CONSULTANCY PROJECT REPORT FOR THE NEW SOUTH WALES DEPARTMENT OF EDUCATION

Measuring Economic Returns to Post-school Education in Australia: Evidence from the 1981-2011 Australian Censuses

By Hui Wei
Economic Analysis and Reporting Section
Australian Bureau of Statistics

1. Introduction

It is widely acknowledged that education plays a crucial role in producing human capital, arguably the most important asset of any country. In particular, investment in university bachelor degrees is the most important form of human capital formation by post-school education (Wei 2008). Economic return to investment in education is an important factor in determining schooling activities of individuals and their educational attainment. In addition, the information on returns to higher education is useful for education policy settings and individuals in making decisions in schooling choices.

In 2010 the ABS released a research paper titled "Measuring Economic Returns to Post-School Education in Australia". That paper presented estimates of the economic returns to post-school education, with a focus on the rates of return to investment in university bachelor degrees. At the time of its publication, the paper attracted attention among policymakers, in particular from those working in the field of public education. The estimates of the paper were based on the Australian Census data 1981-2006. With the availability of the 2011 Census data, this paper updates those estimates to meet the needs of policymakers in public education and the general user community.

During the period 2006-2011, the defining feature of the Australian economy is that Australia experienced the biggest mining boom in history, with the Mining industry's share in the economy growing from 5% to about 10%. This structural change has significant impact on the demand for mining labour and associated construction workers. The mining boom-led expansion saw unemployment rates at historical lows and labour force participation rates at historical highs. The increased demand for less educated workers narrowed wage gaps between the more and less educated workers and reduced rates of return to education. This is why the rate of return for males is significantly lower since 2006 after it peaked at 25.3 percent in 2001. With the mining boom being over, the reverse is possible for years ahead. Indeed, as technical progress is the key driver for long term economic growth, demand for more educated workers will remain high. Meanwhile, with the economy becoming increasingly knowledge based, job

opportunities and choices for the less educated are limited and hence their labour earnings.

In the next section, we summarise the methods and data for constructing estimates of rates of return to post-school education. In particular, we clarify a few conceptual and methodological issues. In section 3, we highlight the key features of the updated estimates. Finally, we present our conclusions.

2 Methods and Estimation Procedures

In the labour/education economics literature, 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 study focus on the economic returns to investment in a university bachelor degree in Australia.

Empirical measures of the returns to education can be obtained by applying two alternative approaches: the financial method[1] and the earnings function method.

2.1 Financial Method

Rates of return to education based on the financial 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 for the lower educated cohort, 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.

[1] Psacharopoulos (1993) terms the financial method as 'the elaborate' method.

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 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 are the rates of returns 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.

The basic scenario of investment in a bachelor degree is defined as the 18 year old group who has completed secondary education and has two choices of career paths: to undertake a four-year university bachelor degree study and commence employment in the labour market; or to join the labour force straightaway without any post-secondary studies.

Private Rate of Return

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 private returns. In terms of equation (1), the cash flows for the representative student are defined as follows:

1) The bachelor degree takes full time of four years to complete;

2) The representative student does not work and therefore incurs an opportunity cost (i.e. the labour earnings of those who have completed secondary education);

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 this 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.

The representative student pays direct costs, such as university fees, Higher Education Contribution Scheme (HECS) and other charges. These costs varied over time. When the HECS was first introduced in 1989, a flat fee of $1,800 was charged to all university students, regardless of the courses. In 1996 the HECS fee structure was revised and fees started to be charged on the basis of the perceived value of courses. Qualifications leading to higher labour market earnings, such as law and medicine degrees, are more expensive than those expected to generate relatively lower incomes, such as art and humanity degrees. Course fees also vary across universities. In addition, government subsidized courses and full-fee paying courses add another layer of complexity to the cost structure of university degrees. In this context, it requires a separate study to obtain accurate estimates of the average direct cost over time for a bachelor

degree from Australian universities.[2] Given the lack of this data, direct costs are excluded in this study.

