DECLARATION

Apart from the assistance indicated in the acknowledgements, this thesis is my own original work.

Tai-Tee Chia
March 1990
ACKNOWLEDGEMENTS

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Paul Miller offered much guidance when I was getting started, and continued to be a source of advice even after he left the A.N.U. Thanks must go also to Francis Teal, George Fane, Geoff Brennan, Frank Milne, Adrian Pagan and Hong Tan for their constructive criticisms on various parts of the thesis.

A preliminary version of Chapter 8 was circulated as a Discussion Paper for the Centre for Economic Policy Research, and was presented at the International Economics Postgraduate Research Conference. Helpful comments were received from Tom Karmel and from two anonymous referees for the Conference volume.

Section 4.2 of Chapter 4 is based on work jointly carried out with Bruce Chapman. Preliminary results were reported in a Centre for Economic Policy Research Discussion Paper [Chapman and Chia (1989)], and were presented at the conference on Issues in Public Expenditure Analysis. Useful comments were received from participants of the conference.

This dissertation is made possible only through a post-graduate scholarship from the Australian National University. I am also grateful to the Singapore Government for suspending my National Service liability and the discharge of bond to enable me to undertake this research.
Finally, I would like to thank my wife, Angelene, for her understanding, patience and love. This thesis is dedicated to her.
This thesis examines the financial returns to higher education in Australia from both the private and social points of view. While some of the issues have been explored in other studies, several substantial contributions are made in this thesis in the areas of both methodology and policy analysis.

The thesis is divided into three parts. In Part I, the analysis is based on the comparison of the mean earnings outcomes of degree-holders and high-school leavers. Private and social gains to investing in higher education are quantified using conventional techniques of Net Present Value and Internal Rate of Return. The effect of alternative fee-regimes on individuals’ incentives to invest in higher education is analysed, with particular attention given to the recently introduced Higher Education Contribution Scheme (HECS). Our results suggest that higher education appears to be an attractive private investment, and that the imposition of HECS has little effect on its profitability.

One of the problems in estimating the social profitability of higher education is that there is little agreement as to the size of externalities. A novel approach adopted in the thesis is to infer the marginal value of the externalities from the fee-structure of HECS, assuming that in setting the charge, the Government is concerned only with allocative efficiency. It is estimated that for HECS to represent an optimal charge, the marginal graduate is expected to deliver between $1,400 and $1,500 (1985-86 dollars) in spillovers per year. The analysis is extended further to consider the consistency of the level of charge in HECS with the Government’s commitment to expand higher education from the efficiency point of view. It is
found that at some discount rates, the two policies are internally inconsistent.

Part II of the thesis examines the implications of the large dispersion in individual incomes around the mean on the profitability of higher education. Treating the dispersion as being the result of luck suggests that there are considerable risks attached to investing in higher education. A model is developed which enables risks to be formally incorporated into conventional measures of educational profitability. The adjustment for risk is found to reduce the attractiveness of higher education as an investment.

An alternative interpretation of the dispersion in individual incomes is that it reflects differences in individuals' unmeasured characteristics, such as ability. The implications of differences in ability across individuals on the profitability of higher education are explored. Our results suggest that self-selection by individuals may lead to serious biases in estimates of the rate of return based on the comparison of mean income profiles.

The attractiveness of HECS vis-a-vis other fee-schemes, such as that proposed by the Liberal-National Parties (LIB) is also investigated in the light of this dispersion. It is found that if individuals are uncertain of their abilities and are risk averse, the income-contingent nature of HECS makes it relatively more attractive compared to LIB. However, if they are aware of their abilities, the more able individuals may be better off under the LIB scheme.

In Part III of the thesis, the issue of how the value of a degree has changed over the last ten years is analysed. An important methodological point made is that a simple comparison of cross-
sectional rates of return over time may lead to misleading conclusions. It is argued that it is preferable to examine how the labour market experiences of successive cohorts of new graduates have changed over time.
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For several years now, criticisms on the Australian higher education system have been mounting. The critics have been from within and outside the academic community, and have included outspoken ranging issues as the quality of teaching and research, the ability of institutions to adapt to changing students, the role in which institutions are funded, and the quality and costs of the public subsidy to higher education. Along with these criticisms, the government has responded with the appointment of various review committees, and finally, with the establishment of the Green Paper on Higher Education and the Green Paper on Higher Education Funding.

One of the key tenets of the Green Paper is the Government's commitment to an expansion of the number of places in higher education. The question of how to fund this expansion under the current and likely future tight budgetary conditions is the subject of the Green Paper. It is somewhat surprising, given the year that most of the Green Paper was written, that an expansion in the higher education system is “unaffordable”, that costs have increased as what is the supply-related rate of return to higher education and how it has changed over time, but not how much in the Green Paper. Moreover, with the ongoing pressure to fund the situation of the main beneficiary of higher education, namely, the humanities themselves, it is important to quantify the distribution costs.

1. Department of Employment, Education, and Training (1986), The Green Paper, which is a discussion paper, and Black Economy (Tertiary) Paper, which are the flagship of a policy paper.

CHAPTER 1

INTRODUCTION

For several years now, criticism on the Australian higher education system has been mounting. The criticisms have come from both within and outside the academic community, and have included such wide-ranging issues as the quality of teaching and research, the ability of institutions to adapt to changing demands, the way in which institutions are funded, and the equity effects of the public subsidy in higher education. Faced with these criticisms, the Government has responded with the appointment of several review committees, and finally, with the institution of the far-reaching reforms outlined in the Green Paper on Higher Education and the Wran Report on Higher Education Funding.

One of the basic tenets of the Green Paper is the Government’s commitment to an expansion of the number of places in higher education. The question of how to fund this expansion under the current and likely future tight budgetary conditions is the subject of the Wran Report. It is somewhat surprising, given the fact that so much of the Green Paper rests on the premise that an expansion in the higher education system is "desirable", that such basic questions as what is the marginal social rate of return to higher education and how has it changed over time, have not been addressed in the Green Paper. Moreover, with the emphasis given to funding sources involving the main beneficiaries of higher education, namely, the students themselves, it is important to quantify the financial gains to

1. Department of Employment, Education, and Training (1987b). The Green Paper, which is a discussion paper, has since become a White Paper, which has the status of a policy paper.

individuals from higher education, and to estimate how these gains are affected when fees are levied. These are some of the important policy questions which provide the motivation for this thesis.

The thesis also seeks to remedy a number of shortcomings in the educational rate of return literature. Estimations of the returns to education have tended to focus almost exclusively on the comparison of mean earnings profiles across different educational groups. The fact that there exists a sizeable dispersion in individual earnings around each of these mean earnings profiles has largely been ignored. One of the major concerns in this thesis is with the implications of this dispersion. One interpretation is that the dispersion represents the influence of luck and other unforeseen events. This suggests that there may be considerable risks associated with investing in education. The treatment of risk in conventional estimates of the returns to education can, at best, be described as ad hoc. An important contribution of this thesis is the development of a simple procedure whereby risks can be incorporated into conventional measures of educational profitability.

An alternative interpretation of the dispersion in individual earnings around the mean is that it represents differences in individual-specific characteristics, such as innate ability. The profitability of education may, therefore, differ across individuals depending on their respective endowments of these characteristics. A fairly novel approach adopted in this thesis is to calculate the rates of return implied by matching different parts of the high-school leavers' and degree-holders' income distributions. In so doing, we obtain a sense of how individual rates of return may differ from the average return to the group. As well, we gain some
interesting insights into how the profitability of educational investments may differ across individuals of different abilities.

Finally, an issue which has not been sufficiently investigated, at least in the Australian literature, is the possibility of students dropping out, or taking longer than the minimum time to complete their courses. This, in our view, is a serious oversight, particularly in the case of Australian higher education where, according to the William's Committee, more than 40% of students fail to complete their courses in the minimum time required. We shall endeavour to shed some light on how failure and drop-out rates affect both the private and social rates of return to higher education.

This thesis is divided into three parts. In Part I of the thesis, the private and social profitability of higher education in Australia are addressed using data from the 1985-86 Income and Housing Survey. The focus in Part I is on the aggregate figures. The analysis is based on the comparison of the mean earnings outcomes among different schooling groups. There, we follow the conventional treatment of ignoring the variance around the mean profiles. The "Internal Rate of Return" (IRR) and "Net Present Value" (NPV) techniques, both of which have been widely used since education was first recognized as an investment, are employed to quantify the private and social gains to higher education. Part I of the thesis contains three chapters. Chapter 2 discusses the IRR and NPV methodologies, and the complications involved in applying these techniques to data. A review of previous Australian research on the profitability of education is also provided. Chapter 3 examines the private returns from higher education. Simulations under alternative

fee-paying regimes are performed in that chapter to determine the effect on individuals' incentive to invest in higher education. The returns to higher education from the social point of view is the subject of Chapter 4.

Part II of the thesis is concerned with the variance around the mean earnings profiles, and its implications on the estimates in Part I of the thesis. Part II contains three chapters. In Chapter 5, we treat the variance as arising entirely from the random effects of luck. A model of how to deal with uncertainty in quantifying the ex ante returns to higher education is developed, and applied. In Chapter 6, we make the opposite assumption with respect to the source of the variation in individual incomes. There, we assume that it is the result of differences in permanent individual-specific characteristics. The effect on individuals' ex-post and ex-ante profitability of higher education is addressed. Chapter 7 brings together both the luck (stochastic) and permanent individual-specific components of the variation in individual incomes, and examines some policy implications arising from the variability in individual incomes.

Part III of the thesis contains Chapter 8 which addresses the question of how the value of the degree has changed over the last ten years. An important methodological point made there is how cross-sectional comparisons over time can lead to misleading conclusions. It is argued that it may be preferable to compare the performances of different cohorts of new graduates over time in terms of their starting salaries, and the types of jobs that they obtain in order to ascertain the changes in the profitability of higher education.
Chapter 9 summarises the major findings of the thesis and suggests areas of further research.
PART I

AGGREGATE ANALYSIS

First, in the case of the recent violence of the White lives
on Black handsome and the Black Reins, there was need for
estimates of the poverty and social status of white and black
education based on the latest data available.

Second, the analysis in Part I of the thesis which is shows on
the importance of the open-minded access attending among
successful investment with which the findings in Part II which indicates
the outcome among the main nodes appeared.

Finally, although neither the research area nor the technique
used here are novel, it finds that by asking different questions to
asking the same questions differently we can gain more conditional
insight into the returns to higher education. For instance, the
problem of placing a monetary value on the socially valued
with higher education is well known. Although there have been
attempts to estimate the value of specific types of education
Part I of the thesis quantifies the returns to investing in higher education by comparing the mean earnings profiles of degree-holders and high-school leavers. The techniques used here are the "Internal Rate of Return Approach" and the "Net Present Value Approach", both of which have been widely utilised in studies of this kind. Research into the profitability of education from both the private and social points of view is not at all new, as the literature review in Chapter 2 will show. Although research in Australia clearly lags behind that in the United States, there has been, nevertheless, a number of studies which have addressed this issue. So, why another study? There are several reasons.

First, in the light of the recent releases of the White Paper on Higher Education and the Wran Report, there is a need for estimates of the private and social rates of return to higher education based on the latest data available.

Second, the analysis in Part I of the thesis which is based on the comparison of the mean outcomes across schooling groups, provides a useful bench-mark with which the results in Part II which considers the variance around the means, can be compared.

Finally, although neither the research area nor the techniques used here are novel, we find that by asking different questions, or asking the same questions differently we can gain some additional insight into the returns to higher education. For instance, the problem of placing a monetary value on the externalities associated with higher education is well-known. Although there have been attempts to estimate the value of specific types of externalities
associated with education, such as the lowering of crime rates, we are a long way from having a comprehensive measure of the value of externalities associated with particular levels and types of education. Yet the answer is clearly crucial to the debate of how much (if at all) the Government should subsidise each level and type of education. Here, instead of asking what is the magnitude of these externalities, we turn the question around and ask: Given the size of the public subsidy in higher education, what is the Government’s implicit judgment with respect to the value of the externalities assuming that the Government aims to maximize efficiency? Further, is this judgement consistent with its resolve to expand the capacity of the higher education system?

As another example, economists have always conceded that there are private consumption benefits to higher education. Yet these are rarely, if ever, included in estimates of the returns to higher education. Again, the problem of measurement appears insurmountable. Here, we turn the question around and ask: Given that students can obtain their degrees very much more profitably on a part-time basis, what does their choosing to pursue higher education on a full-time basis imply about the size of the consumption benefits?

Obviously, there are limitations to these approaches. Nevertheless, they provide us with useful insights into the returns to higher education which are heretofore unavailable.

Part I of the thesis contains three chapters. Chapter 2 begins by briefly tracing the historical roots of the treatment of education as an investment. It then proceeds with a discussion of some of the

conceptual and empirical issues related to the estimation of educational profitability. Finally a survey of previous Australian research on educational profitability is provided.

In Chapter 3, we use data from the 1985-86 Australian Income and Housing Survey to answer: How profitable is higher education as a private investment? A number of complications, such as which income concept to use and how to account for differences in the number of hours worked, are addressed. As well, we compare the private profitability between males and females, and between the part-time and full-time modes of study. A highlight of the chapter is the comparison of the profitability of higher education under alternative fee-paying regimes. Particular attention is paid to the effect of the recently introduced Higher Education Contribution Scheme (HECS) on the private returns to higher education.

In Chapter 4, the focus is on the social profitability of higher education as an investment. Some of the important questions addressed in this chapter are: From society’s point of view, is there an over- or under-investment in higher education? Should the subsidy given to students be raised or lowered? Is the government’s policy of taxing students to fund additional places consistent with maximising allocative efficiency? It is clear that the answers to these questions hinges, to a large extent, on the value placed on the externalities associated with higher education. Under the assumption that the Government acts to maximise efficiency, we estimate the value it implicitly places on the value of these externalities from the charge it levies on students under HECS. This implied value is then used in social NPV calculations to check on the consistency with the Government’s commitment to expand higher education.
CHAPTER 2

PROFITABILITY OF EDUCATIONAL INVESTMENTS: A SURVEY OF THE ISSUES

The aim of this chapter is to review some of the conceptual and empirical issues related to the estimation of the profitability of education as an investment, and to provide a survey of previous Australian studies. This chapter contains 5 sections. We begin, in Section 2.1, with a brief history of the concept of human capital focusing, in particular, on the treatment of education as an investment. This is followed, in Section 2.2, by a discussion of the benefits of education. The costs of education are dealt with in Section 2.3. In Section 2.4, the two most widely-used techniques in comparing the costs and benefits of education -- the Net Present Value (NPV) and the Internal Rate of Return (IRR) techniques -- are discussed. Some of the difficulties associated with the application of these techniques in practice are examined in Section 2.5. Section 2.6 provides a survey of the studies on the profitability of education in Australia.

2.1 Historical Roots of The Concept of Human Capital

The concept of human capital, as Blaug (1976, p.829) puts it, is simply "the idea that people spend on themselves in diverse ways, not for the sake of present enjoyments, but for the sake of future pecuniary and non-pecuniary returns". Examples of such expenses include those incurred in pursuing education and training, in prolonging the period of job search, and in migration to other parts of the country (or to other countries), with the aim of improving one's career opportunities. Although the concept was only formalised and systematically investigated towards the end of 1950s and early 1960s, its historical roots can be traced back to as early as the
17th century in the work of Sir William Petty. Kiker notes that other economists who subscribed to the view that human beings and/or their acquired skills and abilities can be treated as capital included such well-known names as Adam Smith, Jean Baptise Say, John Stuart Mill, Friedrich List, Nassau Senior, Ernst Engel, Leon Walras and Irving Fisher. The concept of human capital was, therefore, prominent in economic thinking all through the eighteenth and nineteenth centuries. According to Kiker, this prominence came to an end in the first half of the twentieth century when Alfred Marshall and his followers rejected this idea of applying the concept of capital to man. They opted instead for a narrower definition of capital, which included only that portion of the nonhuman, material, man-made stock of wealth which is utilised directly in future production.

Since then, economists who adopted the all-inclusive concept of capital have been relegated to the minority ranks of the profession. In spite of the "majority opinion", however, there continued to be sporadic contributions to the literature which treated human beings (or the skills acquired) as capital and valued them in money terms. In the area of education, analyses within what would later be called "the human capital framework" can be found, for instance, in the work of Strumilin (1929), Walsh (1935) and Friedman and Kuznets (1945). Nevertheless, it is fair to say that prior to the work of Schultz and


2. This interpretation of Marshall’s view on human capital is not undisputed. Blandy (1967), for instance, argues that the problem was merely one of definition, and that Marshall basically accepted the "Smithian position that an educated man may be compared to an expensive machine" (p.874).

3. See Walsh (1935) for a bibliography of such work in the first three decades of the twentieth century.
Becker in the late fifties and early sixties, it was uncommon to think of education as anything more than a consumption item like food and clothing.

The importance of treating education and training (and in general, all activities which improve the quality and productivity of human resources) explicitly as a form of investment, in the same way as expenditures on physical capital such as buildings, factories and machines was emphasized by Schultz (1961a). In his 1960 presidential address to the American Economic Association, he argued forcefully that:

"... economists have not stressed ... the simple truth that people invest in themselves and that these investments are very large."

and that:

"The failure to treat human resources explicitly as a form of capital, as a means of production, as a product of investment, has fostered the retention of the classical notion of labor as a capacity to do manual work requiring little knowledge and skill... This notion of labor was wrong in the classical period and it is patently wrong now.

...knowledge and skill are in great part the product of investment and, combined with other human investment, predominantly account the productive superiority of the technically advanced countries. To omit them in studying economic growth is like trying to explain Soviet ideology without Marx." ⁴

Schultz's address can be said to have sparked off what one author has called "the human investment revolution in economic thought".⁵ In addition to education and training, human capital concepts have been applied in such diverse areas as health care,

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migration, job search, occupational choice, marriage, family planning, and child care. Human Capital Theory has proven to be more than just a passing fad which sweeps through the economics profession from time to time. Writing in the mid-1970s, Blaug (1976, p.827) observed that "...the theory of human capital has been with us for more than a decade, during which time the flood of literature in the field has never abated ...". This observation appears no less true today.

2.2 The Benefits of Education

In treating education as a form of investment, one of the first questions to be posed was: Is it profitable to the individual, and to society as a whole? To answer these questions, it is first necessary to identify (and hopefully also measure) the benefits of education. Following Weisbrod (1962), we define a "benefit" as anything that pushes the utility possibility frontier outwards. In the discussion that follows, it is important to distinguish between "private" and "social" benefits. What may be regarded as a benefit from the point of individuals investing in education need not necessarily also be a benefit to society (in the sense of pushing society's utility possibility frontier outwards), and vice versa.

2.2.1 Income Increment

Unquestionably, the most widely studied of the benefits associated with education is the effect on individuals' labour market incomes. The fact that more highly educated individuals tend to have higher earnings than less educated ones is well-established. Figures from the 1985-86 Income and Housing Survey, for instance, show that the mean annual gross income of individuals with degrees is $30,580,
compared to $18,540 for those with no post-school qualification.\(^6\)

This is fairly typical of the finding in almost every country for which data on average earnings and level of educational attainment are available.\(^7\) Blaug (1972, p.54) has noted that:

"The universality of this positive association between education and earnings is one of the most striking findings of modern social science. It is indeed one of the few safe generalizations that one can make about labour markets in all countries whether capitalist or communist."

In spite of this, the relationship between education and earnings has remained controversial. One of the major sources of contention is the extent to which the higher earnings of the more educated are due to additional schooling rather than factors which are correlated with schooling (such as ability, motivation and family background). Related to this is the fundamental question of what schooling actually does. Some researchers have argued that schooling raises individuals' productivity by imparting knowledge and skills which make them more efficient, and thus more valuable in the production process. Others believe that it serves simply as a screening device which enables employers to identify the more able individuals.\(^8\)

The problem of multiple correlations among income-determining variables has been well recognized. In one of the early applications of the investment approach to education, Houthakker (1959, p.28) warned that "...we cannot even be sure that the apparent effect of

\(^6\) A.B.S., 1986 Income Distribution Survey, Persons with Earned Income, Cat. No. 6546.0, Table 11.


\(^8\) This screening view of education will be discussed in greater detail in Section 2.5.1.
education on income is not completely explicable in terms of intelligence and parents' income, so that the specific effect of education could be zero or even negative. Since then, numerous attempts have been made by economists to disentangle the effects of education and other factors on earnings using multi-variate regression techniques. The consensus seems to be that even after controlling for other factors, education and age remain the two most powerful explanators of earnings. Morgan and David (1963, pp.436-437), for instance, have concluded from their study that "...objections to the use of simple average earnings of different age and education groups on the grounds of spurious correlation are correct but quantitatively not terribly important". Similarly, in a review of more than 20 American studies, Psacharopoulos (1975, p.55) has found that overall, education is responsible for more than three-quarters (0.77) of the observed earnings differentials between educational groups. He has concluded, therefore, that (p.58):

"...the greatest part of the observed earnings differentials by educational level is due to education. When all available studies are taken into account, this part is greater than it was thought before."

Another point of disagreement among economists with regard to the education-earnings relationship is whether the higher earnings of the more educated reflect their higher marginal productivities, or whether they merely reflect "societal norms". From the individuals' point of view, as long as the acquisition of schooling entitles them to higher earnings (for whatever reasons), the higher earnings will be regarded as one of the benefits of schooling. How, and why

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9. This literature is discussed in greater detail in Part II of the thesis.
education leads to higher earnings is irrelevant to them. From society's point of view, however, these questions matter greatly.

Clearly, if markets were perfectly competitive, wages would be equal to the value of workers' marginal product. Earnings would then reflect productivity differences, and the extra earnings of educated workers would, therefore, measure their additional contribution to society's output. In this case, the earnings increment to schooling is both a private and a social benefit.

If we believe, however, that earnings reflect social conventions and historical and other non-economic factors rather than productivity differences, then the earnings increment to schooling may not represent an addition to national output. Consequently, what is clearly a private benefit may not also be a social benefit.

Blaug (1965, pp. 227-229) argues that the issue is not whether there are imperfections in the labour market, but whether they are so serious as to invalidate the use of earnings differentials as measures of productivity differences. He points out that even if the wage system is "a system of administered prices" as Vaizey (1962, p.45) suggests, market forces may, nevertheless, still impinge on the level of wages and salaries. Hence, earnings would still be brought into line with relative productivities. He argues, further, that:

10. This should be interpreted in the life-cycle sense, since, wages need not necessarily equal the marginal product of workers in each and every period if, for instance, there are firm-specific training. See, Becker (1975). Other explanations for the divergence between wages and marginal product in a particular period include the shirking-discipline explanation of Lazear (1979) and implicit contracts.

11. Such a view is expounded by Vaizey (1962), for instance.

12. Psacharopoulos and Woodhall (1985, pp. 50-52) make the same point.
"...if relative earnings reflect, not relative productivities, but family connections, traditional conventions, the snob-value of a university degree, nepotism, entry restrictions in trade unions and professional organisations, politically determined wage administrations or any other market imperfections one might care to mention, how is it that more than 60 per cent of gross earnings differentials are directly attributable to education alone?"

Income tax may also result in a divergence between the private and social benefits of the earnings increment associated with education. Individuals, generally, do not get to keep the entire earnings increment. A part of it is paid to the government in the form of tax. Although it may be argued that the individual may receive some satisfaction from paying tax, the general consensus is that it is only the increment in after-tax income which is regarded as a private benefit.

2.2.2. Other Benefits Accruing to Individuals

A number of other benefits associated with schooling have been identified. Psacharopoulos (1975, pp.134-161) has investigated the extent to which the higher earnings enjoyed by more educated workers carry over to fringe benefits as well. These include superior pension or superannuation plans, stock option schemes, better working conditions, generous expense accounts, and so on. He concludes that fringe benefits tend to increase with the level of education, and that money-wage differentials may, therefore, significantly understate the benefit of education. A similar conclusion is reached by Duncan (1976).

13. Cohn (1972, pp.141-142) suggests that individuals may derive utility in paying taxes because i) they believe in supporting the government; and ii) government revenues are spent on collective goods which benefit them.
Other work-related advantages enjoyed by the more educated include the higher social prestige of their occupations [Blau and Duncan (1967), Miller (1982b), Richardson (1986)], their lower vulnerability to unemployment [Bloch and Smith (1977), Nickell (1979)], wider job choices and the flexibility to adjust to changing job opportunities [Weisbrod (1962)].

Some researchers have argued that the education experience itself, rather than being enjoyable and stimulating, may in fact have negative utility for the average student [Blaug (1965) Fane (1984a)]. In other words, instead of being a benefit, the consumption aspect of education may in fact be a cost! Of course, the same individual who finds schooling unpleasant while studying may in later years recognize the value of the skills acquired which enables him or her to enjoy a novel, or appreciate a piece of artwork or music.

Moreover, there are "outside-the-classroom" activities associated with schooling which may yield positive consumption benefits. Salmon (1987), for instance, has suggested that the enjoyment of various sporting activities and the opportunity for individuals to identify a spouse during college years should be counted as part of the benefits of schooling. It has also been argued that students generally enjoy a more leisurely life-style compared to someone working full-time in the "real world". To the extent that this claim is justified, this more desirable life-style will count as a consumption benefit of education as well.

14. Some authors have argued that higher occupational prestige and lower unemployment vulnerability are not social benefits. See Blaug (1965 p.221) and Cohn (1972, p.142) for a discussion.

15. Blaug (1965, p.219) argues that these cannot be considered as benefits since they are a result of a change in taste.
Recent developments in the literature on "New Home Economics" have shed considerable light on other non-marketed benefits of education. Several studies have suggested that education leads to improved sorting in the marriage market and arguably, to greater happiness in marriage as a result [Becker (1981), Michael (1982), McMahon (1984)]. Schooling has been shown to increase the ability of families to avoid unplanned babies through more efficient use of contraceptives [Michael (1973), Michael and Willis (1976)]. It contributes to better health and increases the life-span of the individual [Grossman (1975), Fuchs (1974), Lee (1982)]. The children and spouse of more educated individuals tend to be healthier as well [Auster et al. (1969), Rosenweig and Schultz (1982)]. Parents with more education tend, also, to contribute to the intellectual development of their children [Leibowitz (1974)]. It has been argued that education improves an individual's ability to achieve greater efficiency in consumption [Michael (1975), Hettich (1972)] and in managing their savings portfolio [Solmon (1975)]. It has been argued, as well, that those who are more educated tend to be more effective in adapting to the "technological revolution within the home" in the use of dishwashers, automatic washing machines, tele-shopping for groceries, tele-banking, and so on [McMahon (1987a)].

16. See Michael (1972) for a survey.

17. For a more detailed discussion, see Michael (1982), Haveman and Wolfe (1984), McMahon (1987a).
2.2.3 External Benefits

External benefits of education are those benefits accruing to persons other than the individual investing in education. Consideration of these benefits is of great importance in policy discussions of the appropriate level of fees to be charged (or the appropriate level of subsidy to be given) for education. As Chapman and Chia (1989, p.213) have pointed out in their discussion of tertiary charges, "...ultimately, if only allocative efficiency prevails, this question is concerned with the relative size of social spillovers from higher education".

A fairly comprehensive list of externalities in education is provided by McMahon (1987b). Among the external benefits which accrue to society at large is the role which education plays in preserving democratic freedom, in transmitting cultural values, and in promoting a greater consciousness towards a national identity. Several authors have claimed, in addition, that education leads to more intelligent voting behaviour [for example, Brennan (1971)].

It has been suggested that education lowers crime rates [Ehrlich (1975), Webb (1977)]. This, in turn, translates into cost savings to society in terms of the resources used in criminal apprehension, and in maintaining the judicial and penal system.

Those who are more educated are alleged to be less likely to require welfare assistance. Their better health condition will tend to reduce the cost to the public health system. There is also some evidence which suggests that the more educated are more likely to participate in voluntary community service activities.

18. See, Brennan (1988), and the discussion in Chapter 4.
In the work-area, Weisbrod (1962) has suggested that education may not only improve the productivity of the individual, but the productivity of others working with him or her as well. It is important, however, that we do not 'double-count'. Brennan (1971) has pointed out that there is no reason why the individual will not be paid by the firm for this 'service' to fellow workers. To that extent, the benefits would have already been accounted for by his or her higher income. The spill-overs to workers in other firms, on the other hand, may not have been captured. Chapman and Chia (1989, p.16) have argued that highly educated individuals are more able to initiate, develop, and adopt technological change in the workplace. To the extent that the technology, once implemented, can be easily copied by other firms without cost, externalities will still exist.

Summing up, a wide range of benefits associated with education have been identified in the literature. The empirical importance of many of these, however, remain largely unknown. Researchers have tended to restrict themselves to estimating only the marketed, earnings-based effects of education because of the inherent difficulties in measuring non-marketed effects.

Haveman and Wolfe (1984) have recently developed a technique whereby the value of non-market effects (including external effects) can be estimated. They demonstrated the feasibility of this technique by estimating the value of a handful of non-marketed effects (cognitive development of children, contraceptive use, consumption efficiency, criminal apprehension, improvement in own health). The results from their study suggest the total annual value of the non-marketed effects of schooling may be as large as the marketed ones. This, as they have pointed out, "...suggests that the annual
incremental schooling reported in standard human capital estimates may capture only about one-half of the total value of an additional year of schooling". Haveman and Wolfe are the first to admit that their conclusion is "highly tentative". Still, it is clear from their work that the non-marketed benefits of education cannot be ignored.

In this thesis, however, our focus will continue to be mainly on the earnings increment associated with education. This is simply a reflection of the data which are available. Our results, therefore, need to be interpreted in the light of the omission of the (possibly large) non-marketed effects of education.

2.3 The Costs of Education

The costs of education can be divided into direct and indirect costs. From the individual's point of view, direct costs include the fees and other charges levied by the institution, as well as the cost of books and stationery, and any other out-of-pocket expenses which the individual would not have incurred if he or she were not studying. Off-setting these costs are the various forms of financial support the individual may be in receipt of, such as, scholarships, bursaries, Austudy allowances.19

From the social point of view, financial support from the various sources are merely transfer payments. They do not lessen the resources used in the provision of education, and as such, they are not subtracted from the direct costs. Similarly, the fees and other

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19. These exclude the financial support from family if we consider the family to be the decision unit. If, however, the individual is regarded to be the decision unit (so that a dollar from his or her family is treated no differently to a dollar from, say, the government) then financial support from the family need to be subtracted from direct costs as well.
charges levied on students may be regarded also as transfer payments.20 The direct costs to society comprise of the opportunity costs of all the resources necessary to provide the educational service -- wages of teachers and other support staff, books, sporting equipment, other goods and services such as heating and lighting, the imputed rent of buildings and grounds, and so on. To these, the direct costs incurred by individuals which involve the use of real resources must also be added.

The indirect costs of education are the earnings foregone by individuals as a result of their schooling. This is usually estimated by the earnings of individuals with the same observed characteristics who are not in school. The assumption implicit in this procedure is that students have zero earnings while studying. In higher education at least, many students do, however, engage in part-time work. Their foregone earnings would, therefore, be reduced by the amount received from these jobs.21 As with earnings increment associated with education, it is the after-tax magnitude of foregone earnings which individuals are concerned with. In the calculation of the indirect social cost of education, on the other hand, pre-tax foregone earnings are the relevant figures.

20. Strictly speaking, these are not transfer payments. For accounting purposes, however, it is simpler to treat them as such.

21. A difficulty which arises is that full-time students who are also engaged in part-time employment may have less leisure hours compared to a full-time worker (who is not studying). Failure to account for this loss of leisure time will, therefore, lead to an understatement of the cost of education.
2.4 The Profitability of Education -- Cost-Benefit Analysis

The profitability of education depends on the relative magnitudes of its costs and benefits. Education is considered profitable from the individual's point of view if it leads to a higher level of utility for the individual when both the costs and benefits are considered. Similarly, education is considered socially profitable if its net result is to push society's utility possibility frontier outwards. In the latter case, a complication arises in that there are costs and benefits which accrue to persons other than the individual being educated. A simplifying assumption which is usually made in cost-benefit analyses is that a dollar's worth of benefits (costs) to individual A increases (decreases) social welfare to the same extent as a dollar's worth of benefits (costs) to individual B. This allows the social desirability of an investment to be assessed by simply comparing the sum of its costs and the sum of its benefits. 22

It should be clear from the discussion in the last two sections that the costs and benefits of education, especially the latter, do not accrue in a single period, but are drawn out over time. Since individuals are not necessarily indifferent between a dollar today and a dollar in the future, the time patterns of the costs and benefits matter.

As an illustration, consider the investment decision of an 18 year-old individual who has just finished Year 12, and is choosing whether to pursue a three-year university degree. For simplicity, we consider only the pecuniary costs and benefits of education. Suppose

22. See the discussion in Cohn (1972) pp. 163-166.
that if the individual enters the workforce immediately, she can expect to earn $X_i$ per annum, where $i$ is the number of years of labour force experience. Alternatively, if she joins the workforce after completing her degree, she can expect to earn $Y_i$ per annum. It is assumed that the individual plans to retire at the age of 60 regardless of her educational decision. The out-of-pocket expenses of attending university (direct costs less scholarships/allowances and part-time earnings) are assumed to be $Z$ per year. This individual is, therefore, faced with a choice of two alternative income streams:

<table>
<thead>
<tr>
<th>Age</th>
<th>Income Stream A</th>
<th>Income Stream B</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>$X_1$</td>
<td>$-Z$</td>
</tr>
<tr>
<td>20</td>
<td>$X_2$</td>
<td>$-Z$</td>
</tr>
<tr>
<td>21</td>
<td>$X_3$</td>
<td>$-Z$</td>
</tr>
<tr>
<td>22</td>
<td>$X_4$</td>
<td>$Y_1$</td>
</tr>
<tr>
<td>23</td>
<td>$X_5$</td>
<td>$Y_2$</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>$\cdots$</td>
</tr>
<tr>
<td>59</td>
<td></td>
<td>$\cdots$</td>
</tr>
<tr>
<td>60</td>
<td>$X_{42}$</td>
<td>$Y_{39}$</td>
</tr>
</tbody>
</table>

Income stream A is associated with the choice of not going to university and income stream B is associated with the choice of going. Let the present value associated with the two income streams be denoted by $V_A$ and $V_B$, respectively. Then,

$$V_A = \frac{X_1}{(1+r)^1} + \frac{X_2}{(1+r)^2} + \frac{X_3}{(1+r)^3} + \cdots + \frac{X_{42}}{(1+r)^{47}}$$

$$V_B = \frac{-Z}{(1+r)^1} + \frac{-Z}{(1+r)^2} + \frac{-Z}{(1+r)^3} + \frac{Y_1}{(1+r)^4} + \cdots + \frac{Y_{39}}{(1+r)^{47}}$$

where $\delta$ is the individual's discount rate.
The net present value (NPV) of investing in higher education is given by \( V_B - V_A \). The investment is considered profitable if the NPV is positive, and the individual’s decision would be to enrol in higher education. Conversely, if \( NPV < 0 \), the individual would be better-off not attending university.

An alternative way of making the same comparison is to calculate the value of \( \delta \) which equates \( V_A \) and \( V_B \). This particular discount rate is called the "Internal Rate of Return" (IRR). The decision rule would then be as follows: If IRR exceeds the individual’s discount rate, the investment is considered profitable.

The same procedures as described in the preceding paragraphs can be used to determine the social profitability of higher education. In this case, however, the income streams \( X_i \) and \( Y_i \) will be pre-tax figures rather than post-tax, and \( Z \) is defined as the difference between direct social costs and the student’s part-time earnings. Instead of the individual’s discount rate, social profitability requires the use of the "social discount rate". In both private and social calculations, the figures should ideally be adjusted for non-pecuniary benefits. In the former case, these benefits include only those accruing to the individual, whereas in the latter case, they include external benefits as well.

