MEASURING OPTION VALUES AND ECONOMIC BENEFITS OF COMPLETING SECONDARY EDUCATION IN AUSTRALIA

HUI WEI

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ABSTRACT

This paper presents estimates of the economic benefits of completing secondary education in Australia. The purpose of focusing on secondary school education is to highlight the importance of base level education in the production of human capital over life cycles of young men and young women. The distinctive feature of this study is that it attempts to calculate the option values generated by completing secondary education which are the opportunities for obtaining more advanced human capital skills through undertaking tertiary study programs.

This study uses a modified Jorgenson and Fraumeni (1989, 1992) lifetime labour income approach, which measures economic benefits of completing secondary education by additions to lifetime labour incomes due to additional schooling activities. Option values are calculated as differences between alternative lifetime labour incomes associated with the corresponding schooling choices upon completing secondary education.

The empirical results show that option values make up significant proportions of total returns to secondary education, ranging from 20% to 30% for men, and from 28% to 44% for women over the period 1986–2001. In particular, option values become increasingly prominent in recent years which have witnessed strong demand for more educated workers.

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1. INTRODUCTION

The objective of this paper is to present estimates of the economic benefits of completing secondary education [1] in Australia. The purpose of focusing on secondary school education is to highlight the importance of base level education in the production of human capital over life cycles of young men and young women. The distinctive feature of this study is that it attempts to account for the option values generated by completing secondary education which are the opportunities for obtaining more advanced human capital skills through undertaking tertiary study programs. These open up possibilities of getting better paid jobs and entering higher status occupations. Our estimation is Australia wide based on Census data from 1986 to 2001.

Estimating returns to education is one of the most widely applied topics in the labour literature. Until very recently much of the literature has focused on the returns to investment in university degrees following completion of secondary schooling – for example, Card (1999, 2001), Larkins (2001) and Access Economics (2005). Recent research in studies of human capital skill formation [2] show that human capital skills are produced sequentially; those human capital skills acquired at one stage of the life cycle become a necessary condition for learning more advanced human capital skills for the next stage; and it is costly to remedy the skills that have been missed at the stage when their formation should occur. Drawing on these research developments and related policy experience of other OECD countries, the Council of Australian Governments attaches importance to completion of a base level qualification (equivalent to Year 12) by arguing

> "A base qualification is rapidly becoming a basic requirement for employment security….adult workers aged 25–64 who have not attained a qualification equivalent to Year 12 are significantly more likely to be jobless – that is, either unemployed or not in the workforce." (COAG, 2005, p. 36)

By quantifying the economic benefits of completing secondary education, this paper provides empirical evidence for those benefits.

In estimating the economic benefits of completing secondary school education, this study takes a broad view. It does not only focus on participation in the final year of secondary school but also on school participation in the years leading up to the final year. This choice arises from two considerations. First, an increase in participation in the final year of secondary school is closely related to increases in school participation in the earlier years of secondary school leading up to Year 12. Secondly, secondary

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1 The study scope of secondary education in this paper is confined to schooling activities undertaken by 15–18 year olds.

2 Heckman provided excellent surveys of research development in this area in several recent papers, such as Heckman (2005) and Carneiro and Heckman (2003).

school participation in the years prior to completing Year 12 contributes to human capital formation and can be estimated in terms of additions to lifetime labour incomes, which forms the central framework of this paper. Ideally, we would like to measure the contribution of each year of post compulsory secondary education (Year 9 to Year 12). Instead, due to data limitations (to be discussed later), this study considers school participation by the age group of 15–18 year olds.

One more introductory comment is necessary on the limitations associated with studies based on the Population Census, the main data source in this study. Census data lacks ability measures and therefore estimates of returns to education derived from Census data usually ignore ability bias.[3] That is they assume that the additional earnings obtained by someone with a higher qualification are due to that qualification and not to higher ability. The same applies to the present study. However, many empirical studies suggest that ability biases are small and education has a significant impact on earnings of individuals undertaking additional schooling activities.[4] Even if we could measure the returns to abilities which are independent from education, it is not clear what is the best way to correct for ability biases.[5] Nevertheless, readers should be aware of the assumption made about ability bias.

The structure of this paper is as follows. Section 2 provides a brief review of recent development in the return-to-education literature, with focus on the concept of option value being applied in estimating returns to education. Section 3 presents our methodology and introduces the variables appearing in the calculations and computation procedures. Section 4 provides some sample statistics of the key variables used in projecting per capita lifetime labour incomes. Section 5 presents empirical results. Section 6 concludes.

3 See Heckman, Lochner and Todd (2005).

4 See Card (1999) for a selective review of empirical evidence on effect of ability on earnings. In addressing the concern of ability bias to the JF lifetime labour income approach, Fraumeni (2000) provides this response: "Griliches (1970) and Griliches and Mason (1972) pursued this question of ability, income and schooling. Their conclusion is that ability has little effect on income, but that schooling has a significant effect on income."