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 study cost is given by $\sum_{a=18}^{21} x_{ja} / (1+r)^{-(a-18)}$, 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:

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

Pre-income-tax Rate of Return

Human capital does not only bring benefits to individuals but also to the society and the community to which individuals relate. These benefits include extra income taxes and lower social transfers paid to individuals due to enhanced earnings through additional education, better health, informed political participation, fewer crimes, and higher returns to capital. These social returns are harder to measure and it seems that empirical evidence so far is meagre.[3] Some researchers use pre-tax income as a measure of social returns (Maani 1996). This study produces pre-tax estimation of returns to education. Anyway, income tax is an important component in income flows and hence the internal rate of returns can be estimated on an after- and before-income-tax basis. As such measures may capture only a proportion of social returns, this study prefers to call these returns pre-tax returns instead of social returns.

Ex-ante and Ex-post Rates of Return

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

[2] The Department of Education, Employment and Workplace Relations commissioned Deloitte Access Economics to conduct a study of higher education teaching and learning costs in 2011.
[3] Lange and Topel (2006) provide a survey of the literature on the social returns to education.

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, ……65, and t stands for year, with t =1, 2, ……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 $(y_{18,1} - x_{18,1})$, $(y_{19,2} - x_{19,2})$, $(y_{20,3} - x_{20,3})$, ……$(y_{32,15} - x_{32,15})$; in the second option, the cash flow series is constructed as $(y_{18,1} - x_{18,1})$, $(y_{19,2} - x_{19,2})$, $(y_{20,3} - x_{20,3})$, …… $(y_{32,15} - x_{32,15})$, $(y_{33,15} - x_{33,15})$, $(y_{34,15} - x_{34,15})$,……$(y_{65,15} - x_{65,15})$.

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. On the other hand, because it mixes the realised and the expected income flows, it may not be appropriate to term this as 'ex-post'. However, estimating the rate of return in this way 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.

2.2 Mincer's Human Capital Earnings Function

The semi-logarithmic earnings function, the well-known Mincer's 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's 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:

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

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 an omitted variable 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.

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 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 Rodrigues-Clare (1997) call the "Macro-Mincer" wage equation:

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

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:

$$\ln W_{e,a} = \alpha_0 + \beta_1 Year12_{e,a} + \beta_2 Skilled_{e,a} + \beta_3 Bachelor_{e,a} + \beta_4 Higher_{e,a} + \beta_5 X_{e,a} + \beta_6 X_{e,a}^2 + u_{e,a} \qquad (3a)$$

where $W_{e,a}$ denotes the average annual earnings for a given education/age group. The age range and associated working experience for each education category is specified as follows:

- When e = Year12 (or incomplete secondary education), a =18,19,20…63,64,65 and $X_{e,a} = a - 18$;
- When e = Skilled, a =20…63,64,65 and $X_{e,a} = a - 20$;

- When e = Bachelor, a =22, 23,24 ...63,64,65 and $X_{e,a} = a - 22$;

- When e = Higher, a =24, 25, 26 ...63,64,65 and $X_{e,a} = a - 24$.

There are 223 observations for each education/age 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 individual level, but the magnitudes of coefficients should be of 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 in executing the regression programs.

This study employs ordinary least squares (OLS) to estimate the group earnings function specified in equation (3a). The return to education obtained through the OLS estimates of the Mincer earnings function is subject to various sources of bias and recent developments provides alternative estimation techniques to solve these issues.[4] 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 1981-2011 waves of Australian Census data, and they may provide a reasonable picture of the long-term trend of returns to education in Australia.

3 Empirical Results

3.1 Financial Method Estimates of Rates of Return to Bachelor Degrees

Table 3.1 present 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, 2006 and 2011. 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

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

return was 15.4 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 who 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.

Table 3.1 Private rates of return to a university degree for persons in Australia: 1981-2011 (%)

	1981	1986	1991	1996	2001	2006	2011
Male							
Ex-ante	13.1	18.7	20.9	22.4	25.3	21.2	20.8
Ex-post (a)	23.6	25.7	25.7	26.8			
Female							
Ex-ante	18.0	22.0	23.1	24.7	25.6	26.0	28.8
Ex-post (a)	26.9	26.6	28.1	31.0			

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 2001 and 2011 is less than 15 years, no ex-post returns are estimated for 2001 onwards.