Although most practitioners agree that the NPV technique is superior to the IRR technique, the latter is generally accepted as being easier to interpret. This explains the dominence of IRR as a measure of educational profitability in the literature. For the purposes of deciding whether a particular educational investment is

23. The justification for this decision rule is considered below in Section 2.5.2.
worthwhile, both the IRR and the NPV techniques will lead to the same
conclusion, as long as the two alternative income profiles cross over
only once (which eliminates the problem of multiple solutions in the
IRR technique). In comparing the relative attractiveness of mutually-
exclusive investments, however, the ranking under the two techniques
may differ. That is, the investment with the highest IRR may not
necessarily also be the one with the highest NPV. When this happens,
the NPV technique should be used.\(^{24}\)

In this thesis, the profitability of education will be measured
by its IRR for comparability with other studies. Where possible
conflict between the IRR and NPV techniques exists, however, the NPV
technique will be used.

2.5 Some Outstanding Issues

2.5.1 The Screening Hypothesis

One of the greatest challenges to Human Capital Theory comes
from what is known as "the screening hypothesis".\(^{25}\) Several versions
of this argument exists, but the unifying theme in all of them is the
proposition that education serves as a signalling device which
enables employers to identify individuals who possess superior
ability and other desirable personal attributes, such as, high
motivation, subservience to authority, good work attitude, and so on.
In the extreme version of this argument, the education process does
not impart any knowledge and skills which make individuals more

\(^{24}\) For a fuller discussion, see, Dryden (1963).

\(^{25}\) The screening hypothesis also goes under various other titles
like "credentialism", "educational filtering", "pig-skin effect",
"signalling", and so on. Original contributions to this literature
valuable in the labour force; its social value, to the extent that there is any at all, lies in the role it plays in matching the "right" people to the "right" jobs. 26 It is surmised that cheaper methods of allocating people to jobs exist, and hence, education is socially wasteful. The problem with this argument is that nobody has yet come up with an estimate of how much this allocative function performed by schooling is worth, or a convincing explanation of why, if cheaper methods of screening exist, employers do not use them. 27

A number of attempts to test the screening hypothesis have been made. These include the studies by Taubman and Wales (1973), Chiswick (1973), Layard and Psacharopoulos (1974), Wolpin (1977), Psacharopoulos (1979), Riley (1979), Albrecht (1981), Liu and Wong (1982), Miller and Volker (1984), Lang and Kropp (1986). The results from these studies are quite mixed. Some studies, like Layard and Psacharopoulos (1974), conclude that the evidence is in conflict with the screening hypothesis. Others, such as, Lang and Kropp (1986), reject the human capital model in favour of the screening model. There are problems with each of the studies, and in general, it is difficult to be convinced one way or the other by the empirical evidence.


27. Taubman and Wales (1975) have argued that such mechanisms may exist, although they have not been discovered yet. Whether something can be said to "exist" before its "discovery" is a question that is best left to philosophers. For the purpose of analysing society's production possibility set, however, it would seem most logical and useful to base the analysis on currently-known technology.
It should be noted that from the individual investment point of view, whether schooling is productivity-enhancing is irrelevant.\textsuperscript{28} Individuals will invest as long as it is profitable for them to do so. The educational investment will confer the same benefit to individuals irrespective of whether education makes them more productive, or simply provides them with a device to signal their superior ability. Hence, it is only the measures of social profitability which are called into question by the screening hypothesis.

2.5.2 Choice of Discount Rate

In almost all studies on the profitability of education, the existence of perfect capital markets is assumed. Under this assumption, individuals are able to freely borrow and lend at the market rate of interest $i$. As shown in Appendix 2.1, this allows the consumption decision of how much to consume in each period, to be made separately from the production decision of how much to invest in each period. This proposition is commonly referred to as the "Separation Theorem". An implication of the separation theorem is that irrespective of individuals' intertemporal preferences,\textsuperscript{29} future income flows would be discounted with a constant discount rate equal to the market rate of interest. Hence, provided capital markets work perfectly, maximisation of discounted wealth is equivalent to individual utility maximisation.\textsuperscript{30} This is the usual justification

\textsuperscript{28} The argument here refers to the effect of schooling on earnings. Clearly, for non-marketed effects, whether schooling is productivity-enhancing is as important to the individual as it is to society.

\textsuperscript{29} The only restriction is that individuals' utility functions are quasi-concave.

\textsuperscript{30} It is important to note, however, that we have abstracted from the demand for leisure. In integrated models where leisure enters
for employing the NPV and IRR techniques in the evaluation of educational investments even though it is not always explicitly stated.

Capital markets are, of course, not perfect. It is well recognized that individuals may encounter considerable difficulties raising funds to invest in human capital because of the problems in using such capital as collateral. It has been shown, most recently by Kodde and Ritzen (1985), that if individuals face credit rationing or increasing borrowing costs in the capital market, the separation theorem breaks down. In other words, we can no longer assess the profitability of an educational investment, independent of individuals' wealth and time preferences.

Becker (1975, pp.102-104) has observed that the capital market for financing education is highly segregated, and that there are various sources from which funds can be drawn, each associated with a different cost. The cheapest sources of funds usually come from families and friends, and from individuals' own resources (savings, inheritances, etc.). These, however, tend to be limited, and individuals frequently have to resort to more expensive sources such as commercial loans, and cutting back on their consumption. When all sources are exhausted, the cost may be considered to be infinitely large.

Strictly speaking, the break down of the separation theorem would invalidate the use of the NPV and IRR techniques as described into the utility function (see, for instance, Becker (1975) pp. 56-66) the separation between consumption and production decisions breaks down.

in Section 2.4. To assess the profitability of an educational
investment, it would be necessary to explicitly model individuals' preferences, their initial endowments, and the capital market constraints that they are faced with. As a practical compromise, however, it may be suggested that the NPV and IRR techniques can still be used, with the modification that the discount rates be allowed to vary across individuals, and across investments,\textsuperscript{32} to reflect differences in the cost of funds in each case.\textsuperscript{33} Under this approach, the discount rate for an individual from a wealthy background is expected to be lower than that for an individual from a less wealthy background. The discount rate will also be influenced by the financing arrangements of the investment. For instance, between two schemes, one requiring an up-front payment of fees, and the other allowing students to defer their payment till when they are employed, we may expect the discount rate used by the same individual to be higher in the former case.

The choice of the social discount rate is also far from straight-forward. Again, the problem arises because of the various imperfections in capital markets. In addition, taxes may also result in large distortions. Opinion is divided among economists as to whether the "correct" social discount rate should be the social rate of time preference, the social opportunity cost of capital, or some weighted average of the two.\textsuperscript{34} Cohn (1972, p.176) has concluded that

\textsuperscript{32} The use of different discount rates across projects here is motivated by concerns quite apart from differences in riskiness across projects (which will be discussed later).

\textsuperscript{33} Such an approach is adopted by Willis and Rosen (1979), for instance.

\textsuperscript{34} For a recent review of the debate, see, Department of Finance (1987).
"... the only consensus in this controversy is that there is a lack of consensus". We do not intend to enter into this debate in this thesis, but note only that the figures typically used in the literature for educational investments range from between 3% to 15% (with 10% being the rule-of-thumb figure).

2.5.3 Variation in Rates of Return

Empirical estimates of educational profitability are typically based on the comparison of mean earnings profiles corresponding to different schooling groups. The fact that there exists considerable variation in incomes among individuals with the same sex, age (or labour market experience), education, and other observable characteristics, has largely been ignored. Early on, Becker (1975, p.181) has drawn attention to the fact that there is substantial variation in the rates of return between individuals. This suggests that education, like other investments, carry with it a certain degree of riskiness. Unfortunately, as Blaug (1976, p.841) has observed that "... the problems this creates for interpreting private rates of return have been generally ignored".

The treatment of risk in the assessment of educational profitability has, as we have remarked in the previous chapter, tended to be rather ad hoc. The IRR of education is usually compared to the rate of return on investments with the same degree of riskiness in order to determine the attractiveness of the educational investment.35 Without an explicit modelling of risk, however, it is difficult to see what this entails. Should the IRR be compared with the returns from investments in the stock market, for instance? And,

35. Equivalently, in the calculation of the NPV, a "risk-adjusted" discount rate is used.
if so, which stocks? Or, should it be compared to the returns in the housing market instead? And so, the list of questions goes on. Moreover, this procedure confuses the issues of time discounting and risk, and may result in misleading conclusions as Stiglitz (1988, pp.270-271) has pointed out.

The large variation in individual rates of return also raises a further question: How does the rate of return to the marginal student (defined as the last student to be admitted under the selection criteria for entrance) differ from the average rate of return? For a number of policy questions, the first figure is often of more interest than the second, which has received the bulk of the attention so far.

These, and other implications of the variability in individual rates of return are tackled in Part II of the thesis.

2.5.4 Cross-Sectional and Life-Cycle Profiles

Almost all existing empirical work on educational profitability have been based on cross-sectional data. Estimation proceeds by first obtaining the cross-sectional earnings profiles corresponding to different educational groups. These cross-sectional profiles are then treated as if they are life-cycle profiles of individuals with the corresponding education. The NPV or IRR can then be derived as described in Section 2.4.

36. "Life-cycle" earnings profiles are obtained by tracing the same cohorts over its entire lifetime. "Cross-sectional" earnings profiles, on the other hand, are obtained by observing the earnings of individuals of different ages at a single point in time. The profile is, therefore, made up of many different cohorts.
The critical assumption in using cross-sectional data is that individuals' incomes grow at the cross-sectional rate. In other words, the average income of, say, degree holders aged 25 in 1986 is assumed to be equal, ten years later in 1996, to the average income of 35 year-old degree-holders in 1986.

There are several reasons why this assumption may not be valid. First, the economy is clearly neither static nor in a steady-state equilibrium. The demand and supply of graduates may change in the future. This may, in turn, result in the average income of 35 year-old graduates today being substantially different to what 25 year-old graduates will receive in ten years' time.

Second, the 35 year-old cohort may have characteristics (acquired and inborn) which are quite different to those of the 25 year-old cohort. For instance, the 25 year-old graduates of today may be employed in jobs which have less on-the-job training compared to those in which the 35 year-old cohort were employed. Ceteris paribus, the average income of the 25 year-old cohort in ten years' time would, therefore, be less than the average income received by the 35 year-old cohort today. On the other hand, the 25 year-old cohort may, on average, have higher innate ability and may have received higher quality schooling. This would then suggest that the average income of the 35 year-old cohort may understate the 25 year-old cohort's future income.

To the extent that the differences in characteristics across cohorts can be identified and measured, they can then be controlled.

37. Sometimes growth factors are incorporated to allow for secular growth in earnings. These are, however, ad hoc and undifferentiated between educational classes.
for using regression techniques. The problem is that many of these differences, such as the amount of on-the-job training and quality of schooling, are not directly measurable. Moreover, each cohort is by definition unique, and we can never be sure that differences across cohorts in all the characteristics which influence income are controlled for. 38

Economists have long been aware of the potential pitfalls in using cross-sectional data. Miller (1965), for instance, has examined the differences in results obtained by tracing the same cohort across two successive decennial censuses and by using the cross-section. He concluded that the two methods yielded "quite different results".

In spite of this, cross-sectional data continued to be widely used in the literature for several reasons. First, longitudinal data are hard to come by, and they rarely cover a period long enough to allow entire life-cycle earnings profiles to be constructed. 39

Second, even if life-cycle earnings profiles could be obtained, they would apply to individuals who have already left the work-force. In the case of degree-holders, for instance, this would mean that the earnings profiles are for individuals who graduated some 40-50 years ago. It is difficult to see how useful this information would be to individuals currently contemplating whether to pursue higher education, given the changes that have occurred over the last four to

38. For further discussion on the importance of examining cohort uniqueness, see, Bowman (1987).

39. An alternative to using longitudinal data is to use successive cross-sections to trace the same cohort over time. For a working-life of 40-50 years, however, this requires comparable cross-sectional data encompassing four to five decades. Again, such information is rarely available.
five decades. Since the interest in calculating rates of return lies primarily in the implications they hold for current educational decisions, it is what individuals (and society) expect to gain from their investment which is relevant. Hence, if cross-sectional data encompass the most up-to-date information, and if students base their expectations on these data, then it can be argued that cross-sectional data are the most relevant.

Finally, the use of cross-sectional data carries with it an advantage in that they do not need to be adjusted for changes in the value of money.

2.6 Australian Research on the Profitability of Education

A handful of studies on the profitability of education in Australia were made in the 1970s. These include Blandy and Goldsworthy's (1973) study on private rates of return in South Australia, Selby-Smith's (1975a, 1975b) calculations of private and social benefit-cost ratios of various post-secondary courses, Chapman's (1977) study on the private returns to university qualification in the Australian Public Service, and Davis' (1977) estimation of the social rate of return to the training of doctors. Surveys of these studies are available in Blandy et al. (1979) and Miller (1982b). Therefore, the comments here will be brief.

The Blandy-Goldsworthy and Selby-Smith studies were hampered by the lack of proper income data, and the authors had to pool their

40. To the extent that there are differences in the characteristics across cohorts, these differences would tend to be larger, the further apart the cohorts are. In this sense, using the life-cycle profile of a cohort separated by more than 40 years to estimate the earnings of the current cohort may be worse than using the cross-section.
data from several different sources (and even different years) to construct the age-earnings profiles. This immediately raises questions about the comparability of the data from the different sources, and the quality of the resulting estimates. Lack of appropriate income data was also a major problem in the Davis study requiring him to make some very dubious assumptions about the shape of the age-earnings profiles. Chapman's study had the unusual luxury of a large sample size combined with good quality earnings data. Unfortunately, the scope of coverage is limited to males in clerical or administrative positions in the Second and Third divisions of the Australian Public Service, which makes it difficult to generalise the results to the population as a whole.

With regards to higher education, Blandy and Goldsworthy have found that the private rate of return for males is around 14%. The figure is raised slightly (to 15.2%) if students are assumed to be in receipt of Commonwealth University Scholarships. Selby-Smith's results show that private rates of return to various university under-graduate courses generally exceed 8%. The private Benefit-Cost ratios (discounted at 8%) appear to be somewhat higher for higher degrees. From the social point of view, however, Selby-Smith has found that the returns to higher degree courses and a number of under-graduate courses to be less than 8%. Davis' estimate of the social rate of return to medical training is around 10%. Finally, the Chapman study reports rates of return to university education between 11% to 16%, depending on the assumption regarding student earnings.

The results from these early studies were generally interpreted as suggesting that higher education is an attractive proposition.
compared with other possibilities for investment, at least from the point of individuals.

In the 1976 Australian Census, a question on income was included for the first time since 1933. This enabled Miller (1982a, 1982b) to conduct his investigation from a broad base and to estimate the rates of return to different levels of schooling for both males and females, and for Australian and overseas-born. Miller’s results indicate that the private rate of return to a Bachelor degree is around 21% for all groups (male, female, Australian-born, overseas-born). The social rates of return are slightly lower -- around 16% for males and 15% for females -- but is still regarded as profitable.

A major short-coming of the census data is that the exact dollar amounts of individuals’ incomes were not asked. Instead, respondents to the census questionnaire were asked to indicate which of the fourteen pre-determined income intervals their incomes fell into. It was, therefore, necessary for Miller to specify the mean values of the incomes for each of the fourteen categories. This task was particularly difficult for the top category which was an open interval, set at $18,000 and above. Almost 25% of all male degree-holders with reported income fell into this category, with the percentages in some specific age groups exceeding 50%. The estimated rates of return were, therefore, not surprisingly, very sensitive to the choice of the mean income for this top category, as Miller has found. The problem is, however, less severe in the case of females, where only 4% of all female graduates fell into the top income category.

41 The percentages of male and female high-school leavers with incomes in the top category are 0.4% and 2.7% respectively. The bias imparted by the open-ended income category to the shape and position
It is interesting to note that Miller's estimate of the private rate of return to higher education is substantially higher than those reported in the earlier studies. In a later study [Miller (1984)], he attempted to confirm his earlier results by re-estimating with a different data set. Using data from the 1973-74 Income Distribution Survey on the incomes of full-time full-year male workers, he estimated that the private rate of return to higher education is 22.4%. Miller concluded that the estimates from the two data sets were very similar, and that the results could, therefore, be used with some degree of confidence.

In a recent study, Miller and Volker (1987) examined the profitability of doing a three-year degree to individuals under alternative fee structures. Data from the 1985 panel of the Australian Longitudinal Survey was used for this purpose. They estimated that for males, with a 4% discount rate, the NPV of higher education fell from $47,500 when no fees were imposed, to $42,128 when fees of $2,000 were levied. In the case of females, the NPV fell from $49,133 to $43,361. Their results, therefore, suggest that university education would remain a highly attractive investment to individuals even when a $2,000 fee is charged, assuming that 4% is the appropriate discount rate.

A major short-coming with this study is that the data on which the analysis is based consisted only of youths between the ages of 16 and 25. For degree-holders, this implies that the earnings of graduates with no more than four to five years work experience is used to predict the earnings over their lifetime. The results would, therefore, be highly sensitive to the functional form of the earnings of the income profiles of high-school leavers is, therefore, not likely to be large.
function which is imposed. As such, Miller and Volker’s results need to be treated with great care.

In summary, previous Australian research on the profitability of higher education have generally concluded that it is an attractive investment from the point of individuals. The question of social profitability is less often addressed, but if we accept Miller’s (1982b) results, then higher education appears to be attractive from society’s point of view as well.
CHAPTER 3

PRIVATE PROFITABILITY OF HIGHER EDUCATION

Is higher education a profitable investment from the point of individuals in Australia? Several studies have attempted to answer this question. However, as we have discussed in the previous chapter, there are problems with each of these previous studies primarily because suitable income data were not available to the researchers. The recent initiatives taken by the Government to reform the higher education system, have renewed interest in the question of the social and private benefits of higher education. On the one hand, in the light of the proposal to substantially increase the number of graduates, there is an urgent need to know whether we already have too many graduates from an investment perspective. On the other hand, it is important to know the effect that the imposition of the tertiary tax would have on student incentives to enrol in higher education.

The former question, which relates to the social rates of return, is addressed in the next Chapter. In this chapter, we assess the profitability of higher education from the point of view of private individuals, using the NPV and IRR techniques described in Chapter 2. In addition, we examine how the rate of return differs across sexes, whether it is more profitable to pursue higher education on a part-time basis, and how the rate of return changes under different fee-paying regimes.

This chapter is divided into 6 sections. Section 3.1 describes the data used in this analysis. The private rates of return to higher education applicable to full-time students are presented in Section
3.2. In Section 3.3, we consider the issue of differences in the number of hours worked. Section 3.4 examines the private rates of return to students who pursue their degrees on a part-time basis. We also gain some insight into the magnitude of the consumption value of higher education by comparing the returns to full-time and part-time students. Section 3.5 analyses the impact of various fee-paying proposals on the private rates of return. We sum up the findings of this chapter in Section 3.6.

3.1 Data Description

Income data for this study were drawn from the sample file of the 1985-86 Income and Housing Survey. This particular data set is notable for its rich and extremely good quality data on income. The survey is based on a multi-stage area sample of private and non-private dwellings, and covers about a sixth of one percent of the population of Australia. The data were collected by means of personal interviews by trained interviewers in the period September to December 1986. A total of 17,714 observations, each containing 253 variables, are available in the 'persons record' of the sample file. Demographic variables include age (15, 16-17, 18-20, 21-24, and in 5-year groups from 25), sex, school-leaving age, and details of post-school qualifications. Labour force variables include the number of weeks worked in the 1985-86 financial year, the number of weeks spent looking for work, and the number of hours usually worked in a week.

Respondents were specifically asked by the interviewers to refer to his or her personal records, such as, tax returns or assessments, pay slips, group certificates, etc. in answering questions about income to enhance the accuracy of the data. Details were sought with respect to the amount the individual received in
1985-86 from wages and salaries, income and trusts, government pensions and benefits, personal investments, superannuation, and other regular payments. Within each of these main sources, information on the detailed breakdown was also asked. As well, respondents were asked for the amount of tax paid for the 1985-86 financial year.

The period income of some individuals might have been low because they were not earning for the whole period. The most obvious of this group are those who were studying full-time for part or all of the period. They have been excluded from the analysis.¹

For the purpose of the analysis, a high-school leaver is defined as anyone who completed the highest year in secondary school, but did not possess any post-school qualifications. A degree-holder is defined as anyone with a Bachelor degree or higher. Ideally, we would have liked to separate the higher degree holders from those with just pass and honours degrees, but the data do not permit us this luxury.

3.2 Private Internal Rates of Return to Higher Education

In this section, the private internal rate of return to higher education for full-time students is calculated. Initially, we ignore the distinction between earned and non-earned income, and consider the differences in **total income** across educational groups. As

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¹ Others include migrants who arrived during or after the period, and persons who were out of Australia for the whole period. Ideally, we would have liked to exclude these individuals as well. However, because of the way the data were made available, we were unable to identify these individuals. Fortunately, the number of such individuals is small and, therefore, unlikely to affect our results significantly. See A.B.S. Cat.No. 6546.0 p. 29.
discussed in the previous chapter, after-tax figures are used in private rates of return calculations.

The average after-tax total income and the number of observations for degree-holders and high-school leavers by sex and age are given in Table A3.1.1 of Appendix 3.1. The age-income profiles for each of the four groups (degree-holders and high-school leavers, male and female) are constructed as follows. For high-school leavers, we assume that the figure for the 15-20 age category is the income of individuals aged 19. In the case of degree-holders, the figure in the 21-24 age category is assumed to be the income of those aged 23. For all other age categories, we assume that the figures in Table A3.1.1 are the incomes of individuals of average age in each age group. Linear interpolation is then used to determine the incomes at all other ages. The resulting cross-sectional income profiles are shown in Figures 3.1 and 3.2.

It is unclear what economic significance should be attached to the dip in the male high-school leavers' earnings profile over the ages of 40 to 55. The low incomes could simply be the result of sampling errors. In any case, this dip does not affect our results substantially since it occurs fairly late in the life-cycle, and is therefore, heavily discounted.

Rates of return are calculated for individuals having just completed high school under the assumption that members of the relevant sex group believes that their income experience in the future will correspond with the average income experience of the group. That is, we assume that individuals believe that their future incomes will be as given by the cross-sectional income profile of graduates if they were to proceed to higher education before entering
FIGURE 3.1: AFTER-TAX INCOME PROFILES
ALL MALES

1985/86 DOLLARS

AGE

degree-holders
high-school leavers
FIG. 3.2: AFTER-TAX INCOME PROFILES
ALL FEMALES

1985/86 DOLLARS

degree-holders

high-school leavers
the workforce, and by the income profile of high-school leavers if they were to join the workforce immediately.²,³

It is a common practice to assume that the time taken to complete is three years. Although this is certain to be less than the time taken by a typical individual for completion, it is argued that individuals believe that they would complete their degrees in the minimum time required.⁴ Even so, three years would still be an underestimate since a number of courses require minimums of more than that for completion (medicine, dentistry, architecture, law, veterinary science, engineering, etc.). In our case, this is further compounded by the inclusion of honours and higher-degree holders amongst the pass-degree holders. We have, therefore, decided to assume three and half years as a minimum time taken to complete the degree.⁵

The net income received whilst studying has a major impact on the rate of return to higher education. The Commonwealth Department

². Implicit in this procedure is the assumption that there are no systematic ability differences between high-school leavers and degree holders. The sensitivity of results to this assumption is addressed in Part II of the thesis.

³. Individuals' annual income depends on the total number of hours worked during the year and the wage rate. The former, in turn, depends on the number of weeks worked during the year, and the average number of hours worked during those weeks. In this section, we assume that individuals form their expectations regarding their future participation rates, unemployment probabilities, average weekly number of hours worked, and wage rates on the basis of the cross-section.


⁵. The rate of return figures calculated are sensitive to this parameter. Miller (1984) who was also unable to distinguish between pass and higher-degree holders used a figure of 3.3 years as the time taken to complete. We examined the course and level (pass, graduate diploma, Masters, PhD) mixes of degree-holders in the 1981 Census, and found that the average minimum time for completion was around 3.5 years.
of Employment, Education, and Training estimated that in 1984, the average annual course-related expenses (union and general service fees, cost of books, stationery, equipment, materials, etc.) for a university undergraduate amounted to $595. It was also estimated in the same report that university students on the Tertiary Education Allowance Scheme (TEAS) received an average of $2,565 in assistance, and earned an average of $865 during the year. Those not on any student assistance schemes, on the other hand, averaged $1,483 in income from employment. Converting these figures into 1985-86 dollars and rounding off, we assume that the direct cost to the individual in studying amounts to $660 per year. Three scenarios with respect to the amount of income received whilst studying are considered in this study: a) $0 (or -$660 net); b) $1,640 (or $980 net); and c) $3,790 (or $3,130 net). Scenario (b) corresponds to students not on any assistance scheme, and earning the average income for that group, and scenario (c) reflects the situation faced by a typical TEAS recipient who had worked some time during the year.

In the calculations, we have also assumed that individuals, regardless of qualifications, retire at the age of sixty. The choice of the retirement age is not likely to affect the rate of return to any great extent, since incomes some forty years after the decision whether to enrol in higher education is made are very heavily discounted.

Table 3.1 shows the rates of return to higher education corresponding to each of the three income scenarios, calculated using after-tax total income.

TABLE 3.1: PRIVATE INTERNAL RATES OF RETURN TO HIGHER EDUCATION
(TOTAL INCOME)

<table>
<thead>
<tr>
<th>NET INCOME WHILST STUDYING</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALES</td>
</tr>
<tr>
<td>-$660</td>
</tr>
<tr>
<td>9.68%</td>
</tr>
<tr>
<td>FEMALES</td>
</tr>
<tr>
<td>12.64%</td>
</tr>
</tbody>
</table>

A prominent feature of figures in Table 3.1 is the higher IRR for females compared to males. This is principally because female graduates have relatively higher participation rates, lower unemployment rates, and longer working hours compared to female non-graduates, resulting in significantly higher incomes for the former group. Participation rates and working hours for men differ to a much lesser degree across education groups, with most of them working full-time, for the full year. The monetary advantage of having a degree is consequently lower. The higher profitability of higher education to females is not necessarily incompatible with the observation that males, on average, earn more than females. The IRR figures in the table are obtained by comparing the incomes of graduates to the incomes of high-school leavers of the same sex, and it is this differential which determines the profitability of higher education. There is no reason to expect this differential to be larger for males just because the incomes of males are, on average, higher than the incomes of females.

A second prominent feature of the figures is their magnitude. Given that the real after-tax returns to individuals from investments in the market portfolio since the mid-1970s are of the order of 4 to 7 per cent, our estimates show that higher education appears to be

profitable to the private individual, even if he or she did not receive any form of student assistance, and did not work at all.\footnote{This assumes that investments in the market portfolio are in the same risk class as investments in higher education. If the latter is considered to be more risky, then it may well be the case that higher education is unattractive to individuals as an investment. This problem is discussed in Part II of the thesis.}

Among those who worked whilst studying (scenarios b and c), the returns to the recipients of TEAS are significantly higher than those not on any form of student assistance, particularly in the case of females. An implication of this is that changes in the eligibility requirements for student allowances would, \textit{ceteris paribus}, have a greater impact on female enrolment in higher education compared to male enrolment. This is not at all surprising, since males, on average, tend to have higher incomes than females, which means that a given dollar-amount in tertiary allowances reduces the opportunity cost of female students proportionately more than that of male students.

It is often argued that rates of return estimated with income figures are biased upwards, since the human and the non-human components of wealth tend to be correlated. The argument is that schooling influences individuals' incomes only through its effect on their earnings potential. As such, \textit{earned income}, rather than total income should be used in the calculations. We are able to determine the extent of the bias arising from the use of total income with our data set.

\textit{Earned income} is defined in this thesis as the income from wages or salary, and from the individual's own business, trade or profession. Table A3.1.2 of Appendix 3.1 shows the average \textit{pre-tax earned income} by sex and age for high-school leavers and degree...
FIG. 3.3: PRE-TAX EARNINGS PROFILES
ALL MALES

1985/86 DOLLARS

AGE

degree-holders
high-school leavers
FIG. 3.4: PRE-TAX EARNINGS PROFILES
ALL FEMALES

1985/86 DOLLARS

AGE

degree-holders

high-school leavers
holders. The earnings profiles for the four groups are constructed in the same way as before. These pre-tax earnings profiles are plotted in Figures 3.3 and 3.4.

In calculating the private rates of return, the personal tax rates operating in the 1985-86 financial rates are applied to the gross earned-income profiles. The rates of return to higher education using earned income are presented in Table 3.2.

<table>
<thead>
<tr>
<th>NET INCOME WHILST STUDYING</th>
<th>MALES</th>
<th>FEMALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>-660</td>
<td>9.84%</td>
<td>13.34%</td>
</tr>
<tr>
<td>980</td>
<td>11.07%</td>
<td>15.20%</td>
</tr>
<tr>
<td>3,130</td>
<td>13.30%</td>
<td>18.76%</td>
</tr>
</tbody>
</table>

Comparing the figures in Tables 3.1 and 3.2, we note that for both sexes, the rates of return calculated using earned income are, in fact, slightly higher. The differences are, however, negligible. This may be due to the higher take-up rate of the various forms of government benefits among individuals in the non-graduate group, and the proportionately greater effects these payments have on their total incomes.

In summary, the results in this section confirm the findings of the earlier studies that higher education appears to be a profitable investment to individuals. It is also found that the differences in the rates estimated using income, as opposed to earnings data, are small. There are three non-mutually exclusive reasons for the latter finding. First, the link between human and non-human wealth may not...

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9. No allowance is made for tax deductions and rebates.
be as strong as commonly assumed. Second, the non-human component of total wealth may be small. Finally, to the extent that the various forms of transfer payments from the government benefit non-graduates more so than graduates, the rates of return calculated using the total income concept would, ceteris paribus, be smaller than the rates calculated using the earned-income concept. This last factor would reduce, and might even reverse the upwards bias caused by any link between human and non-human wealth.

3.3 Adjustments for Hours Worked

It was established in the previous section that having a degree is associated with higher earnings in the labour market. Those calculations, however, do not take into account differences in the number of weeks worked, or the number of hours worked per week. Eckaus (1973b) has pointed out that one of the differences between human capital and physical capital is that in using the former to earn income, individuals in which the capital is embodied suffer some loss of utility. Consequently, he has argued that rates of return calculations should be estimated using hours-standardised earnings data.

Eckaus' argument can be easily understood with the help of a diagram. Figure 3.5 shows the leisure-labour choice in an indifference-curve framework. AC and AD are the budget-lines which define the consumption sets for a typical high-school leaver and a typical graduate, respectively. Empirically, we can only observe the points X and Y. The procedure in the previous section measures the income advantage to having a degree by the distance GH. This measure, however, is composed of both the "income" and "substitution" effects. To isolate the pure "income" effect so as to give a welfare measure
FIGURE 3.5: LEISURE-LABOUR CHOICE

In the key Lucasian approach to the determination of leisure, it is important which figure we choose to substitute for the constant which the original quantity of leisure was intended to represent. This implicitly assumes that individuals are not aware of how their leisure and income are affected by changes in leisure. Therefore, it can be argued that they are not aware of how their leisure and income are affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure.

In a Lucasian model, the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure.

In this Lucasian context, individuals are not aware of how their leisure and income are affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. Therefore, it can be argued that they are not aware of how their leisure and income are affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure.

In a Lucasian model, the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. Therefore, it can be argued that they are not aware of how their leisure and income are affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure.

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In a Lucasian model, the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. Therefore, it can be argued that they are not aware of how their leisure and income are affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure. This in turn implies that the value of leisure is not affected by changes in leisure.
in terms of either the compensating variation (FD), or the equivalent variation (CE), the number of hours worked needs to be standardised, either at AJ or AI. In practice, it is unimportant which figure we choose to standardise the number of hours at.  

The key to Eckaus' argument is that individuals working more hours are worse off ceteris paribus because they have less time for leisure, or they could have used the extra hours productively in home activities (mowing the lawn, child-care, etc.). The hours-standardisation is equivalent to valuing leisure (or home production) at individuals' marginal wage rates. This implicitly assumes that individuals are completely free to choose the number of hours in a year that they work. If this last assumption does not hold, then individuals may, in fact, value the extra hours at more, or less than their marginal wage rates.

There are circumstances where individuals may value the extra "leisure" at zero, or even negatively. For instance, if those who are working less hours are only doing so because they cannot find more work, it can be argued that the extra "leisure" not only does not bring any utility, but may even cause disutility due to stress, low self-esteem, and so on. In this case, the estimates presented in Table 3.2, which implicitly assume that there is no disutility

---

10. This is because the direct cost to students in terms of course-related expenses is small compared to the opportunity cost. In the limit, when the direct cost is zero, the rate of return is invariant to choice of the standard number of hours worked. See Eckaus (1973b) p.124 footnote 7.

11. Individuals who are constrained to work less than they would have liked, would value the extra leisure at less than their wage rates, and conversely for those who are constrained to work more than they would like at the margin.
associated with working extra hours would, therefore, adequately reflect the value of a degree.\textsuperscript{12}

Alternatively, as Miller (1982b, p.65) has argued, if we view higher education as a "ticket" which provides entry into jobs which are different to those open to high-school leavers (hours associated with the jobs being one such difference), and are interested only in assessing the monetary advantages of the job package, or if we merely want to know the \textit{monetary} returns to having a degree assuming that the choice of hours is as reflected by the cross-section, then the figures in Table 3.2 would suffice.

On the other hand, if the number of hours worked is a choice variable, and we want to know more than just the monetary returns, then Eckaus' argument would apply, and hourly-standardised incomes should be used.\textsuperscript{13}

Hourly wages are not reported in our data set. Although it is possible to construct such a variable using the information on income, number of weeks worked, and the number of hours usually worked per week, such a procedure would require assumptions about the distribution of the number of hours worked, since, data on this variable are available only in broad intervals (0-9, 10-19, 20-34, 35-44, and 45+). The alternative, which is the procedure we adopted,

\textsuperscript{12} If one argues that working less hours entails a loss of utility, then ideally, the dollar value of this loss should be added to the earnings of those working more hours. This valuation is, unfortunately, difficult. Consequently, the extra hours are usually assumed to be valued at zero for simplicity.

\textsuperscript{13} A more sophisticated treatment would be to model labour-supply and educational investment decisions simultaneously [see, for instance, Becker (1975), Heckman (1976a), Blinder and Weiss (1976), Ghez and Becker (1975), Deaton and Muellbauer (1980)]. Such a treatment is beyond the scope of this thesis.
is to base the rate of return estimates on the earnings of full-time, full-year workers. The cost of doing this, however, is that our sample size is reduced quite significantly, particularly for females.

The restriction of the sample to full-time, full-year workers affects the estimated rates of return in two ways. First, to the extent that the earnings of the high-school leavers when they first enter the labour force are higher for the restricted sample than for the full sample, the opportunity cost of higher education increases. Ceteris paribus, this would lead to a lower rate of return compared to that estimated with unadjusted earnings.

Second, to the extent that degree-holders in the full-sample are more likely to have worked full-time and for the full year than high-school leavers of the same age, the restriction of the sample would raise the earnings profile of the latter group by a larger margin. The standardisation of hours worked would, therefore, reduce the difference in earnings between the two groups, and lower the estimated rate of return to higher education.

The discussion in Eckaus (1973b) proceeded in such a way as to give the impression that the hours-adjustment affects estimates of the rate of return only via the second avenue. This is incorrect. If anything, the effect via the first avenue would tend to be more potent due to the discounting process. The effect on the opportunity cost is weighted more heavily in the calculations than the effect on net returns which accrue in the future.