5 For recent critical reviews of instrumental and IQ variables models, see Hansen, Heckman and Mullen (2004) and Heckman, Lochner and Todd (2005).

2. RECENT DEVELOPMENT IN THE RETURNS-TO-EDUCATION LITERATURE

The conventional method of estimating returns to education, represented by the framework of Mincer's (1974) human capital earnings function (HCEF hereafter), is based on the comparative analysis of two educational groups which take an alternative course of action: one group participates in the labour market, while the other group makes an investment by undertaking additional schooling activities. The returns to additional education are estimated based on the comparison between the two earnings flows associated with these two courses of actions. No option value (defined later) is accounted for by the conventional method.

In a recent paper, Heckman, Lochner and Todd (2005) (HLT hereafter) have challenged the conventional cross-sectional based estimation of lifetime earnings profiles and associated rates of returns to education. Their central point is that using current cross-sectional earnings profiles as guidelines for lifetime earnings profiles of persons was fine for the 1960s US labour market data. In recent time periods, age/earnings profiles differ considerably across cohorts. They argue that current cross-sectional age earnings profiles are no longer useful for estimating the life cycle earnings of any particular individuals or groups. Under this circumstance, continuing to rely on current cross-sectional information to forecast future earnings patterns would produce a misleading prediction of potential economic benefits. Changing patterns and nonstationarity of earnings across cohorts over time must be accounted for in estimating rates of return to investment in education. They suggest that alternative approaches are needed to incorporate these uncertainties into predictions of the future earnings growth paths.

According to HLT, in dynamic settings in which schooling choices are made sequentially and rates of returns to education vary with alternative levels of schooling activities, there exist sizeable option values generated by completing lower levels of schooling activities.

> "Completing high school generates the option to attend college and attending college generates the option to complete college … part of the economic return to finishing high school or attending college include the potential for completing college and securing the high rewards associated with a college degree." (HLT, 2005, p. 5).

The HCEF estimates the rate of return to education by using the direct return, which is the return from stopping at one schooling level versus the return from stopping at the next schooling level. The option value is the return in excess of the direct return – that is the potential for possible greater returns associated with completing a base level education. The human capital skills produced by one schooling level are important inputs in the production of additional human capital. In this sense, option values are the economic benefits of probabilities of higher qualifications for

individuals who complete base level education qualifications. In accounting for economic benefits arising from additional schooling, the potential benefits from the probabilities of obtaining higher education qualifications should be included as an important element.

So far methods used for valuing option values generated by investment in education are micro-model based. These models adopt advanced econometric techniques to separate effects of schooling and ability on wage premiums.[6] The running of these models generally requires the availability of longitudinal survey based data sets. Since census-based data set is not appropriate for applying these econometric techniques, this paper adopts the lifetime labour income approach to measure option values associated with completing secondary education (Section 3.3 shows how option values are estimated using the JF approach).

The original JF approach is based on current cross sectional education/age/earnings profiles and hence its estimates of lifetime labour incomes are subject to short-term business cycle effects. In order to remove this kind of effects, this study has modified the original JF approach to take into account the impact of current short-term fluctuations of labour market incomes on projections of the lifetime labour incomes. More detailed description of the JF methodology and our associated modifications is provided in Section 3.

6 HLT (2005) provides surveys of such models.

3. METHODOLOGY

3.1 Jorgenson and Fraumeni lifetime labour income approach

Our methodology for estimating economic benefits (including option values) of completing secondary education is based on the lifetime labour income approach, developed by Jorgenson and Fraumeni (1989, 1992) and applied to the Australian economy by Wei (2004). This method measures human capital per capita for a given sex/education/age group as the discounted present value of expected lifetime labour income per capita for that group. Expected income streams are derived from using current cross-sectional information on labour incomes, employment rates and school participation rates. The lifetime labour incomes are projected by backward recursion, which works as follows: an individual's present value of his or her lifetime income is equal to the current period income plus the present value of his or her lifetime income in the next period. Of course, the present value of his or her lifetime income in next period is not readily available and has to be estimated. By working backward from the lifetime income of individuals with the highest level of education and oldest working age, the present value of an individual's next period income can be derived. JF assume that all individuals retire at age of 75. Holding sex and education level as constant, for example, an individual's present value of lifetime labour income at age of 74 is just his or her current period's labour income; then, this individual's present value of lifetime labour income can be used to estimate the next period's present value of lifetime labour income for a 73 years old individual with the same sex and education level. By working backward in this way for all possible combinations of sex and education level, all individuals' present value of lifetime labour income in next period can be derived. Given lifetime labour incomes per capita for various educational groups, the economic benefits of undertaking additional educational activities are measured by additions to lifetime labour incomes due to the higher educational attainments achieved.

3.2 Cohort-based estimation of lifetime labour income

One of the major concerns with the JF approach is that estimation of lifetime labour incomes based on current cross-sectional information is subject to short-term business cycle effects: it tends to under-estimate lifetime labour incomes in recession years and over-estimate in booming years. This problem becomes obvious if the measurement of human capital is confined to labour market activities, which fluctuates with business cycles. For example, since the Australian economy was in recession in 1991 and real wages experienced negative growth, our human capital stock and flow measures for the 1991 figures show significant downturns (Wei, 2004).

