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Measuring Economic Returns to Post-School Education in Australia

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Measuring Economic Returns to Post-School Education in Australia

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Economic Analysis and Reporting Branch

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CONTENTS

MEASURING ECONOMIC RETURNS TO POST-SCHOOL EDUCATION IN AUSTRALIA: EVIDENCE FROM THE 1981–2006 AUSTRALIAN CENSUSES

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ABSTRACT

Using the rich data provided by the 1981–2006 six waves of the full Australian Census, this paper estimates the rates of return to post-school education in Australia, with a focus on bachelor degrees. Both the internal rate of return method and Mincer's human capital earnings function method are applied. The expected private rates of return from investment in bachelor degrees increased over time for males, from 13.1 percent in 1981 to 19.6 percent in 2001, and then dropped to 15.3 percent in 2006; the range was 18.0 percent to 17.3 percent for females over the same period. Drawing on the recent work of Heckman, Lochner and Todd (2005), this study also compares the two methods. The key difference is that the internal rate of return method can account for the effect on earnings of increased working experience associated with higher educational attainment, while Mincer's method does not as it assumes parallel earnings experience profiles across different educational levels.

Keywords: Rate of return to education, Internal rate of return, Mincer's human capital earnings function.

JEL classification: C31

1. INTRODUCTION

Post-school education plays a critical role in the growth of the human capital stock in Australia. In particular, investment in university bachelor degrees is the most important form of human capital formation by post-school education (Wei, 2008). The purpose of this paper is to present estimates of the economic returns to post-school education, with a focus on the rates of return to investment in university bachelor degrees.

This paper has been motivated by a few factors. First, measuring the economic returns to education is important for the measurement of human capital and hence a natural extension of the previous Australian Bureau of Statistics (ABS) studies on the measurement of human capital. Second, the information on returns to higher education is useful for education policy settings and an important factor in determining schooling activities of individuals and their educational attainment. Third, recent years have witnessed a resurgence of interest in estimating the economic returns to education. Some recent Australian examples include Borland *et al.* (2000), Borland (2002), Daly, Fleming and Lewis (2004, 2006), Leigh (2007) and Leigh and Ryan (2005). Fourth, this study makes an important contribution to this research by providing estimates of returns to education spanning 25 years, using the rich data provided by the 1981–2006 six waves of the full Australian Population Census.

Estimating returns to education is one of the most central themes in labour economics and the economics of education. Over the past four decades, numerous techniques have been developed in the literature to estimate the true rates of return to education, net of various biases and measurement errors. With the availability of extensive data on schooling and earnings at individual levels, the measurement of the education effect on earnings is reported widely in research papers and policy reports. Educational attainment is measured either by years of schooling or by educational qualifications obtained. Accordingly, in estimating returns to education, researchers either attempt to estimate returns to one additional year of schooling or to estimate returns to the investment in a particular educational qualification. The estimates presented in this paper focus on the economic returns to investment in a university bachelor degree in Australia.

One introductory comment is necessary on the limitations associated with studies based on the Population Census, the main data source in this study. Census data lack ability measures that could be used for separating effects of education and other factors affecting earnings. Therefore, estimates derived from Census data are subject to ability biases as it is well documented that ability does impact on earnings. However, despite painstaking efforts to identify and measure the returns to abilities

that are independent of education but potentially correlated with schooling levels, the dust has not settled over the best way to correct for ability biases.[1] Secondly, many empirical studies suggest that ability biases are relatively small and education has a significant impact on the earnings of individuals undertaking additional schooling activities.[2] Given the apparent small size of ability bias and its possibly static nature over time, the estimates made by this study using Census data sets may be considered indicative of the general trend and patterns of the economic benefits from obtaining a university degree.

The rest of this paper is organised as follows. Section 2 discusses methodological issues including estimation methods commonly used in the returns-to-education literature. Section 3 presents estimates of the rates of return to investment in post-school education in Australia over the period 1981–2006, based on the Census data. Section 4 compares the two estimation methods and the results. Section 5 compares the results with other Australian studies. Section 6 concludes.

1 For critical reviews of instrumental and IQ variables models, see Hansen *et al.* (2004), Heckman, Lochner and Todd (2005).

2 See Card (1999) for a selective review of empirical evidence on the effect of ability on earnings.

2. METHODOLOGICAL ISSUES

Empirical measures of the returns to education typically are obtained by applying two alternative approaches: the internal rate of return method [3] and the earnings function method. The choice of method made by individual researchers largely depends on the research questions they attempt to answer and the availability of data. Understanding the details of each method and their relationship is important for correctly interpreting empirical results of these estimation exercises and making meaningful comparisons between figures obtained through alternative methods.

2.1 Internal rate of return method

The internal rate of return is a key method for selecting among alternative investment proposals in financial analysis. When education is viewed as a form of investment in human capital, it is natural to apply the internal rate of return method to evaluate the financial soundness of obtaining an additional educational qualification. The internal rate of return can be defined as the discount rate that makes the net present value of an investment zero. The net present value of an investment in education is the difference between the discounted present value of lifetime monetary benefits from obtaining an additional educational qualification and the cost incurred in this investment.

Mathematically, the rates of return to education based on the internal rate of return method are derived by solving the following equation for r:

$$\sum_{a=a^w}^{a^r} (x_{ia} - x_{ja})(1+r)^{-(a-a^w)} = 0 \qquad (1)$$

where x_{ia} and x_{ja} represent income flows for the higher and lower education cohorts respectively at the age a, a^w is the age starting paid employment, a^r is retirement age, r is the internal rate of return to investment in the higher education attainment on the basis of obtaining the lower level educational attainment.

To apply equation (1) in practice, one needs to make a few choices. The first is the choice of investment scenarios from one education level to the next: from completion of secondary education to a university bachelor degree, from a bachelor degree to a PhD, or generically from s years of schooling to $s+1$ years of schooling.