14. Note that hours worked may still vary to some degree even among those who work full-time (defined as 40 hours a week and above).
FIG. 3.6: PRE-TAX EARNINGS PROFILES
FULL-TIME FULL-YEAR MALES

1985/86 DOLLARS

AGE

degree-holders
high-school leavers
FIG. 3.7: PRE-TAX EARNINGS PROFILES
FULL-TIME FULL-YEAR FEMALES

1985/86 DOLLARS

AGE

degree-holders
high-school leavers
The pre-tax average earned income by education, sex and age for the sample full-time full-year workers is given in Table A3.1.3 in Appendix 3.1. Figures 3.6 and 3.7 show the corresponding pre-tax earnings profiles. The private rates of return to higher education calculated using these profiles are given in Table 3.3.

TABLE 3.3: PRIVATE INTERNAL RATES OF RETURN TO HIGHER EDUCATION
(EARNED INCOME, FULL-TIME, FULL-YEAR WORKERS)

<table>
<thead>
<tr>
<th>NET INCOME WHILST STUDYING</th>
<th>MALES</th>
<th>FEMALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>-$660</td>
<td>7.73%</td>
<td>8.80%</td>
</tr>
<tr>
<td>$980</td>
<td>8.68%</td>
<td>9.84%</td>
</tr>
<tr>
<td>$3,130</td>
<td>10.27%</td>
<td>11.63%</td>
</tr>
</tbody>
</table>

Comparing the figures in Tables 3.2 and 3.3, we note that the rates of return calculated using the restricted sample are smaller. For instance, the IRR to males using the full sample is 11.07% (assuming net income while studying of $980). When the sample is restricted to full-time, full-year males, this falls to 8.68%. This suggests that the higher earnings of graduates are due, at least in part, to the longer hours they worked, on average, in a year.

A second point of interest is that the effect of the standardisation of hours worked on female rates of return is stronger than on the male rates. The IRR for males falls by between 2-3 percentage points compared to the fall of 4-7 percentage points for females when the sample is restricted to full-time full-year workers. This is not unexpected since the difference in participation rates between graduates and non-graduates is much more marked in the case of females. It is interesting to note, however, that even after standardising the number of hours worked, the rate of return to higher education for females is still higher than for males.
Finally, we note that higher education appears to be a profitable investment for individuals even when we focus solely on full-time full-year workers.

3.4 Private Rates of Return to Part-Time Students

So far, we have examined the private rates of return to higher education assuming that individuals pursue their degrees on a full-time basis. In this section, we compare the strategy of studying full-time with that of pursuing a degree on a part-time basis. Because the data do not allow us to distinguish between graduates who studied full-time from those who studied part-time, some assumptions must be made. First, we assume that while studying, part-time students earn the average of high-school leavers of the same age. Second, we assume that upon graduation, their earnings are equal to the average earnings of degree-holders of the same age. Third, we assume that part-timers take 7 years to complete their degrees.

The first assumption may appear overly generous to those opting to study part-time. One may be inclined to believe that part-time students tend to have less demanding jobs with lower wages compared to the average high-school leaver in the workforce who is not studying. The evidence from the 1981 Census, however, indicates otherwise. Focusing on just high-school leavers below the age of thirty, it was found that for both males and females, those studying part-time earn more than those who were not studying.15

---

15. Regression results are given in Appendix 3.2. The higher earnings of those studying part-time could be a reflection of the characteristics of this group which are not modelled e.g. motivation and ability. The inclusion of these variables may well reverse the signs on those studying part-time. In that case, our first assumption would underestimate the opportunity cost of studying part-time.
It could also be argued that graduates who obtained their degrees on a part-time basis might be expected to earn more than similarly-aged graduates who studied full-time, since they have more years of labour force experience. However, in terms of experience as a graduate, the advantage lies with latter group. To the extent that experience in non-graduate work is irrelevant to their performance in graduate-work, we may then expect those who studied part-time to earn less than those who completed their degrees on a full-time basis. Unfortunately, our data do not allow us the luxury of testing these hypotheses. Consequently, the middle ground was chosen for our second assumption. That is, on graduation, those who completed their degrees on a part-time basis cannot be distinguished from similarly-aged individuals who studied full-time.

We consider two different scenarios of part-time study. The first assumes that the individual starts his or her part-time study at age 19, immediately following the completion of high-school. This scenario is referred to in the analysis as PT1. The second scenario (referred to as PT2) considers the case of an individual who joins the workforce upon completion of high-school, and does not commence his or her studies until the age of 25. In both cases, the direct cost to the student was set at $660 per year, and the retirement age is assumed to be 60.

The internal rates of return to higher education by part-time studies are presented in Table 3.4. The figures estimated using the restricted sample consisting of only full-time, full-year workers are given in the table as well.
The most striking feature of the figures in Table 3.4 is clearly their magnitude. Pursuing higher education on a part-time basis appears to be an extremely profitable venture. This is so whether we use the full- or restricted-samples. Why then would students opt to study full-time? Several possible reasons may be suggested.

First, the ranking of investment projects by the NPV and IRR criteria may differ as we have discussed in the previous chapter. Hence, although the IRR to part-time study is higher than to full-time study, individuals may nevertheless be financially better off pursuing their degrees full-time. To overcome this deficiency in the IRR technique, the NPVs to both modes of study at various discount rates are calculated. These are given in Table 3.5.16 Figures for the restricted sample of full-time full-year workers are used in this exercise.17

16. Figures for the full-time mode of study correspond to column 3 of Table 3.3.

17. Results applicable to the full sample of are given in Appendix 3.3.
### TABLE 3.5: PRIVATE NET PRESENT VALUE OF HIGHER EDUCATION BY MODE OF STUDY (1985/86 DOLLARS)

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>Full-time</th>
<th>PT1</th>
<th>PT2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IRR</td>
<td>MALES</td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>10.27%</td>
<td>31.07%</td>
<td>34.22%</td>
</tr>
<tr>
<td>3%</td>
<td>$162,860</td>
<td>$184,020</td>
<td>$162,060</td>
</tr>
<tr>
<td>5%</td>
<td>$65,780</td>
<td>$86,130</td>
<td>$70,740</td>
</tr>
<tr>
<td>10%</td>
<td>$34,440</td>
<td>$54,240</td>
<td>$42,090</td>
</tr>
<tr>
<td>15%</td>
<td>$900</td>
<td>$19,350</td>
<td>$12,680</td>
</tr>
<tr>
<td></td>
<td>-$9,390</td>
<td>$7,770</td>
<td>$4,220</td>
</tr>
</tbody>
</table>

**FEMALES**

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>Full-time</th>
<th>PT1</th>
<th>PT2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IRR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>11.63%</td>
<td>34.67%</td>
<td>36.41%</td>
</tr>
<tr>
<td>3%</td>
<td>$196,700</td>
<td>$215,550</td>
<td>$187,300</td>
</tr>
<tr>
<td>5%</td>
<td>$80,840</td>
<td>$99,300</td>
<td>$79,300</td>
</tr>
<tr>
<td>10%</td>
<td>$44,210</td>
<td>$62,360</td>
<td>$46,440</td>
</tr>
<tr>
<td>15%</td>
<td>$5,450</td>
<td>$22,710</td>
<td>$13,700</td>
</tr>
<tr>
<td></td>
<td>-$6,690</td>
<td>$9,630</td>
<td>$4,600</td>
</tr>
</tbody>
</table>

The danger of using the IRR to choose between two mutually exclusive investment projects is apparent from the figures. Note, for instance, that IRR ranks PT2 above PT1 in the case of males. Yet, for the range of discount rates considered here, the NPV of PT1 is clearly higher. That is, individuals (with discount rates between 0% and 15%) are better off commencing their part-time studies immediately upon completion of high-school (PT1) instead of later (PT2). However, between part-time and full-time studies, both IRR and NPV (within the range of discount rates considered here) give the same ranking, with the exception of the comparison between full-time and PT2 at a zero discount rate. Students are clearly better off from an investment perspective completing their degrees on a part-time basis. Therefore, the potential conflict between IRR and NPV rankings does not explain why the full-time mode of study may be preferred.
In the case of females, again, within the range of discount rates considered here, PT1 is preferred to PT2 (contrary to what the respective IRRs suggest). That is, between the two part-time strategies -- commencing higher education at 19, and commencing at 25 -- the former would be preferred from an investment perspective. The comparison between full- and part-time modes of study is slightly more complicated. Here, at low discount rates, the NPVs associated with PT2 is lower than those associated with studying full-time (again, conflicting with IRR ranking). Hence, for females with low discount rates, if the only choices available were studying full-time, or PT2, the former would be preferred. If, however, the choice of commencing part-time higher education immediately, upon completion of high-school (PT1) were available as well, then our investment model predicts that females would choose to study part-time. Again, we are forced to conclude that the conflict between IRR and NPV cannot be the whole story.18

The second possible explanation for preferring full-time studies is that, so far, our calculations have implicitly assumed the household as the decision-making unit. That is, we have not considered transfers of income within the family. If individuals were to regard non-repayable cash assistance from parents, relatives and friends as part of his or her income whilst studying (not unlike other forms of student assistance like TEAS), then the cost of full-time higher education is reduced, and rate of return increased. To the extent that these money gifts would not be forthcoming if individuals were working (and studying on a part-time basis), they may bias individuals' decision towards studying full-time. The

18. For both sexes, the results using the full sample are very similar.
Department of Employment, Education and Training\(^{19}\) has estimated that in 1984, university students, on average, received a total of $1,435 in money gifts from parents, relatives and friends. Although this amount does not appear to be large enough to eliminate the difference in NPV between the modes of study, it may well be an important part of the whole explanation.

Thirdly, not all jobs have working hours which are flexible enough to permit workers to enrol in higher education. This may make the part-time choice irrelevant to all but a handful of cases. Closely related to this point, are the non-monetary sacrifices associated with simultaneously holding a full-time job and studying part-time. Even if individuals could find jobs which permitted them to pursue higher education on a part-time basis, they may still be disinclined to choose this option, simply because it is considered too "stressful". On the other side of the coin, full-time study has the attractiveness of offering students a less-taxing life-style, with the opportunity to participate in a wide variety of sports, recreational, and other student activities, organised within the higher education institutions. It allows students time to interact with each other on an intellectual, and social basis. These consumption benefits are purchased as part of a whole educational package when students choose to study full-time. Under this interpretation, the difference in the profitability of full-time and part-time studies reflects the value individuals place on these consumption benefits.\(^{20}\) The figures in Table 3.5 allow us to estimate


\(^{20}\) Consumption benefits are defined in this context to include not having to suffer the stress and loss of leisure associated with part-time studies. To the extent that the alternative to studying full-time is not studying at all (rather than studying part-time), and to
how much these consumption benefits associated with higher education are worth. The present values of these benefits at various discount rates are shown in Table 3.6. For easy interpretation of the figures, we have also calculated the equivalent value of the consumption benefits per full-time year of higher education.\textsuperscript{21}

**TABLE 3.6: VALUE OF CONSUMPTION BENEFITS TO HIGHER EDUCATION (1985/86 DOLLARS)**

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>MALES</th>
<th>FEMALES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present Value</td>
<td>Annual Value</td>
</tr>
<tr>
<td>0%</td>
<td>$21,160</td>
<td>$6,050</td>
</tr>
<tr>
<td>3%</td>
<td>$20,350</td>
<td>$6,210</td>
</tr>
<tr>
<td>5%</td>
<td>$19,810</td>
<td>$6,300</td>
</tr>
<tr>
<td>10%</td>
<td>$18,450</td>
<td>$6,490</td>
</tr>
<tr>
<td>15%</td>
<td>$17,160</td>
<td>$6,630</td>
</tr>
</tbody>
</table>

For males, the value placed on these consumption benefits are around $6,000 to $6,500 per full-time year of higher education. For females, they are in the range of around $5,500 to $6,500 per year. Even if we deducted from these figures, the value of money gifts from friends and relatives (say, $1,500 per year), the estimated value of consumption benefits is still very sizeable.\textsuperscript{22}

It is important to note that the figures in Table 3.6 are not estimates of the total consumption benefits to higher education as such. They do not include, for instance, the alleged consumption

the extent that the stress and loss of leisure suffered by part-time students would not result if individuals were not studying, our estimates would be biased upwards. On the other hand, part-time students do enjoy some of the consumption benefits of higher education. To that extent, our estimates would be biased downwards.

21. For this exercise, we have used the figures corresponding to PT1.

22. The figures calculated using the full-sample (Appendix 3.2) are smaller -- in the range of $3,500 to $4,500 for males, and $2,000 to $3,500 for females. Nevertheless, they are far from negligible.
benefits derived from "the joy of learning". The consumption benefits associated with the effect of higher education on his or her ability to appreciate "the finer things in life" such as art, classical music, and the opera have also not been included.

There is some evidence which suggests, however, that the "joy of learning" to most students may be small, or even negative [Fane (1984a)]. There is also some debate as to whether the effect of higher education on a person's taste should be considered a benefit as such [Blaug (1965)]. To the extent that these two omitted components are small, or should be ignored on conceptual grounds, the figures in Table 3.6 may be regarded as estimates of the total consumption benefits of higher education.

3.5 Private Rates of Return Under Alternative Fee-Regimes

In 1974, tertiary fees were abolished in Australia. Since then, successive governments have come under increasing pressure to squeeze the higher education budget. With an increasing number of eligible students being rationed out of the higher education system, and continuing pressures on the size of the deficit, the idea of a user-pays system became more and more attractive. The first step towards a user-pays system was taken in 1986 when the Higher Education Administrative Charge (HEAC) was introduced. HEAC involved a charge of $250 per annum ($272 in 1989) on all students, other than those receiving AUSTUDY or TEAS. The next step came in 1988, where upon the recommendation of the Wran Committee, the Government announced in the 1988-89 Budget that the Higher Education Contribution Scheme (HECS) would be implemented from January 1, 1989. Under this scheme, students are charged a uniform rate of $1800 in 1989 dollars (which is indexed for inflation) for each year of equivalent full-time
study. The repayment can be made through the tax system, or paid 'up-front'. Under the first alternative (referred to as HECS1 in the analysis below) students pay an additional 1% of their personal taxable income once their incomes reach $22,000, 2% at the $25,000 threshold, and 3% at $35,000, until their liabilities are completely discharged. These threshold figures are in 1989 dollars and are indexed for inflation. With 'up-front' repayments (referred to as HECS2 below), students are offered a 15% 'discount' on their liabilities. As part of the package, the higher education administrative charge was abolished.

The Liberal-National Opposition has since released their Higher Education Policy statement. Among other things, they propose a pro-rata tuition-charge of $1,200 per full-time student year. In the analysis that follows, this is referred to as the LIB scheme. As well, institutions are permitted to offer additional places "on whatever basis they see fit". This means that institutions can offer places to those Australians who fail to be admitted under the normal merit-based channel, on a full-fee basis, in the same way that they are currently making places available to foreign students.

Starting from 1989, students have another alternative. Australia's first private university -- Bond University -- began classes for its first intake of students. Potential students are lured with the possibility of completing a normal three-year degree in two years, under their three-semester-a-year system. Fees are set at $6,000 per semester.

How do students fare under each of these fee-regimes? We compare the private rates of return and net present values under the
following alternative regimes: 1) zero fees; 2) HEAC; 3) LIB; 4) HECS1; 5) HECS2; 6) Full-Fees; 7) Bond University.

For this exercise, the restricted sample of full-time, full-year workers is used. The figures in Table A3.1.3 are converted into 1989 dollars using the CPI. To obtain after-tax earnings, the personal tax rates operating in 1988-89 are applied to the figures. The analysis is limited to the choice full-time study only. In all cases other than (7), income while studying, and course-related expenses (excluding fees), in 1989 dollars, are assumed to be $2,070 per annum and $830 per annum, respectively, and the completion time is 3.5 years.

Students of Bond university are assumed to complete their degrees in two years. They are assumed not to have any earnings whilst studying, and to incur course-related expenses (excluding fees) of $1,245 per annum ($1.5 \times 830). Under the "full-fees" regime, students are assumed to be charged $12,000 per full-time year of study. This figure is based on the fee structure in Bond University.

We noted in the previous chapter that under imperfect capital markets, the cost of funds may differ across individuals, and across investment projects. An individual may, therefore, use a different discount rate for each fee-regime, depending on the amount (and hence, the cost) of funds that needs to raised in each case. With the exception of HECS1, and the zero-fee regime, students are required to

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23. Equivalent results using the full-sample are given in Appendix 3.3.

24. The attractiveness of the various fee-regimes considered in this section may well be different for those contemplating studying part-time. As well, there are important and interesting issues relating to the relative attractiveness of part and full-time studies under each of the fee-regimes. These are left for subsequent research.
pay some amount of money up-front. Under some regimes (e.g. HEAC), the amount is small. Under others (e.g. Bond University), the amount can be quite substantial, and students may not always be able to raise the money to finance their higher education. Even the loan scheme introduced by the Westpac Bank "exclusively" for Bond University students would not completely alleviate the problem. Here, students are given the opportunity of borrowing up to a maximum of only $5,000 a year (bearing in mind that fees amount to $6,000 a semester), and then, only after they have passed their first year. Hence, liquidity constraints may mean that the cost of funds for some individuals, under some regimes, is effectively infinite. More generally, we can assume that, in the absence of a perfect capital market, the cost of funds for most individuals will rise with the amount of up-front fees, becoming infinitely large for some, at some point. Hence, the discount rate used to evaluate the educational investment will tend to rise with the amount of up-front fees.

The IRR and NPV (at various discount rates) of higher education under the various fee-regimes are presented in Table 3.7. A number of interesting observations may be made. First, the NPV criterion (at 0%) ranks HECS2 above HECS1. The reason for this is that if individuals have a zero discount rate, then the 15% discount offered on up-front payment of HECS is a true saving to the individual. Since the real interest rate on bank deposits is generally positive, it is unlikely that individuals will use a zero discount rate in evaluating their investments. At a discount rate of 3% (5% for

25. Even under HECS1 and the no-fee regime, students may have to pay union fees and other charges levied by the institution.

26. The assumption here is, of course, that individuals believe that their future incomes will follow the cross-sectional profiles of full-time full-year graduates.
<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>No Fees</th>
<th>HEAC</th>
<th>LIB</th>
<th>HECS1</th>
<th>HECS2</th>
<th>Full-Fees</th>
<th>Bond Uni.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MALES</td>
<td>FEMALES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRR</td>
<td>IRR</td>
<td>IRR</td>
<td>IRR</td>
<td>IRR</td>
<td>IRR</td>
<td>IRR</td>
<td>IRR</td>
</tr>
<tr>
<td>0%</td>
<td>8.87%</td>
<td>9.52%</td>
<td>8.72%</td>
<td>8.35%</td>
<td>8.34%</td>
<td>8.13%</td>
<td>5.45%</td>
</tr>
<tr>
<td></td>
<td>$199,010</td>
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<td>$193,650</td>
<td>$165,110</td>
</tr>
<tr>
<td>3%</td>
<td>8.72%</td>
<td>9.35%</td>
<td>8.28%</td>
<td>8.04%</td>
<td>8.34%</td>
<td>8.13%</td>
<td>5.45%</td>
</tr>
<tr>
<td></td>
<td>$75,830</td>
<td>$85,270</td>
<td>$74,820</td>
<td>$71,900</td>
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<td>$70,820</td>
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<td>8.34%</td>
<td>9.04%</td>
<td>8.13%</td>
<td>7.89%</td>
<td>8.73%</td>
<td>8.13%</td>
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<tr>
<td></td>
<td>$36,310</td>
<td>$42,480</td>
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<td>$32,180</td>
<td>$31,510</td>
<td>$6,040</td>
</tr>
<tr>
<td>10%</td>
<td>5.45%</td>
<td>8.73%</td>
<td>5.34%</td>
<td>5.14%</td>
<td>8.73%</td>
<td>5.34%</td>
<td>5.68%</td>
</tr>
<tr>
<td></td>
<td>-$5,450</td>
<td>-$2,280</td>
<td>-$6,310</td>
<td>-$8,840</td>
<td>-$8,230</td>
<td>-$9,770</td>
<td>-$32,670</td>
</tr>
<tr>
<td>15%</td>
<td>5.30%</td>
<td>5.68%</td>
<td>5.34%</td>
<td>5.04%</td>
<td>5.34%</td>
<td>5.68%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-$17,770</td>
<td>-$15,740</td>
<td>-$18,550</td>
<td>-$20,860</td>
<td>-$19,710</td>
<td>-$21,700</td>
<td>-$42,440</td>
</tr>
</tbody>
</table>
females) or higher, the NPV under HECS1 is higher than under HECS2, and students would be better off choosing the tax option (HECS1). This is even more so for students from poorer families who may have to borrow to cover the "up-front" payment. As we have argued, these students may use a higher discount rate to evaluate HECS2 compared to HECS1.

A second point to be made about the recent introduction of HECS is that the effect on the private rates of return is negligible. Comparing the figures under HEAC and HECS1, we note that the IRR for both sexes falls by less than 0.4 of a percentage point. If we take into account the income-contingent aspect of HECS1, and factor into our calculations the fact that some individuals may withdraw from the labour force (permanently, or otherwise), or engage only in part-time work prior to completely discharging their debt, then the effect on the IRR will be even less.27 This is particularly applicable to females.

HECS1 is also advantageous to females for a second reason. Since female graduates generally earn less than their male counterparts, they take a longer period to discharge their debt to the government. Given the (real) interest-free nature of the debt under HECS1, this implies that in present value terms, females tend to pay less than males for the same education. This difference is small when we focus solely on full-time full-year workers. For the full sample, however, the advantage to females in paying through the tax-system (HECS1) instead of up-front (HECS1) is immediately obvious (see Table A3.3.3 in Appendix 3.3).

27. Some individuals may even be better off under HECS1 than HEAC. For instance, if an individual never earns above $22,000 per annum, then HECS1 is effectively the same as a zero-fee regime.
How does the Liberal-National scheme compare with HECS? The figures show that the IRR under the LIB-regime is very close to that under HECS1. At low discount rates, the NPV tends to be slightly higher under LIB. It is important, however, to reiterate that the former scheme requires an up-front payment, which may pose liquidity problems for some individuals. If individuals were induced to use a higher discount rate for the LIB-scheme, then, they may well prefer HECS1 to LIB. For instance, if individuals were to use a discount rate of 3% in evaluating HECS1, and a 5% discount rate for LIB, then for both males and females, the NPVs under HECS1 would be considerably higher than under LIB. Moreover, the income-contingent nature of payments under HECS provides an insurance function which makes it even more attractive, to the extent that individuals are risk-averse.28

The rate of return under full-fees ($12,000 per year) is significantly lower than the rates under HEAC, LIB, or either of the HECS options. The IRR falls to 5.45% for males, and to 5.34% for females. These returns are no more than what individuals can obtain from alternative investments.29 Given the illiquid nature of human capital -- graduates cannot sell off his or her accumulated human capital -- individuals may not see higher education as an attractive investment.

Finally, the IRR under the Bond University scheme is not very different to that under the full-fee regime. Although students save

28. This is considered in Chapter 7.

29. As cited earlier, the Department of Finance estimates that the real after-tax rates of return to individuals from investments in the market portfolio have averaged between 4 and 7 per cent since the mid-1970s. The returns to individuals from investment in housing and household mortgages have been found, also, to lie within this range.
considerably in terms of foregone earnings, this is offset by the higher present value of the fees to be paid. Instead of paying $36,000 for a three-year degree over three years, the same amount has to be paid over two, which increases the cost in present value terms. In addition, if we were to take into account the fact that the substantial up-front payment required under the BOND-scheme may increase the cost of funds to individuals, then studying in Bond university would appear even less attractive.

3.6 Summary and Conclusions

In this chapter, we examined the private rate of return to higher education in Australia. The results support the findings of earlier studies that higher education appears to be an attractive investment to individuals. The rates of return, however, tend to be lower than those estimated by Miller (1982a). How much of this is due to the value of the degree having changed over the period, and how much is due to differences in our methodologies, cannot be determined at this stage.

It was also found that the rates of return estimated using total income are not significantly different to those estimated using earned income. Three possible explanations for this were suggested. First, the link between the human and non-human components of wealth may not be as strong as commonly assumed. Second, the non-human component of wealth is small. Third, transfer payments from the government may benefit non-graduates more than graduates. To the extent that this is so, it tends to offset any upward bias on the rate of return caused by the inclusion of non-human wealth in the calculations.
Depending on whether we regard observed differences in the number of hours worked across individuals as the result of unconstrained individual choices, and whether we are interested only in the monetary returns to investment in higher education, we may wish to standardise income for the number of hours worked. Restricting our sample to only those who worked full time and for the full year, we found that the returns to higher education were significantly lower, particularly in the case of females. In spite of this, higher education still remains an attractive investment, especially for those in receipt of TEAS.

The rate of return to completing a degree on a part-time basis is found to be extremely high. This is consistent with Chapman’s (1977) earlier finding using data on males working in clerical and administrative positions in the Australian Public Service. One explanation is that the difference in the rates of return between part-time and full-time study reflects the consumption benefits associated with the latter. Under this hypothesis, we estimated that the value placed on these consumption benefits amounts to around $5000 to $7000 per full-time year of study.

In the penultimate section of this chapter, we analysed the effect of HECS and of several other fee-structures on private rates of return for full-time students. It was found that HECS would push the rate of return down from the HEAC-regime, but only negligibly. It was also found that individuals would generally be better off paying through the tax system, contingent on their income, rather than paying up-front with a 15% discount on their liability.

Private rates of return under Liberal-National scheme are very similar to those under HECS. However, it requires an up-front
payment, which may result in some individuals being better off under HECS.

Finally, the rates of return under a full-fee regime, and for Bond University students are substantially lower than under HECS, or any of the other fee-regimes we have considered. The figures suggest that higher education may not be an attractive investment to individuals when full-fees are charged, even if they could complete their courses in two years.

Throughout the chapter, we have assumed that there are no ability differences between university graduates and high-school leavers. To the extent that part of the observed income differential is due to the superior ability of the former group, our estimates will be biased upwards. Moreover, we have concentrated solely on the mean income profiles of the two groups. The variance around these mean profiles has been ignored. In other words, the riskiness of education as an investment is not explicitly modelled. This has led to some ambiguity as to which is the appropriate discount rate to use as a benchmark with which the profitability of education may be judged. These issues will be addressed in Part II of the thesis.
CHAPTER 4
SOCIAL PROFITABILITY OF HIGHER EDUCATION

In this chapter, we examine the profitability of higher education as an investment from the social point of view. This chapter is divided into four main sections. In the next section, we calculate the social rates of return under alternative assumptions regarding the magnitude of externalities. Section 4.2 presents some novel calculations which attempt to infer the magnitude of externalities from the fee-structure of the recently introduced Higher Education Contribution Scheme (HECS). In Section 4.3, we discuss the consistency of HECS with the Government’s aim to expand the higher education system on the grounds of allocative efficiency. Section 4.4 concludes.

4.1 Social Rates of Return to Higher Education

In calculating the social rates of return to higher education, it is extremely important to specify the question we are attempting to answer. If the question is whether higher education, as a whole, has been a profitable investment from the society’s point of view, then it is the relation between average benefits and average costs which is relevant. On the other hand, if we want to know if society, at the margin, should expand investment in higher education, then clearly, it is the relation between the benefits and costs in producing an extra graduate that is of interest. It is the latter question which we are concerned with in this chapter.

As in the previous chapter, our analysis is based on the mean income profiles across educational groups. For social rate of return calculations, however, pre-tax earnings profiles are used. We assume
that the expected earnings of the marginal graduate are as given by
the mean earnings profile of degree-holders.\textsuperscript{1} It is also assumed that
this individual’s earnings would have been as given by the mean high-
school earnings profile had he or she not attended university. We
assume, further, that markets are sufficiently competitive so that
earnings reflect the marginal productivities of workers,\textsuperscript{2} and that
the higher productivity of more educated workers is the result of the
extra schooling they received.\textsuperscript{3}

On the cost side, in addition to private expenditure on course-
related items (assumed to be $660 per year in 1985/86 dollars),\textsuperscript{4} the
cost to tax-payers in providing the educational service -- wages of
teaching and support staff, books, computer and laboratory facilities
etc. -- must also be included. Throsby (1986) has recently estimated
cost functions for Australian universities. The marginal total
cost\textsuperscript{5,6} at the mean value of total student load derived from his

\textsuperscript{1} This would be the case if the variance around the mean earnings
profile is due purely to luck, or if the selection criteria used to
allocate university places is uncorrelated with individuals’ future
earnings. We shall discuss this in greater detail in Part II of the
thesis.

\textsuperscript{2} As note previously, this is to be interpreted in a life-cycle
context.

\textsuperscript{3} As noted in Chapter 2, these last two assumptions are required
only in social rate of return calculations. In private rate of return
calculations, whether earnings reflect workers’ marginal
productivities, and whether schooling increases their productivity or
acts simply as a signalling device is irrelevant.

\textsuperscript{4} We have assumed this figure to be the same as in the private rate
of returns calculations (Chapter 3). Strictly speaking, the figure
here should be lower, since, union fees and other university charges
should be excluded (see Chapter 2). The difference, however, is
small, and is therefore ignored.

\textsuperscript{5} Throsby estimated separate cost functions for departmental, and
for central expenditures. The marginal total cost is the sum of the
marginal departmental and marginal central costs.
estimates (Tables I and II) is $5,210 (1984 dollars). This figure, however, includes research costs. Elsewhere, Throsby (1985) has estimated that the proportion of departmental expenditure attributable to teaching is 56%. Assuming that the proportion of central expenditure attributable to teaching is the same, the marginal total cost for the teaching function of universities amounts to $2,917 per student-year. Converting to 1985/86 dollars and rounding off, it is assumed, therefore, that the marginal cost of providing an extra place in university is $3,200 per year.

In estimating the cost to society in producing an extra graduate, it is important to realise that a large proportion of students do not complete their courses in the minimum time required. Moreover, the resources used by those students who dropped out of university without completing their courses must also be included.

West et al. (1986) have estimated that for every 1000 full-time first-year students enrolled in a university on April 30 in any year, 771 would eventually graduate as full-time students. Of the remainder, 66 would change to part-time studies at some point during their course, 152 would drop out in their first year, and 11 in later years. For simplicity, it is assumed that all withdrawers do so at the end of their first year. Ignoring those who change to part-time studies, it follows that on average for every 100 successful graduates, we need to add the social cost of the resources used by the other 21 students who fail to complete. This adjustment is made by increasing the first-year costs (direct and indirect) of each

6. Almost all social rate of return calculations in the literature have used the average cost rather than the marginal cost because the latter is seldom available. The assumption implicitly made in these calculations insofar as they are to be used to assess whether society has over- or under-invested in education, is that the two are equal.
graduate by a factor of 1.21. Strictly speaking, the cost of producing an extra graduate will need to be adjusted by a factor higher than this, since, ex ante the marginal graduate would tend to have a higher than average probability of dropping out. For simplicity, however, the average probability is assumed.

The number of years which the marginal graduate is assumed to take in completing the course has a strong bearing on the estimated profitability of higher education. The 1984-85 National Social Science Survey contained a question which asked respondents for the number of years of tertiary education completed since they left school. For degree-holders, the mean number of years reported was approximately 4.5. This figure is used as the number of years taken by the marginal graduate to complete his or her degree.

Offsetting the costs is the amount students earn from part-time employment while studying. This is assumed to be $1,640 (1985/86 dollars) per annum which, in real terms, is the average amount earned by university students not in receipt of any educational assistance in 1984. The figure for those receiving Tertiary Education Assistance Scheme (TEAS) allowances is smaller.

In the first part of the analysis, we shall use the mean earnings profile corresponding to the full sample. The implicit assumption is that other than the time spent at work, individuals are not socially productive.

7. For details, see, Kelley et al. (1987).
8. To the extent that the marginal graduate is likely to take longer to complete his or her course, this assumption would, again, cause an understatement in the cost of producing an extra graduate.
9. This assumption allows us to disregard differences in the number of hours worked.
Table 4.1 presents estimates of the marginal social rate of return to higher education for males and females. A number of hypothetical values for externalities associated with higher education are considered. These represent (subjective) annual dollar values one may place on the externalities flowing from an extra graduate, for each year from graduation to retirement (at age 60).  

**TABLE 4.1: MARGINAL SOCIAL RATES OF RETURN TO HIGHER EDUCATION (FULL SAMPLE)**

<table>
<thead>
<tr>
<th>Hypothetical Value of Externalities Per Year</th>
<th>MALES</th>
<th>FEMALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>9.93%</td>
<td>11.25%</td>
</tr>
<tr>
<td>$1,000</td>
<td>10.23%</td>
<td>12.24%</td>
</tr>
<tr>
<td>$2,000</td>
<td>11.07%</td>
<td>13.21%</td>
</tr>
<tr>
<td>$5,000</td>
<td>13.52%</td>
<td>16.00%</td>
</tr>
<tr>
<td>$10,000</td>
<td>17.46%</td>
<td>20.28%</td>
</tr>
</tbody>
</table>

The major features of the results in Table 4.1 are as follows. First, compared to the private rates of return (Table 3.5) the social rates (assuming zero externalities) are smaller. This is, in part, because in calculating the private rates of return, we followed the literature in assuming that individuals believe that they would complete their courses in the minimum time required. In the social calculations, however, we increased the expected length of study to reflect the possibility of failure. In part, the social returns are also lower because of the addition of the cost borne by tax-payers in providing the educational service.  

10. Arguably, externalities will continue to flow from the marginal graduate even after he or she retires. This does not affect our calculations much because they will be highly discounted.

11. The importance of this assumption is examined in Part II of the thesis.

12. On the other hand, the use of pre-tax instead of post-tax earnings tends to increase the social rates of return (over the private rates) because graduates tend to pay more tax over their lifetime.
Secondly, as with private rates of return, the social rate of return is higher for females. This is due, to large extent, to the higher participation rate and hours worked by female graduates compared with female non-graduates.

Thirdly, the adjustment for externalities has a surprisingly small impact on the calculated rates of return. For every increment of $1,000 on the annual value placed on the externalities from an extra graduate, the social rate of return is increased by less than one percentage point.

Do these figures support the Government’s position on expansion of the higher education system from the point of efficient resource allocation? The Department of Finance (1987) has argued that the appropriate discount rate to be used in the evaluation of government projects is given by average cost of funds in the corporate sector. It has estimated that the real required rate of return on total assets since the mid-1970s is about 12.1%.  

Using 12.1% as the appropriate social discount rate, the decision as to whether to expand the higher education system clearly depends on the value one places on the externalities flowing from an extra graduate. If the value, as commonly argued in some quarters [see, for instance, Fane (1984a)], is negligible, then resources can be more productively employed elsewhere in the economy. For males, unless society values the externalities at more than $3,250 per annum, an increase in the number of tertiary places cannot be justified on efficiency grounds alone. In the case of females, our

13. On the other hand, some researchers have argued that the cost to the Government in borrowing from abroad is only about 3%, and that it is this figure which should be used as the social discount rate. See, for instance, Kelley (1988).
calculations suggest that an expansion would only be favoured if the externalities from an extra graduate are valued at more than $850 per annum.

Obviously, if the social discount rate is low (say, below 9%), then the existence of positive spill-overs is not necessary to support an expansion of higher education from the point of allocative efficiency. As a rule-of-thumb, 10% is the figure commonly used to assess the profitability of educational investments. At this discount rate, the figures suggest that for males, the amount of resources spent on higher education is near optimal. For females, on the other hand, there may still be an under-investment from the efficiency point of view.