In addressing the business cycle effect on projection of lifetime labour incomes, this paper uses a cohort-based moving average method. We start with the JF method which decomposes lifetime labour incomes into two elements: current labour incomes and lifetime labour incomes for the group with the same sex/education characteristics but one year older. In the original JF approach, the second element is approximated by current incomes of older age groups plus uniform real income growth factor. By our simplified moving average method, the second element in the JF framework is approximated by a linear combination of lifetime labour incomes of older age cohorts between Census years. Just like the JF approach which calculates the incomes by a backward recursion, we work backward from the lifetime incomes of individuals in the most recent period (2001 in our case), then move on to the next recent period (1996) and so on. In this way, all Census income data is chained together.

3.3 Computation assumptions and procedures

This study considers three scenarios of an individual life path for 15–18 year olds: joining the working age population without completing secondary education; completing secondary education and joining the working age population without undertaking any post school studies; and obtaining post school qualifications beyond secondary education. Their current and continuing participation in secondary education gives them options for completing secondary education and undertaking further study.

The computation of lifetime labour incomes for the above three scenarios are based on the following assumptions:

1) All persons in the same sex/age cohort are identical in terms of their abilities to acquire knowledge and skills at school.

2) An increase in the supply of labour force in one education group (e.g. bachelor degree) has no impact on the average earnings of that group.

3) All returns to investment in education are pecuniary in terms of increases in labour market earnings (nonmarket returns are excluded).

4) Earnings grow at a constant real rate of 1.75% and a constant real discount rate of 5% applies across sex/education/age cohorts over time. [7]

5) All persons complete their studies once they are enrolled in a post-school study (e.g. bachelor degree, TAFE qualification) and in a given year of secondary school study.

6) All persons retire at the age 66.

7 These are the assumptions adopted by Australian Government Treasury (2002).

To construct a measure of option values generated by completing secondary education, we now describe our implementation, beginning with notation.

Personal characteristics

Define

a = age (15, 16, …, 64, 65);

e = highest level of educational attainment, which can take 1 of 5 values:

- $e = 1$ indicates not completed nor currently participating in secondary education,
- $e = 2$ indicates completed or currently participating in secondary education,
- $e = 3$ indicates a TAFE qualification,
- $e = 4$ indicates a bachelor degree,
- $e = 5$ indicates a higher degree.

Variables that vary by age cohort

Define

Sr_a = survival rate: the probability of remaining alive at age a,

Si_a = economic benefit per capita in one additional year of secondary education for individuals of age a when a=15, 16, 17, 18,

Ov_a = option value per capita, conditional on current school enrollment, for individuals of age a when a=15, 16, 17, 18.

Variables that vary by educational attainment and age cohort

Define

$mi_{a,e}$ = lifetime labour income per capita for individuals of age a and education level e,

$ymi_{a,e}$ = annual market labour income per capita for individuals of age a and education level e, conditional on being employed,

$empr_{a,e}$ = employment rate for individuals of age a and education level e,

$senr_{a,e}$ = enrolment rate in post-secondary education: the probability that individuals of age a are enrolled in a program to attain education level ($e \neq 1,2$).

Constants

Define

g = real income growth rate,

r = discount rate.

Using the above notation, a general equation for calculating the present value of lifetime labour income is given by

$$mi_{a,e} = ymi_{a,e}\, empr_{a,e} + mi_{a+1,e}\, sr_{a+1}\,(1+g)/(1+r) \tag{1}$$

Using equation (1), the present value of lifetime labour income per capita for those who have not completed secondary education is given by

$$mi_{a,1} = ymi_{a,1}\, empr_{a,1} + mi_{a+1,1}\, sr_{a+1}\,(1+g)/(1+r) \tag{2}$$

Similarly, the present value of lifetime labour income per capita for those who are participating or have completed secondary education in a given year and sex is given by

$$mi_{a,2} = ymi_{a,2}\, empr_{a,2} + mi_{a+1,2}\, sr_{a+1}\,(1+g)/(1+r) \tag{3}$$

Equation (2) and equation (3) are assumed to be known with certainty, as individuals can begin working with their existing educational attainment, earning income streams of those with the same level of educational attainment.

People who are of school age (which I define as those aged between 15 and 18) and who are involved in and complete secondary education have options to undertake formal post-school studies. Given the possibilities of obtaining higher educational attainments in the future, the present value of *expected* lifetime labour income per capita for those who participating or have completed secondary education is given by

$$E(mi_{a,2}) = ymi_{a,2}\, empr_{a,2} + \left\{ \sum_{j=3}^{5} senr_{a,j}\, mi_{a,j} + mi_{a+1,2}\left(1 - \sum_{j=3}^{5} senr_{a,j}\right)\right\} sr_{a+1}\,\frac{(1+g)}{(1+r)} \tag{4}$$

where E defines an expectation operator over future educational attainment.