The second choice is a specific age group. Other things being equal, the amount of return to investment in a particular education level depends on the time period available for generating higher labour earnings in the labour market. The younger an individual is, the longer the future horizon in which he or she can expect to reap the benefits from his or her investment in the next education level. In estimating the rate

3 Psacharopoulos (1993) terms the internal rate of return method as 'the elaborate' method.

of returns to each education level, researchers are often interested in the age (or age range) at which individuals usually start to enrol at this level of education. For example, people usually start their university studies at 18 (or from 18 to 21), and researchers are interested in knowing what the rates of returns are for this (these) age cohort.

The third choice is the assumptions in regard to cash flows associated with alternative education paths, such as costs incurred for achieving a particular level of education, including direct and indirect costs, and increments in earnings attributable to obtaining a higher education qualification.

2.2 Mincer human capital earnings function

The semi-logarithmic earnings function, the well-known Mincer human capital earnings function (Mincer, 1974), is the commonly accepted functional form for the earnings function. Many empirical estimates of rates of returns to education are derived by using this framework. The Mincer human capital earnings function is specified as:

$$\ln W_i = \alpha_0 + \beta_1 S_i + \beta_2 X_i + \beta_3 X_i^2 + u_i \qquad (2)$$

where W_i is the earnings for individual i, S_i is his or her years of completed education, X_i is the number of years an individual has worked since completing schooling (experience), X_i^2 is experience-squared, and u is a statistical residual reflecting unobserved factors such as innate ability. The coefficient β_1 is interpreted as the estimate of the rate of return to an additional year of schooling.

To estimate returns to different levels of education, where education attainment is measured by binary variables, the conventional Mincer-style earnings function takes the form:

$$\begin{aligned} \ln W_i = {} & \alpha_0 + \beta_1 Year12_i + \beta_2 Skilled_i + \beta_3 Bachelor_i + \\ & \beta_4 Higher_i + \beta_5 X_i + \beta_6 X_i^2 + u_i \end{aligned} \qquad (3)$$

where $Year12_i$, $Skilled_i$, $Bachelor_i$ and $Higher_i$ are dummy variables for completion of secondary education, TAFE qualification, university bachelor degree and higher degree. The coefficients of these four binary variables are estimates of the marginal effect of each additional level of education on earnings, in comparison with the next lower level of education. The category 'incomplete secondary school' is the lowest education level and is omitted in the regression. Equation (3) holds separately for men and women.

The earnings function method relates earnings to schooling and potential working experience and compares the earnings of two individuals (or groups) of the same age with different education levels. The coefficients on schooling variables are partial regression coefficients, that is, the relationship between education and earnings removes the effect of age on education and earnings. The estimates of coefficients on schooling variables indicate how much average earnings increase with alternative educational levels.

3. EMPIRICAL RESULTS

To provide more comprehensive estimates of rates of returns to post-school education, this study employs both the internal rate of return method and Mincer's earnings function method. The application of the internal rate of return method needs to specify the average study length for each educational investment and the associated direct costs incurred during the study period. Of the three types of post-school education credentials – skilled labour, bachelor degree and higher degree – these requirements are relatively easily met for the bachelor investment. Therefore, the estimates of rates of return are for investment in the bachelor degree only. In addition, the rates of return are estimated before and after income tax for both methods. Post-tax estimates are the preferred basis and are referred to as 'private returns' in this paper.

3.1 Internal rate of return method estimates of rates of return to bachelor degrees

Following a few recent Australian studies of estimating returns to higher education (Borland, 2002; Daly, Fleming and Lewis, 2004 and 2006; and Larkins, 2001), the basic scenario of investment in a bachelor degree is defined as the cohort of 18 year olds that has completed secondary education and has two choices of career paths: to undertake a four-year university bachelor degree and, on completion, commence employment in the labour market; or to join the labour force without any post-secondary studies.

A variety of costs and benefits are associated with undertaking a university bachelor degree. These costs and benefits can be viewed from both a private and social perspective. Private costs are those privately borne costs including foregone earnings due to studying. Private returns are those accrued to individuals such as higher earnings brought about by additional education (net of extra tax paid). This study is mainly concerned with estimation of private rates of return to education. In terms of equation (1), the cash flows associated with investment in a bachelor degree are assumed as follows:

1. The bachelor degree takes four years full time to complete and during this period the representative student does not participate in the labour market. This simplifying assumption is conservative in estimating rates of return to education, as a significant proportion of students may undertake part-time employment. But it is preferred to err on this side, given that estimates of return to education are often subject to upward biases;

2. The representative student incurs an opportunity cost (i.e. the labour earnings of those who have completed secondary education and joined the workforce), as well as incurring negative cash flows by paying direct costs, such as university fees, Higher Education Contribution Scheme (HECS) and other charges during the four years of study;

3. The income flows after completion of the bachelor degree are projected by current age–earnings profiles of people with bachelor degrees. The income flows for the lower education group are projected by current age–earnings profiles of people who have completed secondary education but without any post-school qualifications.

4. The expected gains from obtaining a bachelor degree are projected by the observed income differentials between bachelor and year 12 education groups from 22 year olds to 65 year olds age cohorts.

Given the above assumptions, the cash flows from this investment can be grouped into cost and benefit elements. During the study period, that is, when a = 18, 19, 20, 21, the present value of total cost is given by

$$\sum_{a=18}^{21} (c_a + x_{ja})/(1+r)^{-(a-18)}$$

with c_a representing the direct schooling cost at age a.

The present value of total benefits is given by

$$\sum_{a=22}^{65} (x_{ia} - x_{ja})/(1+r)^{-(a-18)}$$

Therefore, equation (1) can be rewritten as:

$$\sum_{a=18}^{21} (c_a + x_{ia})/(1+r)^{-(a-18)} = \sum_{a=22}^{65} (x_{ia} - x_{ja})/(1+r)^{-(a-18)} \qquad (1a)$$

In words, the rate of return to investment in a bachelor degree is the discount rate that equates the present value of costs to the present value of future income gains of obtaining a university bachelor degree.