There are a number of findings. First, the expected rates of return for male cohorts increased over time until 2001, from 13.1 percent in 1981 to 25.3 percent in 2001, and then dropped to 20.8 percent in 2011. Second, compared with the rates for male cohorts, the corresponding rates for female cohorts are higher throughout the whole period. Third, the ex-post estimates are much higher than the ex-ante estimates for both male and female, reflecting the overall increasing trend over time. It is particularly so for females.

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

Table 3.2 Pre-tax rates of return to a university degree for persons in Australia: 1981-2011 (%)

	1981	1986	1991	1996	2001	2006	2011
Male							
Ex-ante	15.5	22.5	24.8	25.9	28.9	24.4	24.5
Ex-post (a)	26.9	29.0	28.9	29.9			
Female							
Ex-ante	20.3	24.8	26.4	28.0	28.9	29.7	32.6
Ex-post (a)	29.7	29.4	31.0	34.1			

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 2001 and 2011 is less than 15 years, no ex-post returns are estimated for 2001 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 derived from earnings flows without adjustment for the effects of unemployment rates and labour force participation rates on lifetime earnings. The lower rates of returns with respect to those in Table 3.1 and Table 3.2 are due to the fact that these estimates exclude the benefits of lower unemployment rates and higher labour force participation rates for the more educated cohorts.

Table 3.3 Private rates of return to a university degree for employees in Australia: 1981-2011 (%)

	1981	1986	1991	1996	2001	2006	2011
Male							
Ex-ante	9.4	9.6	10.6	11.7	13.1	16.0	15.5
Ex-post (a)	16.3	15.5	15.2	16.5			
Female							
Ex-ante	10.6	10.9	10.5	11.8	13.3	18.4	22.0
Ex-post (a)	16.5	15.5	16.4	19.4			

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 2001 and 20011 is less than 15 years, no ex-post returns are estimated for 2001 onwards.

Table 3.4 Pre-tax rates of return to a university degree for employees in Australia: 1981-2011 (%)

	1981	1986	1991	1996	2001	2006	2011
Male							
Ex-ante	11.8	13.1	14.1	15.1	16.5	18.9	18.7
Ex-post (a)	19.6	18.5	17.9	19.2			
Female							
Ex-ante	12.6	13.6	13.5	14.6	16.1	22.0	25.6
Ex-post (a)	19.2	17.8	18.7	22.1			

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 2001 and 20011 is less than 15 years, no ex-post returns are estimated for 2001 onwards.

Without adjustments for the effects of unemployment rates and labour force participation rates on lifetime earnings, the rates of return to investment in bachelor degrees are relatively stable over time and the gap between male and female estimates is much smaller. This indicates that the benefits of lower unemployment rates and higher labour force participation rates account for a significant proportion of returns to these educational investments.

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. Table 3.5 and Table 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.

Table 3.5 Sensitivity analysis: retirement age and private rates of return to a university degree (%)

	1981	1986	1991	1996	2001	2006	2011
Male							
Retire at 55	12.89	18.67	20.89	22.33	25.33	21.21	20.81
Retire at 60	13.03	18.72	20.92	22.35	25.34	21.23	20.82
Retire at 65	13.09	18.73	20.92	22.35	25.34	21.24	20.83
Female							
Retire at 55	17.97	21.97	23.05	24.74	25.63	25.98	28.84
Retire at 60	18.01	21.99	23.06	24.75	25.64	25.98	28.84
Retire at 65	18.02	21.99	23.06	24.75	25.64	25.98	28.84

Table 3.6 Sensitivity analysis: retirement age and pre-tax rates of return to a university degree (%)

	1981	1986	1991	1996	2001	2006	2011
Male							
Retire at 55	15.41	22.47	24.76	25.86	28.86	24.43	24.45
Retire at 60	15.50	22.49	24.78	25.87	28.87	24.44	24.46

Retire at 65	15.53	22.50	24.78	25.87	28.87	24.44	24.47
Female							
Retire at 55	20.31	24.84	26.34	27.97	28.90	29.72	32.62
Retire at 60	20.33	24.85	26.35	27.97	28.90	29.73	32.62
Retire at 65	20.34	24.85	26.35	27.97	28.90	29.73	32.62

3.2 Estimates of Mincer Earnings Function

The estimates of private (after-tax) returns are reported separately for males and females in Table 3.7 and Table 3.8 respectively. The corresponding pre-tax estimates are reported in Table 3.9 and Table 3.10. The dependent variable is log (annual after-tax or pre-tax incomes). T-ratios are in parentheses. 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 age-earnings profile.