The assumption that only time spent working is socially productive is clearly an extreme case. It would certainly not be true, for instance, of those who chose to withdraw from the labour force, or worked fewer hours in order to bring up their children or to perform household chores. Unfortunately, putting a dollar value on these services is extremely difficult. One possible assumption is that at the margin, individuals equate their marginal productivities in home and market activities. The value of these home-produced services is, therefore, given by the extra income they could otherwise have earned in the labour market. This, in turn, suggests that it may be more appropriate to use the earnings profiles of full-time full-year workers in the estimation of the social rate of return. The results are shown in Table 4.2.
TABLE 4.2: MARGINAL SOCIAL RATES OF RETURN TO HIGHER EDUCATION (RESTRICTED SAMPLE)

<table>
<thead>
<tr>
<th>HYPOTHETICAL VALUE OF EXTERNALITIES PER YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
</tr>
<tr>
<td>MALES</td>
</tr>
<tr>
<td>FEMALES</td>
</tr>
</tbody>
</table>

A number of interesting features in the table may be noted. First, the social rates of return estimated using the restricted sample of full-time full-year workers are smaller than those estimated with the full sample, especially for females. Secondly, the rates of return for males and females are very similar. Finally, we note that using a social discount rate of 10%, the case for expanding higher education would rest on the perceived size of externalities flowing from an extra graduate.

4.2 Implied Value of Externalities in HECS

It is clear from the previous section that the desirability of expanding higher education from the point of allocative efficiency ultimately depends on the marginal value of externalities (unless the social discount rate is sufficiently low). Relatedly, in discussions about the appropriate level of fees for higher education, it is again the value of externalities which plays the key role. Although work has begun on estimating the value of specific types of externalities associated with education as noted in Chapter 2, we are a long way from having a comprehensive estimate.

In this section, we approach the question of externalities from a different perspective. Rather than attempting to estimate the value of externalities associated with higher education so as to determine the appropriate level of fees, we calculate, instead, the value of
externalities implied by the fee-structure under the assumption that the fee structure was motivated solely by concerns of efficiency. The usefulness of this approach is that it provides some insights heretofore unavailable into the credibility or otherwise of the current policy stance from the perspective of the conventional framework of allocative efficiency.

The method is clarified by considering the well-known proposition in welfare economics that for allocative efficiency, and in the absence of relevant market distortions, goods should be goods should be priced at:

$$P_x = M_x - E_x$$

where $P_x$ is the price if good $x$; $M_x$ is the marginal cost of producing $x$; and $E_x$ is the marginal value of the externalities associated with the production or consumption of $x$.\(^{14}\)

This pricing rule can be explained easily with the help of Figure 4.1.

Assume that the marginal private and social costs and benefits are as shown. The costs and benefits are all given in present value terms, discounted by the social discount rate. The marginal benefit curves are assumed to slope downwards because as more places are provided, the flow of tertiary graduates increases, and this, in turn, drives down their earnings. The distance between the benefit curves measures the value of externalities flowing from an extra graduate.\(^{15}\)

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14. See, Brennan (1988) for a discussion of the application of this rule in the context of higher education.

15. In this analysis, we ignore income taxes. See, Brennan (1988) for a discussion of the complications on the pricing rule resulting from the distortionary effects of the tax system.
**FIGURE 4.1: PRIVATE AND SOCIAL COSTS AND BENEFITS**

![Graph showing marginal social and private costs and benefits.](image)

The marginal private cost curve shows the increasing cost of providing additional units of a good or service. The distance between the marginal private and marginal social cost curves indicates the marginal cost of resources used in the provision of a public good. The marginal social benefit curve represents the additional benefit received by society from an additional unit of a public good.

The point A represents the equilibrium enrollment level, where the marginal social cost equals the marginal private benefit. The distance between the marginal social cost and private cost curves at point A indicates the cost inefficiency of the private market solution. The distance between the marginal social benefit and private benefit curves at point A represents the benefit inefficiency of the private market solution. The government intervention at point A is justified because it moves the equilibrium from point A to point C, where the marginal social cost equals the marginal social benefit, improving the efficiency of resource allocation.
The marginal private cost curve shows the cost under a zero-fee regime, and is assumed to slope positively due to the increasing opportunity costs to students from the increased earnings of high-school leavers as relatively more individuals pursue higher education. The distance between the marginal private and social costs reflects the marginal cost of resources used in the provision of tertiary education, which is paid for by the Government.

Given the position of the curves as drawn, a zero-fee regime (in the absence of quotas) would lead to an over-investment in higher education from the social point of view (i.e. \( q' > q^* \)). On the other hand, if students were made to pay "full" fees (defined in this context as the marginal cost to the Government), then there would be an under-investment in tertiary education (i.e. \( q'' < q^* \)). It is clear that the optimal fee is given by the distance BC.

The substantial methodological point is that given estimates of AC, the marginal cost to the Government in providing an extra place, and BC, the charge levied on students, it is possible to derive the value which the Government places on net marginal externalities, AB. Importantly, it is worthwhile emphasizing again that the validity of these calculations depends on the assumption that in setting the charge on students, the Government is concerned solely with allocative efficiency. The goal of this exercise is to get some understanding of the annual dollar value of spill-overs from higher education implied in the context of HECS.

The assumptions regarding the cost of producing an extra graduate are as discussed in the previous section. The Government is, therefore, assumed to incur a cost of $3,872 (1.21 x $3,200) in the first year, $3,200 in the second, third and fourth years, and $1,600
in the fifth year. The present value of this stream of costs to the
Government at the beginning of year 1 depends importantly on the
social discount rate used. The higher the discount rate is, the lower
the present value of the marginal cost.

To obtain an estimate of BC it is necessary to determine the
effective steady state charge expected under HECS. This can be
approximated by assuming that the Government uses the average full-
time earnings profiles of graduates under the assumption that 4.5
years are spent in higher education. This implies that the total
undiscounted amount charged is $8,100 in 1988-89 dollars or $6,430 in
1985-86 dollars for both males and females.\(^{16}\)

However, because the time pattern of repayment differs between
the sexes, the discounted fees the Government expects to recoup must
also vary with sex. Since male graduates are more highly paid on
average, members of this group discharge their debt relatively
quickly. This implies that the present value of repayment from the
average male exceeds that of the average female.

With this as background, Table 4.3 sets out the present values
of the marginal cost to the Government in producing an extra
graduate, male and female, the amount expected to be recovered
through the tertiary tax on average, and the implied marginal value
of externalities, at various discount rates. To put the implied value
of externalities in the context of the results in the previous
section, it is useful to think of the externalities as a constant

\(^{16}\) For consistency, the amount recouped from dropouts must also be
added. Since we have assumed that dropouts, on average, stay for a
year in university, and that for every 100 successful graduates there
are 21 dropouts, the extra revenue from the dropouts per graduate is
$378 (0.21 x $1,800) in 1988-89 dollars or $300 in 1985-86 dollars.
For simplicity, we assume that this amount is always paid in year 1.
stream of benefits, valued at $X per annum, flowing from an extra graduate each year, from graduation to retirement. The value of X is given in the final two columns of the table.

**TABLE 4.3: ESTIMATES OF MARGINAL VALUE OF EXTERNALITIES**

(1985/86 DOLLARS)

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>Marginal Cost</th>
<th>Effective Fee</th>
<th>Implied Externality</th>
<th>Annual Value of Externality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>0%</td>
<td>15,070</td>
<td>6,780</td>
<td>8,300</td>
<td>8,300</td>
</tr>
<tr>
<td>3%</td>
<td>13,950</td>
<td>5,090</td>
<td>8,860</td>
<td>9,100</td>
</tr>
<tr>
<td>5%</td>
<td>13,270</td>
<td>4,240</td>
<td>9,030</td>
<td>9,340</td>
</tr>
<tr>
<td>7%</td>
<td>12,650</td>
<td>3,560</td>
<td>9,080</td>
<td>9,420</td>
</tr>
<tr>
<td>10%</td>
<td>11,800</td>
<td>2,780</td>
<td>9,020</td>
<td>9,350</td>
</tr>
<tr>
<td>12%</td>
<td>11,280</td>
<td>2,370</td>
<td>9,000</td>
<td>9,220</td>
</tr>
<tr>
<td>15%</td>
<td>10,570</td>
<td>1,900</td>
<td>8,670</td>
<td>8,950</td>
</tr>
<tr>
<td>18%</td>
<td>9,930</td>
<td>1,540</td>
<td>8,390</td>
<td>8,630</td>
</tr>
<tr>
<td>20%</td>
<td>9,550</td>
<td>1,350</td>
<td>8,190</td>
<td>8,410</td>
</tr>
</tbody>
</table>

The results may be summarised as follows. For the range of social discount rates considered above, the implied value of externalities flowing from an extra graduate is around $8,000 to $9,500 in present value terms (1985-86 dollars). At low discount rates (0%-7%), this implies that for the tertiary tax to be consistent with allocative efficiency, the marginal graduate is expected to deliver to society around $200 to $1,000 worth of spill-overs per year. At higher social discount rates (10%-20%), the annual delivery of spill-overs ranges from around $1,500 to $3,800.

A useful summary statistic is the marginal value of externalities associated with a 10% social discount rate, which is probably the least controversial figure to use. At that level, the marginal male and female graduate must deliver, respectively, around $1,420 and $1,480 per year in spill-overs for the tertiary tax to represent an optimal charge in terms of allocative efficiency. In
other words, if allocative efficiency were the main concern of the Government when deciding on the size of the charge, then the policy implication suggests that the external economies from reduced crime, more informed voting, lower welfare and public health costs, inter alia, outweigh any possible external diseconomies to the tune of about 5 per cent of the average full-time full-year income of degree-holders (around $30,000). 17

It is important to offer several observations on the methodology used in the context of the current rationing of university places. The figures in columns (5) and (6) in the table are estimates of the Government’s valuation of the externalities expected to flow from an extra graduate at the optimum (i.e. at q*). Implicit in the framework is the assumption that at the optimum there will be no excess demand for places. Since we are not attempting to measure the value of externalities at the current (rationed) level of graduates, or the Government’s perception of this magnitude, the fact that the system is in a situation where the number of students enrolled in higher education is supply-determined is not pertinent to the validity of these calculations. This is true so long as the marginal cost of producing an extra graduate to the Government remains approximately the same as the system expands towards the optimal level. Throsby’s (1986) regression results suggest that the marginal total cost of providing university places is relatively insensitive to the total student load. However, it may still be the case that as the system expands, the ratio of dropouts to graduates rises, and the average time taken to complete a degree increases. This would lead to an increase in the cost of producing an extra

graduate to the Government. To the extent that the cost at the optimum is higher than at the current level of enrolments, our estimates of the marginal value of externalities would be biased downwards.

4.3 Internal Consistency of HECS and Expansion of Higher Education

The analysis in the previous section can be carried one step further to consider the consistency of HECS with the Government's resolve to expand the higher education system. The idea behind this is relatively straight-forward.

At the optimum enrolment level $q^*$, the following relationship holds:

$$\text{MPB}(q^*) + \text{EXT}(q^*) = \text{MPC}(q^*) + \text{MRC}(q^*) \quad (4.1)$$

where $\text{MPB}(q^*)$ is the marginal private benefit at $q^*$; $\text{EXT}(q^*)$ is the marginal value of externalities at $q^*$; $\text{MPC}(q^*)$ is the marginal private cost under a zero-fee regime at $q^*$; and $\text{MRC}(q^*)$ is the marginal cost to the Government in producing an extra graduate at $q^*$.

All magnitudes are expressed in present value terms discounted by the social discount rate. The equation can be rearranged into:

$$[\text{MPB}(q^*) - \text{MPC}(q^*) - \text{MRC}(q^*)] + \text{EXT}(q^*) = 0 \quad (4.2)$$

Let the current enrolment level be denoted by $q^#$. As we have noted, the marginal cost to the government in producing an extra university place is fairly insensitive to the enrolment level. It is, therefore, assumed that $\text{MRC}(q^#) = \text{MRC}(q^*)$.

Quite clearly, if $q^# < q^*$, then

$$\text{MPB}(q^#) - \text{MPC}(q^#) > \text{MPB}(q^*) - \text{MPC}(q^*) \quad (4.3)$$
This follows directly from the assumptions that the MPB curve is downward-sloping and the MPC curve, upward-sloping.\footnote{See the discussion in the previous section.} Hence,

\[
[\text{MPB}(q^\#) - \text{MPC}(q^\#) - \text{MRC}(q^\#)] + \text{EXT}(q^*) > 0
\]

Note that the sum of terms within the square brackets is simply the marginal social NPV to higher education at current enrolment levels, assuming zero externalities. If (4.4) is found\footnote{See the discussion in the previous section.} to be true, it must mean that \( q^\# > q^* \) (assuming that \( \text{EXT}(q^*) \) is correctly estimated). That is, the current level of enrolment is actually higher than the optimal level. Rather than expanding the higher education sector, the Government should be shifting resources out of the sector into more socially productive projects. In this case, the marginal value of externalities implicit in HECS would not be consistent with the desire to expand higher education from the point of allocative efficiency.

Column (2) of Table 4.4 shows the marginal social NPV at the current enrolment level, assuming zero externalities. The figures in column (3), which are taken from Table 4.3, show the present value of the marginal externalities implicit in HECS at the optimal level of enrolments (i.e.\( \text{EXT}(q^*) \)). Since the figures in these two columns are all expressed in present value terms, they can be simply added to yield the marginal social NPV given the value of externalities implicit in the tertiary tax (i.e. the left-hand-side of (4.4)). This is given in the final column of the table.
### TABLE 4.4: SOCIAL NET PRESENT VALUE OF HIGHER EDUCATION WITH EXTERNALITIES IMPLIED BY HECS (1985-86 DOLLARS)

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>NPV with zero Externalities</th>
<th>Implied Marginal Externalities</th>
<th>NPV with Implied Externalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>0%</td>
<td>286,360</td>
<td>8,300</td>
<td>294,660</td>
</tr>
<tr>
<td>3%</td>
<td>100,370</td>
<td>8,860</td>
<td>109,230</td>
</tr>
<tr>
<td>5%</td>
<td>41,680</td>
<td>9,030</td>
<td>50,710</td>
</tr>
<tr>
<td>7%</td>
<td>7,960</td>
<td>9,080</td>
<td>17,050</td>
</tr>
<tr>
<td>10%</td>
<td>-18,400</td>
<td>9,020</td>
<td>-9,390</td>
</tr>
<tr>
<td>12%</td>
<td>-27,430</td>
<td>8,900</td>
<td>-18,530</td>
</tr>
<tr>
<td>15%</td>
<td>-34,520</td>
<td>8,670</td>
<td>-25,850</td>
</tr>
<tr>
<td>18%</td>
<td>-37,470</td>
<td>8,390</td>
<td>-29,080</td>
</tr>
<tr>
<td>20%</td>
<td>-39,200</td>
<td>8,190</td>
<td>-30,010</td>
</tr>
</tbody>
</table>

**MALES**

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>NPV with zero Externalities</th>
<th>Implied Marginal Externalities</th>
<th>NPV with Implied Externalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>277,940</td>
<td>8,300</td>
<td>286,240</td>
</tr>
<tr>
<td>3%</td>
<td>97,780</td>
<td>9,100</td>
<td>106,890</td>
</tr>
<tr>
<td>5%</td>
<td>41,670</td>
<td>9,340</td>
<td>51,010</td>
</tr>
<tr>
<td>7%</td>
<td>9,550</td>
<td>9,420</td>
<td>18,980</td>
</tr>
<tr>
<td>10%</td>
<td>-15,690</td>
<td>9,350</td>
<td>-6,340</td>
</tr>
<tr>
<td>12%</td>
<td>-24,500</td>
<td>9,220</td>
<td>-15,270</td>
</tr>
<tr>
<td>15%</td>
<td>-31,650</td>
<td>8,950</td>
<td>-22,700</td>
</tr>
<tr>
<td>18%</td>
<td>-34,900</td>
<td>8,630</td>
<td>-26,260</td>
</tr>
<tr>
<td>20%</td>
<td>-35,870</td>
<td>8,410</td>
<td>-27,460</td>
</tr>
</tbody>
</table>

**FEMALES**

The results reveal a number of highly interesting points.

First, at low discount rates (0%-7%), the marginal social NPV with the implied value of externalities is positive. The value of externalities implicit in HECS appears, therefore, to be consistent with the social desirability for an expansion in higher education on grounds of efficiency.

At higher social discount rates (10%-20%), however, the NPV is negative. It is interesting to note that with a 10% social discount rate, HECS is inconsistent with the Government’s commitment to increase the capacity of the higher education sector. This suggests that if 10% were indeed the appropriate social discount rate, then either the value of externalities is actually higher than HECS.
implies, or that its rationale for expanding higher education is not based on grounds of allocative efficiency alone. Alternatively, the fee-structure may be motivated on grounds other than allocative efficiency.\footnote{Another possible explanation is that we have under-estimated the marginal private benefit to higher education because the non-pecuniary benefits have not been included.}

It is worth emphasizing that the analysis in this section is based on a "first-best" efficiency framework. It is assumed that there are no market distortions and income taxes. Further, the Government is assumed to maximize allocative efficiency. In the "first-best" world, HECS is clearly inconsistent with the Government's commitment to expand higher education, at some discount rates, from the efficiency point of view. In a "second-best" world, however, the two policies may well be consistent.

4.4 Conclusion

In this chapter, we focussed on the question of whether society has over- or under-invested in higher education from an efficiency point of view. This is a particularly important question in the light of the Government's commitment to expand higher education. Attempts to answer this question have been hampered by the lack of consensus regarding what is the appropriate social discount rate and the size of the externalities from higher education. The results in Section 4.1 show that the marginal social rate of return to higher education is around 10\% for males and 11\% for females, using the full sample, and assuming zero externalities. Using the rule-of-thumb 10\% figure as a benchmark to judge educational investments, these figures suggest that the marginal returns to the resources used in higher
education are about the same as could be obtained in alternative uses. Using the restricted sample of full-year full-time workers, the rate of return falls to about 7%-8%. Hence, if we accept 10% as the appropriate social discount rate, the case for expanding higher education would seem to rest on the existence of positive externalities associated with higher education.

Becker (1960, p.350) commented three decades ago, that:

"External or indirect effects are very embarrassing to the economist, since his theories say little of them, he has few techniques for measuring them, and he usually does not even think he knows much about them."

Although some progress has been made in this area since then, a convincing estimate of the overall magnitude of externalities associated with higher education remains illusive. In Section 4.2, we addressed the issue of externalities from a different angle. Instead of attempting to estimate its magnitude, we asked: What is the the marginal value of externalities implicit in the fee-structure, assuming that the Government was motivated solely by allocative efficiency? This approach presents us with some insights heretofore unavailable. At a 10% discount rate, the marginal value of externalities implicit in HECS was estimated to be around $1,400-$1,500 per year.

In Section 4.3, the value of externalities implied by the HECS structure was incorporated in estimates of the marginal social NPV of higher education. This enabled us to assess the consistency of the HECS structure with the Government’s commitment to expand higher education, from the point of allocative efficiency. It was found that at low discount rates (0%-7%), an expansion of higher education is

consistent with the marginal value of externalities implicit in HECS. At discount rates of 10% or higher, however, the two were inconsistent. This suggests that either the marginal value of externalities is understated (in which case HECS is not an optimal fee), or the aim of expanding higher education is based on concerns other than allocative efficiency, or both.
PART II

ANALYSIS OF RESIDUALS
In Part I of the thesis, the focus was on the aggregate statistics. The analyses were based solely on the comparison of the mean earnings profiles across different schooling groups. Whilst these results are useful in giving a broad view of economic effects of higher education, their limitations must be recognized. In particular, the aggregate results conceal the extent of variability in the personal experiences of individuals. Hence, although it is certainly the case that degree-holders earn more than similarly-aged high-school leavers on average, it is by no means true of each and every individual degree-holder vis-a-vis each and every high-school leaver. This is so, even if we restricted our attention to only those who worked full-time, and for the full year.

As an illustration, the distributions of earned income obtained from the 1985/86 Income and Housing Survey for 30-39 year-old full-time-full-year male workers\(^1\) are given in Figure II.1. The mean and median incomes for degree-holders in the sample are, respectively, $31,430 and $30,920. For high-school leavers, they are $23,020 and $22,000 respectively. Clearly, degree-holders are better off, on average. However, we find that about one-fifth of the degree-holders earn less than the median income of high-school leavers. The fraction of degree-holders earning less than the mean income of high-school leavers is also about a fifth. On the other hand, about 14% of high-school leavers receive more than the median income of degree-holders, and 13% earn more than the mean. These figures show that the experiences of individuals may be quite different from those of the

\(^1\) The figures are calculated from the 1985-86 Income and Housing Survey. Definitions of the sample, and of the income concepts are as given in the previous chapters.
FIG II.1: INCOME DIST. OF 30–39 YR-OLD BY EDUCATION

FRACTION OF SAMPLE

$'000

degree-holders

high-school leavers
"statistically average" individual — a point which is all too frequently neglected in policy discussions.

The extent of the variability in income within each educational group can also be seen from the figures provided in Table II.1 which show the standard deviation and the coefficient of variation of pre-tax earned income by age groups.

**TABLE II.1: PRE-TAX EARNED-INCOME (1985-86 DOLLARS) BY AGE FOR MALES WHO WORKED FULL-TIME, FULL-YEAR**

<table>
<thead>
<tr>
<th>AGE</th>
<th>MEAN</th>
<th>SD</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;24</td>
<td>20570</td>
<td>5640</td>
<td>27.4%</td>
</tr>
<tr>
<td>25-34</td>
<td>28050</td>
<td>11870</td>
<td>42.3%</td>
</tr>
<tr>
<td>35-44</td>
<td>35290</td>
<td>17450</td>
<td>49.4%</td>
</tr>
<tr>
<td>45-54</td>
<td>41840</td>
<td>26540</td>
<td>63.4%</td>
</tr>
<tr>
<td>55-64</td>
<td>35000</td>
<td>15270</td>
<td>43.6%</td>
</tr>
</tbody>
</table>

**DEGREE-HOLDERS**

<table>
<thead>
<tr>
<th>AGE</th>
<th>MEAN</th>
<th>SD</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;24</td>
<td>5640</td>
<td>27.4%</td>
<td></td>
</tr>
<tr>
<td>25-34</td>
<td>11870</td>
<td>42.3%</td>
<td></td>
</tr>
<tr>
<td>35-44</td>
<td>17450</td>
<td>49.4%</td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>26540</td>
<td>63.4%</td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>15270</td>
<td>43.6%</td>
<td></td>
</tr>
</tbody>
</table>

**HIGH-SCHOOL LEAVERS**

<table>
<thead>
<tr>
<th>AGE</th>
<th>MEAN</th>
<th>SD</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;24</td>
<td>5640</td>
<td>27.4%</td>
<td></td>
</tr>
<tr>
<td>25-34</td>
<td>9460</td>
<td>43.0%</td>
<td></td>
</tr>
<tr>
<td>35-44</td>
<td>16530</td>
<td>66.2%</td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>17310</td>
<td>73.3%</td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>20630</td>
<td>75.4%</td>
<td></td>
</tr>
</tbody>
</table>

It is evident from the table that there is considerable variation in earned incomes within each age-education group, even amongst full-time, full-year workers. Becker (1975 p.181) has pointed out that if members of the same cohort are affected very differently, then individuals may well be justified in ignoring the aggregate results, when deciding whether to pursue higher education. The extent of the variation within each age-education group suggests that Becker’s point may be relevant here. Hence, to better understand the effect of higher education on individuals, a much more careful analysis of the variation in individual incomes is required.

The variation in individual income poses (at least) two interesting and important sets of questions to researchers. First, in
addition to education and age (or experience), which other factors are important in determining an individual's earnings? Second, how does the variability in income affect the ex-post and the ex-ante profitability of higher education?

With regards to the first question, the factor which has received the most attention to date is native ability. From the outset, critics of the human capital approach to education have argued that more highly educated individuals earn more, largely (or even, solely) because of their superior innate ability. This has led to a proliferation of studies on the extent of the "ability bias" in estimates of the returns to education.\(^2\)


Despite the concerted efforts of researchers, and the increasing sophistication of the estimation techniques and data sets used, a large proportion of the variance in individual earnings still remains unexplained. Typically, these so-called "Human Capital Earnings Functions" explain less than half the total variance in earnings. This has prompted at least one researcher to suggest that

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\(^2\) See, for example, Griliches and Mason (1972), Griliches (1977), Hause (1971), Chamberlain (1978), Taubman and Wales (1974), and the survey in Psacharopoulos (1975).
luck is at least as important as human capital in determining an individual's earnings. Others, however, attribute the unexplained variance largely to differences in personal characteristics of individuals which are unmeasured, and perhaps, even unmeasurable.

These concerns have opened up a whole new line of inquiry which asks: how much of the observed differences in earnings is systematic, or caused by differences in individual characteristics (both measured and unmeasured), and how much is stochastic, or due to luck? This line of research is, to a great extent, facilitated by the increasing availability of panel data, which permits researchers to exploit information in the error structure in a way which is not previously possible with single-period cross-sectional data.

For our purposes, the disentangling of income variation into its systematic and stochastic components is important because the implications of each of the components on the profitability of higher education from the point of individuals, and of society, are quite different. On the one hand, if the income variation within each education-age group is due entirely to the random effects of luck, then ex-ante, higher education is equally profitable across all individuals. In this case, the aggregate results in Part I provide reasonable guides to what any individual can expect to earn, conditional on their education. Nevertheless, to the extent that individuals are not indifferent to risk, there is still the question of how to take into consideration the effect of the uncertainty in future earnings on the ex-ante profitability of higher education. If higher education increases the variability of individuals' incomes, then the ex-ante value of a degree to those who are risk-averse is

lower than suggested by the rates of return calculated in Part I. The converse is true if higher education reduces the uncertainty associated with future earnings.

On the other hand, if the variation within each age-education category arises entirely from differences in the unmeasured characteristics of individuals (which are known to the individuals themselves), the rates of return calculated in Part I on the basis of mean earnings profiles may be of less relevance. In this case, depending on their respective endowments of the unmeasured characteristics, and how these characteristics are valued across jobs associated with different educational qualifications, individuals may expect to have lifetime earnings which are more, or less, than those given by the mean earnings profiles. Consequently, their rates of return may differ quite markedly from that based on the mean outcomes across schooling groups.

The variation in individual rates of return has an important policy implication. Discussions of whether society, at the margin, should expand investment higher education, have largely been based on average rates of return. To the extent that individual rates of return are systematically related to the selection mechanism used to allocate university places, the rate of return to the marginal graduate may be quite different to the average rate of return. It follows, therefore, that the average rate of return may be a misleading indicator of the returns to an expansion in higher education.

Part II of the thesis consists of three chapters (Chapters 5-7) which discusses these issues. Following Lillard and Willis (1978), we assume that the earnings function is of the form:
\[ Y_{it} = X_{it} \beta + \Gamma_t + u_{it} \quad i = 1, \ldots, N; \quad t = 1, \ldots, T; \]

where \( Y_{it} \) is the natural logarithm of annual earnings of the \( i \)th person in the \( t \)th year; \( \Gamma_t \) are time dummies; and \( X_{it} \) contains the usual human capital variables.

The error structure is assumed to be of the following form:

\[ u_{it} = \delta_i + v_{it} \]

where \( \delta_i \) is a random individual component, which is assumed to be time-invariant, and captures the individual-specific characteristics not included in \( X_{it} \); and \( v_{it} \) is a stochastic component (which may be serially correlated).

In Chapter 5, the focus is on the effect of risk on the private profitability of higher education. We assume in that chapter, that the error term \( (u_{it}) \) consists only of the stochastic component (i.e. \( \sigma_{\delta}^2 = 0 \)). A simple two-step procedure is developed, which enables us to adjust the profitability of higher education for risk. We examine how the results in Part I of the thesis, which are based on a certainty framework, are altered as a result of the uncertainty in future incomes. In addition, the impact of the risk of dropping out of university, as well as of the uncertainty with respect to the length of time required to complete the course on the economic value of a degree is analysed.

Chapter 6 is concerned with the effect of differential abilities across individuals on the private returns to higher education. There, we assume that the error term \( (u_{it}) \) consists solely of the individual-specific component (i.e. \( u_{it} = \delta_i \)). Using the Willis and Rosen (1979) model of educational self-selection, three cases of sorting by ability into different educational groups -- positive hierarchical sorting, negative hierarchical sorting, and
non-hierarchical sorting -- are identified. In addition, a fourth case, whereby no sorting by ability occurs, may arise under certain conditions. It is not possible with our data to test for the type of sorting which takes place. Nevertheless, by pairing incomes from different parts of the high-school leavers' income distribution with incomes from different parts of the degree-holders' income distributions, we can shed some light into the extent to which rate of return estimates based on mean earnings profiles may be biased in each of the four cases. As well, we can gain considerable insight with regards to how individual rates of return may differ from the average return to the group.

The individual and stochastic components are brought together in Chapter 7, using the parameter estimates from Miller (1989) as a guide to their relative importance. The aim of this chapter is to consider some policy implications arising from differential ability across individuals, as well as the riskiness of higher education as an investment. In particular, we analyse the effect of the Higher Education Contribution Scheme (HECS) on the incentives of individuals with different ability levels to invest in higher education, as well as the extent to which HECS is made more attractive vis-a-vis other fee-paying proposals because of its income-contingent nature.
5.1 Introduction

The analyses in Part I of the thesis were set within a certainty framework. In the private rate of returns calculations, individuals were assumed to use the minimum time required by their courses as the basis of their calculations, and the possibility of failing to complete was not considered. As well, they were assumed to know the future income streams associated with the alternative levels of education with complete certainty.

Clearly, these assumptions are untenable in the real world. Uncertainty is very much a fact of life, and the ex-post profitability of higher education may differ quite markedly across individuals. In other words, there are risks\(^1\) associated with investing in higher education. To the extent that individuals are not indifferent to risk, they will take the uncertainty into account when evaluating the profitability of the educational investment.

Becker (1975) had clearly anticipated these difficulties. In his book, *Human Capital*, he identified three types of risks

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1. In the original economics of uncertainty literature, the terms "uncertainty" and "risk" have quite different meanings. The former refers to situations whereby the probability distribution of the outcome is unknown, whereas the latter is used in situations where it is known. Since, we shall be dealing only with situations where the probability distribution is assumed to be known, we shall follow the example of other researchers applying the concept of uncertainty to education, and use the terms "risk" and "uncertainty" interchangeably.
associated with investments in human capital. First, there is uncertainty regarding the length of life. Second, individuals may be uncertain about their ability to learn, and to benefit from the schooling process. Finally, there is uncertainty about the returns to education due to events which are not predictable -- in other words, luck. In this chapter, we are primarily concerned with the third type of uncertainty.

It is important to note that adjustments for risk need not necessarily make higher education less profitable even if all individuals are risk-averse. This is because the uncertainty in the returns arises from two separate sources: a) that associated with successful completion of the course and the length of time taken; and b) the uncertainty in income as a graduate vis-a-vis income as a high-school leaver. The first source of uncertainty unambiguously leads to a reduction in the profitability of higher education. The effect of uncertainty from the second source is not as clear-cut. There is no a priori reason to expect the income of high-school leavers to be more, or less, variable than that of degree-holders. If the possession of a degree leads to less variability in future earnings, and this effect dominates the uncertainty from the first source, then from the point of individuals, higher education is risk-reducing. The (risk-adjusted) rate of return to higher education will, as a result, be higher than when uncertainty is ignored.


3. Questions relating to uncertainty in ability are taken up in the next chapter.
Despite the obvious importance of this issue, there have been few attempts to consider the empirical implications of risk on the ex-ante profitability of education. To the best of our knowledge, there has only been one study [Weiss (1972)] which has attempted to empirically estimate the effect of risk on the ex-ante returns to education. Unfortunately, as we shall see, there are some rather serious shortcomings with that study. It should be noted, as well, that none of the previous studies addresses the risk of failure. This is a serious oversight, particularly in the case of Australian higher education where, according to the William's Committee, more than 40% of students fail to complete their degrees in the minimum time required.

This chapter develops a simple two-step procedure to assess the private profitability of higher education as an investment in the presence of uncertainty. The approach is sufficiently flexible to allow for the probability of the failure to complete, and the uncertainty with regards to the time required for completion of the degree, to be incorporated. We shall use the model developed to examine how the results in Part I of the thesis are altered as a result of the adjustment for risk.

There are seven sections in this chapter. Section 5.2 reviews the handful of studies on the effect of risk on human capital investment. We shall point out why these studies are not satisfactory, and proceed, in Section 5.3, to develop a model which overcomes some of the difficulties. Section 5.4 presents the empirical results of our model. In Section 5.5, the effects of interest rates, and the level of initial wealth on the profitability of higher education are analysed. Section 5.6 examines the issue of
serial independence in year-to-year income variations. The main conclusions of the chapter are set out in Section 5.7.

5.2 Literature Review

5.2.1 Variability in IRR and Discounted Lifetime Income

One of the main conclusions of Becker's (1975) pioneering work on investment in human capital was that the private rate of return to college education, in aggregate, was quite substantial even after adjustments for differential ability. Becker was quick to point out that these results applied to individuals only insofar as members of the same cohort were affected 'more or less to the same extent'. Unfortunately, that was not the case. Becker found that there was considerable variation in the gain within a group even after standardizing for sex, race, locality (urban or rural), and graduate or drop-out status. As a crude approximation, he estimated that the coefficient of variation of the rate of return to college education was 'almost certainly higher than one and possibly a good deal higher'. This implies that although the rate of return to the cohort in aggregate might be 12%, many members of that cohort would receive more than 25%, or less than 0% on their investments. He concluded that:

"... the variation in gain within a group ... is much greater than can be explained by the variation in ability alone. So great is it that an individual can be only loosely guided by the gain of his cohort, and has to place considerable weight on his own situation and hope for the best." [pp.181-182]

Hause (1974) suggested that while it was not possible to compute the probability distribution of an individual's discounted
lifetime income from cross-sectional data because the covariances of annual incomes over the life cycle cannot be derived, it was possible, nevertheless, to obtain an upper bound to the coefficient of variation of the discounted income stream. He showed that the supremum of the standard deviation of discounted lifetime income was simply the discounted value of the standard deviation of income at each age. That is:

\[ \int e^{-rt} [\mathbb{E} (y_t - \mu_t)^2]^{1/2} \text{dt} \geq \left\{ \mathbb{E} \left[ \int e^{-pt} (y_t - \mu_t) \text{dt} \right]^2 \right\}^{1/2} \]

Dividing this supremum of the standard deviation by the mean discounted value of the income stream, which is equal to the discounted value of the mean earnings profile, yields an upper bound to the coefficient of variation of individuals' discounted lifetime income.

A lower bound to the coefficient of variation can also be obtained. If the income profile is determined by a large number of uncorrelated increments over short intervals of time, then the coefficient of variation of the discounted lifetime income approaches zero. Hause admitted, however, that these bounds were 'unpleasantly wide for estimating the true variability of discounted lifetime incomes', and recommended that the estimating procedure developed by Fase (1970, 1971) be used instead.

In the Fase study, a random-walk model of earnings was specified, and estimated using Dutch Income data for 1965. Using the estimated parameters of the model, Fase computed the before-tax means and standard deviations of the discounted lifetime incomes (from age
for five different levels of education. His results showed that there was considerable variation in the lifetime incomes at all levels of education. In the case of university graduates, for instance, the mean and standard deviation were 581,000 gld (Dutch Guilders) and 159,000 gld, respectively. In view of the sizeable variation within each educational group, it is somewhat surprising that in his later calculations of the economic value of education, only the mean income profiles were used.