The economic benefits generated by completing one additional year of secondary education, without considering option values, is given by

$$si_a = (mi_{a,2} - mi_{a,1}), \quad a = 15,16,17,18. \tag{5}$$

Equation (5) measures the incremental increase to lifetime labour income attributable to completing one additional year of secondary education.

The economic benefits generated by completing one additional year of secondary education, with considering option values, is given by

$$\overline{si}_a = \left\{E(mi_{a,2}) - mi_{a,1}\right\}, \quad a = 15,16,17,18. \tag{6}$$

Equation (6) measures the incremental increase to lifetime labour income attributable to completing one additional year of secondary education, plus the associated potential opportunities of achieving higher educational attainments above the secondary level.

Finally, the option values by investing in secondary education is given by

$$ov_a = \left\{E(mi_{a,2}) - mi_{a,2}\right\}, \quad a = 15,16,17,18. \tag{7}$$

In contrast to Equation (6), Equation (7) gives a separate measure of the incremental increase to lifetime labour income attributable to the potential opportunities brought about by completing one additional year of secondary education.

From Equation (1) to Equation (7), we suppress the time and sex dimensions for the sake of simplicity. These equations can be applied separately for males and females, as well as for each calendar year (1986, 1991, etc.).

4. THE DATA

This study builds on the database constructed in the author's previous work on measuring the human capital stocks and flows for Australia (Wei, 2004). The main data source is the Australian Censuses of population and housing conducted in 1981, 1986, 1991,1996 and 2001. This database includes demographic accounts for all the working age population, cross-classified by sex, educational attainment and age. The data items include the number of persons, income from all sources, unemployment rate, labour force participation rate and school participation rate. This section presents summaries of three key variables used in estimating these economic benefits of completing secondary education: annual incomes per capita by education/age groups, unemployment rates by education/age groups and school participation rates by the 15–18 year olds. These figures are useful for understanding potential economic benefits from pursuing further education activities beyond secondary education and changing school participation patterns by the 15–18 age group.

Table 4.1 presents estimated gross annual incomes in 2001 constant dollars[8] of those employed, by sex and selected age and highest education level. These gross annual income figures were calculated from the income ranges of corresponding census question. Three points are important to make here. First, like other studies on education and earnings, these figures show a strong positive correlation between educational attainment and income. However, income gaps between alternative educational groups do vary. This may indicate that rates of return to education are not constant across educational levels, which is an important source of existence of option values. Second, income levels peak at an earlier age in recent years, in particular for more educated men. This is an indication of increasing returns over time to education, as highest income flows among life cycle income streams are closer to the present point of time.

While the market value of human capital skills plays an important role in explaining these income patterns across education/age groups, other factors may also be at work. Using the income variable constructed from the Australian census data sets as proxies for labour market earnings has two limitations. First, as the Census income include all sources of income, it may contain investment and other kinds of incomes. Second, hours worked is an important element in total labour earnings, and changes in earnings patterns across education/age groups could reflect the changes in corresponding patterns of hours worked. As the information on hours worked in the Census data sets was broadly based for pre-2001 periods, it is difficult to separate the effect of hours worked on income levels.

8 The ABS Labour Cost Index (LCI) is used as the deflator.

4.1 Annual gross incomes per capita, by educational attainment and selected age groups, 1986–2001 (constant 2001 dollars)

	Bachelor	*TAFE*	*Year 12 only*	*Under Year 12*
		(a) 1986		
Male				
25 years	38,937	32,485	29,999	27,429
35 years	53,711	40,051	38,764	33,057
45 years	60,165	42,096	38,698	33,852
55 years	63,623	40,641	36,127	32,365
Female				
25 years	34,828	27,497	25,381	22,155
35 years	36,506	25,410	23,683	19,463
45 years	41,002	27,769	23,106	20,184
55 years	41,365	28,115	22,857	20,393
		(b) 1991		
Male				
25 years	40,173	33,742	30,630	28,063
35 years	55,476	40,651	39,115	33,665
45 years	61,031	44,500	43,082	36,596
55 years	61,959	41,679	37,701	33,994
Female				
25 years	35,319	28,070	26,382	23,538
35 years	36,550	26,876	24,809	21,179
45 years	40,419	29,405	24,646	21,961
55 years	40,245	30,170	23,856	20,978
		(c) 1996		
Male				
25 years	40,301	35,169	31,220	29,100
35 years	61,870	43,295	41,564	35,293
45 years	65,396	46,679	45,314	38,316
55 years	65,913	44,783	43,452	36,774
Female				
25 years	35,306	28,623	27,032	24,646
35 years	40,577	28,767	26,698	23,072
45 years	42,753	31,435	28,072	24,471
55 years	42,645	31,690	26,628	23,810
		(d) 2001		
Male				
25 years	44,310	36,279	32,654	29,013
35 years	67,227	47,633	47,203	36,771
45 years	68,094	49,786	48,731	39,127
55 years	67,393	49,088	47,296	38,763
Female				
25 years	38,779	28,996	28,413	24,207
35 years	45,081	31,379	31,333	24,896
45 years	45,905	32,717	30,395	25,252
55 years	45,792	32,834	29,956	24,745