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

	1981	1986	1991	1996	2001	2006	2011
Year 12	0.134	0.114	0.142	0.175	0.223	0.254	0.117
	(8.15)	(7.5)	(5.9)	(6.14)	(7.21)	(9.88)	(5.38)
Skilled labour	0.204	0.207	0.229	0.258	0.302	0.465	0.280
	(12.20)	(13.39)	(9.37)	(8.91)	(9.62)	(17.81)	(13.30)
Bachelor degree	0.481	0.465	0.485	0.530	0.564	0.733	0.526
	(28.58)	(29.77)	(19.69)	(18.16)	(17.83)	(27.8)	(24.88)
Higher degree	0.541	0.530	0.589	0.649	0.662	0.817	0.581
	(31.66)	(33.40)	(23.57)	(21.92)	(20.61)	(30.54)	(27.37)
Experience	0.035	0.037	0.045	0.049	0.054	0.063	0.04
	(23.13)	(26.48)	(20.44)	(18.97)	(19.11)	(26.85)	(26.66)
Experience^2	-0.001	-0.001	-0.001	-0.001	-.001	-0.001	-0.001
	(-19.85)	(-21.89)	(-17.28)	(-15.61)	(-16.02)	(-23.21)	(-23.96)
Constant	9.82	9.85	9.79	9.76	9.76	9.55	10.13
	(550.25)	(594.29)	(375.09)	(315.67)	(291.15)	(341.92)	(431.16)
Adj R^2	0.90	0.92	0.85	0.83	0.82	0.91	0.88

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

	1981	1986	1991	1996	2001	2006	2011
Year 12	0.133	0.139	0.153	0.162	0.211	0.242	0.189
	(7.34)	(8.89)	(5.81)	(5.05)	(6.3)	(9.02)	(10.97)
Skilled labour	0.267	0.274	0.296	0.276	0.300	0.456	0.535
	(14.46)	(17.27)	(11.1)	(8.5)	(8.86)	(16.74)	(32.03)
Bachelor degree	0.557	0.553	0.521	0.532	0.588	0.762	0.799
	(29.94)	(34.52)	(19.32)	(16.2)	(17.22)	(27.70)	(47.65)
Higher degree	0.678	0.674	0.705	0.727	0.789	0.957	0.917
	(35.9)	(41.41)	(25.77)	(21.83)	(22.71)	(34.31)	(54.40)
Experience	0.015	0.015	0.025	0.032	0.037	0.044	0.034
	(8.99)	(10.73)	(10.66)	(11.02)	(12.09)	(17.82)	(26.18)
Experience^2	-0.0003	-0.0003	-0.0005	-0.0006	-0.0007	-0.001	-0.000
	(-7.78)	(-8.38)	(-9)	(-9.14)	(-10.39)	(-15.70)	(-24.1)
Constant	9.68	9.73	9.67	9.65	9.65	9.63	9.80
	(491.1)	(572.48)	(338.66)	(277.4)	(266.18)	(312.96)	(525.44)
Adj R^2							
	0.89	0.92	0.81	0.77	0.78	0.90	0.95

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 increasing important role in the shape of earnings profiles. The relatively lower age coefficients for women may reflect the flatter earning profiles for women.

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

	1981	1986	1991	1996	2001	2006	2011
Year 12	0.157	0.147	0.173	0.2040	0251	0.293	0.138
	(7.76)	(8.56)	(6.39)	(6.45)	(7.28)	(10.32)	(5.78)
Skilled labour	0.237	0.267	0.278	0.302	0.341	0.532	0.322
	(11.57)	(15.31)	(10.14)	(9.40)	(9.76)	(18.50)	(13.90)
Bachelor degree	0.586	0.620	0.613	0.650	0.671	0.836	0.610
	(28.35)	(35.24)	(22.13)	(20.06)	(19.03)	(28.78)	(26.20)
Higher degree	0.662	0.718	0.748	0.804	0.800	0.939	0.677
	(31.55)	(40.21)	(26.61)	(24.45)	(22.36)	(31.88)	(28.92)
Experience	0.042	0.047	0.055	0.059	0 .062	0.071	0.049
	(22.83)	(30.50)	(22.53)	(20.55)	(20.10)	(27.96)	(27.20)
Experience^2							
	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(-19.55)	(-25.29)	(-19.08)	(-16.92)	(-16.86)	(-24.21)	(-24.84)
Constant	9.976	9.96	9.89	9.86	9.87	9.63	10.25
	(455)	(534)	(337)	(287)	(264)	(313)	(395.84)
Adj R^2							
	0.90	0.94	0.88	0.86	0.84	0.91	0.89