Human capital does not only bring benefits to individuals but also to the community. These benefits can include extra income taxes and lower social transfers paid to individuals due to enhanced earnings, better health, informed political participation, and higher returns to physical capital. However, the social returns to education are harder to measure and it seems that empirical evidence so far is meagre. [4]

4 Lange and Topel (2006) provide an excellent survey of the literature on the social returns to education.

Some researchers use pre-tax income as a measure of social returns (Maani, 1996). Income tax is an important component in income flows and hence the internal rate of returns are estimated on an after- and before-income-tax basis in this study. However, such measures may capture only a proportion of social returns, and as such this study refers to 'pre-tax returns' instead of 'social returns'.

Future income flows expected at the time of starting post-school study may be different to realised income flows after completing study and entering the labour force. To compare the expected and realised income flows, one can estimate ex-ante and ex-post returns to education, given the availability of panel data with sufficient time periods. Suppose 65 is the retirement age, then to obtain a complete estimate of ex-post returns for the 18 year old cohort, one needs panel data spanning 48 years. Given panel data spanning 15 years, we denote the income variables for the two education groups by y_{at} (bachelor degree) and x_{at} (secondary education), a stands for age, with $a = 18, 19, \ldots, 65$, and t stands for year, with $t = 1, 2, \ldots, 15$. To develop ex post based measures of rates of return from this data set, in which observed (realised) income flows (15 years in our example) are shorter than the lifetime income flows (47 years spanning from age 18 to 65), two options are available: the first is to confine the estimation to observed income flows, or to put it differently, up to 15 years only; the second is to combine observed and expected income flows to cover the entire lifetime span. In the first option, the cash flow series is constructed as:

$$(y_{18,1} - x_{18,1}), (y_{19,2} - x_{19,2}), \ldots, (y_{31,14} - x_{31,14}), (y_{32,15} - x_{32,15})$$

In the second option, the cash flow series is constructed as:

$$(y_{18,1} - x_{18,1}), (y_{19,2} - x_{19,2}), \ldots, (y_{32,15} - x_{32,15}), \ldots, (y_{65,15} - x_{65,15})$$

The first option produces the true ex-post return estimates. However, as the selected sub-period is short and there are still plenty of years left to reap benefits from a higher educational qualification, the gap between the ex-ante and ex-post return estimates may be too small to reveal sufficient information to assess the outcome of the initial investment in the university degree. The second option covers the entire investment life period, but mixes realised and expected income flows, and it may not be appropriate to term this as 'ex-post'. However, estimating the rate of return in the latter approach is useful for evaluating the investment decision made in early years up to the present, assuming current cross-sectional income patterns among the two education groups continue into the future.

Table 3.1 presents estimates of private rates of returns for the 18 year old cohort that chose to undertake an investment in a bachelor degree upon completing secondary education in 1981, 1986, 1991, 1996, 2001 and 2006. For example, a male who was 18 years old in 1981 was expected to receive a 13.1 percent return on his investment in a bachelor degree but his realised rate of return was 17.4 percent, a better outcome than expected. These calculations are derived from after-tax earnings flows over life cycles. Individuals with university degrees are less likely to be unemployed and more likely to be in the workforce. This has a significant impact on the lifetime earnings differentials between those who have university degrees and those that do not. As a result, the estimates presented in table 3.1 include the effects of lower unemployment rates and higher labour force participation rates on lifetime earnings for the university educated cohorts.

3.1 Private rates of return to a bachelor degree for persons in Australia: 1981–2006 (%)

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Male						
Ex-ante	13.1	17.5	17.6	18.4	19.6	15.3
Ex-post (a)	17.4	19.9	19.7			
Female						
Ex-ante	18.0	20.3	18.7	19.3	19.0	17.3
Ex-post (a)	20.0	20.1	20.5			

Notes: (a) these estimates are for 18 year old group based on combined income flows of 47 years lifetime span, which consists of 15 years observed and 32 years expected income flows. As the time period between 1996 and 2006 is less then 15 years, no ex-post returns are estimated for 1996 onwards.

There are a number of findings. First, the expected rates of return for male cohorts increased over time, from 13.1 percent in 1981 to 19.6 percent in 2001, and then dropped to 15.3 percent in 2006, possibly due to improved labour market conditions for those without a bachelor degree. Second, compared with the rates for male cohorts, the corresponding rates for female cohorts are much higher in the 1980s. Subsequently female returns fall slightly below males in 2001, before rising in relative terms again by 2006. Third, the ex-post estimates are higher than the ex-ante estimates for both male and female, though the two measures narrow over time for males. This pattern is likely due to the increases in wage premiums for more educated young workers in the 1980s and 1990s, which have been documented and analysed by numerous studies (for example, Borland, 1999 and Daly, Fleming and Lewis, 2006 for Australia, and Card and DiNardo, 2002 for the United States).

Table 3.2 presents estimates of the returns which are derived by using pre-tax earnings in cash flow estimates.

3.2 Pre-tax rates of return to a bachelor degree for persons in Australia: 1981–2006 (%)

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Male						
Ex-ante	15.5	21.3	21.4	21.9	23.1	18.3
Ex-post (a)	20.2	23.0	22.9			
Female						
Ex-ante	20.3	23.2	21.9	22.5	22.1	20.7
Ex-post (a)	22.5	22.8	23.5			

Notes: (a) these estimates are for 18 year old group based on combined income flows of 47 years lifetime span, which consists of 15 years observed and 37 years expected income flows. As the time period between 1996 and 2006 is less then 15 years, no ex-post returns are estimated for 1996 onwards.

In the literature, estimation of the return to education is often based on wage rates of employed workers with alternative educational attainments. Analysis of this kind quantifies the effect of education on wage rates. In order to make the figures in this paper comparable to these studies, the estimates based on earnings of employees are also produced. Table 3.3 and table 3.4 present estimates of both private and pre-tax rates of returns for employees, which are both derived from earnings flows without accounting for the effects of unemployment rates and labour force participation rates on lifetime earnings. The patterns for employee based rates of return are quite different from those based on persons reported in table 3.1 and table 3.2. First, the employee based estimates are less than half of those estimated for persons over most of the 1981–2006 period. Second, more dramatic differences are observed for basic time patterns between the two estimates. The person based estimates do not exhibit increasing patterns over time, while the employee based estimates show continually increasing returns from 1991.