4.2 Unemployment rates, by educational attainment and selected age groups, 1986–2001

	Bachelor	*TAFE*	*Year 12 only*	*Under Year 12*
		(a) 1986		
Male				
25 years	4%	6%	11%	18%
35 years	2%	4%	8%	10%
45 years	2%	4%	8%	7%
55 years	2%	5%	9%	7%
Female				
25 years	4%	6%	10%	15%
35 years	4%	5%	9%	9%
45 years	3%	4%	9%	7%
55 years	2%	3%	8%	5%
		(b) 1991		
Male				
25 years	7%	11%	16%	24%
35 years	4%	8%	11%	16%
45 years	3%	7%	10%	10%
55 years	4%	8%	11%	11%
Female				
25 years	6%	8%	12%	16%
35 years	5%	6%	11%	10%
45 years	4%	5%	9%	8%
55 years	3%	4%	9%	7%
		(c) 1996		
Male				
25 years	6%	8%	13%	21%
35 years	3%	5%	9%	14%
45 years	3%	5%	8%	10%
55 years	4%	8%	10%	11%
Female				
25 years	4%	7%	10%	14%
35 years	4%	6%	8%	10%
45 years	3%	4%	7%	7%
55 years	3%	5%	8%	8%
		(d) 2001		
Male				
25 years	5%	7%	10%	21%
35 years	3%	4%	7%	11%
45 years	3%	4%	6%	9%
55 years	4%	5%	8%	8%
Female				
25 years	3%	7%	7%	18%
35 years	3%	6%	6%	9%
45 years	3%	4%	5%	6%
55 years	2%	4%	5%	5%

Table 4.2 presents unemployment rates for the four education groups, measured as percentage of unemployed people among the corresponding labour force. One can make four observations from these figures. First, similar to income patterns, higher educational attainment appears to be positively associated with lower unemployment rates. Second, those with lower educational attainment are more vulnerable to tough labour market conditions. For example, the difference in unemployment rates between less educated age groups and more educated age groups is much higher in the recession year 1991 compared with other normal years. Third, the unemployment gaps among different education groups are generally larger for young age cohorts. Finally, women with lower educational attainment consistently experience lower unemployment rates in the labour market than their male counterparts, in particular in tough labour market condition, such as in the recession year 1991. This phenomenon is possibly due to alternative life path options associated with unpaid work and family responsibilities for women.

Table 4.3 presents school participation rates for the 15–18 age groups, constructed from the Census data. Two patterns are noticeable from these figures. First, the percentages of students remaining at school across all school age groups (15–18) groups have trended upward. However, the school participation rates fell in 2001 for most of the age/sex groups. Second, girls have performed better for most of the age groups. The distinct falls observed for 18 year old groups across males and females are because some 18 year olds have completed secondary education and are actually in the work force or participating in formal post-school education.

4.3 School participation rates, by 15–18 age groups

	1986	*1991*	*1996*	*2001*
Male				
15 years	86%	97%	96%	93%
16 years	68%	86%	91%	88%
17 years	50%	71%	85%	76%
18 years	20%	36%	58%	44%
Female				
15 years	87%	97%	97%	95%
16 years	71%	86%	93%	89%
17 years	54%	65%	86%	80%
18 years	18%	27%	54%	47%

5. RESULTS

5.1 Per capita measures

As per capita lifetime labour incomes by age and education form the backbone of our estimation, I start my exploration of the results with these figures. My benchmark case is based on the discount rate 5 percent and the real income growth rate is 1.75 percent. I then present estimates of economic benefits of remaining at secondary school until the age of 18, which is assumed to be comparable to completing Year 12. I then derive aggregate estimates of economic benefits brought about by increases in school participation in secondary education that occurred in Australia during the 1990s. In order to assess the economic impact of changing school participation rates by the 15–18 age groups, I produce aggregate estimates of economic benefits/losses that are associated with these changes.

Table 5.1 presents lifetime labour income per capita in constant 2001 dollars for 18 year olds by sex and choice of education: leaving school without completing secondary education; completing secondary education but not obtaining any post school qualifications (i.e. without option); and completing secondary education with possibilities of obtaining post school qualifications (i.e. option). These per capita lifetime labour incomes are calculated by using equation (2) to equation (4) respectively.