More recently, Miller and Volker (1989) analysed the riskiness of higher education as an investment in Australia. They demonstrated that there was a great deal of uncertainty regarding an individual's position in the wage distribution, and argued that individuals incorporate this uncertainty into their evaluation of investment in education. In their formulation, individuals are assumed to make their educational choices on the basis of both the present value of the income stream associated with a particular educational level, and the standard deviation of this present value. By considering the polar cases of zero, and perfect correlation in individuals' year-to-year income variation, Miller and Volker estimated that the standard deviations of the discounted lifetime incomes were $7,643 and $7,654 (1985 dollars) for male year 12 leavers and male university degree-holders, respectively, in the zero-correlation case. In the case of perfect correlation, the figures were $42,133 and $42,200, respectively. In each case, the coefficient of variation of discounted lifetime income for high-school leavers was higher than

4. A 4% discount rate was used in his calculations.
for university degree-holders. Miller and Volker concluded that there was, therefore, a lower relative degree of riskiness attached to the income streams of degree-holders, and that this further enhanced the financial attractiveness of higher education as an investment.

The studies reviewed so far demonstrate that from an individual's investment perspective, there is considerable risk attached to investing in education. What is lacking, however, is a framework within which these risks can be taken into account and the rates of return (or NPV) adjusted accordingly. Until such a framework is provided, it is difficult to see how these measures of riskiness can be used, or indeed, if they are even the appropriate measures, in

5. The standard deviations of lifetime incomes for the zero and perfect correlation cases are, respectively:

\[
\sigma_{zc} = \sqrt{\sum_{t=0}^{T} \frac{\sigma_t^2}{(1+r)^t}}
\]

and

\[
\sigma_{pc} = \sum_{t=0}^{T} \frac{\sigma_t}{(1-r)^t}
\]

In their calculations, Miller and Volker used the variance of the predicted earnings from their regression as an estimate of \(\sigma_t^2\). That is,

\[
\sigma_t^2 = s^2 [1 + 1/N + (X_i - \bar{X})'(X'X)^{-1}(X_i - \bar{X})]
\]

where \(s^2\) is the variance of the least squares residuals and \(N\) is the sample size. Note that for both Year 12 graduates and degree-holders, \(s^2\) is restricted to be the same. Since the third term in (*) which measures the deviations in the characteristics from the mean is small, the restriction implies that \(\sigma_t^2\) for the two groups will be close to each other. Given the higher mean income for degree-holders, it is not surprising, therefore, that Miller and Volker found the coefficient of variation for this group to be smaller.
the sense that the higher the "risk" (as measured by these statistics) the worse-off risk-averse individuals are, ceteris paribus. There are several reasons for this.

First, what is relevant to individuals in assessing the profitability of investing in education is the change in income variability as a result of the additional education. Contrary to what Becker [1975 p.184] has claimed, this change may not be reflected by the variation of the gain from the extra education, whether it is measured by the rate of return or the net present value. To illustrate this, suppose that the income stream of high-school leavers is subject to some variability, but not that of degree-holders. Under these circumstances, both the NPV and IRR of higher education will show some variability. Note, however, that as the income stream of high-school leavers increases in variability, both the NPV and IRR become more variable as well. Yet, it is clear that higher education has become more, and not less, attractive to risk-averse individuals. Hence, rather than becoming more risky as the increased variability of NPV or IRR suggests, higher education has become less risky.

Second, even if the variances of the respective discounted lifetime earnings associated with the various levels of education are computed separately, there are still problems. The means of the discounted lifetime incomes associated with alternative educational levels may be different, as is usually the case. Hence, the ordering of riskiness may differ, depending on whether the variance or the

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6. More accurately, it is the change in the variability of consumption which matters, as we shall see later.
coefficient of variation is used. In the Miller and Volker (1989) study, for instance, the standard deviation of discounted lifetime income for university graduates is higher than for high-school leavers. The coefficient of variation, on the other hand, is lower. It is not clear under these circumstances which (if any) of the two statistics should be used as a measure of riskiness.

Thirdly, income streams with present values which have identical means and variances may be associated with consumption streams which have quite dissimilar variances. As such, risk-averse individuals may not necessarily be indifferent between these income streams. This will become clearer after the discussion in Section 5.3.

Finally, the use of the variance statistic (or standard deviation, or coefficient of variation) as the measure of riskiness may be questioned. It can be shown that the variance statistic would only suffice as a measure of risk under very special conditions, namely, that the utility function is quadratic and/or the random
returns are a linear transformation of spherically distributed random vector.\textsuperscript{7,8}

To sum up, the above studies show that there is considerable variability in the returns to education. Unfortunately, these studies stop short of telling us how this affects the attractiveness of education as an investment. This question was taken up by Weiss (1972).

5.2.2 Weiss' Utility Model of Income

Weiss developed a utility-maximization model which allowed risk-adjusted rates of return to education to be calculated. He assumed that given the level of education, occupation, and type of employment, individuals believe that income at each point in the future is a random variable drawn from a distribution identical to that currently observed in each corresponding age group. This implies that individuals' incomes are independently distributed across time, and across educational alternatives. In the Weiss model, instead of just using the mean of the currently observed income distribution at

\begin{itemize}
\item\textsuperscript{7} This condition is both necessary and sufficient (assuming that the utility function is non-quadratic) when there exists a riskless asset. In the absence of a riskless asset, the spherically distributed random vector is replaced by a random vector in which the last n-1 components are spherically distributed conditional on the first component, which has an arbitrary distribution. These results are proved by Chamberlain (1983). See also Meyer (1987) who identifies a restriction on the returns which is sufficient (but not necessary) to ensure that the mean-variance approach is consistent with expected utility maximization. Meyer argues that this restriction, in contrast to others, such as requiring the returns to be normally distributed, holds in many economic models.

\item\textsuperscript{8} For "small" risks, Pratt (1964) has shown that the variance may be used as an approximate measure of riskiness. This property is used in later sections.
\end{itemize}
every age to predict their future incomes, as we have assumed in Chapter 3, individuals use all the available information in the distribution.

The income distribution within each alternative is assumed at each age, to be log-normal. That is,

\[ Y_t \sim \text{LN}(\mu_t, \sigma_t^2) \]

Individuals seek to maximize their expected utilities, which is assumed to be of the form:

\[
EU = E \left\{ \int_{t_0}^{T} e^{-rt} V(Y_t) \, dt \right\}
\]

where \( r \) is the individual's subjective discount rate.

The problem is further simplified by assuming that:

\[ V(Y_t) = \frac{Y_t^{1-a}}{1-a} \]

where \( a \) is the coefficient of relative risk aversion.

The objective function can, therefore, be expressed as:

\[
EU = \int_{t_0}^{T} e^{-rt} \left( \frac{Y_t^\beta (c_t^2 + 1)(\beta^2-\beta)/2}{\beta} \right) \, dt
\]

where \( \beta = 1-a \);

\[ c_t^2 = \exp(s_t^2) - 1 \]; and

\( c_t \) is the coefficient of variation at time \( t \).

Weiss then defined the rate of return as the subjective discount rate at which the individual was indifferent between acquiring and not acquiring the additional education. Note that if
individuals are risk-neutral (i.e. $a=0$), the objective function reduces to $\int e^{-rt}Y_t \, dt$, which is simply the discounted lifetime income. The rate of return is then the rate which equates the discounted cash flows associated with the two alternative educational levels, just as in the certainty case presented in Chapter 3. For risk-averse individuals ($a>0$), $\beta$ is less than zero. A mean-preserving increase in $c_t$, the coefficient of variation of the income distribution at time $t$, reduces the expected utility of the income stream, reflecting their distaste for uncertainty.

Using data on the earnings of scientists in the United States from the 1966 National Register of Scientific and Technical Personnel, Weiss computed the rates of return to a doctorate degree by type of employment and degree of risk-aversion. His results showed that even small increases in the degree of risk-aversion would reduce the rates of return quite substantially. In all cases, the rate of return fell below zero with a coefficient of relative risk-aversion of just 0.8. The most dramatic case was for those employed in educational institutions. There, the rates fell from 15.6% to less than zero as the coefficient of risk aversion increased from 0 (risk-neutral) to 0.8.

One puzzling aspect of Weiss' results is that the coefficient of variation of income is lower, at each age, for the more highly educated. In other words, education is apparently risk-reducing. That being the case, one would expect the rate of return to education to

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9. Barsky et al. (1986) report that recent studies have found that, empirically, the coefficient of relative risk aversion is around 3.
rise as the degree of risk-aversion increases, opposite to what his results show. Weiss explained that this paradoxical result was due to the fact that an increase in the degree of risk-aversion had two opposing effects on the rate of return. First, an increase in $a$, the coefficient of risk-aversion increased the concavity of $V(.)$ which, in turn, increased the rate at which the marginal utility of income declined. Hence, the increment in future incomes due to additional education would be given less weight in utility terms. Coupled with this, the sacrifice of current income was also made more "costly". The result was a decline in the rate of return to education. On the other hand, an increase in the degree of risk-aversion also meant that the risk-reducing aspect of education was given a higher weight, which would have the effect of raising the rate of return. His results indicated that, empirically, the first effect dominated.

Weiss' study has been severely criticized by Hause (1974), who noted that Weiss' main finding of moderate degrees of risk-aversion substantially reducing the rates of return, was caused by the 'foreseen absence of earnings while attending school', and had nothing to do with risk. The root of the problem was traced to Weiss' formulation of the objective function for the consumer, which Hause described as being 'anti-Fisherian with a vengeance'. He pointed out that if one accepted the view that utility was derived from consumption, and not from income directly, then Weiss' objective function could only be justified if intertemporal shifts in consumption through borrowing and saving were not possible. The implication of this is that, between two certain income streams with the same present value, one of which has the same income in every period, and the other having low incomes in the beginning and high
incomes in later periods, risk-averse individuals would prefer the former. Furthermore, the higher the degree of risk-aversion, the stronger the preference for the former. This follows directly from the assumed diminishing marginal utility of income at each point in time, and has nothing to do with risk. It was this, together with the assumption of zero income while studying, which led to Weiss' conclusion.

Hause (p.804) argued that:

"Diminishing marginal utility of income was introduced in the expected utility hypothesis of von Neumann-Morgenstern to characterize risk aversion. It is technically misleading to conclude that the assumption of risk aversion necessarily implies anything about intertemporal preferences under certainty. This unsatisfactory formulation is obvious if we consider an individual with "risk preference" (by considering -1<\(\alpha\)<0 ...). In this case, the maximand ... implies that of all certain income profiles with the same present value, the least desirable is a constant income over time, and the most desirable streams are those concentrated at one point (or period) of time."

He concluded that Weiss' formulation was, therefore, 'theoretically inappropriate for dealing with the problem at hand', and that his main empirical finding was unjustified.10

10. The difficulty of separating intertemporal substitution and risk-aversions in utility functions such as that used by Weiss is the motivation behind the recent studies by Epstein and Zin (1987a, 1987b) who developed two classes of utility functions each of which has the attractive feature of allowing the two parameters (coefficient of risk aversion and the elasticity of substitution) to be clearly separated.
5.2.3 Two-Period Consumption Models

The two-period model developed by Levhari and Weiss (1974) overcomes some of the problems inherent in the Weiss model. In particular, the utility function is defined explicitly on consumption, and individuals are permitted to transfer income across time periods by borrowing and lending. Individuals are assumed to obey the von Neumann-Morgenstern axioms and seek to maximize expected utilities.

Apart from lending, individuals can also transfer income to period 2 by investing in human capital. These investments are assumed to be time-consuming, and reduce the amount of time available for work in the first period. The proportion of time devoted to investing in human capital in the first period is denoted by $p$ (0<$p$<1). Earnings in the second period, $Y_2$, depend on $p$, and the (unknown) state of the world, $\mu$:

$$Y_2 = f(p, \mu)$$

where $\mu$ is a random variable with a known distribution.

Finally, individuals are assumed to have no desire to leave bequests. The individual optimization problem can, therefore, be written as:

11. Levhari and Weiss interpret the interest rate as the return on physical capital. This is somewhat misleading since the interest rate is assumed to be known with certainty, implying that investments in physical capital are riskless. It is more appropriate to treat the interest rate simply as the rate at which one can borrow and lend in a perfect capital market.
Max \( V = E \{u(C_1, C_2)\} \quad u' > 0; \ u'' < 0 \)

subject to:

\[ C_2 = (A + (1-p)Y_1 - C_1)(1+r) + Y_2 \quad \text{and} \]
\[ Y_2 = f(p, \mu) \]

where \( Y_1 \) = potential earnings in the first period;
\( A \) = individual's initial wealth; and
\( r \) = riskless rate of interest.

\( Y_1, A \) and \( r \) are all assumed to be known, and exogenous to the individual. An interior solution to the optimisation problem is assumed to be attained.

The major conclusions from Levhari and Weiss' comparative statics exercise using this simple two-period model are that: 1) the effect of increased risk on investment in human capital is in general, ambiguous; 2) an increase in initial wealth encourages investment, if risk increases with \( p \) (i.e. \( f_p \mu > 0 \)), and the coefficient of absolute risk aversion decreases with wealth; 3) an increase in the rate of interest discourages investment in human capital if the individual is a borrower, and had an ambiguous effect if the individual is a lender.

Extensions to the Levhari and Weiss model were made by Eaton and Rosen (1980) for taxation and endogenous labour supply, and by Paroush (1976) for interest rate uncertainty. Kodde (1986) attempted to test the Levhari and Weiss model empirically using the data he collected on a sample of high-school graduates which contained information of their expectations of incomes (with and without further education), as well as their decisions on whether to pursue further education. Kodde found that parental income (as a proxy for
wealth) increased the probability of pursuing further education.

Expected foregone earnings, on the other hand, had a negative effect, indicating that the substitution effect dominated the income effect. There is some difficulty, however, in interpreting the effect of an increase in the perceived riskiness of future income on the demand for education. This is, in part, due to the rather crude measures used to capture uncertainty (individuals' estimates of their highest and lowest possible levels of future earnings).

This criticism notwithstanding, Kodde's study represents an important first step towards the empirical application of uncertainty models of human capital investment. A significant drawback in Kodde's approach, however, is that it does not yield estimates of the profitability of education which are easily interpretable. Moreover, for empirical applications, it is desirable to extend beyond the simple two-period model into one in which both the investment in human capital and the returns to these investments are distributed over time. An additional dimension of the uncertainty in human capital investment can be incorporated by allowing the opportunity cost of investment ($Y_1$ in the two-period model) to be subject to uncertainty as well.

These modifications are considered in the model to be presented in the following section. Our objective there, is to develop a simple framework whereby the risks associated with investment in higher education can be readily incorporated into conventional measures of profitability, such as the NPV.
5.3 Intertemporal Consumption under Uncertainty

In this section, we present a simple two-step procedure to adjust higher education returns for uncertainty. The strategy is, first, to convert the uncertain income streams associated with the two alternative educational levels into their respective certainty-equivalent streams. We can then apply the standard NPV techniques employed in the previous chapters to these certainty-equivalent income streams.

The idea behind the two-step procedure is not new; it is a standard technique for dealing with uncertainty in Cost-Benefit analysis (see Stiglitz (1988) p.270-271, for example). Unfortunately, the literature on Cost-Benefit analysis is rather vague on how one should convert the uncertain income streams into their respective certainty equivalents. This has led Mishan [1982, p.365], for instance, to complain that:

"This notion of uncertainty equivalence is, perhaps, a useful ploy in working through abstract economic constructs where the troublesome fact of uncertainty can be formally accommodated without any amendment to the theory, simply by attributing a certainty equivalent to every uncertain magnitude. But it provides little guidance to the economist engaged in evaluating a project.... The knowledge that some rational being, when faced with the problem of placing a value on some future magnitude, might well choose a value very different from that chosen by another equally rational individual, may be of some consolation to him in his perplexity. But it cannot provide him with a clear decision rule"

The novelty of our contribution lies in the use of an intertemporal-optimization model of individual consumption, which is

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12. I am grateful to Paul Miller for bringing this to my attention.
drawn from the Permanent Income and Life-Cycle Consumption literature (see, for example, Hall (1978), Deaton (1987)), to derive the risk-premiums associated with alternative (uncertain) income streams, and from these, the respective certainty-equivalent streams. The resulting framework is one which is theoretically appealing, and which can be readily understood. As well, it is sufficiently flexible to allow for variations such as the incorporation of the risk of failure in university, and for a wide range of policy issues to be examined (see Chapters 6 and 7). A further advantage of our framework is that the results generated are straight-forward to interpret.

The first step requires the setting up of a utility model in which individuals' perceptions and attitudes to risk can be considered. For this purpose, a multi-period model of intertemporal consumption under uncertainty is specified. As in the Levhari and Weiss model, we assume that the von Neumann-Morgenstern axioms hold, so that individuals seek to maximize expected utilities. To simplify the problem, we assume that the utility in any period depends only on that period's consumption. Again, as in the Levhari and Weiss model, we assume also that individuals can borrow and lend at the market interest rate \( r \), and that they have no desire to leave bequests. Individuals determine each period's consumption after that period's income is known.

The optimization problem at the beginning of period \( t \) may be expressed as:
Max \( \sum_{t=0}^{T-t} E_t (1 + \delta)^{-t} U(C_{t+t}) \)

subject to:

\[
\sum_{t=0}^{T-t} (1 + r)^{-t} (C_{t+t} - Y_{t+t}) = B_t
\]

where \( E_t \) is the mathematical expectation conditional on all information available at the beginning of period \( t \);

\( B_t \) is the bank balance at the start of period \( t \);

\( Y_t \) is the income in period \( t \); and

\( \delta \) is the individual's subjective discount rate.

Note that this is exactly the same model as that used by Hall (1978) in his investigation of the permanent-income hypothesis. Hall proved that given this optimization problem, individuals would arrange their consumption pattern such that:

\[
E_t U'(C_{t+1}) = \left[ \frac{1+\delta}{1+r} \right] U'(C_t)
\]

(5.1)

is satisfied at every \( t \).

To simplify the problem even further, we assume that \( \delta = r \).\(^{13}\) If the utility function is quadratic, of the form:

\[
U(C_t) = -(\alpha - \beta C_t)^2
\]

then, (5.1) reduces to:

\[
C_t = E_t(C_{t+1})
\]

(5.2)

\(^{13}\text{This simplification is also made in the consumption model of Hall and Mishkin (1982), and is statistically consistent with the empirical evidence in Hall (1978).}\)
For other utility functions, (5.2) is a first-order approximation of (5.1).\(^{14,15}\)

Given that individuals do not intend to leave any bequest, consumption in the terminal period is:

$$C_T = B_T + Y_T$$

At the start of the penultimate period ($t=T-1$), $B_{T-1}$ and $Y_{T-1}$ are known, and the individual chooses $C_{T-1}$ in accordance with (5.2). That is,

$$C_{T-1} = E_{T-1}(B_T + Y_T)
= E_{T-1}(B_T) + E_{T-1}(Y_T)
= (B_{T-1} + Y_{T-1} - C_{T-1})(1+r) + E_{T-1}(Y_T)
= \left[1 + (1+r)\right]^{-1} \left[(B_{T-1} + Y_{T-1})(1+r) + E_{T-1}(Y_T)\right]$$

In the period $t=T-2$, $C_{T-2}$ is chosen such that $C_{T-2} = E_{T-2}(C_{T-1})$.

$$E_{T-2}(C_{T-1}) = \left(1 + (1+r)\right)^{-1} E_{T-2}\{(B_{T-1} + Y_{T-1})(1+r) + E_{T-1}(Y_T)\}$$

Applying the rule that $E_t[E_{t+1}(\cdot)] = E_t(\cdot),^{16}$

$$C_{T-2} = \{1 + (1+r) + (1+r)^2\}^{-1} \{(B_{T-2} + Y_{T-2})(1+r)^2 +
E_{T-2}(Y_{T-1})(1+r) + E_{T-2}(Y_T)\}$$

---

14. $E_t U'(C_{t+1}) = E_t[U'(C_t) + U''(C_t)(C_{t+1} - C_t)]$.

Thus, (5.1) $\Rightarrow U''(C_t).E_t(C_{t+1} - C_t) = 0$ $\Rightarrow C_t = E_t(C_{t+1})$.

15. Note that this consumption rule demonstrates the property of "certainty equivalence" i.e. expected consumption depends solely on the expected values of future incomes, and are not affected by their variability. This does not, however, imply that individuals are necessarily indifferent to changes in income variability, since they affect the variability of their consumption.

16. This follows directly from the definition of $E_t$. 
By repeated substitutions, we have

\[ C_t = G_t \{ (B_t + Y_t)(1+r)^{T-t} + \sum_{i=t+1}^{T} (1+r)^{T-i} E_t(Y_i) \} \]  

(5.3)

where

\[ G_t = \frac{(1 + (1+r) + (1+r)^2 + \ldots + (1+r)^{T-t})^{-1}}{} \]

\[ = \frac{r}{(1+r)^{T-t+1} - 1} \]

The consumption rule given in (5.3) is intuitively appealing. At the start of period \( t \), \( Y_t \) and \( B_t \) are known. In addition, the individual has some expectation as to how much income he or she would receive in the next \( T-t \) periods. The individual wants to spread consumption evenly over time. Based on the amount currently at his or her disposal \( Y_t + B_t \) and expected future incomes, the individual computes the constant amount (given the assumption that the individual's discount rate is equal to the market rate of interest, i.e. \( \delta = r \)) he or she can afford to consume in the current, and in each of the future periods. This constant amount is, precisely, the expression on the right-hand side of (5.3).

The cost of the uncertainty in future consumption at time \( s \), can be measured by means of an annual risk premium, \( \rho \), which satisfies: \(^{17}\)

\[ \sum_{t=s+1}^{T} (1+\delta)^{s-t} U(E_s(C_t) - \rho) = \sum_{t=s+1}^{T} (1+\delta)^{s-t} E_sU(C_t) \]

(5.4)

Note that \( E_s(C_t) \) is a constant for \( t = s+1, s+2, \ldots, T \), and will be denoted by \( \mathcal{C} \). By definition, individuals are willing to pay up to $\rho in each of the future periods to obtain the certain consumption.

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\(^{17}\) This follows the derivation in Newbery and Stiglitz (1981).
stream \( \{C_s, C_{s+1}, \ldots, C_T\} \), instead of the uncertain consumption stream \( \{C_{s+1}, C_{s+2}, \ldots, C_T\} \). It follows from this, that individuals would be indifferent between receiving the certain income stream \( E_s(Y_{s+1}-\rho, E_s(Y_{s+2})-\rho, \ldots, E_s(Y_T)-\rho) \) and the uncertain income stream \( \{Y_{s+1}, Y_{s+2}, \ldots, Y_T\} \). We call the former income stream, the "certainty-equivalent" income stream.

For "small risks", we can use the Taylor's series expansion to approximate each term in (5.4) by:

\[
U(E_s(C_t) - \rho) = U(C) - \rho U'(C) \quad \text{and} \\
E_s U(C_t) = U(C) - \frac{1}{2} A(C) E_s[\text{var}(C_t)] U'(C)  \tag{19}
\]

where \( A(C) = -U''(C)/U'(C) \) is the coefficient of absolute risk aversion.

Hence,

\[
\rho = \frac{\frac{1}{2} A(C) \sum_{t=s+1}^{T} (1+\delta)^{s-t} E_s(\text{var}(C_t))}{\sum_{t=s+1}^{T} (1+\delta)^{s-t}} \tag{5.5}
\]

We now have a way in which uncertain income streams associated with alternative educational levels can be transformed into their certainty-equivalents. These can then be treated as if they are actual riskless income streams for the alternative levels of education, allowing the NPV to be computed. The IRR can also be


19. This is an exact result for the quadratic utility function.

20. It is important to note that the certainty-equivalent profiles are functions of the individual's discount rate. For internal
derived, and compared with the individual's discount rate which, in this case, is equal to the rate of return on riskless assets. For reasons which will be given later, however, interpretation of the IRR can be rather difficult. Hence, only the NPV results are given in the next section.

Earlier, in Section 5.2.1, we stated that the variances of discounted lifetime incomes may be misleading indicators of their relative riskiness. We claimed that individuals may not be indifferent between two alternative income streams with present values which have identical means and variances. This can be easily demonstrated using the model developed above, and is shown in Appendix 5.1.

consistency, the NPV must also be calculated using this same discount rate.

21. The computation of the IRR is more complicated than simply finding the discount rate which equates the present values of the alternative certainty-equivalent profiles because these certainty profiles are themselves functions of the discount rate.

22. In Chapter 3, we compared the IRR with the return an individual can obtain 'by investing in the market portfolio'. The assumption implicit in this procedure is, of course, that investment in education is 'similar in risk' to investment in the market portfolio. Without formally modelling risk and its impact on individuals, however, it is difficult to see what 'similar in risk' means.
5.4 Empirical Estimation

5.4.1 Data and Method of Estimation

As in the previous chapters, the data are drawn from the 1985/85 Income and Housing Survey. We restrict our sample to full-time-full-year male workers with positive earned incomes in 1985/86, so as to abstract from income variation arising from differences in hours worked.23

Following Lillard and Willis (1978), the earnings function is specified as:

\[ Y_{it} = X_{it} \beta + u_{it} \quad i = 1, \ldots, N; \quad t = 1, \ldots, T; \]  

where \( Y_{it} \) is the natural logarithm of annual earnings of the \( i \)th person in the \( t \)th year; and

\( X_{it} \) contains the usual human capital variables.24

Lillard and Willis assume that the error term is made up of an "individual-specific" component \( (\delta_i) \) and a "stochastic" component \( (v_{it}) \).25 They allow for serial correlation in the latter component,26 of the form:

23. The difficulties involved in the treatment of differences in the number of hours worked have been explored in Part I of the thesis.

24. In the original Lillard and Willis model, time dummies \( (\Gamma_t) \) have also been included to capture the combined effect of time-varying macroeconomic variables such as productivity changes, and market conditions. Since our data consist of only a single cross-section of individuals, \( \Gamma_t \) is omitted. Hence, the uncertainty considered in this chapter is restricted to the uncertainty in a given market situation. To the extent that the incomes of degree-holders are less sensitive to the fluctuations of the business cycle (see OI (1962) for example), higher education would tend to be more attractive to risk-averse individuals than our figures would suggest.

25. Lillard and Willis refer to them as "permanent" and "transitory" components. We have chosen not to use their terminology since the
\[ V_{it} = \gamma V_{i(t-1)} + \eta_{it} \]  

(5.7)

where \( \gamma \) is the serial correlation coefficient common to all individuals, and \( \eta_{it} \) is a purely random component (\( \sim \) NID(0,\( \sigma^2 \))). The variates \( \delta_t \), \( \eta_{it} \) are assumed to be independent of each other and of \( X_{it} \).

In this chapter, it is assumed that individuals attribute all the observed variability in income to the "stochastic" component, and believe that their future (uncertain) incomes will be the same as that currently received by individuals with the corresponding educational qualifications in the cross-section. Initially we also assume that the stochastic component is serially independent (i.e. \( \gamma=0 \)). This assumption will be relaxed in Section 5.6.

Individuals are assumed to know their life-span with complete certainty (assumed here to be 60), and not to retire from the workforce before then. In all calculations, it is assumed that net earnings whilst studying (earnings less course-related costs) is known with complete certainty, and amounts to $980 per year. In Section 5.4.2, we ignore the risks arising from the uncertainty with second component may well have "permanent" effects. For instance, an income shock resulting from an incapacitating accident may cause an individual's income to be lower in the current, and all future periods. Less dramatically, some authors have argued that unemployment may have permanent "scarring" effects on an individual's future earnings. See, for example, Miller and Volker (1987).

26. Lillard and Willis suggest that the serial correlation term may be interpreted in two ways. First, it reflects the effect of random shocks which last for more than one year, but deteriorate over time (the rate of deterioration being determined by \( \gamma \)). Second, it reflects the effect of (unobserved) individual-specific characteristics which change slowly through time.
respect to the time required for completion and the risk of non-completion, and focus our attention on the variability of the income profiles related to the alternative levels of education. The risk of failure will be introduced into the model in Section 5.4.3.

It is assumed that within each educational group, \( k \), individuals' earnings are generated by the following earnings function:

\[
\log (\text{Earnings})_{ki} = a_k + b_k \text{AGE}_i + c_k \text{AGE}_i^2 + u_{ki} \tag{5.8}
\]

where \( a_k, b_k, c_k \) are parameters; and

\( u_{ki} \) is a random disturbance term which is independently and identically distributed across individuals within each educational group.

Ordinary Least Squares techniques are used to estimate this relationship. For simplicity, we assume that \( u_{ki} \) is normally distributed.\(^{27}\) From each of the regressions, the variance of the residuals \( s_k^2 \) is obtained. A particular realization of the earnings for an individual, aged \( j \), with educational level \( k \) is given by:

\[
Y_{j,} = \exp(a_k + b_k j + c_k j^2 + e_j,)
\]

where \( a_k, b_k, c_k \) are OLS estimates of \( a_k, b_k, c_k \); and

\( e_j, \) is a residual randomly drawn from the normal distribution with zero mean and variance, \( s_k^2 \).

The after-tax amount is obtained by applying the marginal tax-rates operating in 1985-86 to \( Y_{j,} \).\(^{28}\) By repeated sampling, the

---

27. The importance of this distributional assumption, as well as the particular functional form used in the above specification are examined in Appendix 5.2.

28. For simplicity, no allowance for rebates and tax deductions is made in the application of the tax rates. From here on, unless otherwise stated, all references to earnings and income are to be taken as the post-tax amounts.
distribution of income at each age, and for each educational alternative, is thereby generated.

The life-time consumption pattern corresponding to any particular sequence of life-time realizations in earnings can be computed by sequentially applying the consumption rule in Equation (5.3), and updating the following period's wealth. In the decision of whether to proceed to university, we are interested only in the income and consumption streams from the age of 19 (assuming that the individual finishes high-school at 18). Let the sequence of life-time realizations in earnings for a particular individual be \( \{Y_{19'}, Y_{20'}, \ldots, Y_{60'}\} \). Given the starting wealth, \( B_{19'} \), and the individual's realized income for that year, \( Y_{19'} \), the consumption for the period, \( C_{19'} \), is determined using (5.3). 29 The individual's wealth at the start of the following year,

\[
B_{20} = (B_{19'} + Y_{19'} - C_{19'})(1 + r)
\]

can be computed once \( C_{19'} \) is chosen. \( C_{20'} \) is then determined, given \( Y_{20'} \), and so on, until the entire consumption sequence of \( \{C_{19'}, C_{20'}, \ldots, C_{60'}\} \) is obtained.

A large number (5000) of these sequences of life-time realizations in earnings is generated for each educational group by independently sampling from the income distribution of the respective educational groups, at each age. The corresponding sequences of life-time consumption are then computed as in the above illustration. Subsequently, the variance of consumption at each age, \( \text{var}(C_t) \), which

29. Note that \( Y_{20'}, Y_{21'}, \ldots, Y_{t'} \) are not known at this point.
is required in the computation of the risk premium, is calculated for each of the educational groups.

5.4.2 Empirical Results

Table 5.1 presents the regression results for both degree-holders and high-school leavers. The predicted age-earnings profiles of the two educational groups are shown in Figure 5.1.

<table>
<thead>
<tr>
<th>variable</th>
<th>degree-holders</th>
<th>high-school</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>$0.72802 \times 10^{-1}$</td>
<td>$0.67676 \times 10^{-1}$</td>
</tr>
<tr>
<td></td>
<td>(3.66)</td>
<td>(4.87)</td>
</tr>
<tr>
<td>AGE$^2$</td>
<td>$-0.72886 \times 10^{-3}$</td>
<td>$-0.74530 \times 10^{-3}$</td>
</tr>
<tr>
<td></td>
<td>(3.03)</td>
<td>(4.05)</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>8.6451</td>
<td>8.5205</td>
</tr>
<tr>
<td></td>
<td>(21.84)</td>
<td>(34.85)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.0585</td>
<td>0.0740</td>
</tr>
<tr>
<td>$s^2$</td>
<td>0.32525</td>
<td>0.32986</td>
</tr>
<tr>
<td>no. obs.</td>
<td>527</td>
<td>559</td>
</tr>
</tbody>
</table>

* absolute t-statistics in parenthesis

Comparing the earnings profiles in Figure 5.1 to those in Figure 3.6 where linear interpolation of the mean incomes in each 5-year age interval was used to construct the profiles, we note that the semi-logarithmic-quadratic earnings function popularized by
FIG 5.1: AGE–EARNINGS PROFILES
BY EDUCATION

1985–86 DOLLARS

35000
30000
25000
20000
15000
10000
5000

0

19 24 29 34 39 44 49 54 59

AGE
degree high-school
Mincer (1974)\(^{30}\) replicates the mean age-earnings profiles fairly well. This increases our confidence in using such a simple specification for our model. Both the profiles in Figure 5.1 display features typical of Mincer-type earnings functions. That is, each of the profiles initially rise with age, reaching a peak and then subsequently declining as age increases. The earnings profile for degree-holders is generally steeper, and reaches a peak at a later age than the profile for high-school leavers (54 compared with 45).

Bearing in mind that the dependent variable in the regression is in logarithmic form, and that the mean earnings-profile of degree-holders is almost everywhere higher than that of high-school leavers, it is quite possible for the variance of earnings (in levels) to be greater for degree-holders compared to high-school leavers, despite the variance of the residuals (s\(^2\)) being smaller for the former group.\(^{31}\) Table 5.2, which shows the standard deviations of income for each of the two educational groups at selected ages, confirms that this is indeed the case. The figures are estimated from the income distributions generated using the procedure outlined in the previous sub-section. For the ages presented, other than at age 20, the standard deviation of the earnings (in levels) of university

---

30. Our functional form differs slightly from that of Mincer in two aspects. First, we allow the slopes of the earnings profiles to differ across educational groups. This, as Psacharopoulos and Layard (1979) argue, is more consistent with the theory. Secondly, we have used age and age\(^2\) instead of experience and experience\(^2\) as proposed by Mincer. However, since we do not have a direct measure of labour market experience, the use of a constructed potential experience variable (age-years of schooling-5) is the same as using the age variable itself.

31. Statistically, this difference is insignificant at the 5% level.
graduates is greater than that of high-school leavers, and quite substantially so.

Also shown in Table 5.2 are the standard deviations of consumption obtained from the simulation exercise outlined in Section 5.4.1. The real rate of interest is assumed to be 5% in the calculations.

<table>
<thead>
<tr>
<th>AGE</th>
<th>SD($C_t$)</th>
<th>SD($Y_t$)</th>
<th>SD($C_t$)</th>
<th>SD($Y_t$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0</td>
<td>0</td>
<td>480</td>
<td>6450</td>
</tr>
<tr>
<td>25</td>
<td>830</td>
<td>8150</td>
<td>980</td>
<td>7080</td>
</tr>
<tr>
<td>30</td>
<td>1440</td>
<td>8860</td>
<td>1390</td>
<td>7710</td>
</tr>
<tr>
<td>35</td>
<td>1990</td>
<td>10050</td>
<td>1770</td>
<td>8270</td>
</tr>
<tr>
<td>40</td>
<td>2550</td>
<td>10440</td>
<td>2190</td>
<td>8570</td>
</tr>
<tr>
<td>45</td>
<td>3270</td>
<td>11380</td>
<td>2720</td>
<td>8420</td>
</tr>
<tr>
<td>50</td>
<td>4180</td>
<td>11620</td>
<td>3360</td>
<td>8380</td>
</tr>
<tr>
<td>55</td>
<td>5580</td>
<td>11030</td>
<td>4430</td>
<td>8150</td>
</tr>
<tr>
<td>60</td>
<td>13940</td>
<td>10260</td>
<td>10540</td>
<td>7700</td>
</tr>
</tbody>
</table>

The most striking feature of Table 5.2 is how much smaller the variation in consumption is, compared to the variation in income (with the exception of the final period). This is, of course, due to the ability of individuals to smooth their consumption over time by borrowing and lending. It is evident from these figures that the cost of uncertainty to individuals is considerably less than what the size of income fluctuations suggests. This is another reason why it is important to develop a model where utility is derived from consumption, rather than from income, such as in the Weiss (1972) model.
In the calculations presented below, the utility function is assumed to be of the form:

\[
U(C) = \begin{cases} 
  
  \frac{c^{1-\alpha}}{1-\alpha} & \alpha \neq 1 \\
  \ln(C) & \alpha = 1
\end{cases}
\]

(5.9)

This specification is characterized by its constant relative risk aversion, \( R(C) = \alpha \). Note, however, that \( A'(C) < 0 \). That is, the coefficient of absolute risk-aversion decreases with \( C \).

