765***	0.5735***
Diploma or certificate	0.4627***	0.3508***
Year 12	0.3172***	0.2167***
LitNum Skill level 2		0.3886***
LitNum Skill level 3		0.5652***
LitNum Skill level 4 and 5		0.6704***
Physical health	0.0294***	0.0276***
Mental health	0.0165***	0.0151***
COB – English speaking (not Aus)	0.0959	0.0998
COB – Other	-0.3925***	-0.2253***
Child 0–4	-0.6031***	-0.6273***
Child 5–14	-0.2548***	-0.2595***
Child 15–24	-0.0048	-0.0058
Constant	2.3188	2.1064
Wage equation		
Lives in city	0.0610**	0.0603**
Married	0.0534*	0.0453
Experience	0.0125**	0.0110**
Experience squared	-0.0189*	-0.0136
Degree or higher	0.4970***	0.4148***
Diploma or certificate	0.1416***	0.1061***
Year 12	0.1129**	0.0751
LitNum Skill level 2		0.1396**
LitNum Skill level 3		0.2223***
LitNum Skill level 4 and 5		0.3148***
Physical health	0.0080***	0.0072***
Mental health	0.0041**	0.0036**
COB – English speaking (not Aus)	0.0427	0.0443
COB – Other	-0.2330***	-0.1681***
Works part-time	0.0177	0.0219
Constant	2.0074***	1.9118***
Lambda	*0.0579*	*0.0489*
Log likelihood	*-3942.6*	*-3903.4*

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

Marginal effects

Marginal effects for the education and skills variables were calculated using the same Stata command used for the models of participation (described above). This estimate had to be converted to obtain percentage change in the same way the OLS wages model estimates were converted.

Marginal effects of skills and educational attainment are presented in table B.9.

Table B.9 **Marginal effects of selected variables in Heckman models**

Variable	*Equation 3 (Education only)*		*Equation 4 (With skills)*	
	Men	*Women*	*Men*	*Women*
Degree or higher	59.58***	61.05***	34.21***	49.42***
Diploma or certificate	17.65***	13.76***	9.77***	10.28**
Year 12	15.35***	10.97**	5.18	7.24
Skill level 2			17.97***	13.92**
Skill level 3			32.16***	23.20***
Skill level 4/5			54.26***	35.02***
COB – English speaking (not Aus)	2.53	4.08	2.01	4.27
COB – Other	-14.35***	-19.79***	-6.74*	-14.98***

*** significant at 1 per cent, ** 5 per cent and * 10 per cent.

Source: Productivity Commission estimates based on the ALLS (2006).

Wages model with continuous skills variable

The wages models were also estimated with the continuous test score variable, instead of the skill level variables. Qualitative results were unchanged. For information, the marginal effects from the OLS models estimated with the continuous variable, or alternatively the skill level variable, are presented in table B.10. (Results for the Heckman model with the continuous variable are not reproduced here, but were similar to those of the OLS model). The marginal effect of the literacy and numeracy test score variable for men is about 1.5 times the magnitude for women, in line with results from models which use the skills level variables.

Table B.10 **Marginal effects for wages models using different specifications for the skill variable in equation 4**

OLS regression, employed persons

	Men		*Women*	
Variable	*Skill level*	*Test score*	*Skill level*	*Test score*
Degree or higher	34.21***	32.27***	49.42***	47.80***
Diploma or certificate	9.77***	8.46**	10.28**	9.62**
Year 12	5.18	4.20	7.24	6.66
Literacy/numeracy test score		0.27***		0.19***
Skill level 2	17.97***		13.92**	
Skill level 3	32.16***		23.20***	
Skill level 4/5	54.26***		35.02***	
COB – English speaking (not Aus)	2.01	1.93	4.27	4.53
COB – Other	-6.74*	-4.38	-14.98***	-14.11***

Source: Productivity Commission estimates based on the ALLS (2006).

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