5.1 Lifetime Labour Income per capita, 18 year olds (2001 dollars)

	1986	*1991*	*1996*	*2001*
Male				
Not completed secondary education	675,546	679,171	684,450	686,778
Completed secondary education without options	833,558	844,498	857,499	861,660
Completed secondary education with options	873,195	899,949	934,451	945,690
Female				
Not completed secondary education	511,574	516,292	516,972	516,473
Completed secondary education without options	610,694	619,588	629,732	634,298
Completed secondary education with options	649,119	680,219	714,813	726,770

The economic benefits are measured as additions to lifetime income due to completing secondary education, which are reported in table 5.2. The total economic benefit of completing secondary education is measured by the difference in per capita lifetime labour incomes between those who completed secondary education with options and those who did not complete secondary education. The direct economic benefit of completing secondary education is measured by the difference in per capita lifetime labour income for those who completed secondary education without options

and those who did not complete secondary education. Until very recently the returns-to-education literature has been focusing on estimating this type of returns to education. The option value generated by completing secondary education is measured by the difference in per capita lifetime labour income for those who completed secondary education with options and those who completed secondary education without options. These are the sources of returns that have been identified and estimated in theoretical and empirical analysis of schooling choices in dynamic settings.[9]

5.2 Economic benefits of completing secondary education per capita, 18 year olds (2001 dollars)

	1986	*1991*	*1996*	*2001*
Male				
Total benefit	197,649	220,778	250,001	258,912
Direct benefit	158,012	165,327	173,049	174,882
Option value	39,637	55,451	76,952	84,030
Female				
Total benefit	137,545	163,927	197,841	210,297
Direct benefit	99,120	103,296	112,760	117,825
Option value	38,425	60,631	85,081	92,472

A number of findings are evident from table 5.2. First, per capita economic benefits of completing secondary education, measured either by the direct benefit or total benefits including option values, increased over time.

Second, the option value increasingly became a prominent element in the total returns to completing secondary education, ranging from 20% to 32% for men, and from 28% to 44% for women over the period 1986–2001. The reason for this is succinctly summarised by the COAG report (2006, p. 33): "In today's labour market, obtaining an initial Year 12 or equivalent qualification is critical to subsequent economic opportunities. And with an increasing premium on skills, obtaining a post-school qualification is increasingly desirable. Young people with a post-school qualification can expect to earn, on average, 40 to 50 per cent more than those without."

Third, the economic benefits of completing secondary education grew at faster rates for women than men. For example, the total benefits between 1986 and 2001 grew well over 50% for women and just over 30% for men. This is largely attributable to the distinctly changing school participation rates for women. However, the economic returns of completing secondary education were still significantly higher for men than women.

9 See Section 5 of Heckman *et al.* (2005) for a brief survey of such models.

5.3 Sensitivity analysis: Economic benefits per capita, 17 year olds (2001 dollars)

	1986	*1991*	*1996*	*2001*
Male				
Total benefit				
3% discount rate	301,439	339,287	383,355	395,386
5% discount rate	189,102	213,654	243,560	251,528
7% discount rate	124,382	140,971	162,390	167,840
10% discount rate	71,441	81,225	95,289	98,453
Direct benefit				
3% discount rate	240,442	253,419	262,390	263,302
5% discount rate	151,662	161,594	168,931	169,331
7% discount rate	100,020	107,839	113,966	113,977
10% discount rate	57,414	63,153	67,995	67,582
Option value				
3% discount rate	60,997	85,868	120,965	132,084
5% discount rate	37,440	52,060	74,629	82,197
7% discount rate	24,362	33,132	48,425	53,863
10% discount rate	14,027	18,072	27,294	30,870
Female				
Total benefit				
3% discount rate	206,796	252,946	302,905	318,909
5% discount rate	129,972	159,465	193,598	205,135
7% discount rate	85,895	105,634	130,343	139,100
10% discount rate	49,810	61,406	77,984	84,191
Direct benefit				
3% discount rate	146,954	157,473	168,425	172,487
5% discount rate	94,152	102,436	111,809	115,285
7% discount rate	63,266	69,974	78,126	81,126
10% discount rate	37,415	42,546	49,332	51,770
Option value				
3% discount rate	59,842	95,473	134,480	146,422
5% discount rate	35,820	57,030	81,789	89,850
7% discount rate	22,629	35,660	52,217	57,974
10% discount rate	12,396	18,860	28,652	32,420

The estimates presented in previous tables are based on certain assumptions. The discount rate, which represents the discount on future income flows, is the key factor underlying the variation of estimation for lifetime labour incomes and the associated economic benefits of completing secondary education. So it is necessary to undertake sensitivity test of these estimates to alternative discount rates. With the 5% discount rate as the benchmark case, table 5.3 reports economic benefits per capita of completing secondary education for the 17 year olds under alternative assumptions of discount rates. As it is expected, a higher discount rate reduces the magnitudes of economic benefits and a lower discount rate increases these magnitudes. Generally

speaking, with 5% discount rate as the benchmark, a 3% discount rate increases the economic benefits by 50–70 per cent, a 7% discount rate reduces the economic benefits by 30–40 per cent and a 10% discount rate by 60–70 per cent. However, the general trend and patterns remain the same, and even under the 10% discount rate, the economic benefits are still figures of significant magnitudes.