In the calculation of the risk premium, the coefficient of absolute risk-aversion, \( A(C) \), is evaluated at \( c \), the level expected annual consumption, which is a function of the interest rate, the

---

32. Results for two other specifications of the utility function -- the constant \( A(C) \) Utility Function and the Quadratic Utility Function are reported in Appendix 5.2.

33. The coefficient of relative risk aversion is defined by \( R(C) = -\frac{CU''(C)}{U''(C)} \). Note that it is trivially related to the coefficient of absolute risk aversion, \( A(C) \) by: \( C.A(C) = R(C) \).

34. The point of this whole exercise is to convert the uncertain income streams associated with the alternative levels of education into their respective certainty equivalents so that the profitability of higher education may be assessed at the time when students are deciding whether to enrol in university. Hence, the risk premium is calculated based on the information at that time i.e. \( s=18 \) in (5.5). From here on, the risk premium and the expected annual consumption level are both to be understood as the values applying at the time when the decision whether to enrol is being made. That is,

\[
\mathcal{G} = E_18(C_t) \quad t=19,20,\ldots,60; \text{ and}
\]

\[
\rho = \frac{\frac{1}{2} A(\mathcal{G}) \sum_{t=19}^{60} (1+\delta)^{18-t} E_18(\text{var}(C_t))}{\sum_{t=19}^{60} (1+\delta)^{18-t}}
\]
initial wealth, and the expected future income stream. The last of these is, in turn, a function of the individual's educational level. Hence, the values of $A(C)$ used in the calculation of the risk premiums associated with the different educational levels will, in general, be different. Only in the unlikely case that $C$ is identical between the alternative educational levels, will the value of $A(C)$ be the same.

Let $C_d$ and $C_h$ denote the expected annual consumption associated with the uncertain income streams of degree-holders and high-school leavers, respectively. Given the coefficient of relative risk-aversion, $R(C)$, both $A(C_d)$ and $A(C_h)$ can be easily derived:

$$A(C_d) = \frac{R(C)}{C_d};$$

$$A(C_h) = \frac{R(C)}{C_h}.$$

Table 5.3 presents the risk premiums to the two alternative uncertain income streams, and the private NPV to higher education at various values of $R$. The interest rate is assumed to be 5%, and individual's initial wealth (i.e. at the completion of high-school) is set at zero.

**Table 5.3: Risk Premiums (Per Annum) and Private NPV of Higher Education**

<table>
<thead>
<tr>
<th>R(C)</th>
<th>RISK PREMIUM</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Degree</td>
<td>High-School</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>3</td>
<td>600</td>
<td>450</td>
</tr>
<tr>
<td>4</td>
<td>800</td>
<td>600</td>
</tr>
<tr>
<td>5</td>
<td>1000</td>
<td>750</td>
</tr>
</tbody>
</table>
The interpretation of the figures in the table is extremely straight-forward. As an illustration, consider an individual with a coefficient of relative risk-aversion of 3. As noted earlier, 3 is the figure typically found in studies of the permanent-income hypothesis. If the individual were to attend university, he or she would receive an uncertain amount in each period of her working life, drawn from the income distribution of degree-holders at each corresponding age. Instead of this uncertain income stream, the individual would be willing to give up $600 each year (or $10,500 upfront)\textsuperscript{35} in exchange for receiving the mean of the income distribution at each age with complete certainty. In other words, the present value of the lifetime income stream associated with a degree would be worth $10,500 less because of the uncertainty attached to it.

On the other hand, if the individual were to decide not to proceed to university, he or she would receive in each period an uncertain amount drawn from the income distribution of high-school leavers of the corresponding age. The amount the individual would be willing to give up in exchange for the mean of the distribution in each period with complete certainty is $450 per annum (or $7,800 upfront at 5% discount rate). The present value of the income stream associated with this option would be worth $7,800 less to this individual because of the uncertainty. The private NPV of investing in higher education would, therefore, be $(10,500 - 7,800) = $2,700 less because of the additional risk associated with having a degree.

\textsuperscript{35} This is the present value of an annuity of $600 at 5% interest rate for 42 years (i.e. age 19 to 60).
Hence, the NPV falls from $31,480 in the risk-neutral case (R=0) to $28,780 -- a fall of $2,700 -- when the coefficient of relative risk aversion is 3.

Not surprisingly, the magnitudes of the risk premiums are quite small. Even for relatively more risk-averse individuals (R=5), the risk premium does not exceed $1,000 per annum (or $17,500 upfront). This is a direct result of the ability of individuals to reduce the variability in their consumption by borrowing in "bad" years, and saving during "good" ones. The difference in the risk premiums between the uncertain income streams of high-school leavers and university graduates is even smaller, varying from 0 to $250 per year for the range of R considered. Consequently, the risk-adjusted private NPV is not very different to the unadjusted one.\textsuperscript{36} Using the moderate figure of R=3, the adjusted NPV is about 8.5\% less than the unadjusted NPV. Our earlier conclusion that higher education is a highly profitable private investment to individuals remains unaltered.

5.4.3 Risk of Failure

Students embarking on higher education face the risks of dropping out and/or taking longer than the minimum required time to complete their courses. We refer to these risks, generally, as the risk of failure. Conceptually, the decision whether to drop-out, or to repeat, in the event of failing a part of the course, is endogenous. It depends on their degree of risk aversion, and their

\textsuperscript{36} Note that the NPV when the individual is risk-neutral (i.e. R=0) is exactly equal to the unadjusted NPV.
perception of a whole series of conditional probabilities such as the probability of failing a second time, given that they have failed once, the probability of failing some other parts of the course, given the failure and subsequent passing of the first part, and so on. Detailed data on students' progression through higher education is, unfortunately, not available. Hence, the decision whether to repeat or drop-out is assumed to be exogenous. We assume that of every 1000 students commencing higher education, 175 drop out at the end of their first year, 495 complete their courses in the minimum time required (3.5 years), and the remaining 330 take 6 years to complete. Hence, of the 82.5% who eventually graduate, only 60% of these complete in minimum time. Figure 5.2 provides a flow-diagram of the expected progression through higher education of a typical cohort.

37. As cited earlier, the William's Committee estimated that 56.7% finished their courses in the minimum time required. The drop-out rate of 17.5% is derived from the figures in West et al. (1986) for full-time university students.
Students are assumed to use these probabilities in their calculation of the returns to higher education. Further, those who remain after the end of first year are assumed not to know if they will complete their degrees in the minimum time required, until the end of that time period. After that, those still remaining know with certainty that it will take them 6 years to finish their degrees. We
assume that university drop-outs have the same earnings as high-school leavers of the same age, and that graduates who take 6 years to complete their degrees are paid similarly to those who took only 3.5 years.

The addition of the risk of failure to the model introduces a further complication to the computation of the risk premium. In the previous case (Section 5.4.2), no additional information on future incomes is available until it is actually revealed. That is,

$$E_i(Y_t) = E_j(Y_t) \quad \text{for all } i, j < t$$

Hence, the expectation in period 1 of, say, the income in period 40, is exactly the same as the expectation in period 2, period 3, and so on, up to period 39. In other words, the outcomes of earnings in earlier periods provide no extra information on the outcomes of later periods.

In the present problem, this no longer holds. Prior to the commencement of their studies, individuals do not know which of the 3 paths in Figure 5.2 they will be following. The expected income at

38. Becker (1975) finds that college drop-outs earn more than high-school leavers of the same age, even after adjustment for ability differences. Hence, the years in college, despite the fact that the student did not graduate, are not entirely "wasted". Unfortunately, there are no similar studies on the returns to college drop-outs in Australia. To the extent that Becker's results carry over to Australia, our estimates of the expected returns to higher education will be biased downwards, and the riskiness of the higher education biased upwards.

39. Again, this assumption is forced upon us by the inadequacy of the data. It may be preferable to assume that graduates are paid according to the number of years in the work-force. In this case, the earnings of those who take longer to graduate will lag behind the earnings of similarly-aged graduates who complete their degrees in the minimum time. This correction is, however, not attempted here.
age 30, say, is then a weighted average of the expected incomes of 30
year-old high-school leavers and degree-holders:

\[ E_{18}(Y_{30}) = q \cdot E_{18}(Y_{30}^d) + (1-q) \cdot E_{18}(Y_{30}^h) \]

where \( Y_{30}^d \) = income of 30 year-old degree-holders;
\( Y_{30}^h \) = income of 30 year-old high-school leavers;
\( q \) = probability of following path 1; and
\( E_{18}(.) \) = Mathematical expectation using all information
available at age 18.

By the end of their first year in university, however, individuals
will know for certain whether they will be proceeding along path 1 on
the one hand, or paths 2 and 3 on the other. Hence, their expectation
of the income they will receive in their thirtieth year is either
\( E_{19}(Y_{30}^d) \) or \( E_{19}(Y_{30}^h) \).

In general,

\[ E_i(Y_t) = q_1 \cdot E(Y_{1,t}) + q_2 \cdot E(Y_{2,t}) \]
\[ + (1-q_1-q_2) \cdot E(Y_{3,t}) \]

\[ = \frac{q_2}{q_2+q_3} \cdot E(Y_{2,t}) + \frac{q_3}{q_2+q_3} \cdot E(Y_{3,t}) \]

\[ \begin{cases} 
E_i(Y_t) = E(Y_{1,t}) & i=19,20,21; \ t>i; \\
E_i(Y_t) = E(Y_{2,t}) & i=19,20,21; \ t>i; \\
E_i(Y_t) = E(Y_{3,t}) & i=19,20,21; \ t>i.
\end{cases} \]
where $q_1, q_2, q_3$ are the probabilities of the individual following paths 1, 2 and 3 respectively;

$Y_{j,t}$ denotes the income at age $t$ for individuals following path $j$; and

$$E(Y_{j,t}) = E_s(Y_{j,t}) = E_k(Y_{j,t})$$ for all $s, k < t$.

The variance of consumption for each of the three paths is calculated as in Section 5.4.2. Individuals are uncertain, at the time the decision whether to enrol in higher education is made, as to which path they will be proceeding along if they decide to enrol in university. Hence, the consumption stream corresponding to the choice of going to university is, in effect, a gamble with the uncertain consumption streams corresponding to each of the paths as outcomes. Denote the mean and variance of the consumption in period $t$ if the individual were to follow path $i$ ($i=1, 2, 3$), respectively, by $C_{i,t}$ and $\text{var}(C_{i,t})$. Then the variance of consumption associated with the choice of attending university is given by:

$$\text{var}(C_t) = q_1 \cdot \text{var}(C_{1,t}) + q_2 \cdot \text{var}(C_{2,t}) + q_3 \cdot \text{var}(C_{3,t})$$

$$+ q_1 \cdot [(1-q_1)(C_{1,t} - C_{3,t}) - q_2(C_{2,t} - C_{3,t})]^2$$

$$+ q_2 \cdot [(1-q_2)(C_{2,t} - C_{3,t}) - q_1(C_{1,t} - C_{3,t})]^2$$

$$+ q_3 \cdot [(-q_1)(C_{1,t} - C_{3,t}) - q_2(C_{2,t} - C_{3,t})]^2$$

The variance of the consumption stream corresponding to the uncertain income stream of high-school leavers is the same as in Section 5.4.2. The risk premiums and the private NPV of higher education for various degrees of risk-aversion are as calculated previously, and the results are given in Table 5.4.
TABLE 5.4: RISK PREMIUMS (PER ANNUM) AND PRIVATE NPV OF HIGHER EDUCATION WITH RISK OF FAILURE

<table>
<thead>
<tr>
<th>R(C)</th>
<th>RISK PREMIUM</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Degree</td>
<td>High-School</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>230</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>470</td>
<td>300</td>
</tr>
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<td>3</td>
<td>700</td>
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<tr>
<td>4</td>
<td>940</td>
<td>600</td>
</tr>
<tr>
<td>5</td>
<td>1170</td>
<td>750</td>
</tr>
</tbody>
</table>

The figures in Table 5.4 show that the introduction of the risk of failure reduces the expected (or unadjusted) NPV substantially, to about 40% of the value when individuals are assumed to complete their courses in the minimum time required. This is because now there is a 17.5% chance of them dropping out and receiving negative returns on their investments. In addition, there is a 33% chance that they will take six years to complete their degrees, which lowers their returns substantially.

The risk premiums for high-school leavers are the same as in Table 5.3. For those choosing to attend university, the risk premiums are higher.\(^{40}\) Hence, in dollar terms, the adjustment for risk will clearly matter more than when the risk of failure is ignored. Proportionately, the adjustment is also more important here because the unadjusted NPV is much lower. At R=3, the risk-adjustment reduces the NPV by more than 33%. For the relatively more risk-averse (R=5),

\(^{40}\) The magnitude of the risk premium depends on both the variability of consumption and A(\(\bar{C}\)), the coefficient of absolute risk aversion evaluated at \(\bar{C}\), the expected annual consumption level (see equation (5.5)). Inclusion of the risk of failure clearly increases the variability of consumption. It also reduces the expected lifetime income corresponding to attending university which, in turn, leads to a fall in \(\bar{C}\). As a result, A(\(\bar{C}\)) is larger (since A'(\(\bar{C}\)) < 0). For both these reasons, the risk premium corresponding to university attendance increases when the risk of failure is included.
the adjustment for the cost of uncertainty reduces the NPV by more than 55%.

To sum up, researchers have tended to concentrate on the variability of income profiles associated with the different levels of education in their examination of the risks in educational investment. The risk of failure, which may result in students dropping out of college, or taking longer than the minimum time required to complete their degrees has, so far, been ignored. The analysis in this section shows that in the complete certainty framework, the private NPV of higher education is a sizeable $31,480. The adjustment for the uncertainty in future income streams reduces the ex-ante value of higher education to $28,780 (at R=3). With the inclusion of the risk failure this figure falls to only $8,800, or less than 30% of the value under complete certainty.41

In Appendix 5.2, the sensitivity of these results to the following assumptions is examined: a) the specification of the Utility Function (5.9); b) the functional form of the earnings function (5.8); c) the normality of the residuals. It is found that, quantitatively, the estimates of the risk premiums and the risk-adjusted NPV are somewhat sensitive to these assumptions. Qualitatively, however, the main conclusions appear to be quite robust. That is, taking into account uncertainty reduces the attractiveness of higher education, but for moderately risk-averse

41. This reduction is caused, both by the rise in risk premium as well as the reduction in expected lifetime income associated with attending university.
individuals, higher education remains an attractive private investment.

5.5 The Effect of Wealth and Interest Rates on the Private Profitability of Higher Education

In this section, we examine the effects of: 1) a change in the interest rate; and b) an increase in the initial wealth, on the private NPV to higher education.

In the certainty case, the rate of interest affects the calculation of the NPV only through the discounting process. Assuming that the income profile of graduates cross the income profile of high-school leavers only once, and from below, the effect of an increase in the interest rate is an unambiguous decline in the NPV.

In the uncertainty case, on the other hand, there is an additional mechanism through which the interest rate could enter into the NPV calculation, namely, the risk premiums. We noted in Section 5.4.2 that in the calculation of the risk premium $\rho$, the coefficient of absolute risk-aversion, $A(C)$, is evaluated at $C = \bar{C}$, the expected level of annual consumption. We also noted that $\bar{C}$ is a function of, amongst other things, the interest rate. Now,

$$
\bar{C} = E_{19}(C_t) \quad t = 19, 20, \ldots, 60
$$

(see footnote 34)

$$
= E_{19}\left\{ G_t \left[ B_{19}(1+r)^{41} + \sum_{t=19}^{\infty} (1+r)^{60-t} E_{19}(Y_t) \right] \right\} \quad \text{(from 5.3)}
$$

$$
= G_t B_{19}(1+r)^{41} + G_t \sum_{t=19}^{\infty} (1+r)^{60-t} E_{19}(Y_t)
$$

(5.10)

By writing the expected level of annual consumption as in (5.10), consumption is separated into two components, one which is
due to the individual’s initial wealth, and a second which comes from the capitalized sum of the individual’s future earnings. It can easily be shown that the first term is an increasing function of the interest rate. That is, the higher the interest rate, the more individuals can afford to consume annually from their initial wealth. The direction in which the second term changes with an increase in the interest rate is, however, ambiguous, depending on the time pattern of the income stream, as well as the level of the interest rate. The sign of \( \frac{\partial \mathcal{C}}{\partial r} \) is, therefore, ambiguous, and as a result, so is the sign of \( \frac{\partial A(C)}{\partial r} \).

It is clear from the consumption rule (5.3) that the variance of consumption in any period is an increasing function of the rate of interest. However, the sign of the first derivative of

\[
\sum_{t=s+1}^{T} \frac{(1+\delta)^{s-t}E_s(\text{var}(C_t))}{(1+\delta)^{s-t}}
\]

(see (5.5)) with respect to the rate of interest is ambiguous. Therefore, it is in general not possible to predict how the risk premiums will change in response to changes in the interest rate. It follows that, a priori, it is also not possible to predict how the NPV to higher education would be affected by a change in the level of interest rate. As a consequence of this ambiguity, although it is possible to compute the IRR to higher education under uncertainty, this figure is difficult to interpret. Unlike the certainty case, now an IRR exceeding the rate of interest does not necessarily imply that individuals would be better off investing in the additional education. It is for this reason that we have only presented the NPV results in this chapter.
Table 5.5 shows the risk premiums to the uncertain income profiles associated with degree-holders and high-school leavers, as well as the private NPV at various interest rate levels. The initial wealth is assumed to be zero, and R is set at 3 in the calculations. Both the risk of income variability and the risk of failure are considered in these calculations.

<table>
<thead>
<tr>
<th>interest rate (%)</th>
<th>RISK PREMIUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
<td>High-School</td>
</tr>
<tr>
<td>0</td>
<td>920</td>
</tr>
<tr>
<td>3</td>
<td>750</td>
</tr>
<tr>
<td>5</td>
<td>700</td>
</tr>
<tr>
<td>7</td>
<td>710</td>
</tr>
<tr>
<td>10</td>
<td>800</td>
</tr>
</tbody>
</table>

The figures show that the effect of interest rate changes on the size of the risk premiums appears to be rather small. Hence, it is mainly through the discounting of the income gains from higher education which accrues in future periods that the interest rate makes its effect felt. Consequently, the risk-adjusted NPV falls with an increase in the interest rate.

Interestingly, note that the risk-adjusted NPV is negative for interest rates of 7% and above. The real interest rate has, in recent months, been in excess of this figure. If individuals expect this spell of high interest rate to continue, higher education may no longer be considered profitable.

We consider now, the effect of an increase in the initial level of wealth. In the certainty case, the private profitability of higher education is independent of individuals' wealth. This is a direct
result of Fisher's Separation theorem,\textsuperscript{42} the basis of much of modern Capital and Finance Theory. Put simply, Fisher's Separation Theorem is the proposition that, provided a perfect capital market exists (i.e. individuals can freely borrow and lend at the going rate of interest, $r$), then consumption and production decisions can be determined separately. Hence, the production decision of whether to invest in additional education is independent of individuals' initial endowments and preferences, and depends only on the NPV of the investment.

The independence-of-wealth proposition has led to strong criticisms on the human capital approach for ignoring the consumption aspects of schooling. These criticisms are overcome, to some extent, by the introduction of risk, which breaks down the independence and makes the schooling decision dependent on the individual's initial wealth.

In our model, the initial level of wealth enters the NPV calculation via its effect on the risk-premiums. More specifically, it enters the calculation through its effect on individuals' degree of risk aversion. Note that both $C_d$ and $C_h$ are increasing functions of the initial wealth. That is, individuals with higher levels of initial wealth can expect to consume more in each period. Recall that $A'(C) < 0$ for the utility function specified. Hence, the risk premium declines with the level of initial wealth. The effect of wealth on the NPV is, however, ambiguous. It depends on the relative size of the reduction in the premiums associated with the alternative income

\textsuperscript{42} See Appendix 2.1.
streams. If the risk premium of the income stream related to the choice of attending university is reduced to a greater extent than that related to the choice of not attending, then the NPV to higher education increases with the level of initial wealth. In this case, the wealthier one is, the more profitable higher education tends to be. Conversely, if the effect of wealth on the risk premium of the income stream in the case of not attending university is greater, then it is the poor who benefits more from higher education.

Table 5.6 presents the risk premiums and the private NPV to higher education at various levels of the initial wealth. An interest rate of 5% is assumed, and the value of \( R \) is set at 3.

<table>
<thead>
<tr>
<th>initial wealth (S '000)</th>
<th>RISK PREMIUM</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Degree</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High-School</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>700</td>
<td>450</td>
</tr>
<tr>
<td>5</td>
<td>690</td>
<td>440</td>
</tr>
<tr>
<td>10</td>
<td>680</td>
<td>440</td>
</tr>
<tr>
<td>50</td>
<td>610</td>
<td>390</td>
</tr>
<tr>
<td>100</td>
<td>540</td>
<td>340</td>
</tr>
</tbody>
</table>

As expected, the risk premiums on the income streams associated with both educational levels decline as the level of initial wealth increases. For the range of initial wealth levels presented in the table, the dollar decline in risk premium in response to an increase in initial wealth is larger for the income stream associated with the choice of attending university. As a result, the NPV to higher education is positively related to the level of initial wealth. That is, the richer one is, the more attractive higher education tends to be. This is consistent with the evidence presented in Miller and Volker (1987), for instance, which shows the importance of
socioeconomic background variables and family size in determining an individual's probability of completing high school, and the probability of proceeding to higher education. 43

5.6 Serial Correlation in Year-to-Year Income Variation

Recall that in (5.7) the stochastic component of the error term \( (\xi_{it}) \) is specified as:

\[
\xi_{it} = \gamma \xi_{i,t-1} + \eta_{it}
\]

So far, we have assumed that year-to-year income fluctuations are independent. That is, \( \gamma \) is assumed to be zero. In this section, we investigate the consequences of relaxing this assumption. A priori, we expect risk premiums to increase with the degree of serial correlation because the more highly correlated year-to-year income fluctuations are, the less able individuals are to smooth their consumption over time by borrowing and lending. In the limit, when \( \gamma \) approaches unity, income evolves around a random-walk (with a determinate increment in each year). Under these circumstances, individuals will perceive each income shock as "permanent", and will adjust their consumption in each period accordingly. The variance of consumption in this limiting case will be equal to the variance of income.

43. The usual explanation for the importance of these variables is through their effect on the individuals' liquidity constraints and on their innate ability and tastes. Our model provides an additional avenue through which these variables may affect the individuals' schooling decisions.
Following Lillard and Willis (1978), we assume that the earnings at the start of each individual's working life are shocked by an error of the form:

\[ v_{it} = \begin{cases} 
\frac{\eta_{i1}}{\sqrt{1-\gamma}} & \gamma > 0 \\
\eta_{i1} & \gamma = 0
\end{cases} \]

and \( \eta_{it} \sim \text{NID}(0, \sigma_{\eta}^2) \) thereafter. Lillard and Willis suggest that this error structure may, alternatively, be interpreted as one assuming an infinite history of random shocks. Note that given this assumption, the residuals for any single cross-section are homoscedastic, since the (unconditional) variance of the residual for any individual, at any point in his or her career, is \( \sigma_{\eta}^2/(1-\gamma^2) \).

For each educational level, \( \sigma_{\eta}^2 \) is estimated as \( s^2(1-\gamma^2) \), where \( s^2 \) is the variance of the OLS residuals. The income shock in each period is then randomly drawn from a normal distribution (mean 0, and variance \( \sigma_{\eta}^2 \)).

It is assumed that individuals are fully aware of the values of \( \gamma \) and \( \sigma_{\eta}^2 \) for each of the alternative income streams. Prior to entry into the workforce, the best estimate of the error in each future period is zero. The variance of the error in each future period, conditional on the information available at that time, is \( \sigma_{\eta}^2/(1-\gamma^2) \).

On entry into the workforce, however, individuals will be able to exploit the information contained in the stochastic shocks. In each period, once the income in that period is revealed, individuals will
revise their expectations of future incomes. Given \( u_{it} \), the best estimate of the next period's error (\( u_{it+1} \)) is \( y_{it} \), and \( y^2 u_{it} \) for the following period's error (\( u_{it+2} \)), and so on. In general,

\[ E_t(u_{it+s}) = y^s u_{it} \quad s = 1, 2, \ldots, T-t \]

The variance of the error in each future period, conditional on \( u_{it} \), is given by:

\[
\text{var} \left( u_{it+s} | u_{it} \right) = (1 + y^2 + \ldots + y^{2s}) \sigma^2 \quad s = 1, 2, \ldots, T-t
\]

\[
= \sigma^2 \frac{1-y^{2s}}{1-y^2}
\]

It is assumed that individuals use the first two terms of Taylor's series to approximate their future pre-tax incomes. That is,

\[
E_t(Y_{it+s}) = \exp(\hat{\ln}Y + y^2 u_{it}) + 0.5\exp(\hat{\ln}Y + y^2 u_{it}) \cdot \text{var}(u_{it+s} | u_{it})
\]

where \( Y_{it+s} \) = pre-tax income of individual \( i \) in period \( t+s \);

\( \hat{\ln}Y \) = predicted value of \( \log(Y_{it+s}) \) from OLS regression.

The expected post-tax income \( E_t(Y_{it+s}) \) is then obtained by applying the prevailing tax rates to \( E_t(Y_{it+s}) \).

Table 5.7 presents the risk premiums corresponding to the income streams associated with the alternative educational choices, and the private NPV to higher education at various values of \( \gamma \). The rate of interest is set at 5%, and the initial wealth level at zero. The coefficient of relative risk aversion \( R \) is set equal to 3.

\[ 44. \text{ Recall that in this chapter, we assume that } u_{it} = v_{it}. \]
TABLE 5.7: RISK PREMIUMS (PER ANNUM) AND PRIVATE NPV OF HIGHER EDUCATION FOR VARIOUS DEGREES OF SERIAL CORRELATION IN RESIDUALS

<table>
<thead>
<tr>
<th>Serial corr. coeff. (γ)</th>
<th>Degree</th>
<th>High-School</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>700</td>
<td>450</td>
</tr>
<tr>
<td>0.1</td>
<td>810</td>
<td>530</td>
</tr>
<tr>
<td>0.2</td>
<td>930</td>
<td>630</td>
</tr>
<tr>
<td>0.3</td>
<td>1080</td>
<td>750</td>
</tr>
<tr>
<td>0.4</td>
<td>1280</td>
<td>900</td>
</tr>
<tr>
<td>0.5</td>
<td>1530</td>
<td>1100</td>
</tr>
<tr>
<td>0.7</td>
<td>2370</td>
<td>1780</td>
</tr>
<tr>
<td>0.9</td>
<td>4470</td>
<td>3530</td>
</tr>
</tbody>
</table>

As anticipated, the figures show that the risk premium increases with the degree of serial correlation. In all cases, moving from serial independence (γ=0) to γ = 0.5, more than doubles the value of the risk premium. More interestingly, we note that the dollar increment in risk premium in response to an increase in γ is larger for the income stream associated with attending university. As a result, the private NPV to higher education falls as the degree of serial correlation in year-to-year income variations rises.

In the Lillard and Willis (1978) study, the value of γ is estimated to be around 0.4. More recently, using data from 1985 and 1986 panels of the Australian Longitudinal Survey, Miller (1989) estimates that the correlation of earnings in adjacent years across individuals is around 0.4 for females, and 0.5 for males. At these levels of correlation, higher education still appears to be

---

45. Conceptually, the parameter estimated by Miller is different from that estimated by Lillard and Willis. Miller's parameter includes the correlation resulting from the individual-specific component. The equivalent figure in the Lillard and Willis study is around 0.84. The smaller estimate in Miller's study is, in part, due to the youth of his sample (aged 16-25 in 1985) which is typically characterized by "job-shopping", and high wage-mobility.
profitable for moderately risk-averse individuals, assuming that the rate of interest is 5%.

5.7 Summary and Conclusion

In Part I of the thesis, we followed the standard practice of using the NPV and IRR techniques to evaluate the private profitability of higher education as an investment. We noted that risks are not explicitly modeled in that framework. Yet, implicitly, when choosing the "appropriate" discount rate in the calculation the NPV, or when choosing the "appropriate" benchmark rate of return with which the IRR is to be compared, some concept of relative riskiness is required.

Uncertainty is very much a part of life, and investment in higher education is by no means exempt from it. Potential students do not know with complete certainty how long they will take to complete their degrees, or if they will even successfully complete them. Neither do they have complete knowledge on the incomes they will receive in each future period corresponding to their educational choices.

Past research has tended to ignore the issue of risk altogether. Insofar as the issue is addressed at all, researchers have generally been content with simply demonstrating that "it matters". We sought to remedy this deficiency in this chapter. A simple two-step procedure which allows risks to be incorporated into the standard measures of profitability is developed. The empirical results reveal that higher education is less attractive than the results obtained using the standard techniques (i.e. where risks are ignored) would suggest. However, for moderately risk-averse
individuals, higher education is still financially attractive as an investment.

4.1 Introduction

It was shown in the Introduction to Part II that there exists a high degree of income variability of each education-experience level. In the previous chapter, it was argued that this variability is not entirely due to random institutional actions. In this chapter, we assume instead, that it is caused by differences in the unobserved characteristics of individuals which, we shall simply refer to as "ability". The variability in incomes among the most profitable is, therefore, assumed to reflect the extent of "variation in individuals' lifetime incomes, or human capital. This raises the following questions. First, what are the implications of this large variation in the lifetime incomes within each educational group on Individual's income and wage private rates of return? Second, how does the interpretation of individual (in earnings) variation as unobserved individual ability affect estimates of the average return to the group, such as those presented in Part I of the thesis? Questions along these lines can lead to issues of ability bias and self-selection which have been so prominent in the economics of education literature.

Consequently, the estimation of the size of ability bias depends on straightforward the actual test of estimation is empirically. However, very much less clear is the problem arises primarily because of the method for estimating an individual's alternative income streams. In the calculation of returns to higher education, for instance, we could only know what the individual's income profile would be if the individual had chosen to attend university, and what the public
CHAPTER 6

ABILITY AND THE PRIVATE PROFITABILITY OF HIGHER EDUCATION

6.1 Introduction

It was shown in the introduction to Part II that there exists a high degree of income variability at each education-experience level. In the previous chapter, it was assumed that this variability is due entirely to random (stochastic) effects. In this chapter, we assume, instead, that it is caused by differences in the unmeasured characteristics of individuals which, we shall simply refer to as "ability". The variability in incomes around the mean profile is, therefore, assumed to reflect the extent of variation in individuals' lifetime incomes, or human wealth. This raises the following questions. First, what are the implications of this large variation in the lifetime incomes within each educational group on individuals' ex-post and ex-ante private rates of return? Second, how does the interpretation of residuals (in earnings functions) as unobserved individual ability affect estimates of the average returns to the group, such as those presented in Part I of the thesis? Questions like these quickly lead to issues of ability bias and self-selection which have been so prominent in the economics of education literature.

Conceptually, the estimation of the rate of return to schooling is straightforward. The actual task of estimating it empirically is, however, very much less so. The problem arises primarily because we cannot observe an individual's alternative income stream. In the calculation of returns to higher education, for instance, we would like to know what the individual's income profile would be if the individual had chosen to attend university, and what the profile
looks like if he or she had decided, instead, to join the workforce immediately after high school. It would then be a relatively simple exercise to compute the internal rate of return (or the NPV) to investing in a university degree. In practice, what we have, of course, is either one or the other income profile, and not both.1

The challenge to researchers is to find an appropriate comparison income profile of an individual (or a group of individuals) differing only in the decision of whether to invest in higher education.

Early researchers simply compared the earnings outcomes among schooling classes to obtain the returns to education. This was also the approach adopted in Part I of the thesis, which we shall call the conventional approach. The assumption implicit in this procedure is that educational groups differ only in the years of schooling and are otherwise identical (at least with respect to the characteristics which affect earnings).2

Critics of this approach argue that the higher earnings of the more educated are due, at least in part, to superior innate ability of this group. Hence, a simple comparison of the outcomes would overstate the benefit of schooling. Some would even go so far as to claim that the entire difference in earnings is due to ability

1. Typically, we do not even have information on the entire profile. With cross-sectional data, we observe only a single point along each individual’s lifetime profile. The problems this can lead to are explored in Part 3 of the thesis.

2. There are two ways of interpreting the rate of return calculated using the conventional approach. The first assumes that individuals are all identical except for their educational attainments. Under this interpretation, the rate of return to education to each and every individual is the same. Under the second interpretation, differences in individual-specific characteristics such as ability may exist. However, the distribution of these characteristics is assumed to be the same across the two educational groups. The rate of return calculated using mean profiles is interpreted as the average rate of return to the group.
differences. These concerns have led to a flood of studies on the extent of the "ability bias" since the early sixties, particularly in the United States, utilising ever-more sophisticated econometric techniques and richer data sets. In Australia, work in this area of research has barely begun.

In this chapter, we attempt to fill this gap in our knowledge. Whilst we do not have the necessary data to perform a complete analysis, it is possible to use the information contained in the residuals (of earnings functions) to gain some insight into the extent to which the average private rate of return estimated using the conventional approach may be biased. We shall also examine how individual rates of return may differ from the average returns to the group. Finally, the framework developed in the previous chapter is used to analyse the effect of individuals' uncertainty with regards to their own abilities on the ex-ante rate of return to higher education.

The chapter is divided into five main sections. In the next section, a review of the literature is provided. Since excellent surveys on this topic already exist, we shall attempt only to give a flavour of the developments in this field. The Willis and Rosen (1979) model is, however, discussed in some detail since it provides a useful framework for analysing the results in later sections. Section 6.3 provides some estimates of the private rates of return using the residuals from earnings functions as indicators of individual ability. In Section 6.4, the effect of uncertainty in ability on individuals' ex-ante profitability of higher education is

examined. The main conclusions of the chapter are set out in Section 6.5.

6.2 Review of Ability Studies

6.2.1 Simple Regression Studies

Early attempts by researchers to control for ability differences consisted of simply entering whichever ability measure was available (such as IQ scores, school grades, and class ranks) as an additional regressor in the earnings equation. In other words, some version of the following equation is estimated:

$$\ln Y_i = \alpha + \beta S_i + \gamma A_i + X_i \delta + u_i$$

where $Y$ is measure of income, $S$ is the number of years of schooling, $A$ is a measure of ability, and $X$ is a vector of personal attributes which may influence income. 4

In most studies, the introduction of the ability variable lowers the estimated schooling coefficient somewhat, but by only 10-20%. The independent contribution of the ability measure to the fit of the equation is, in general, minuscule. Hence, it would appear that if ability is important in influencing relative earnings at all, it is through its impact on educational attainment, rather than directly. These findings are echoed by the small handful of Australian studies which include an ability measure in the earnings function [Blandy and Richardson (1982), Richardson (1986), Kelley (1988) 5]. The results, therefore, support the view that a simple

4. A fairly exhaustive survey of these early regression studies can be found in Psacharopoulos (1975).

5. Kelley's regression results were not published and were obtained by private correspondence.
comparison of the incomes among schooling groups leads to an upward bias on the estimated returns to schooling. However, they suggest that the magnitude of the bias is probably quite small.