3.3 Private rates of return to a bachelor degree for employees in Australia: 1981–2006 (%)

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Male						
Ex-ante	9.4	9.2	9.4	10.2	10.7	12.5
Ex-post (a)	11.2	11.6	11.9			
Female						
Ex-ante	10.6	10.4	9.2	10.0	10.6	13.4
Ex-post (a)	11.0	10.8	11.4			

Notes: (a) these estimates are for 18 year old group based on combined income flows of 47 years lifetime span, which consists of 15 years observed and 32 years expected income flows. As the time period between 1996 and 2006 is less then 15 years, no ex-post returns are estimated for 1996 onwards.

3.4 Pre-tax rates of return to a bachelor degree for employees in Australia: 1981–2006 (%)

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Male						
Ex-ante	11.8	12.7	12.8	13.5	14.1	15.2
Ex-post (a)	13.9	14.3	14.4			
Female						
Ex-ante	12.6	13.0	12.1	12.7	13.2	16.6
Ex-post (a)	13.3	13.0	13.7			

Notes: (a) these estimates are for 18 year old group based on combined income flows of 47 years lifetime span, which consists of 15 years observed and 32 years expected income flows. As the time period between 1996 and 2006 is less then 15 years, no ex-post returns are estimated for 1996 onwards.

The benefits of education not only include higher wages but also lower unemployment rates and higher labour force participation rates. The estimates based on comparing earnings of employed workers with alternative educational attainments only capture the higher wage effect. The differences between the estimates presented in table 3.1 and table 3.2 and those presented in table 3.3 and table 3.4 measure the effects of lower unemployment rates and higher labour force participation rates on the rates of return to education. When the economy goes through business cycles, unemployment rates and labour force participation rates fluctuate more dramatically for less educated workers than their more educated counterparts. The person based estimates capture the impact of business cycles on earnings differentials between less and more educated individuals. The employee based estimates largely reflect the skill premium paid for the more educated but fail to measure the economic benefits of lower unemployment rates and higher labour force participation rates arising from education. The comparison between these two estimates suggests that the economic benefits of lower unemployment rates and higher labour force participation rates account for a significant proportion of the returns to educational investments.

Like the causal relationship between education and labour earnings, the impact of educational attainment on labour force participation is a complex issue. Wei (2004) shows that higher educational attainment is positively associated with lower unemployment rates and higher labour force participation rates. Using the same data source, Kennedy and Hedley (2003) identify "substantial variations in the labour force participation rates of males and females with different levels of educational attainment" (p. 15). Addressing the economic impact of population ageing, the Productivity Commission (2005) considers the role of education in lifting labour force participation rates in Australia. In that report, it finds a positive relationship between education and labour force participation. Despite the evidence of a positive correlation between education and labour force participation, technical rigour

requires economists to be cautious in drawing strong inferences about the causality from degree of education to labour force participation.[5] It might be the case that other factors are at play that influence both levels of education attainment and levels of labour market engagement. In this context, the caveat discussed in the Introduction of this paper regarding ability biases also applies here.

Our estimates assume that workers retire at 65. Obviously this assumption affects the rates of returns, so we conducted some sensitivity analysis of our estimates. Tables 3.5 and 3.6 present estimates of the private and pre-tax rates of returns for alternative retirement ages. It appears that whether workers retire at 65 or 55 does not matter much to the rates of return. This is because those benefits after 55 are very remote from the present, and do not weigh greatly in the calculation of the net present value of income flows over the life cycle.

3.5 Sensitivity analysis: Retirement age and private rates of return to a bachelor degree (%)

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Male						
Retire at 55	12.9	17.4	17.5	18.3	19.5	15.3
Retire at 60	13.0	17.5	17.6	18.4	19.6	15.3
Retire at 65	13.1	17.5	17.6	18.4	19.6	15.3
Female						
Retire at 55	18.0	20.2	18.6	19.3	19.0	17.3
Retire at 60	18.0	20.3	18.6	19.3	19.0	17.3
Retire at 65	18.0	20.3	18.7	19.3	19.0	17.3

3.6 Sensitivity analysis: Retirement age and pre-tax rates of return to a bachelor degree (%)

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Male						
Retire at 55	15.4	21.2	21.4	21.9	23.1	18.3
Retire at 60	15.5	21.0	21.4	21.9	23.1	18.3
Retire at 65	15.5	21.3	21.4	21.9	23.1	18.3
Female						
Retire at 55	20.3	23.2	21.9	22.5	22.1	20.6
Retire at 60	20.3	23.2	21.9	22.5	22.1	20.7
Retire at 65	20.3	23.2	21.9	22.5	22.1	20.7

5 Lattimore (2007) provides a selective review of this literature.

3.2 Estimates of Mincer's earnings function

The Mincer wage equation can be run at a level higher than the individual. If the earnings variable is defined as the average earnings of all workers of a given country, and the schooling variable as the average years of schooling of the labour force of this country, then the conventional micro based Mincer wage equation can be written as what Klenow and Rodriguez-Clare (1997) call the 'Macro-Mincer' wage equation:

$$\ln Y_{jt}^{g} = \beta_{0jt} + \beta_{1jt} S_{jt} + \varepsilon_{jt} \tag{4}$$

where Y_{jt}^{g} denotes the geometric mean wage for country j at time t, and S_{jt} is the mean education. At the individual level, the Mincer wage equation is mainly concerned with whether, and to what extent, a person's education affects his or her labour market earnings. At a macro level, the Mincer wage equation is used to measure the overall effect of increased educational attainment on per capita earnings of workers across countries.