The above sensitivity analysis, based on alternative discount rates, can be translated and extended into sensitivity analyses of other factors, such as ability biases and real income growth rate. Within a certain range, alternative combinations of assumed magnitudes for these factors give some of the same results as those presented in Table 5.3. For example, the measures presented under the assumption of a 7% discount rate in Table 5.3 are equivalent to the measures that would result from an assumption of 30 per cent ability bias in the benchmark case of 5% real discount rate.

5.2 Aggregate measures

Aggregate measures of economic benefits of secondary schooling activities by the 15–18 year olds in Australia, can serve as measures of the output of secondary education. In conducting this computation, I apply the per capita measures of economic benefits, including option values, for the 15–18 year olds, derived by using equation (6) in Section 3, and aggregate to total numbers by using the corresponding school participation rates and number of persons in each sex/age cohort. Table 5.4 presents the results. It should be noted that these measures (including those to be presented in the rest of the paper) are gross figures, as the cost components of education, such as labour input (teachers' effort) and capital services (rental outlays on school buildings and equipment), are not deducted. The values of economic benefits for each age group from 1986 to 2001 are the products of three factors: per capita economic benefit, school participation rate and number of persons of each age group. Accordingly, the differences of these values across age groups and over time are attributable to the changes underlying these three factors. With reference to Table 4.3, which shows that the school participation rates trend significantly downwards with age, and upwards with time until 1996 and then downwards in 2001, we can see that the changing patterns of aggregate values of economic benefits are basically reflecting those underlying the school participation rates.

5.4 Aggregate economic benefits of participating in secondary school education by the 15–18 year olds in Australia (millions of 2001 dollars)

	1986	*1991*	*1996*	*2001*
Male				
15 years	17,127	18,857	20,264	20,320
16 years	13,079	17,587	19,033	19,911
17 years	9,874	14,958	17,749	16,923
18 years	4,775	10,705	17,734	14,467
Subtotal	44,855	62,107	74,781	71,622
Female				
15 years	10,037	11,515	12,852	13,213
16 years	7,808	10,770	12,202	13,241
17 years	6,000	8,246	11,351	11,585
18 years	2,692	5,688	12,378	11,751
Subtotal	26,537	36,219	48,782	49,790
Total	71,392	98,326	123,563	121,412

Over the past decades there have been significant changes to the levels of participation in the secondary education. It may be interesting to estimate the economic benefits brought about by such changes. The school participation rates by the 15–18 year olds, reported in table 4.3, show that the percentage of students aged 15–18 remaining at school rose significantly between 1986 and 1996.[10] So our second estimation is concerned with the economic benefits created by increasing school participation rates by the 15–18 age groups. Table 5.5 reports my estimates of economic benefits attributable to the increases in the school participation rates for 1991, 1996 and 2001, compared with the base year 1986. These figures are derived by applying per capita economic benefits calculated in equation (5) to the number of persons and increases in school participation rates of the corresponding age group for each year.

10 According to Fullarton *et al.* (2003), the levels of secondary school participation rates peaked in 1992 in Australia. Since this study draws on the Australian Census data, which runs at every five years interval, it is impossible to make comparison with the corresponding figures for 1992 here.

5.5 Aggregate economic benefits due to increases in school participation rates (1986=base period) (millions of 2001 dollars)

	1991	*1996*	*2001*
Male			
15 years	2,156	2,064	1,528
16 years	3,604	4,799	4,490
17 years	4,332	7,228	5,737
18 years	4,917	11,758	8,050
Subtotal	15,008	25,848	19,805
Female			
15 years	1,181	1,218	988
16 years	1,926	2,937	2,788
17 years	1,421	4,243	3,781
18 years	2,004	8,317	7,293
Subtotal	6,533	16,715	14,849
Total	21,541	42,563	34,654

In order to assess the significance of the magnitudes of economic benefits brought about by completing secondary education for the 15–18 year old age groups, I use the GDP figures as reference points. Such a comparison is presented in Table 5.6.

5.6 GDP, and aggregate economic benefits of completing secondary education (millions of current dollars)

Year	*GDP (a)*	*Economic benefits (b)*	*Ratio to GDP*
1986	255,261	44,742	0.17
1991	408,837	79,617	0.19
1996	518,144	109,182	0.21
2001	689,262	123,413	0.18

(a) GDP figures in current prices from Table 1 in *Australian System of National Accounts*, ABS cat. no. 5204.0;
(b) These figures are derived from table 5.4 and converted into current dollars.

One important finding from studying Table 5.6 is that the secondary schooling activity is a non-negligible part of the broad capital formation (both human and physical capital) in the Australian economy, and the aggregate economic benefits are significant order of magnitudes of total GDP, with the ratio in the order of 0.17–0.21 to GDP. Of course, this comparison does not imply any simple quantitative relationship between the growth of GDP and the increasing school enrolment rates. It is beyond the ambition of this paper to estimate the percentage points of the GDP growth rates over this period that could be attributable to the rise of participation rates in secondary education.