6.2.2 Some Econometric Problems

There are a number of problems related to the estimation of returns to schooling using an equation like (6.1). We shall focus on just two of them here. The first concerns the measured ability variable. A fundamental question which arises is: Which is the correct measure of ability to use? Is it IQ, class rank, school grade, or some other measure? Psacharopoulos (1975) argues that the ability measure should relate to the ability to earn income. In this respect, the measures of ability typically used in regression studies are far from ideal. Becker (1975, p.83), for instance, notes that conventional measures of ability, "... while undoubtedly relevant at times, do not reliably measure the talents required to succeed in the economic sphere". To the extent that the measures of ability used are imperfect or incomplete representations of "true ability", the estimated schooling coefficients may still be biased even after controlling for measured ability.

Griliches (1977) suggests that two extreme views on ability are possible. The first views ability as being equivalent to IQ or something close to it. The only problem there is that the measures are subject to possibly large test-retest errors. In the second view, ability is that unobserved "thing" which enables some people to earn

---

higher wages than others.\footnote{To the extent that conventional measures such as IQ can be used as indicators of this "thing", however, the same estimation procedure is applicable in both cases. That is, the ability variable is treated as being correlated with the error term, and an instrumental-variable approach is used to estimate parameters of the equation.} Such an approach is adopted in Griliches (1976, 1977).\footnote{See, also, Griliches and Mason (1972).} He finds that allowing for errors in the ability variable reduces the coefficient on schooling by even more than when the ability variable is simply entered in the regression (a reduction of 23.5\% compared to 13.2\% in the latter case). As well, the coefficient on the ability variable is significantly altered, suggesting that IQ scores are quite unreliable as measures of the true underlying ability. Griliches estimates that "noise" makes up about 30 per cent of the observed variance in the IQ variable. In view of this, more recent studies have abandoned the idea of including direct measures of ability, choosing instead to treat ability as an unobservable latent variable.\footnote{This approach exploits the information in the error structure contained in sibling or longitudinal data. The basic idea behind these models is that if we can assume that different observations, across equations, across individuals, or across time, share the same values of the unobserved latent variable (in this case, $A$), then it is possible to use this "replication" to identify some of the parameters in the model. See Griliches (1979) for a survey.}

The second set of problems in the estimation of (6.1) relates to the possible correlation between the schooling variable and the error term. Griliches (1976) suggests three reasons for this. First,
the schooling variable may be measured with error. Second, the error component (i.e. "noise") in the ability measure may be correlated with the level of schooling due to test-wiseness. This, in turn, leads to correlation between the schooling variable and the disturbance term in the earnings equation. Third, in the human capital framework at least, schooling decisions are the result of individuals' optimising behaviour, based on their expectations of future earnings. To the extent that the "errors" in the ex-post earnings regression were correctly anticipated by individuals at the time when their schooling decisions were made, the schooling variable and the disturbance term will, again, be correlated.10

Griliches (1977, p.12) points out that the literature on the "ability bias" has been somewhat asymmetric in the sense of focussing on the potential upward bias in the schooling coefficient and trying to guard against it by including ability and other variables in the equation. In the presence of measurement errors in the schooling variable, this practice can easily lead to the "...kill[ing] of the patient in our attempts to cure what may have been a rather minor disease originally". Moreover, he shows that once we allow for individual optimising behaviour in their schooling decision, it is not even clear that the schooling coefficient is biased downwards to begin with!11

In this respect, the work of Griliches (1976, 1977), based on the NLS Young Men database, in which he allows for both ability and schooling (as well as experience) to be endogenous, is particularly

10. In the extreme case, individuals are assumed to be able to forecast their respective error terms in the ex-post earnings equation perfectly. See the Willis and Rosen (1979) model below.

interesting. Using the second ability measure and family background variables as instruments, he finds that "...the original simple least squares estimates of the schooling coefficient may have seriously under-estimated rather than over-estimated it".12,13

6.2.3 The Willis and Rosen Model of Educational Self-Selection

The models reviewed so far are incomplete in the sense that the restrictions implied by individuals' optimising behaviour in their educational decisions are not fully incorporated. Moreover, in almost all cases, ability is treated as a one-dimensional characteristic. That is, regardless of the type of job and the level of formal schooling required for that job, an individual with higher "ability" will always be more productive than one with less "ability". Hence, an individual who does well (relative to the rest of the population) as a degree-holder, for instance, will also do well as a high-school leaver. It follows, therefore, that if degree-holders are, as a group, more able than high-school leavers, a simple comparison of the earnings outcomes of these groups would lead to an upwardly-biased estimate of the average returns to higher education.

In contrast, if "ability" were multi-faceted so that the types of talents required in one job are not necessarily the same for another job, then it is not clear that the simple comparison of

12. ibid. p.16.

13. Hausman and Taylor (1981) have developed a method for use with panel data which does not require the use of excluded exogenous instruments. Based on their analysis of the Panel Study on Income Dynamics sample, they report that using family background variables as excluded instruments for schooling raises the estimated coefficient of schooling, echoing the results of Griliches (1976,1977). More interestingly, applying the method they developed to the data, increases the estimated coefficient of schooling by an even larger amount, implying that the original schooling coefficient may be biased downwards even more than Griliches suggests.
outcomes would lead to an upward bias on the estimated returns to schooling. For instance, if the types of jobs associated with high-school qualification require "mechanical ability" more than "academic ability", and vice-versa for the types of jobs associated with university qualification, then self-selection might lead to those endowed with more "academic ability" to pursue higher education and those with more "mechanical ability" to stop after high school. In this case, a direct comparison of the actual earnings outcomes between the two groups (degree-holders and high-school leavers) would lead to an estimate of the average returns to higher education which is biased downwards for the individuals who have chosen to go to university, and upwards for those who have opted to stop at high school.

Willis and Rosen (1979) consider the educational decision of whether to proceed beyond high school. In their model, the life-cycle earnings profile of an individual $i$, conditional on his or her level of schooling $j = \{A, B\}$, is defined by two parameters: the level of initial earnings ($Y_{ji}$) and the rate at which his or her earnings grow ($g_{ji}$). Earnings at any point in time is, therefore, given by $Y_{ji} \exp(g_{ji}J)$, where $J$ is the number of years of labour market experience.

The structural (in the sense of population) earnings equations in this model are:

14. For simplicity, we assume that individuals with above-average "academic ability" have below-average "mechanical ability", and vice-versa. The argument is, strictly speaking, one of comparative advantage, not absolute advantage. See Willis (1986). An early discussion of occupational self-selection between fishermen and hunters can be found in Roy (1951).
\[
\begin{align*}
\ln Y_{Ai} &= X_i \beta_A + u_{1i} \\
\xi_{Ai} &= X_i \gamma_A + u_{2i} \\
\ln Y_{Bi} &= X_i \beta_B + u_{3i} \\
\xi_{Bi} &= X_i \gamma_B + u_{4i}
\end{align*}
\]

Subscript "A" denotes the educational choice of proceeding to higher education (for \( s \) years) and subscript "B" the choice of stopping after high-school. \( X \) is a vector of individuals' observable ability variables. No restrictions are placed on the variances and covariances of the errors \( u_{1i} \) to \( u_{4i} \) which are assumed to capture individuals' unobserved abilities. Note also that \( \beta \) and \( \gamma \) are allowed to differ across the two schooling alternatives. Hence, both the observed and the unobserved ability components may affect earnings quite differently depending on the educational choice.

To allow for the opportunities to finance educational investments to vary across individuals, Willis and Rosen assume that each individual's discount rate \( r_i \) is influenced by a vector of his or her family background variables \( Z_i \) and an unobserved component \( u_{5i} \). That is,

\[
r_i = Z_i \delta + u_{5i}
\]

Assuming an infinite horizon and ignoring the direct costs of schooling, the present values corresponding to alternatives A and B are, respectively:

---

15. Although in their estimation, Willis and Rosen do not allow \( X \) and \( Z \) to have common elements, this is not necessary for identification. In fact, as they have pointed out, the earnings equations (6.2)-(6.5) may still be estimable even if \( X \) and \( Z \) are identical. See their section on identification.
\[ V_{A_i} = \int_{s}^{\infty} y_{A_i}(t) \exp(-r_i t) \, dt = \frac{Y_{A_i}}{r_i - g_{A_i}} \exp(-r_i s) \; \text{and} \]
\[ V_{B_i} = \int_{s}^{\infty} y_{B_i}(t) \exp(-r_i t) \, dt = \frac{Y_{B_i}}{r_i - g_{B_i}} \exp(-r_i s) \]

An important assumption in the Willis and Rosen model is that individuals are completely aware of their respective unobserved components \((u_{1i} \text{ to } u_{5i})\), or at least have unbiased estimates of these components at the time the educational decision is made. They are further assumed to choose their level of schooling purely on financial grounds. That is, individuals will choose alternative A if \( V_{A_i} > V_{B_i} \) and alternative B, otherwise. Defining an index \( I_i \) as \( \ln \left( \frac{V_{A_i}}{V_{B_i}} \right) \), this translates to the selection rule that individuals choose alternative A if and only if \( I_i > 0 \).

Estimation of the model follows a two-step procedure. First, a reduced form of the selection rule is estimated, from which an estimate of the "inverse Mills ratio" for each educational choice is obtained. The second step involves the estimation of the structural earnings equations (6.2)-(6.5) using OLS, with the respective inverse Mills ratios included in the regressions to correct for selectivity bias. 16

Applying this model to a sample of 3,611 respondents to the NBER Thorndike-Hagen survey of 1968-71, Willis and Rosen found evidence for positive selectivity bias in the earnings of both high-

16. See Heckman (1976b) for the justification of this procedure.
school graduates and college-goers. This indicates that the average income of a high-school leaver with given measured abilities (i.e. X) is higher than would have been obtained by a degree-holder with the same X, had the latter not attended university. It also suggests that the average earnings of an individual who proceeded to college are higher than would have been received by someone from the high-school group (with the same measured abilities), had the latter person received college training. This, they argue, is consistent with the view that those endowed with the types of talents (measured and unmeasured) useful in jobs associated with college qualification (intelligence?) will proceed to college, whereas those with skills which are more valuable in non-college jobs (strength?) will stop at the high-school level. They estimate that the rate of return to persons with the average characteristics (measured and unmeasured) of those who opted to proceed to university is 9.9%, compared to 9.3% for a person with the average characteristics of the group which chose not to attend higher education.

There are a number of difficulties with the Willis and Rosen study. First, their estimation proceeds on the assumption that the structural earnings functions (6.2)-(6.6) are properly specified, with the errors satisfying the classical assumptions. In particular, the u's are assumed to be uncorrelated with the explanatory variables in the same equation. In (6.2) for instance, \( u_{1i} \) is assumed to be uncorrelated with \( X_i \). This is somewhat problematic since \( u_{1i} \) is

17. For high-school graduates, they report that the bias is statistically insignificant with respect to initial earnings, but significantly positive with respect to the growth rate. For college-goers, the bias is positive with respect to initial earnings, and negative with respect to the growth rate. The latter, they argue, is due to the fact that the bias on earnings later in the careers of college-goers is small.
supposed to be a measure of the individual’s unobserved abilities, and it is hard to believe that this would be uncorrelated with his or her measured ability, \( X_i \). This statement applies equally to (6.3)–(6.5). In the same way, it is hard to believe that the permanent unobserved component influencing the financial barriers to school choice, \( u_{5i} \), is uncorrelated with \( Z_i \) which contains various measures of the individual’s family background.

Secondly, as we have pointed out, one of the key assumptions in the Willis and Rosen model is that individuals are completely aware of their respective unobserved components, namely \( u_{1i}-u_{5i} \). Griliches (1977, p.13) argues that the observed "errors" in ex-post earnings functions \( (u_{1i}-u_{4i}) \) are, in part, due to events which are random and probably unanticipated by the individual at the time when the schooling decision was made. Even if the "errors" consist solely of individuals’ permanent unobserved ability components, there is still some doubt as to whether, ex-ante, individuals are able to forecast them correctly. Becker (1975, p.190), for instance, points out that investors in college education are usually youths in their early twenties who are unlikely at that age to be fully aware of their talents.

One must also be especially cautious about generalising from the results of the Willis and Rosen study. The data on which the study is based come from a sample of male World War II veterans who applied for the army air corps. The applicants had all passed a preliminary screening test based on physical fitness and certain aspects of their ability. As such, the sample is hardly representative of the population in general. Moreover, in attempting to apply the findings to Australia, one must recognize that there has
been, for some years now, an excess demand for college places here, and the limited number of places have been allocated on the basis of individuals' performance in high-school. Thus, depending on how well performance in high-school relates to individuals' true ability, the magnitude (and even direction) of the selection bias in Australia may well be quite different from that found in the United States.

Summing up, what lessons can we learn from past ability studies? The first lesson is that estimation of returns to schooling in the light of differences in individual ability requires more than simply getting hold of an ability measure (such as IQ), and adding it to the regression. Griliches (1976, 1977) has shown that conventional measures of ability may be rather poor indicators of individuals' true underlying ability. This suggests that there is much to be gained from modelling ability as an unobserved latent variable. Unfortunately, the data demands from this approach are severe.

The second major lesson is that once we allow for the possibility of the schooling variable being correlated with the error term, a priori, even the direction of the ability bias is unclear. Allowing for ability to be multi-dimensional complicates things even further. In this case, individuals who do well in jobs associated with, say high-school qualification, may perform badly in jobs associated with tertiary qualification. The magnitude and direction of the ability bias, therefore, depend on the relative importance of the different types of talents at each educational level, and individuals' relative endowments of these talents. 18

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18. This will be discussed in greater detail in the next section.
With these lessons in mind, we proceed in the next section to use the residuals from the earnings function as indicators of individuals' unobserved ability. Although data limitations preclude an analysis along the lines of Willis and Rosen, we can nevertheless use their model as a framework for our analysis. The approach we adopt is to compare different parts of the high-school leavers' income distribution with different parts of the degree-holders' income distribution. This enables the sensitivity of rates of return estimates to alternative assumptions regarding ability and self-selection to be examined. For convenience, we shall continue to follow the notation in Willis and Rosen (1979), and use A to denote the choice of attending university, and B the choice of quitting formal schooling after high-school. In some contexts, A and B refer to the individuals who opted for these choices.

6.3 Matching Simulations

As we have seen, the validity of the conventional approach to estimating returns to education relies on the absence of systematic differences between the groups, other than in the level of schooling. In the case of returns to higher education, this requires that the characteristics of those who stopped formal schooling after high-school not be systematically different from the characteristics of those who proceeded to university. Only then will the mean income profile of the high-school group provide a reasonable estimate of what the average degree-holder would have received if he or she had not attended university. It is also only under these conditions that the mean income profile of degree-holders can be used as an estimate of what the average high-school leaver would have obtained had he or she proceeded to university.
If these conditions are not met, so that the average degree-holder is expected to be in, say, the top 20% of the observed high-school income distribution had he or she not attended university, then a simple comparison of the mean income profiles will lead to an upward bias in the estimated returns to higher education. In this case, it would be better, for purposes of comparison, to use the mean income profile of the top 20% (in terms of incomes) of high-school leavers. The problem is, of course, that we do not know in which part of the high-school income distribution the average degree-holder is likely to end up. The Willis and Rosen model, however, provides us with a useful framework for specifying the conditions under which the average degree-holder would have ended up in the top or bottom ends of the high-school distribution if he or she had chosen not to attend university, and likewise for the average high-school leaver with respect to the degree-holders’ income distribution.

To begin, let us assume that the observed educational outcomes are the result of optimisation decisions on the part of fully-informed (with respect to their respective abilities) individuals based, purely on financial considerations. Implicit in this, is the assumption that the number of university places is not supply-constrained, so that anyone who wants to attend university is able to. For expositional purposes, we shall follow Willis (1986) in assuming that there are only two types of talent, intelligence ($\xi_1$) and strength ($\xi_2$), and omitting the consideration of life-cycle earnings growth given in (6.3) and (6.5). To focus on the ability issue, we assume initially that individuals have the same discount rate. The structural earnings equations in this simplified model are:
\[
\ln Y_{A1} = \alpha_0 + \alpha_1 \xi_{11} + \alpha_2 \xi_{21} \\
\ln Y_{B1} = \beta_0 + \beta_1 \xi_{11} + \beta_2 \xi_{21}
\]

(6.7)  
(6.8)  

Note that \( \xi_1 \) and \( \xi_2 \) contain both the measured and unmeasured components in the original Willis and Rosen formulation. Without loss of generality, assume that the scales and units of \( \xi_1 \) and \( \xi_2 \) are chosen so that they each have zero mean and unitary variance. Let \( \rho_{12} \) be the correlation between \( \xi_1 \) and \( \xi_2 \). Then,

\[
\begin{align*}
\sigma_A^2 &= \text{var}(\ln Y_A) = \alpha_1^2 + 2\alpha_1\alpha_2 \rho_{12} + \alpha_2^2 \\
\sigma_B^2 &= \text{var}(\ln Y_B) = \beta_1^2 + 2\beta_1\beta_2 \rho_{12} + \beta_2^2 \\
\sigma_{AB} &= \text{cov}(\ln Y_A, \ln Y_B) = \alpha_1 \beta_1 + (\alpha_1 \beta_2 + \alpha_2 \beta_1) \rho_{12} + \alpha_2 \beta_2 \\
\rho_{AB} &= \sigma_{AB}/\sigma_A \sigma_B
\end{align*}
\]

(6.9)  
(6.10)  
(6.11)  
(6.12)  

Willis identifies three different types of sorting in this model, which he calls positive hierarchical sorting, negative hierarchical sorting, and non-hierarchical sorting. In addition, he identifies a fourth case where no sorting by ability occurs. We shall consider each in turn.

In the discussion to follow, an important distinction to bear in mind is between the population distribution of potential earnings corresponding to a particular schooling level (A or B) and the actual observed income distribution corresponding to that schooling level. For short, we shall refer to these simply as the population distribution (corresponding to A or B) and the actual distribution (corresponding to A or B). The former is the hypothetical income distribution which would be observed if everybody in the population were given that level of schooling. In contrast, the latter consists of only those individuals who have self-selected into this level of
schooling. As such, the underlying ability distribution in this latter case may be quite different to the ability distribution of the population.

Positive Hierarchical Sorting

With positive hierarchical sorting, those who opt to attend university tend to be drawn from the top end of the population distribution corresponding to A, and those who choose to quit after high-school tend to come from the lower portion of the population distribution corresponding to B. The actual mean income profile of high-school leavers would, therefore, underestimate the earnings which the average degree-holder would have received if he or she had not attended university. The actual mean income profile of degree-holders, on the other hand, would overestimate the earnings which the average member of the high-school group would have received had he or she gone to university. Hence, conventional estimates of the rate of return to higher education based on the comparison of mean income profiles would be biased upwards.

Positive hierarchical sorting arises when the condition $\frac{\sigma_A}{\sigma_B} > \rho_{AB} > \frac{\sigma_B}{\sigma_A}$ is met. This requires $\rho_{AB}$ to be sufficiently positive and $\sigma_A > \sigma_B$. The intuitive explanation is as follows.

Assuming that individuals who do well as degree-holders also tend to do well as high-school leavers, then provided that having a degree offers greater scope for their talents (i.e. $\sigma_A > \sigma_B$), the more able individuals will choose A. That is, they will opt to attend university which enables them to obtain jobs where their talents ($\xi_1$, $\xi_2$) will be well-rewarded. The less talented, however, will prefer to quit after high-school (alternative B) since the jobs associated with
this level of education penalise their lack of talents to a lesser
degree.

Even if strength and intelligence in an individual are
uncorrelated (i.e. $\rho_{12} = 0$),\(^1\) provided that the scope for talent at
the university level exceeds that at the high-school level
sufficiently (i.e. $\alpha_1^2 + \alpha_2^2$ is sufficiently greater than $\beta_1^2 + \beta_2^2$),
positive hierarchical sorting may still take place. Here, individuals
who opt for higher education tend to be well-endowed in either one or
both of the talents. Conversely, those who are poorly-endowed with
either one or both of the talents will opt to stop after high-school.

Willis (1986, pp.579-580) demonstrates that in the extreme case
where $\rho_{AB} = 1$, if selection is based solely on ability as assumed,
then the least talented person in the degree-holders group (A) will
be more talented than the most talented in the high-school group (B).
In other words, the lowest income-earner in A would earn more than
even the highest income-earner in B, had the former not attended
university. Conversely, had the highest income-earner in B attended
university, he or she would have earned less than even the lowest
income earner in A.

However, to the extent that $\rho_{AB}$ is less than unity, and to the
extent that the schooling decision is also affected by individuals’
ability to finance their educational investment, by non-financial
considerations, and by institutional restrictions, there may be some
overlap. That is, the amount which some members of A would have
earned had they not attended university may be less than the income

---

19. Note from (6.13) that even if $\rho_{12} = 0$, $\rho_{AB}$ will still be positive
as long as $\alpha_1, \alpha_2, \beta_1, \beta_2 > 0$ i.e. strength and intelligence are useful
in jobs associated with both levels of education.
of some existing members of B. Hence, it may still be possible to use the mean incomes of individuals in the top end of the actual high-school distribution as an estimate of what the average degree-holder would have received had the educational decision been different. Similarly, to overcome the bias in estimating the average rate of return to individuals with the average characteristics of the high-school group, we can compare the mean high-school income profile to that of degree-holders in the bottom end of the actual distribution.

In this spirit, we present in row 1 of Table 6.1 the rates of return obtained by comparing the mean income profile of degree-holders to that corresponding to different portions of the actual high-school income distribution. The second row shows the rates of return by matching the mean profile of high-school leavers with different portions of the actual degree-holders' income distribution. For comparison, the last column gives the rate of return obtained by comparing the mean profiles of the two groups.20

20. As in Chapter 3, we assume that individuals take 3.5 years to complete their degrees and receive a net income of $980 per annum while studying.
TABLE 6.1: AVERAGE PRIVATE RATES OF RETURN TO HIGHER EDUCATION UNDER POSITIVE HIERARCHICAL SORTING

<table>
<thead>
<tr>
<th>portion of actual</th>
<th>top 25%</th>
<th>top 50%</th>
<th>top 75%</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>high-school leavers'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>degree-holder</td>
<td>negative</td>
<td>negative</td>
<td>3.91%</td>
<td>8.97%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>portion of actual</th>
<th>bottom 25%</th>
<th>bottom 50%</th>
<th>bottom 75%</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>degree-holders'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high-school leaver</td>
<td>negative</td>
<td>negative</td>
<td>3.78%</td>
<td>8.97%</td>
</tr>
</tbody>
</table>

The procedure used to generate the mean profiles corresponding to different portions of the distribution is a variant of that used in the previous chapter. Earnings functions of the two groups are first estimated (Table 5.1). The residuals from each regression are then sorted with the largest positive value at the top, and stored as a vector. To obtain the mean (post-tax) income profile corresponding to, say, the top 25% of the degree-holder distribution, a residual is randomly selected from the top quartile of the corresponding residual vector. This is then added to the predicted earnings (in logarithms) at each age, and the exponential of each of the sums is computed. Next, the marginal tax rates operating in 1985-86 are applied to this figure to give the after-tax earnings at each age. By repeated sampling (with replacement) and averaging, the mean (after-tax) income profile corresponding to the top 25% of degree-holders is thereby obtained.21

21. Note that this procedure does not give the same results as simply using the average of the residuals in the top quartile. The difference arises because the residuals affect income.
The figures in Table 6.1 show that the rate of return obtained using the conventional approach is 8.97%. Not surprisingly, the assumption of positive hierarchical sorting leads to lower estimates of the returns to higher education. Our calculations show that the rate of return from matching the average degree-holder to the top 25% of high-school leavers is, in fact, negative. What is surprising is that even if we matched the average degree-holder to the top 50% of high-school leavers, the rate is still negative. Even more surprisingly, the rate of return is less than 4% when we compare the average degree-holder to the average high-school leaver in the top 75% of the distribution. Putting it differently, if the average degree-holder could be certain that he would not be in the bottom quartile of the observed high-school income distribution had he not attended university, then the return to his investment in higher education would have been less than 4%.

The results for the average high-school leaver are quite similar. Assuming that the average high-school leaver would have been in the bottom half (or quarter) of the observed degree-holders' income distribution had the individual's decision to attend higher education been different, the rate of return to the educational investment would have been negative. If, however, the average earnings of the bottom 75% of actual degree-holders is closer to the average high-school leaver’s potential earnings as a university graduate, then the rate of return to investing in higher education for this individual would have been 3.78%. This is less than half the

22. The figure in Part 1 of the thesis is 8.68%. The small difference is due to slightly different methodologies used to construct the mean profiles.
rate of return obtained using the conventional method, and is smaller than the rate of return typically considered to be acceptable.

Note that the more highly correlated the two talents are (i.e. the higher $\rho_{12}$ is), the more severe is the bias, assuming that both types of talents are useful in A and B. Consequently, the more we expect individuals who excel in one job to also excel in another job requiring, perhaps, different skills and educational qualifications, the more we lean towards the estimates in the left end of Table 6.1. That is, the more extreme is the part of the alternative schooling income distribution which should be used for comparison.

**Negative Hierarchical Sorting**

Negative hierarchical sorting occurs when the condition $\sigma_A/\sigma_B < \rho_{AB} < \sigma_B/\sigma_A$ is satisfied. This condition implies that the scope for talent is greater in jobs associated with high-school qualifications than in jobs requiring degrees (i.e. $\sigma_B > \sigma_A$). Here, individuals who are relatively well-endowed in one or both of the talents will tend to self-select into the high-school group. That is, they will tend to stop formal schooling after high-school since their talents will be more highly-valued at this level of qualification than at higher levels. Conversely, those who are poorly-endowed with either one or both types of talents will tend to go on to university, and obtain jobs where talents (or lack of them) will matter less in the determination of earnings.

Negative hierarchical sorting implies that if the typical high-school leaver had attended college, he or she would have done better than the average degree-holder. Since it is empirically well-established that, on average, degree-holders earn more than high-
school leavers, this type of sorting appears somewhat implausible. As such, we shall dispense with the simulations for this case.

Non-Hierarchical Sorting

Willis calls the third type of sorting "non-hierarchical sorting". A more informative name for it might be "comparative-advantage sorting", since, individuals are assumed to self-select on the basis of their comparative advantage in jobs associated with different educational levels. That is, those who do better in jobs requiring university qualification proceed to university, and those who are better-endowed in the type of talent required for high-school level jobs stop after high-school.

The conditions under which non-hierarchical sorting occurs are

\[
\sigma_A/\sigma_B > \rho_{AB} \quad \text{and} \quad \sigma_B/\sigma_A > \rho_{AB}
\]

These conditions are met when \(\rho_{AB}\) is negative, or when \(\rho_{AB}\) is sufficiently small (in the positive sense), and the scope for talent is about the same at both educational levels (i.e. \(\sigma_A \approx \sigma_B\)).

With non-hierarchical sorting, conventional estimates of higher education returns based on the comparison of mean income profiles would understate the profitability of the educational investment to those individuals who have chosen to attend university. The reason is that compared to the average high-school leaver, the average degree-holder is relatively less well-endowed in the talent which is highly valued in high-school level jobs. It follows that, had the average degree-holder not gone to university, he or she would have earned less than the average high-school leaver.

Likewise, because the average high-school leaver is relatively less well-endowed in the talent which is highly valued in university-
level jobs, the earnings he or she would have received as a university graduate would have been less than that received by the average degree-holder. Hence, for individuals with the average characteristics of B, the conventional approach would overstate the true returns to higher education.

In Table 6.2, we match the earnings of the average degree-holder to those corresponding to high-school leavers in the bottom end of the income distribution. For the average high-school leaver, we match the earnings to those received by individuals in the bottom end of the actual degree-holders’ income distribution.

**TABLE 6.2: AVERAGE PRIVATE RATES OF RETURN TO HIGHER EDUCATION UNDER NON-HIERARCHICAL (COMPARATIVE-ADVANTAGE) SORTING**

<table>
<thead>
<tr>
<th>portion of actual high-school leavers' distribution</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) average degree-holder</td>
<td>30.03%</td>
<td>20.05%</td>
<td>14.78%</td>
<td>8.97%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>portion of actual degree-holders' distribution</th>
<th>bottom 25%</th>
<th>bottom 50%</th>
<th>bottom 75%</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) average high-school leaver</td>
<td>negative</td>
<td>negative</td>
<td>3.78%</td>
<td>8.97%</td>
</tr>
</tbody>
</table>

It is interesting to note that for the average member of A, higher education appears to be highly profitable. In the extreme case presented, the rate of return is more than 30% for this individual. Even with less extreme assumptions, the rate of return is still well in excess of 10%, the benchmark figure typically used in assessing the feasibility of educational investment.
The picture for the average member of the high-school group (B) is quite different. The figures suggest that even with fairly moderate assumptions regarding the part of the degree-holders' distribution this person would have been in had he or she attended university, the rate of return would still have been less than 4%.

Hence, if we believe that the observed pattern of schooling is the result of non-hierarchical sorting, then the divergence in the returns to higher education between those who have voluntarily opted not to attend university and those who have chosen to pursue higher education may be quite substantial. Clearly, the more negatively correlated individuals' endowments of the two types of talents are, and the more their usefulness in A and B differ, the more we will lean towards the estimates using the more extreme ends of the alternative schooling income distribution for comparison.

Non-Sorting Case

Willis identifies a special case, which he calls "equality of comparative advantage", under which no sorting by ability occurs. This case arises when $\sigma_A = \sigma_B$ and $\rho_{AB} = 1$. Under these conditions, the rate of return to higher education is identical across all individuals. Assuming that the discount rate is the same for all individuals, then in equilibrium, the rate of return to higher education is equal to the discount rate. Individuals are, therefore, indifferent as to whether to attend university since their discounted lifetime incomes are independent of education. Willis assumes that, under these circumstances, the schooling decision is random. It
follows, therefore, that the rate of return estimated using the conventional approach will be unbiased.\textsuperscript{23}

More generally, we can perceive other circumstances under which no sorting by ability occurs. In the discussion so far, we have focussed on differential returns to investing in education due to differences in abilities as an explanation of why some individuals choose to attend university while others are content to stop after high-school. Even if individuals are fully informed with regards to their respective abilities, as assumed, there are still a number of other factors which affect their educational attainments. First, individuals' discount rates may differ, reflecting differences in their opportunities to finance education. Second, there may exist non-financial considerations in individuals' educational decisions. Griliches (1977), for instance, argues that such decisions are influenced, to a large extent, by parents, the state, teachers, and classmates whose motives are varied. As such, individuals' educational choices can only be interpreted as partly the result of their ex-ante optimisation based on financial incentives. Moreover, studies of identical twins suggest that tastes have a strong influence on individuals' educational attainment. Third, as we have stated earlier, institutional restrictions play an important role in Australia, at least with respect to whether individuals proceed to university. To the extent that these factors are not systematically related to individuals' true abilities, and to the extent that they dominate in the determination of individuals' educational

\textsuperscript{23} Even if the discount rates across individuals are not equal, to the extent that the factors influencing individuals' discount rate are orthogonal to \(\xi_1\) and \(\xi_2\), the conventional approach will still lead to unbiased estimates of the rate of return. In this case, of course, the estimate is to be interpreted as the average rate of return.
attainments, the distribution of schooling outcomes will approach the non-sorting case. Unlike the special case of equality of comparative advantage, however, the rate of return to higher education may differ across individuals depending on their relative endowments of the talents ($\xi_1, \xi_2$) and how these talents are valued across the two educational levels.

In our view, a more convincing reason as to why there may be no sorting by abilities is that individuals may be unaware of their talents at the time of making the educational choice. In this case, too, provided the tendency to overestimate or underestimate one's abilities is not systematically related to one's true abilities, the actual income distributions of the different schooling groups will reflect the underlying population distribution of abilities. In other words, for both A and B, the actual distribution asymptotically approaches the population distribution. Hence, the conventional approach will yield the correct estimate of the average returns to higher education. Of course, the ex-post rate of return to any particular individual may be quite different from the average rate of return, depending on the individual's abilities as a graduate and as a high-school leaver. However, since the individual is uncertain of his or her own abilities when deciding whether to attend university, ex-ante, the profitability of investing in higher education (unadjusted for the cost of uncertainty) to this individual is given by the average rate of return.

Note that in the special case of equality in comparative advantage ($\rho_{AB} = 1; \sigma_A = \sigma_B$), individuals in, say, the top 10% of the degree-holders' income distribution would also have been in the top 10% of the high-school income distribution had they not gone to
university. Likewise, high-school leavers in the top 10% of the high-school income distribution would have been amongst the top 10% of income-earners with degrees, had they chosen to attend university. In contrast, if the non-sorting case had arisen from individuals' uncertainty with regards to their abilities, \( \rho_{AB} \) need not necessarily be equal to one. The same is true of non-sorting caused by differences in individuals' abilities to finance their educational investments, institutional restrictions, and non-financial considerations dominating the decision of whether to proceed to higher education. Hence, it is quite conceivable in these cases, for individuals in the top 10% of the degree-holders' income distribution to have finished in the bottom 10%, or any other part of the high-school income distribution had they not gone to university. That is, there may not be a strong positive relationship between how well an individual does as a university graduate (relative to other degree-holders) and how well he or she performs as a high-school leaver (relative to other high-school leavers).

With this as background, we have divided the income distributions of high-school leavers and degree-holders into quintiles, and calculated the implied rate of return to higher education by matching the average incomes corresponding to different quintiles of the two distributions. The results are presented in Table 6.3.

---

24. The equality of comparative advantage actually implies more than this. The second condition \( (\sigma_A = \sigma_g) \) ensures that the dollar amount in excess of the mean of the corresponding distribution is the same whether the individual attends university.
TABLE 6.3: RATE OF RETURN TO HIGHER EDUCATION IMPLIED BY MATCHING DIFFERENT PARTS OF THE HIGH-SCHOOL AND DEGREE-HOLDERS' INCOME DISTRIBUTIONS

<table>
<thead>
<tr>
<th></th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>6.99%</td>
<td>negative</td>
<td>negative</td>
<td>negative</td>
<td>negative</td>
</tr>
<tr>
<td>H2</td>
<td>17.48%</td>
<td>8.15%</td>
<td>3.92%</td>
<td>negative</td>
<td>negative</td>
</tr>
<tr>
<td>H3</td>
<td>23.12%</td>
<td>13.50%</td>
<td>9.38%</td>
<td>4.42%</td>
<td>negative</td>
</tr>
<tr>
<td>H4</td>
<td>29.04%</td>
<td>18.94%</td>
<td>14.63%</td>
<td>9.78%</td>
<td>negative</td>
</tr>
<tr>
<td>H5</td>
<td>50.83%</td>
<td>38.85%</td>
<td>33.67%</td>
<td>28.02%</td>
<td>12.51%</td>
</tr>
</tbody>
</table>

D1 denotes the top quintile of degree-holders in terms of earnings, D2 the second quintile, and so on. Similarly, H1 to H5 denote the top to the bottom quintiles of the high-school income distribution. Hence, the cell D2H3, for instance, shows that the rate of return to a degree-holder in the second quintile of the degree-holders' distribution, given that he or she would have been in the third quintile of the high-school income distribution had the decision to pursue higher education been different, is 13.50%.

Note that depending on the magnitude of $\rho_{AB}$, not all the cells in Table 6.3 may be applicable. For instance, as we approach the case where individuals who do well as university also tend to excel as high-school graduates ($\rho_{AB} \to 1$), the outcomes would congregate along the D1H1-D5H5 diagonal. Conversely, if individuals who do well as degree-holders generally fare badly as high-school leavers and vice versa ($\rho_{AB} \to -1$), then individuals' rates of return would congregate along the D1H5-D5H1 diagonal. Of course, when there is no systematic relationship between an individual's performance as a university graduate and his or her performance as a high-school leaver, or when the relationship is weak ($\rho_{AB} \to 0$), any of the combinations is possible.
It is interesting to note that if an individual expects to be in the top quintile of the high-school distribution (H1) without going to university, then unless he or she can be sure of being in the top quintile of the degree-holders' distribution (D1) as a university graduate, the rate of return to higher education is negative. Similarly, for an individual who expects to be in the bottom-most quintile of the degree-holders' distribution (D5) as a graduate, unless this person also expects to be in the bottom-most quintile of the high-school distribution if he or she does not attend university, then the rate of return to higher education is negative.