This study runs the regression at the group level, where the earnings variable is the average earnings for a particular sex/education/age group. Using notations similar to those adopted in the previous ABS human capital papers (Wei, 2004; Wei, 2008), the above equation (3) takes the form:

$$\begin{aligned} \ln W_{e,a} = \alpha_0 + \beta_1 Year12_{e,a} + \beta_2 Skilled_{e,a} + \beta_3 Bachelor_{e,a} + \\ \beta_4 Higher_{e,a} + \beta_5 X_{e,a} + \beta_6 X_{e,a}^2 + u_{e,a} \end{aligned} \tag{5}$$

where $W_{e,a}$ denotes the average annual earnings for a given education/age group. Data on actual work history is rarely available and the usual practice in the literature is to estimate potential working experience through information on age and educational attainment. The age range and associated potential working experience for each education category is specified as follows:

- when $e = Year12$ (or incomplete secondary education), $a = 18, 19, \ldots, 65$, and $X_{e,a} = a - 18$;
- when $e = Skilled$, $a = 20, 21, \ldots, 65$, and $X_{e,a} = a - 20$;
- when $e = Bachelor$, $a = 22, 23, \ldots, 65$, and $X_{e,a} = a - 22$;
- when $e = Higher$, $a = 24, 25, \ldots, 65$, and $X_{e,a} = a - 24$.

Empirical studies [6] show that potential experience is a good proxy for the actual labour market experience of men, but not for that of women, because many women leave the labour market some time during their life cycle for family reasons. As a result, the

6 For example, Heckman and Hotz (1986).

measurement error in estimating years of working experience is more serious in the case of women than in the case of men.

There are 223 observations for each sex/education category. At the group level, variation of earnings within the group is removed by averaging, and therefore R^2 and t-ratios are higher than those derived at the individual level, but the magnitudes of coefficients should be of a similar order. To take into account the distribution of workers among alternative education/age groups, the weight variable (proportion of the number of persons in each education/age groups in the corresponding population) is added.

This study employs ordinary least square (OLS) to estimate the group earnings function specified in equation (5). The return to education obtained through the OLS estimates of the Mincer earnings function is subject to various sources of bias and recent developments provide alternative estimation techniques to solve these issues.[7] Owing to a lack of (or high costs of obtaining) information required to apply these techniques, such as data on parental education, occupation and other characteristics, ability measures, twins' information and changes in the arrangements of education institutions, the sensitivity of OLS estimates to these sources of bias is not examined in this study. However, these estimates are based on the full 1981–2001 waves of Australian Census data, and they may provide a reasonable picture of the long-term trend of returns to education in Australia.

The estimates of private (after-tax) returns are reported separately for males and females in tables 3.7 and 3.8 respectively. The corresponding pre-tax estimates are reported in tables 3.9 and 3.10. The dependent variable is log (annual after-tax or pre-tax incomes). t-ratios are in parentheses. The coefficients of each education level measures the relative percentage increases in earnings brought about by obtaining these educational qualifications compared with those who did not complete Year 12. For example, on average, a male with Year 12 earned 13.4 percent more than those who did not complete Year 12 or an equivalent qualification in 1981. The rates of return between two levels of educational attainment are derived from subtracting their coefficients and the annual rate of return is obtained by subtracting coefficients of these two levels of education and dividing by the number of years needed to complete the next level of education. For example, the rates of return to complete a bachelor degree expected for those who have completed secondary education are equal to the differences between the coefficients of bachelor degree and year 12 education groups divided by four (recall that it is assumed that it takes four years to complete a bachelor degree).

7 See Heckman, Lochner and Todd (2005) for a detailed discussion of these issues.

3.7 Regression estimates of the private rates of return to education in Australia, male employees

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Year 12	0.134	0.114	0.142	0.175	0.223	0.254
	(8.15)	(7.5)	(5.9)	(6.14)	(7.21)	(9.88)
Skilled labour	0.204	0.207	0.229	0.258	0.302	0.465
	(12.20)	(13.39)	(9.37)	(8.91)	(9.62)	(17.81)
Bachelor degree	0.481	0.465	0.485	0.530	0.564	0.733
	(28.58)	(29.77)	(19.69)	(18.16)	(17.83)	(27.80)
Higher degree	0.541	0.530	0.589	0.649	0.662	0.817
	(31.66)	(33.40)	(23.57)	(21.92)	(20.61)	(30.54)
Experience	0.035	0.037	0.045	0.049	0.054	0.063
	(23.13)	(26.48)	(20.44)	(18.97)	(19.11)	(26.85)
Experience^2	–0.001	–0.001	–0.001	–0.001	–0.001	–0.001
	(–19.85)	(–21.89)	(–17.28)	(–15.61)	(–16.02)	(–23.21)
Constant	9.82	9.85	9.79	9.76	9.76	9.55
	(550.25)	(594.29)	(375.09)	(315.67)	(291.15)	(341.92)
Adjusted R^2	0.90	0.92	0.85	0.83	0.82	0.91

3.8 Regression estimates of the private rates of return to education in Australia, female employees

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Year 12	0.133	0.139	0.153	0.162	0.211	0.242
	(7.34)	(8.89)	(5.81)	(5.05)	(6.30)	(9.02)
Skilled labour	0.267	0.274	0.296	0.276	0.300	0.456
	(14.46)	(17.27)	(11.10)	(8.50)	(8.86)	(16.74)
Bachelor degree	0.557	0.553	0.521	0.532	0.588	0.762
	(29.94)	(34.52)	(19.32)	(16.20)	(17.22)	(27.70)
Higher degree	0.678	0.674	0.705	0.727	0.789	0.957
	(35.90)	(41.41)	(25.77)	(21.83)	(22.71)	(34.31)
Experience	0.015	0.015	0.025	0.032	0.037	0.044
	(8.99)	(10.73)	(10.66)	(11.02)	(12.09)	(17.82)
Experience^2	–0.0003	–0.0003	–0.0005	–0.0006	–0.0007	–0.0008
	(–7.78)	(–8.38)	(–9.00)	(–9.14)	(–10.39)	(–15.70)
Constant	9.68	9.73	9.67	9.65	9.65	9.42
	(491.10)	(572.48)	(338.66)	(277.40)	(266.18)	(323.29)
Adjusted R^2	0.89	0.92	0.81	0.77	0.78	0.90