5.7 Economic benefits missed due to decreases in school participation rates in 2001 (1996=base period) (millions of 2001 dollars)

Age	*Male*	*Female*
15 years	603	292
16 years	709	526
17 years	1,947	878
18 years	4,577	1,838
Total	7,836	3,534

It is evident from table 4.3 that 2001 witnessed a significant drop in school participation rates across every age/sex age subgroups of the 15–18 group compared with 1996. Consequently, economic benefits were missed due to this decline. These are reported in Table 5.7. With reference to the figures in table 5.5, this missed economic benefits was significant: the potential economic benefits dropped about 40% for males and over 23% for females. It is important to note that this estimation is based on the assumptions spelled out in Section 3.3 and the associated caveats apply. It is possible that those students who choose to leave school early when economic conditions are buoyant do not have the same abilities as those who stay on to undertake higher study leading to more highly paid jobs. In that respect, these figures can be seen as an upper bound. Also there will be savings in education input costs.

6. CONCLUDING REMARKS

This paper presents estimates of per capita economic benefits of completing secondary education for the period 1986–2001 in Australia. Using these per capita estimates, this paper assesses the economic benefits of completing secondary education and increasing school participation rates for the 15–18 year olds group. The economic benefits brought about by secondary education, as measured in this paper, are significant order of magnitudes of total GDP, with the ratio in the order of 0.17–0.21 to GDP.

This paper shows that option value is a large component in the total return to education, and the proportions of option values in the total returns have been increasing over time. Empirical work with option values of schooling is in its infancy. Our results show that option value is empirically important in estimating returns to education.

The estimates in this study are aggregate based and uses census data. As a result, ability biases are inevitable. However, empirical studies of ability biases suggest that it is relative small, and the figures presented in this paper are useful for providing a big picture view of the importance of completing secondary education.

7. REFERENCES

Access Economics (2005) *Economic Value of University Business Education*, Report by Access Economics Pty Limited for Australian Business Deans Council.

Australian Government Treasury (2002) Intergenerational Report 2002–2003, Budget Paper no. 5, 14 May, Commonwealth of Australia.

Card, David (1999) "The Causal Effect of Education on Earnings", Chapter 30 in Ashenfelter, O. and Card, D. (eds), *Handbook of Labour Economics*, Volume 3, pp. 1801–1863.

Card, David (2001) "Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems", *Econometrica*, 69(5), pp. 1127–1160.

Carneiro, Pedro and Heckman, James J. (2003) "Human Capital Policy", in Heckman, James J. and Krueger, Alan (eds.), *Inequality in America: What Role for Human Capital Policy?*, Cambridge, MA: MIT Press.

Council of Australian Governments (COAG) (2005) *Human Capital Reform*, Report by the COAG National Reform Initiative Working Group.

Fraumeni, Barbara (2000) "The Output of the Education Sector as Determined by Education's Effect on Lifetime Income", Paper presented at the Workshop on Measuring the Output of Education Sector, Brookings Institution, Washington, DC.

Fullarton, Sue; Walker, Maurice; Ainley, John and Hilman, Kylie (2003) "Patterns of Participation in Year 12", Longitudinal Surveys of Australian Youth Research Report 33, Australian Council for Educational Research.

Larkins, Frank P. (2001) "The Economic Benefits of Australian University Degrees: Bachelor and Research Higher Degrees", *Australian Economic Review*, 34(4), pp. 403–414.

Hansen, Karsten T.; Heckman, James J. and Mullen, Kathleen J. (2004) "The Effect of Schooling and Ability on Achievement Test Scores", *Journal of Econometrics*, 121, pp. 39–98.

Heckman, James J. (2005) "Lessons from the Technology of Skill Formation", NBER Working Paper Series, Working Paper 11142.

Heckman, James J.; Lochner, Lance J. and Todd, Petra E. (2005) "Earnings Functions, Rates of Return and Treatment Effects: The Mincer Equation and Beyond", NBER Working Paper Series, Working Paper 11544.

Hill, Peter (2003) "The Measurement of Intellectual Capital Formation in the System of National Accounts", Unpublished project paper.

Jorgenson, Dale W. and Fraumeni, Barbara M. (1989) "The Accumulation of Human and Non-Human Capital, 1948–1984", in Lipsey, R.E. And Tice, H.S. (eds), *The Measurement of Savings, Investment, and Wealth*, pp. 227–282, University of Chicago Press, Chicago.

Jorgenson, Dale W. and Fraumeni, Barbara M. (1992) "The Output of the Education Sector", in Griliches, Z. (ed.), *Output Measurement in the Service Sectors*, University of Chicago Press, Chicago.

Mincer, Jacob (1974) *Schooling, Experience and Earnings*, Columbia University Press, New York.

OECD (1998) *Human Capital Investment: An International Comparison*, Paris.

OECD (2001) *The Well-being of Nations: The Role of Human and Social Capital*, Paris.

OECD (2006) *Education at a Glance*, Paris.

Wei, Hui (2004) "Measuring the Stock of Human Capital for Australia", *Methodology Research Papers*, cat. no. 1351.0.55.001, Australian Bureau of Statistics, Canberra.