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

	1981	1986	1991	1996	2001	2006	2011
Year 12	0.164	0.164	0.171	0.1920	0.244	0.279	0.207
	(7.39)	(8.71)	(5.78)	(5.45)	(6.62)	(9.57)	(11.3)
Skilled labour	0.323	0.321	0.346	0.329	0.348	0.529	0.607
	(14.37)	(16.82)	(11.50)	(9.19)	(9.30)	(17.92)	(34.20)
Bachelor degree	0.656	0.677	0.634	0.634	0.677	0.881	0.910
	(28.96)	(35.13)	(20.90)	(17.56)	(17.94)	(29.59)	(50.97)
Higher degree	0.802	0.840	0.871	0.883	0.918	1.099	1.051
	(34.84)	(42.93)	(28.30)	(24.08)	(23.98)	(36.36)	(58.55)
Experience	0.018	0.019	0.030	0.037	0.042	0.049	0.038
	(8.91)	(11.17)	(11.17)	(11.61)	(12.60)	(18.41)	(27.52)
Experience^2	-0.000	-0.000	-0.000	-0.001	-0.001 (-	- 0.001	-0.001
	(-7.69)	(-8.73)	(-9.43)	(-9.66)	10.85)	(-16.22)	(-25.23)
Constant	9.82	9.85	9.77	9.75	9.75	9.48	9.885
	(408.50)	(482.02)	(304.00)	(254.68)	(243.85)	(300.48)	(497.52)
Adj R^2	0.89	0.92	0.84	0.80	0.80	0.91	0.96

The rates of returns between two levels of educational attainment are derived from subtracting their coefficients and the annual rate of return of educational investment from one level to the next 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. 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 ($(\beta_3 - \beta_1)/4$) (assuming that it takes four years to complete a bachelor degree). Table 3.11 presents a comparison of estimated rates of return to four year bachelor degrees derived from the regression coefficients with comparable figures derived by the financial 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).

Table 3.11 Regression-based and financial method-based estimates of private rates of return to a four-year bachelor degree (%)

	1981	1986	1991	1996	2001	2006	2011
Male							
Regression method	8.7	8.8	8.6	8.9	8.5	12.0	10.2
Financial method	9.4	9.6	10.6	11.7	13.1	16.0	15.5
Female							
Regression method	10.6	10.4	9.2	9.3	9.4	13.0	15.3
Financial method	10.6	10.9	10.5	11.8	13.3	18.4	22.0

The most interesting pattern is that the estimates based on the regression method are consistently lower than those obtained from the financial method for both male and female throughout all years. Our interpretation is that the financial method applied in this study captures 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.

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.

4 Conclusions

Using the 1981-2011 seven waves of full Australian Census data, this study produces estimates of rates of return to education in Australia spanning a 30 year period. Given the importance of university education in human capital formation, the measurement of this study focuses on the expected rates of returns to four-year bachelor degrees in Australia.

Drawing on the recent work of Heckman et al (2005), this paper highlighted the connections and differences between the financial method and Mincer's human capital earnings function method. The key difference is that the financial 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 financial method with those derived from the regression method. It showed that estimates of the rates of return to bachelor degrees, obtained by applying the financial 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.

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 rate of return for females continued to increase throughout the period. For males, this rate increased over time, from 13.1 percent in 1981 to 25.3 percent in 2001. It then started to drop since 2006 to 20.6 percent in 2011. This falling rate of return is largely due to the structural change in the Australian economy starting around 2003 when China's unprecedented economic growth created extraordinary demand for Australia's iron ore and other mineral products. Massive investment projects in the Mining industry saw rapid expansion of employment for less educated workers and hence greatly narrowed wage gaps between the more educated and the less educated. During this period, Australia also witnessed record lows of unemployment rates and record highs for labour force participation rates.

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