3.9 Regression estimates of the pre-tax rates of return to education in Australia, male employees

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Year 12	0.157	0.147	0.173	0.204	0.251	0.293
	(7.76)	(8.56)	(6.39)	(6.45)	(7.28)	(10.32)
Skilled labour	0.237	0.267	0.278	0.302	0.341	0.532
	(11.57)	(15.31)	(10.14)	(9.40)	(9.76)	(18.50)
Bachelor degree	0.586	0.620	0.613	0.650	0.671	0.836
	(28.35)	(35.24)	(22.13)	(20.06)	(19.03)	(28.78)
Higher degree	0.662	0.718	0.748	0.804	0.800	0.939
	(31.55)	(40.21)	(26.61)	(24.45)	(22.36)	(31.88)
Experience	0.042	0.047	0.055	0.059	0.062	0.071
	(22.83)	(30.50)	(22.53)	(20.55)	(20.10)	(27.96)
Experience^2	–0.001	–0.001	–0.001	–0.001	–0.001	–0.001
	(–19.55)	(–25.29)	(–19.08)	(–16.92)	(–16.86)	(–24.21)
Constant	9.976	9.96	9.89	9.86	9.87	9.63
	(455.23)	(534.13)	(337.14)	(287.12)	(264.36)	(312.96)
Adjusted R^2	0.90	0.94	0.88	0.86	0.84	0.91

3.10 Regression estimates of the pre-tax rates of return to education in Australia, female employees

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Year 12	0.164	0.164	0.171	0.192	0.244	0.279
	(7.39)	(8.71)	(5.78)	(5.45)	(6.62)	(9.57)
Skilled labour	0.323	0.321	0.346	0.329	0.348	0.529
	(14.37)	(16.82)	(11.50)	(9.19)	(9.30)	(17.92)
Bachelor degree	0.656	0.677	0.634	0.634	0.677	0.881
	(28.96)	(35.13)	(20.90)	(17.56)	(17.94)	(29.59)
Higher degree	0.802	0.840	0.871	0.883	0.918	1.099
	(34.84)	(42.93)	(28.30)	(24.08)	(23.98)	(36.36)
Experience	0.018	0.019	0.030	0.037	0.042	0.049
	(8.91)	(11.17)	(11.17)	(11.61)	(12.60)	(18.41)
Experience^2	–0.0003	–0.0003	–0.0005	–0.0006	–0.0007	–0.0009
	(–7.69)	(–8.73)	(–9.43)	(–9.66)	(–10.85)	(–16.22)
Constant	9.82	9.85	9.77	9.75	9.75	9.48
	(408.50)	(482.02)	(304.00)	(254.68)	(243.85)	(300.48)
Adjusted R^2	0.89	0.92	0.84	0.80	0.80	0.91

These estimates confirm the conventional wisdom: the coefficients of the educational level dummy variables are positive; the effect of working experience is also positive; and it is negative for experience squared, reflecting the non-linear pattern of experience–earnings profile. The patterns of returns and their changes over time vary across alternative sex/education groups. The reference education group is those who do not complete secondary education. The returns for male employees increase over time and the increase is particularly noticeable for the secondary education group. For female employees, the patterns of increasing returns are only observed for the lower education groups. The increasing age coefficients over time for both men and women indicate that experience plays an increasingly important role in the shape of earnings profiles. The relatively lower experience coefficients for women are likely to reflect the flatter earning profiles for women.

4. TWO ESTIMATION METHODS COMPARED

4.1 Comparison of methodologies

Through comparing the two methods and a brief review of the developments in the returns-to-education literature, we can reach a number of conclusions. First, the estimates produced by the two methods provide related measures of rates of return to education, but from different perspectives. The regression-based method provides the foundation upon which increments in earnings attributable to education can be derived. The internal rate of return method is convenient and well defined for estimating the rate of return through comparing two alternative education paths for particular age groups, usually young age cohorts, who are major investors in formal education. Second, both estimates are useful but may serve different purposes. For decision making purposes in education investment, the internal rate of return method should be applied. For evaluating outcomes of past investment in education, both the financial and regression based methods could be applied.

To quantify the contribution of capital to the growth of output, economists need to estimate the rates of return to capital investments. In the case of physical capital, the basic question is what the rates of return are; in the case of human capital, economists have one unique fundamental question to confront: does education improve the productive capacity of an educated worker and hence increase his or her labour market earnings? To address the *ceteris paribus* issue of the impact of education on labour market earnings, the regression based estimation method is the appropriate tool to employ, because it allows us to control for other variables that affect labour market earnings as well. In this sense, the regression method is of primary importance for quantifying the impact of education on earnings and estimating the 'true' rates of return to investment in education. Accordingly, the internal rate of return method is secondary, based on the assumption that the ceteris paribus question is properly addressed and the earnings differentials between workers of different education levels are attributable to investment in education. Anyway, many studies (Hanoch, 1967; Borland, 2002; Access Economics, 2005) based on the internal rate of return method derive income streams of alternative educational paths by using fitted values from estimated earnings functions. This can not only fill in missing observations or replace 'outliers' but also isolate the impact of education on earnings by controlling for other explanatory variables affecting earnings.

In essence, the 'internal rate of return' is a financial concept. So a fundamental question is whether such regressions based on a financial analysis framework truly represent an 'internal rate of return' to investment in education? Heckman, Lochner and Todd (2005) relate this coefficient to the financial meaning of rate of return and show that under certain conditions this coefficient is a measure of the internal rate of

return to investment in education. Are these conditions met and subsequently is the schooling coefficient in applied human capital earnings function regressions a proper measures of the 'true' rate of return? The literature is divided on this issue. The conventional view is that the estimates of the profitability of investment in education derived by the regression method should give similar results to those derived by the internal rate of return method (Psacharopoulos, 1993) and the differences stem from non-conceptual factors, such as treatments of direct and indirect schooling costs, data sample coverage and incorporation of different variables (Psacharopoulos and Patrinos, 2004).

Heckman, Lochner and Todd (2005) disagree with the above conventional view and argue that "few of these estimates (obtained by running the earnings functions) are true rates of return" (p. 311). They demonstrate that the schooling coefficient in the Mincerian earnings function "is an average rate of return across all schooling investments and not, in general, an internal rate of return or a marginal return that is appropriate for evaluating the optimality of educational investments … (the coefficient) is the ex post average growth rate of earnings with schooling. It communicates how much average earnings increase with schooling, but it is not informative on the optimality of educational investments which requires knowledge of the ex ante marginal rate of return" (pp. 317–318).

Instead of using fitted values from estimated earnings functions, the internal rate of return method could rely on observed income flows of each age/education group, which is the way the present study constructs income streams of alternative educational paths. This approach may be useful for estimating nonparametric returns to education but its application is more challenging in terms of data requirements: rich cross-sectional data on individual labour market earnings (wages) are difficult to obtain. To derive appropriate estimates of the rates of return to education by the internal rate of return method, researchers need to collect data on various costs incurred across alternative types of education over different stages of each investment cycle. In addition, they need to construct 'desirable' age–earnings profiles for each types of investment and undertake calculations across different age groups. In contrast, the earnings function method is less data-demanding and relatively easy to run across countries over time. Due to these factors, the earnings function method is the most widely used in empirical investigations of rates of return to education. "Almost daily, new estimates of 'rates of return' to schooling are reported, based on numerous instrumental variable and ordinary least squares estimates" (Heckman, Lochner and Todd, 2005, p. 311).

As noted, the earnings function regression method is generally more convenient and significantly less costly in terms of data requirements. However, it is technically more complex as it requires rigorous econometric analysis. In contrast, the internal rate of return method is relatively easier to apply, and can provide comparable estimates for the private and social rates of returns to education. However, it is inconvenient to conduct a ceteris paribus analysis within the internal rate of return set-up. For example, in estimating the causal effects of higher education on wages, researchers may like to control for other variables such as experience and ability. The internal rate of return method does not readily allow researchers to do that.

Probably the most critical issue inherent in each method is the choice of an appropriate comparison group. The fundamental question labour economists attempt to address is what additional earnings an individual will receive if he or she undertakes additional schooling. In order to obtain estimates of the effect of investment in the next level of education, economists need to compare two income streams associated with alternative actions. As the same individual has already undertaken his education path, the other behaviour cannot be observed. Only one income stream is observed for a particular individual, not both. Economists have to derive their estimates of the returns to education by comparing earnings of different individuals with alternative educational attainment. This practice brings in the well-known self-selection problem. Of course, the self-selection problem is ubiquitous in economic analyses, and it is even more fundamental in estimating the economic return to education.

4.2 Comparison of results

Care must be taken in interpreting empirical results obtained from applying these two methods, because they may be based on slightly different assumptions and may take into account different effects in counting income flows stemming from alternative education paths. For example, direct costs and employment effects (i.e. more educated workers are more likely to have jobs) may not be (or inadequately) captured in the regression method.

Table 4.1 presents a comparison of estimated rates of return to four year bachelor degrees derived from the regression coefficients with comparable figures derived by the internal rate of return method, which are the ex ante estimates for employees presented in table 3.3 (recall that the earnings functions are based on employees' education/ experience profiles, which does not take into account employment effects on returns).

4.1 Regression-based and internal rate of return method-based estimates of private rates of return to a bachelor degree (%)

	1981	*1986*	*1991*	*1996*	*2001*	*2006*
Male						
Regression method	8.7	8.8	8.6	8.9	8.5	12.0
Internal rate of return method	9.4	9.2	9.4	10.2	10.7	12.5
Female						
Regression method	10.6	10.4	9.2	9.3	9.4	13.0
Internal rate of return method	10.6	10.4	9.2	10.0	10.6	13.4

The most interesting pattern is that the estimates based on the regression method are consistently lower than those obtained from the internal rate of return method for males throughout all years and for females in 1996 and 2001, and the two figures are the same for females for 1981, 1986 and 1991. Our interpretation is that this reflects the internal rate of return method applied in this study capturing the working experience wage premiums attributable to bachelor degrees (recall that the observed education/age earnings profiles are used to calculate the internal rates of return). While the regression method assumes that working experience is separate from educational attainment and parallel across all education groups, the wage premiums attributable to working experience associated with bachelor degrees are not accounted for in the earnings functions. Our human capital data (figure 1 in Wei 2004) show that females have relatively flatter age earnings profiles than their male counterparts and hence the two methods produce closer results for females.

One fundamental issue is whether the wage premiums attributable to working experience associated with higher educational attainment should be accounted for in estimating returns to investment in education. We think that human capital grows through regular use, and more educated workers are more likely to be employed in the labour market. The wage premiums attributable to the growth of human capital through increased working experience are important economic benefits of investment in education, and therefore should be captured in calculating rates of return to education.

5. COMPARISONS WITH OTHER AUSTRALIAN STUDIES

There are a few recent Australian studies of rates of return to university bachelor degrees on the basis of completing secondary education. This section compares the estimates of this study with findings of some of those studies. As empirical measures are subject to alternative methods, data sources and their dates, assumptions adopted, and the purposes for which measures are derived, to name a few, it is not possible to track down all differences between estimates presented in this study and other authors' estimates. The focus here is on the order of magnitudes in these estimates.

Borland *et al.* (2000), Larkin (2001) and Daly, Fleming and Lewis (2004) are selected for comparison because those studies are most comparable to this study. All of these studies employ the internal rate of return method to estimate rates of return to four year bachelor degrees for males. They differ in data sources, treatment of employment effects and selection of degree fields. Table 5.1 presents key information on these studies. The key methodological difference between those studies and this study is that those studies used regression equations to derive lifetime age earnings profiles, which are essential for calculating internal rates of return. Table 5.2 presents a comparison of the results from the above cited three studies, with the results of this study. This comparison is confined to employees without taking into account employment effects.

5.1 Australian studies of private rates of return to four-year bachelor degrees

Study	*Data*	*Factors accounted for*
Borland *et al.* (2000)	The ABS 1997 Training and Education Experience Survey, cost data taken from other studies.	After tax earnings, employment effects, foregone earnings, fees and direct costs
Larkin (2001)	Combined data from various sources in different points of time, such as education council data, data from education authorities, and an industry salary survey.	Gross earnings, tax rates, foregone earnings, fees and direct cost. (No employment effects were taken into account.)
Daly, Fleming and Lewis (2004)	1% sample of Australian Census from 1986 to 2001, cost data taken from other studies.	Annual gross incomes, employment effects, tax rates, foregone earnings, fees and direct costs.

5.2 Comparison of private rates of return to four-year bachelor degrees for males

Study	1986	1991	1996	1997	1999	2001
Borland *et al.* (2000) (a)				12.0		
Larkin (2001) (b)					15.0 (10.3)	
Daly, Fleming and Lewis (2004) (c)	9.4 (9.0)	10.3 (10.7)	10.0 (11.3)			11.7 (13.1)
This study	9.2	9.4	10.2			10.7

(a) This figure, as a single year estimation for 1997, is for four-year general bachelor degree without adjustment for employment effects, taken from Table 2.5 of Borland *et al.* (2000);

(b) As a single year estimation for 1999, Larkin (2001) provides separate estimates for four year science & technology (used as for main comparable figure) and humanities & social sciences (in brackets) bachelor degrees in 1999. As Larkin uses salary statistics as earnings variable, no employment effects are taken into account in that study;

(c) Daly, Fleming and Lewis (2004) provide separate estimates for four year economics, law, business and other bachelor degrees for the 1986–2001 four Australian Census years. As for 'other' bachelor degree category may better represent general bachelor degree, its rates of return are chosen as main comparable figures, with the corresponding figures for the economics degree presented in brackets.

The main findings from this comparison are twofold. First, all these studies confirm that the private rates of return to bachelor degrees are sizeable, even if employment effects are not captured in these figures. Second, the differences between these estimates are also noticeable. Our results are much closer to those of Daly, Fleming and Lewis (2004). As discussed earlier, these differences could be tracked due to differences in details of methodology, assumptions, data sources and other factors. As both Daly, Fleming and Lewis (2004) and this study use Australian Census data, the source of data is likely to be very important in explaining differences of estimated rates of return to education from different studies.

6. CONCLUSIONS

Estimates of rates of return to education are widely reported in academic research papers and have even become regular statistics of the OECD (*Education at a Glance*, OECD, 2007). Using the 1981–2006 six waves of full Australian Census data, this study attempted to produce estimates of rates of return to education in Australia spanning a 25 year period. Given the importance of university education in human capital formation, the measurement of this study focused on the expected rates of returns to four-year bachelor degrees in Australia.

The base case of this study was the 18 year old age cohort facing alternative educational paths between engaging in the labour market on a full time basis and full time study for a bachelor degree at a university. The expected private rates of return from this educational investment increased over time for males, from 13.1 percent in 1981 to 19.6 percent in 2001, and then dropped to 15.3 percent in 2006; the range was 18.0 percent to 17.3 percent for females over the same period. Comparing table 3.1, which takes into account the employment effects of education on earnings, with table 3.3, which excludes the employment effects, we can say that around half of the returns can be traced to greater experience in the labour market and the other half can be attributed to the enhanced productive capacity of educated persons. The associated ex post estimates show that the investment outcomes prove to be consistently better than expected.

In addition, this study also provided estimates of the Mincer-type rates of return to various levels of post-school education. Though not informative in relation to the optimality of educational investment, these estimates are useful for evaluating the outcomes of past educational investments. The results from the group earnings regressions showed that returns to educational investments generally increase over time for both males and females, with some short term fluctuations for the bachelor degree category. In particular, increases in the returns to completion of secondary education since 1991 are dramatic, confirming the popular notion that completing secondary education is the basic skill requirement in the labour market.

Drawing on the recent work of Heckman, Lochner and Todd (2005), this paper highlighted the connections and differences between the internal rate of return method and Mincer's human capital earnings function method. The key difference is that the internal rate of return method accounts for the effect on earnings of enriched working experience associated with higher educational attainment, while the regression method assumes that earnings experience profiles are parallel across educational levels and impose this restriction on regression functions. This study compared estimates produced from the internal rate of return method with those derived from the regression method. It showed that estimates of the rates of return to bachelor degrees, obtained by applying the internal rate of return method, were

higher than those derived by using the regression method. This study argued that the growth of human capital through increased working experience are important economic benefits of investment in education, and therefore should be captured in calculating rates of return to education.

One important finding from the comparison with other Australian studies is that the magnitudes of estimated rates of return appear to be related to data sources. There is a variety of data sources available for obtaining estimates of rates of return. Data sets may vary in terms of definitions of income (weekly, hourly or annual rates, wages and salaries or total compensation), sample method, sample sizes, availability of variables associated with income, and other factors. Therefore given the same estimation technique, estimation results may be sensitive to what kind of data source is used.

The rates of returns estimated by this study are based on a broad group level, which makes it easier to conduct calculations by using the full Census data. One shortcoming of this practice is its inability to control for other variables that affect income, such as family background. One possible extension of this study is to estimate rates of returns at an individual level, so we could remove the effects on labour incomes of other variables associated with individuals' labour market earning power. In addition, we could produce estimates of rates of returns to education by study fields, ethnic backgrounds, and other social characteristics. Another interesting direction for future research is to investigate the impact of alternative data sources on magnitudes of estimated rates of returns to education.

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