A puzzling aspect of the figures in Table 6.3 is that if individuals are assumed to be aware of their respective abilities when the educational choice is made, so that the ex-post and ex-ante rates of return are the same, why would those who have very low (or negative) rates of return invest in higher education? There are two possible explanations. First, as has been suggested, individuals' educational decision may not be entirely the result of their ex-ante optimising behaviour; the influence of parents, teachers and friends on their decision cannot be dismissed. Second, there may be substantial non-pecuniary benefits of education which have been ignored in the calculations. Part I of the thesis suggests that the consumption value of higher education may be quite large. Hence, individuals may find the prospect of attending university attractive despite the monetary returns being low or even negative.

It is perhaps more plausible to assume that individuals are not fully aware of their respective abilities when deciding whether to pursue higher education. Therefore, it is possible that ex-ante, higher education may appear to be profitable as an investment; ex-
post, however, it may turn out to be quite unprofitable for some individuals. The figures show that individuals' ex-post rates of return to their investments in higher education may differ quite markedly. In the case where no systematic relationship exists between an individual's performance as a degree-holders and his or her performance as a high-school leaver (or if the relationship is negative), the rate of return for some individuals may be in excess of 50%, while for others, it may be negative. Even when there is a strong positive relationship between what an individual can earn as a degree-holders and what he or she can earn as a high-school leaver, the range of individuals' rates of return is still fairly wide.

This, in turn, raises the questions of what is the cost of the uncertainty in returns, and how does it affect the ex-ante profitability of higher education as an investment in the risk-adjusted sense? These questions are addressed in the next section.

6.4 Uncertainty in Abilities

In this section, we investigate the implications of individuals' uncertainty with regards to their own abilities on the ex-ante economic value of higher education. The two-step procedure developed in the previous chapter is used for this purpose. It is worth reiterating that in this chapter we assume that the variation in individual incomes around the mean income profile is due entirely to permanent individual-specific differences. Thus, the labour market income of individual $i$ in period $t$ is given by:

$$\ln Y_{it} = a + b \text{AGE}_{it} + c \text{AGE}_{it}^2 + \delta_i$$
where the residual $\delta_i$ is time invariant. Note that in this case, once
the starting salary is revealed, the individual knows all future
period incomes with perfect certainty.

For comparability with the results in the previous chapter, we
assume that the residuals from the earnings functions are normally
distributed, and include in the calculations the risk of failure. As
in the previous chapter, an interest rate of 5% is assumed and
individuals' initial wealth is set at zero.

| TABLE 6.4: RISK PREMIUMS (PER ANNUM) & NPV OF HIGHER EDUCATION
<p>| GIVEN UNCERTAINTY WITH RESPECT TO OWN ABILITY |</p>
<table>
<thead>
<tr>
<th>R</th>
<th>RISK PREMIUM Degree</th>
<th>RISK PREMIUM High-School</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13180</td>
</tr>
<tr>
<td>1</td>
<td>1950</td>
<td>1700</td>
<td>8880</td>
</tr>
<tr>
<td>2</td>
<td>3900</td>
<td>3410</td>
<td>4570</td>
</tr>
<tr>
<td>3</td>
<td>5850</td>
<td>5110</td>
<td>270</td>
</tr>
<tr>
<td>4</td>
<td>7800</td>
<td>6810</td>
<td>-4040</td>
</tr>
<tr>
<td>5</td>
<td>9750</td>
<td>8520</td>
<td>-8340</td>
</tr>
</tbody>
</table>

The most striking feature of the figures in the table above is
how much larger the size of the annual premiums are compared to the
previous chapter. At R=3, for instance, assuming that the variation
in individual incomes is caused by serially-independent random
shocks, the estimates of the risk premium to the degree-holder income
stream is around $700 per annum (see Table 5.4). On the other hand,
when the variation is assumed to be the result of permanent
individual-specific differences, the risk premium is $5,850 per
annum, a more than eight-fold increase! This, of course, simply
reflects the assumed permanent nature of income differences across
individuals of the same age, sex, and educational attainment. Unlike
the model in the previous chapter, individuals who do badly in one
period also do badly in all other periods in their life-cycle, and
those who do well in one, also do well in all other periods. The observed variability in individual income is, therefore, a source of much greater concern in the present model. However, a word of caution is necessary. The risk-premium formula (5.5) used to compute the figures is strictly valid only for "small" risks.\textsuperscript{25} Since we have reason to believe that the risks here may be rather "large", the estimates of the risk premiums should be interpreted with care.

The figures in the last column of the table show that the consequences of individuals' ignorance of their own abilities on the \textit{ex-ante} value of a degree are very serious indeed. Even for moderate degrees of risk-aversion ($R=3$), the risk-adjusted NPV is reduced so substantially as to make higher education only marginally attractive as a private investment. For individuals with higher degrees of risk aversion, the figures suggest that \textit{ex-ante}, they are financially better-off not going to university. This is certainly quite different from the result in the previous chapter which finds that the adjustment for uncertainty reduces the profitability of higher education somewhat, but does not alter the conclusion that it is an attractive private investment.

6.5 Conclusion

It is assumed in this chapter that variation in individual incomes around the mean profile corresponding to their respective educational levels, reflects individual ability differences. Thinking in this way quickly leads us into complicated issues of ability bias in the conventional estimates of the average private rate of return to schooling.

\textsuperscript{25} See the derivation in Section 5.3.
A simplified version of the Willis and Rosen model is used to distinguish between the different sorting cases which may arise, depending on the correlation between different types of talents in an individual, how these talents are valued in jobs associated with the different educational levels, and the individual's assumed knowledge regarding his or her own abilities. Three different cases of sorting by ability are identified. In each case, we compare the average income streams of high-school leavers and degree-holders with different parts of the corresponding alternative schooling income distribution. It is shown that even with quite moderate assumptions about the part of the distribution to use for comparison (such as, using the mean income of the top 75% of high-school leavers rather than the mean income of whole sample of high-school leavers) lead to estimates of the average private rate of return to higher education which are markedly different from that obtained using the conventional approach. The figures presented are not, in any way, meant to be definitive, but are to be interpreted along the lines of a sensitivity analysis. They serve as a warning that, in view of the large unexplained component in earnings functions, the effect of individuals' self-sorting by ability on conventional estimates of the rate of return to schooling may be quite serious.

In the non-sorting case, the conventional estimates of the average rate of return are unbiased. However, the ex-post private rate of return to any particular individual may differ quite markedly from the average experience of the group. Assuming that an individual's performance as a degree-holder (relative to other degree-holders) is not systematically related to his or her performance as a high-school leaver (relative to other high-school leavers), the rate of return to this individual could be negative, or
it could be more than 50%. This immediately prompts the question of how uncertainty with respect to one's own abilities affects the ex-ante value of a degree.

Using the framework developed in the previous chapter, we find that the riskiness from the point of the variability in consumption is very much higher under the assumption that the observed variability in income is due to permanent individual-specific differences. In terms of the effect on the ex-ante value of higher education, we find that the greater variability in consumption which individuals will be subject to if they choose to attend university, reduces the private profitability of higher education to such an extent that higher education is only marginally attractive for the moderately risk averse. For those who have greater aversion towards risk (R>3), the adjustment for the cost of risk completely overturns the conclusion that higher education is a profitable private investment.
CHAPTER 7

SOME IMPLICATIONS OF RISK AND DIFFERENTIAL ABILITY IN THE INVESTMENT OF HIGHER EDUCATION

7.1 Introduction

In the previous two chapters we studied the implications of the large earnings variation amongst individuals of the same age, sex, and educational attainment, on the private returns to higher education. First, it was assumed that the variation is due entirely to the random effects of chance (Chapter 5). The opposite assumption that the earnings variation is the result of differences in individual-specific characteristics ("ability") was then made (Chapter 6). Clearly, these are extreme assumptions. They have been made so as to enable us to focus on the complications arising from each of the two components of unexplained income variation separately.

In this chapter we bring together the two components in order to draw out the implications for policy, and for individuals contemplating higher education. It is not possible, with our data, to determine the fraction of the residuals (from earnings functions) which is due to ability differences, and the fraction which is due to stochastic shocks. Therefore, we rely on Miller's (1989) finding, based on the Australian Longitudinal Survey, that the correlation in individuals' incomes (in logarithms) between adjacent years is around 0.5 for males. Assuming that the stochastic shocks are serially independent, this translates into half the observed variation in individual incomes (in logarithms) amongst individuals of the same age, sex, and education, being caused by ability differences, and the other half being due to luck.
It is important to note that Miller's estimate is based on a sample of very young individuals, who are usually characterised by a high degree of income mobility. Hence, the permanent component of variation in individual incomes may be underestimated when applied to an older sample. On the other hand, by attributing the correlation in individual incomes between adjacent years entirely to the permanent component (and none to the possible serial correlation in the stochastic component), we tend to overestimate the fraction of the observed income variation which is due to ability differences. The results presented in this chapter should be interpreted with these caveats in mind.

This chapter is divided into five sections. In the next section, we analyse the effect of uncertainty on the ex-ante private profitability of higher education when the residuals from the earnings functions contain both stochastic and permanent individual-specific components. Section 7.3 deals with the question of how the social rate of return to investment in higher education is affected by risk. In Section 7.4, the effects of risk and differential abilities across individuals on the ex-ante private profitability of higher education is examined in the context of the Higher Education Contribution Scheme (HECS). We focus, in particular, on the attractiveness of income-contingent feature of HECS vis-a-vis other fee-paying schemes when individuals are uncertain, and when they have full knowledge of their abilities. Section 7.5 concludes the chapter.

To facilitate discussion, we define the following concepts. The "cost of uncertainty" refers to the present value of the stream of annual risk premiums associated with a particular educational decision. We define the "cost of risk-bearing associated with the
investment" as the difference in the costs of uncertainty between attending and not attending university. The convention used in this chapter is that the cost of risk-bearing is positive when the cost of uncertainty associated with attending university exceeds that of not attending. Unless otherwise stated, the cost figures are always expressed in present value terms.

With reference to the discounted lifetime earnings associated with a particular educational choice, we use the term "adjusted" to indicate that this magnitude is net of the cost of uncertainty. Similarly, for the NPV (social or private) of higher education, the "adjusted" amount is that which is net of the cost of risk-bearing associated with the investment. Discounted lifetime earnings and NPV figures (adjusted and unadjusted) are always taken to be in the ex-ante sense in this chapter. As with the cost figures, unless otherwise stated, these figures are always expressed in present value terms. The discount rate used in all calculations is 5%.

7.2 The Effect of Uncertainty on the Ex-ante Private Profitability of Higher Education

We have considered, in Chapters 5 and 6, the effect of uncertainty on the ex-ante private value of higher education when income variation is assumed to be due entirely to luck, and when it is assumed to be due entirely to individual ability differences. It is clear from the results that the importance of the uncertainty adjustment depends on the source of the variation in individual incomes assumed. Therefore, it is of considerable interest to examine the effect of uncertainty when income variation contains both individual-specific and stochastic components.
We consider, first, the case where the individual is ignorant of his or her ability when deciding whether to proceed to university. The individual is, therefore, assumed to use the mean income profiles conditional on education in calculating the ex-ante value of higher education. It is further assumed that the individual can distinguish between the permanent and stochastic components of his or her earnings.\(^1\) Hence, on receipt of his or her first pay, the individual instantly knows the permanent component of his or her earnings in all future periods. Accordingly, expectations of all future period incomes are revised. Of course, the actual earnings in each of the future periods can be higher or lower than the permanent component depending on the outcomes of the stochastic component. However, there will not be any further adjustment to expectations of future incomes after the first period in the labour market, since, the stochastic shock in one period provides no information on the size of the shocks in future periods (given the assumption that they are serially independent).

Table 7.1 presents the risk-premiums corresponding to the income streams of degree-holders and high-school leavers, as well as the adjusted private NPV of higher education for various degrees of risk aversion. As before, we assume an interest rate of 5\%, and an initial wealth of zero.

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\(^1\) The permanent component of an individual’s earnings includes both the measured and unmeasured components. In the notation of Chapter 5, an individual’s income (in logarithms) at time \(t\) is \(X_{it}^\beta + \delta_i + \upsilon_{it}\). The permanent component is given by \(X_{it}^\beta + \delta_i\). If we assume that the individual cannot distinguish between \(\delta_i\) and \(\upsilon_{it}\), so that he or she knows only the sum of the two, the risk premiums to the income streams corresponding to high-school leavers and degree holders are both higher. However, this does not alter any of the conclusions in this section.
TABLE 7.1: RISK PREMIUMS (PER ANNUM) AND PRIVATE NPV OF HIGHER EDUCATION GIVEN UNCERTAINTY WITH RESPECT TO OWN ABILITY AND STOCHASTIC COMPONENT BY DEGREE OF RISK AVERSION

<table>
<thead>
<tr>
<th>R</th>
<th>Risk Premium</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Degree</td>
<td>High-School</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1080</td>
<td>880</td>
</tr>
<tr>
<td>2</td>
<td>2160</td>
<td>1760</td>
</tr>
<tr>
<td>3</td>
<td>3240</td>
<td>2640</td>
</tr>
<tr>
<td>4</td>
<td>4320</td>
<td>3530</td>
</tr>
<tr>
<td>5</td>
<td>5400</td>
<td>4410</td>
</tr>
</tbody>
</table>

As we would expect, the magnitudes of the risk premiums fall between those in Table 5.4 (all luck) and Table 6.4 (all ability). It is interesting to note that at R=3, higher education is still attractive as an investment when the variability in individual incomes is caused by both ability and stochastic factors. The adjusted NPV is, however, less than $3,000. Put differently, a "one-off" registration fee of $3,000 for higher education, for instance, is more than sufficient to discourage even moderately risk-averse individuals from enrolling in higher education. This is certainly quite different to the rosy picture presented when the cost of uncertainty is ignored, in which case the private NPV of higher education is in excess of $13,000. For more risk-averse individuals, the adjusted NPV of higher education is negative, which suggests that for these individuals higher education is not attractive from a purely financial point of view.

If the individual is fully aware of his or her ability when deciding whether to proceed to university, the riskiness of higher

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2. This figure takes into account the probabilities of dropping out and of taking more than the minimum time to complete the course, both of which lower the expected returns to higher education. Individuals are, however, assumed to be indifferent to these risks. If they do not even recognise the possibility of failing, the ex-ante value of higher education is more than $31,000 (see Table 5.3).
education as an investment and the cost of this riskiness depend on how much he or she can expect to earn as a graduate, and as a high-school leaver. That is, the cost of risk-bearing associated with investing in higher education varies according to the individual’s ability as a degree-holder, and his or her ability as a high-school leaver.

Recall that the income of an individual $i$, at time $t$, conditional on schooling level $j$ is given by:

$$\ln Y_{ijt} = a_j + b_j \text{AGE}_t + c_j \text{AGE}_t^2 + \delta_{ij} + \nu_{ijt}$$

The stochastic term $\nu_{ijt}$ is assumed to be independently and identically distributed across $i$ and $t$, and to be independent of $\delta_{ij}$. This implies that given the level of schooling $j$, the variance of an individual’s income in logarithms at any time $t$ is independent of his or her ability (i.e. $\delta_{ij}$). However, the variance of the individual’s income in levels increases with $\delta_{ij}$. Hence, at any age, given the level of education, the more able an individual is, the higher is his or her expected income, and the larger is the variance of that income. This, in turn, translates into higher consumption variability, and a higher cost of uncertainty.

An individual’s ability at a particular educational level also affects the cost of uncertainty via $A(C)$. Since $A'(C) < 0$, the higher $\delta_{ij}$ is, the higher is the expected annual consumption level $C$ and the lower is $A(C)$. This has the opposite effect of lowering the cost of uncertainty. Hence, a priori, it is not possible to predict how the cost of uncertainty associated with $j$ would vary with $\delta_{ij}$.

There is a further factor to consider in calculating the cost of uncertainty associated with attending university. In our model, we
allow for the possibility of the individual dropping out at the end of his or her first year in university, and subsequently joining the workforce as a high-school leaver. Hence, in addition to the individual's ability as a degree-holder, his or her ability as a high-school leaver also enters into the calculation. Ceteris paribus, the greater is the divergence between what an individual expects to earn as a university graduate and as a high-school leaver, the greater is the ex-ante uncertainty with respect to the income stream associated with the choice of attending university.

Table 7.2 presents the cost of risk-bearing associated with investing in higher education, and the unadjusted private NPV of higher education by the percentiles of the degree-holder and high-school leaver income distributions the individual expects to be in.\(^3\),\(^4\) The cost of risk-bearing is calculated on the basis of a coefficient of relative risk aversion of 3.

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3. Individuals' expectations are based solely on the magnitudes of their permanent components, since, \(E(V_{ijt})=0\).

4. We continue to assume, in this case, that individuals are uncertain with regards to the number of years required for completion of their degrees, and whether they will drop out of their courses.
TABLE 7.2: COST OF RISK-BEARING AND UNADJUSTED PRIVATE NPV OF HIGHER EDUCATION (IN PARENTHESES) ASSUMING ABILITY IS KNOWN (1985-86 DOLLARS)

<table>
<thead>
<tr>
<th>Percentile of deg-holders' distribution</th>
<th>Percentile of high-school leavers' distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>12250</td>
<td>48340</td>
</tr>
<tr>
<td>(37280)</td>
<td>(243030)</td>
</tr>
<tr>
<td>25</td>
<td>18560</td>
</tr>
<tr>
<td>192030</td>
<td>5870</td>
</tr>
<tr>
<td>(-192030)</td>
<td>(14180)</td>
</tr>
<tr>
<td>50</td>
<td>86260</td>
</tr>
<tr>
<td>(-340070)</td>
<td>14510</td>
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<tr>
<td>75</td>
<td>209100</td>
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<tr>
<td>(-437980)</td>
<td>67420</td>
</tr>
<tr>
<td>90</td>
<td>349650</td>
</tr>
<tr>
<td>(-492900)</td>
<td>145670</td>
</tr>
</tbody>
</table>

Since our interest is in higher education as an investment, we focus our attention only on those cells with positive unadjusted NPV. The cells with negative unadjusted NPV are presented for completeness. The figures show that, for an individual whose respective abilities as a university graduate and as a high-school leaver are such that he or she will be placed in the tenth percentile of the degree-holders' ability distribution and in the bottom tenth percentile (or ninetieth percentile) of the high-school leavers' ability distribution, the expected unadjusted NPV of higher education is $534,190. The cost of risk-bearing from the investment in higher education to this individual amounts to $177,080, or 33% of the unadjusted NPV. In contrast, the unadjusted NPV for an individual whose respective abilities place him or her in the ninetieth percentile of both distributions is $9,970. The cost of risk-bearing 5.

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5. Individuals represented by these cells may still proceed to university if they are not purely motivated by financial considerations.
to investing in higher education for this individual is only $1,550, which is 15.5% of the unadjusted NPV. In absolute terms, the cost of risk-bearing associated with the investment in higher education for some of the cells is even higher than the cost of risk-bearing when individuals are assumed to be ignorant of both their permanent and stochastic components at the time when the decision is made (which is $10,530). In percentage terms, however, the adjustment for the cost of risk-bearing has a much greater effect when ability is assumed to be unknown at the time the educational decision is made. The NPV of higher education is reduced by 78.5% in Table 7.1 at R=3. In comparison, the percentage reduction in the NPV in Table 7.2 which ranges from 15.5% to 41.4% (for the cells with positive unadjusted NPV) is small, although far from trivial.

Summing up, the analysis above suggests that if individuals are uncertain of their own abilities when deciding whether to attend university, the cost of uncertainty (arising from both the permanent and stochastic components) reduces the value of higher education quite substantially. For moderately risk-averse individuals (R=3), the NPV is reduced by almost 80%. Higher education to these individuals is still profitable as an investment, but is nowhere near as lucrative as is commonly thought, when the cost of risk-bearing associated with the investment is ignored.

If individuals are assumed to know their respective abilities at the time of making the educational choice, the cost of risk-bearing from the investment in higher education varies, depending on how well they expect to perform in the labour market as university

6. This figure can be easily derived from Table 7.1 by subtracting the adjusted NPV (R=3) from the unadjusted NPV (R=0).
graduates and as high-school leavers. For the cases in which the unadjusted NPV of higher education is non-negative, we estimate that the adjustment for the cost of risk-bearing leads to a reduction in the NPV ranging from 15% to 40%.

7.3 Uncertainty and Social Returns

One of the arguments often used to justify government intervention in the provision of education is the alleged imperfection of the capital market. The argument usually runs as follows. Investors in human capital face uncertain returns. By and large, these returns are uncorrelated across individuals. Hence, if it is possible for individuals to buy and sell shares in each other's human capital, or to insure their returns, then the risk of investing in human capital can be eliminated. Unfortunately, a market for such exchanges does not exist. Because of this, assuming that individuals are risk-averse, they will fail to invest up to the point where the marginal expected return is equal to the marginal cost of financing the investment. It follows, therefore, that from society's point of view, there will be an under-investment in human capital. The implication of this is that, insofar as the risks faced by individuals are independent, they should be ignored when considering the social profitability of the investment. Levhari and Weiss (1974, p.953) argue, for instance, that:
"If one assumes that...[the return to investment] is an independent random variable across individuals, ... then for a discussion of over- or underinvestment in human capital [vis-a-vis physical capital], it is the difference between the expected marginal rates of return which is relevant. If the expected rate of return to human capital is above \(1+r\) (or \(E(1+r)\))\(^7\), then it is desirable from a social point of view to transfer resources from physical into human capital investment. Since the investment is performed by many individuals, society will enjoy the average (expected) rate of return."

This line of argument seems to suggest that "society" has an existence apart from its members. If this were not the case, and "society" is regarded simply as a collection of individuals, then clearly, the costs of risk-bearing borne by its members cannot be ignored.\(^8\) Alternatively, the proposition that individual risks are irrelevant could have arisen from a confusion between the treatment of risks which are borne collectively, and those that are borne by the individuals themselves.

In their discussion of the treatment of risk in the evaluation of public investment decisions, Arrow and Lind (1970) were careful to distinguish between these two types of risk. If all benefits and costs associated with an investment accrued to the government and were distributed among the tax-payers, then the risk of the investment is borne collectively. They showed that under these conditions, provided that the investment is a small fraction of the government's total investment portfolio, and provided that the return to this investment is uncorrelated with the returns to other government investments, the cost of risk to society would be negligible. Hence, if risks are

---

7. \(r\) is the rate of return to investment in physical capital, which is assumed to be riskless.

8. Fane (1984b) makes a similar point in his case against subsidised loans on the basis of the inability of individuals to spread risk.
borne collectively, Levhari and Weiss’ observation is completely valid. That is, in considering the social returns to higher education, individual risks are irrelevant.

However, Arrow and Lind (p.356) went on to say that if "...benefits and costs ...accrued directly to individuals so that these individuals incurred the attendant costs of risk-bearing [then] it is appropriate to discount for the risk, as would these individuals". In other words, if risks are privately borne, then the cost of risk-bearing to individuals cannot be ignored in the evaluation of the social feasibility of the investment.

In general, some benefits and costs of public investments will accrue to the government and the risks of these will be borne collectively. Other benefits and costs will accrue to individuals and the attendant uncertainties related to these will be borne privately by the individuals. In assessing the social desirability of investment projects, it is, therefore, crucial to distinguish between private and public benefits and costs. In the case of investment in higher education, we can think of the income tax foregone while individuals are studying and the cost of providing the education service as the government’s contribution to the cost of the investment. The additional taxes collected as a result of graduates’ higher incomes can be regarded as the benefit accruing to the government. The cost of risk-bearing on this part of the investment is negligible since the risks are borne collectively. The private part of the investment consists of individuals’ foregone (after-tax) income and their expenditures on books and stationery as cost, and the increment to their after-tax incomes as benefit. The cost of risk-bearing on this part of the investment may be significant, and
must be taken into account when calculating the social returns to higher education.

The risk-premiums given in the previous section provide an estimate of the cost of risk-bearing borne privately by individuals. Assuming that individuals are uncertain of their respective abilities, the annual risk premiums to the degree-holders’ and high-school leavers’ income streams are $3,240 and $2,640, respectively (at R=3). Over the lifetime, in present value terms, these figures translate to $56,420 and $46,060, respectively (at 5%). In other words, the discounted cost of uncertainty over the lifetime if the individual chooses to cease formal education after high-school is $46,060. On the other hand, if the individual decides to proceed to university, the cost of the uncertainty is $56,420. Hence, the cost of risk-bearing to the individual as a result of the investment is $(56,420-46,060) = $10,360. This amount should be subtracted from the expected social NPV to obtain a risk-adjusted measure of the social returns to higher education.

Table 7.3 presents the cost of risk-bearing borne privately by individuals as a result of the educational investment at various degrees of risk aversion. The figures assume that, ex-ante, individuals are uncertain of their abilities. The risk-adjusted social NPV of higher education at a 5% discount rate is given in the final column of the table. We assume in these calculations that the selection mechanism used to allocate university places is unrelated to individuals’ true potentials as university graduates, and as high-school leavers. It follows, therefore, that the expected income of the marginal student (i.e. the last person to be admitted under the selection mechanism) is given by the mean income profile of degree-
holders (adjusted for the probability of failure). Had this individual chosen not to pursue higher education, his or her expected income is given by the mean income profile of high-school leavers. We assume that individuals' pre-tax income reflects their respective productivities.

As in Chapter 4, the marginal cost to the government (excluding income tax foregone) in providing an extra university place is taken to be $3,200 per year. The probabilities of failure and dropping out are as assumed in Chapter 5. We assume that these probabilities are unrelated to the probability of gaining admission to university. The net income of students whilst studying is assumed to be $980 per annum. We assume in this section that the marginal value of externalities associated with higher education is zero.

<table>
<thead>
<tr>
<th>R</th>
<th>Cost of Risk-Bearing</th>
<th>Social NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>41080</td>
</tr>
<tr>
<td>1</td>
<td>3450</td>
<td>37630</td>
</tr>
<tr>
<td>2</td>
<td>6900</td>
<td>34180</td>
</tr>
<tr>
<td>3</td>
<td>10350</td>
<td>30730</td>
</tr>
<tr>
<td>4</td>
<td>13800</td>
<td>27280</td>
</tr>
<tr>
<td>5</td>
<td>17260</td>
<td>23820</td>
</tr>
</tbody>
</table>

The figures in the table show that the social profitability of higher education as an investment is reduced quite substantially when the cost of risk-bearing borne privately by individuals is taken into account. Assuming that the coefficient of relative risk aversion among those choosing to attend university is around 3, the marginal

9. If the marginal student is more likely to drop out, or take longer than the minimum time to complete his or her degree, this assumption biases our estimates of the marginal social NPV upwards.
social NPV is reduced by some 25%. In spite of this, the adjusted social NPV (with a discount rate of 5%) still remains sizeable. Hence, assuming that the social discount rate is 5%, it would appear that there is an under-investment in higher education. This result is, of course, highly dependent on the assumptions that, a priori, individuals do not know their respective abilities, and that the selection mechanism for allocating university places are not related to these abilities. If either or both of these conditions do not hold, the mean income profiles of the alternative educational groups may not be appropriate as estimates of the marginal student's expected earnings conditional on his or her educational choice.

Table 7.4 presents the adjusted social NPV by the percentiles of the degree-holders' and the high-school leavers' income distribution the marginal student is expected to be in. We assume in these calculations that individuals are fully aware of their respective abilities so that uncertainty in future incomes is due only to the effects of chance and the risk of failure in university.

<table>
<thead>
<tr>
<th>percentile of deg-holders' distribution</th>
<th>percentile of high-school leavers' distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>145170</td>
<td>601890</td>
</tr>
<tr>
<td>-428870</td>
<td>77740</td>
</tr>
<tr>
<td>-850400</td>
<td>-267050</td>
</tr>
<tr>
<td>-1127840</td>
<td>-491640</td>
</tr>
<tr>
<td>-1345620</td>
<td>-650090</td>
</tr>
<tr>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>601890</td>
<td>843610</td>
</tr>
<tr>
<td>77740</td>
<td>344640</td>
</tr>
<tr>
<td>-267050</td>
<td>35410</td>
</tr>
<tr>
<td>-491640</td>
<td>-142360</td>
</tr>
<tr>
<td>-650090</td>
<td>-253600</td>
</tr>
<tr>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>843610</td>
<td>942070</td>
</tr>
<tr>
<td>344640</td>
<td>456780</td>
</tr>
<tr>
<td>35410</td>
<td>166400</td>
</tr>
<tr>
<td>-142360</td>
<td>13620</td>
</tr>
<tr>
<td>-253600</td>
<td>-68670</td>
</tr>
<tr>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>942070</td>
<td>984310</td>
</tr>
<tr>
<td>456780</td>
<td>500420</td>
</tr>
<tr>
<td>166400</td>
<td>216460</td>
</tr>
<tr>
<td>13620</td>
<td>73230</td>
</tr>
<tr>
<td>-68670</td>
<td>3560</td>
</tr>
</tbody>
</table>
If we assume that an individual’s performance in Year 12 (which is currently used as the selection criterion for entry into university) is highly correlated with his or her earnings as a university graduate, then ex-ante, we expect the marginal graduate to finish in the bottom-end of the degree-holders’ income distribution. Using the income profile of a degree-holder in the ninetieth percentile as an estimate of the marginal graduate’s expected income, it is clear that unless we expect this individual to do worse than at least 90% of high-school leavers had he or she not attended university, then the (adjusted) marginal social NPV to higher education is negative. Even if we were to use the income profile of a degree-holder in the seventy-fifth percentile as an estimate of the marginal graduate’s expected income, unless without a degree, he or she is expected to finish in the bottom quartile of the high-school distribution, the (adjusted) marginal social NPV is negative.

If an individual’s performance in Year 12 is uncorrelated with his or her earnings as a graduate, the mean income profile of degree-holders may be used to estimate the marginal graduate’s earnings. However, it may still be inappropriate to use the mean income profile of high-school leavers as an estimate of how much the marginal graduate would have earned as a high-school leaver if individuals are assumed to have full knowledge of their abilities. The discussion in the previous chapter makes it clear that in such a situation, depending on the type of sorting which takes place, the mean high-school profile may over- or under-estimate the marginal graduate’s earnings as a high-school leaver. Only in the non-sorting case is the

10. Ex-post, because of the stochastic component, the marginal graduate may actually do better than more able graduates.
mean high-school profile an appropriate representation of what the marginal graduate would have earned had he or she not attended university. It is obvious from the table that depending on the precise part of the high-school distribution used for comparison, the (adjusted) social NPV may be greater, or less than zero.11

The question of whether society, at the margin, should expand its investment in higher education, therefore, hinges critically on the relationship between the admission criterion (i.e. Year 12 results) and individuals’ true abilities. It also depends on individuals’ knowledge of their own abilities, and the type of sorting which results. Unfortunately, work in this area is scarce. Little is known about the relationship between individuals’ performance in Year 12 and labour market success in later years. Equally little is known about the relationship between individuals’ abilities as degree-holders and as high-school leavers. Until these issues are resolved, we can only speculate about whether an expansion in higher education is desirable from the efficiency point of view.

7.4 Ability and Uncertainty in the Context of the Tertiary Tax

One of the attractive features in the recently introduced tertiary tax scheme (HECS) from the point of individual risk-bearing, is the risk-insurance aspect of the scheme.12 In contrast to other fee-paying schemes such as that proposed by the Liberal and National

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11. As an approximation, we assume that the marginal graduate’s expected income is given by the median income profile of degree-holders. The mean income profile of graduates is slightly higher than the median profile, but this does not affect the conclusion.

12. We shall consider only the HECS option of paying through the taxation system. The "up-front" payment option, which amounts to a charge of $1,530 per full-time year is quite similar to the Liberal-National proposal of an "up-front" fee of $1,200.
Parties (LIB), HECS is income-contingent. Under HECS, in 1989, students are charged $1,800 for each full-time year of higher education they receive. The rate of repayment is set at 1% of taxable income when annual personal incomes are less than $24,499 but more than $22,000; 2% of taxable income when their personal incomes fall between $25,000 and $34,999 per annum; and 3% of taxable income for those earning more than $35,000 per year. Students and ex-students will pay at these rates in every year in which their incomes exceed $22,000 until their total debt (indexed only for inflation) to the government is completely discharged. This implies that, with a positive real interest rate, the more quickly individuals discharge their debt because of their higher incomes, the more they will have paid for their education in present value terms. For individuals whose annual incomes never exceed the minimum threshold of $22,000, higher education is effectively free except for foregone earnings. Assuming that individuals are risk averse, uncertainty in future incomes implies that HECS would be preferred to an equivalent expected repayment "up-front" fee.

Using the consumption optimisation model developed in Chapter 5, we can compare the cost of uncertainty to individuals investing in higher education under different fee-regimes. We assume, for this exercise, that individuals are uncertain of their abilities when making the educational choice. As before, we assume that the residuals are normally distributed and contain both permanent and stochastic components which have equal variances. The stochastic

13. See the discussion in Chapter 3.

14. As noted previously, this implies that ex-ante, individuals use the mean earnings profiles conditional on education to estimate their earnings under each educational alternative.
component is assumed to be serially uncorrelated. Individuals are also assumed to be able to distinguish between the permanent and stochastic parts of their income.

Following the procedure described in Chapter 5, the regression results in Table 5.3 are used to generate the income profiles of individuals conditional on education. For this exercise, however, individuals' incomes are converted into 1988-89 dollars using the CPI, and subjected to the marginal tax rates applying in the 1988-89 financial year.

As a reminder, the LIB scheme imposes a $1,200 fee for each year of full-time education. We assume for the full-fee regime that students are charged $12,000 per year (based on Bond University's fee schedule).

Table 7.5 presents the cost of risk-bearing and the unadjusted NPV of higher education under the different fee-regimes. As usual, the initial wealth is set at zero, and an interest rate of 5% is assumed.

<p>| Table 7.5: Cost of Risk-Bearing and Unadjusted NPV of Higher Education Under Alternative Fee-Regimes (1988-89 Dollars) |
|---|---|---|---|---|</p>
<table>
<thead>
<tr>
<th>R</th>
<th>No Fees</th>
<th>HECS</th>
<th>LIB</th>
<th>Full Fees</th>
</tr>
</thead>
<tbody>
<tr>
<td>COST OF RISK-BEARING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8910</td>
<td>8910</td>
<td>9240</td>
<td>12970</td>
</tr>
<tr>
<td>2</td>
<td>17810</td>
<td>17810</td>
<td>18470</td>
<td>25950</td>
</tr>
<tr>
<td>3</td>
<td>26720</td>
<td>26720</td>
<td>27710</td>
<td>38920</td>
</tr>
<tr>
<td>4</td>
<td>35630</td>
<td>35620</td>
<td>36940</td>
<td>51900</td>
</tr>
<tr>
<td>5</td>
<td>44540</td>
<td>44530</td>
<td>46180</td>
<td>64870</td>
</tr>
</tbody>
</table>

| UNADJUSTED NPV | | | | |
|---|---|---|---|
| 25500 | 21630 | 21500 | -14640 |
Note that the cost of uncertainty and the expected lifetime income associated with not going to university is the same under all fee-regimes. Hence, the differences in the cost of risk-bearing and the unadjusted NPV are due solely to the differences in the cost of uncertainty and the expected lifetime income associated with attending university under the various fee-regimes. Under the no-fee regime, the cost of risk-bearing is $26,720 at R=3. The cost of risk-bearing under the LIB is slightly higher, at $27,710, reflecting the higher cost of uncertainty associated with attending university under LIB. In part, this increase in the cost of uncertainty is due to the increase in the degree of risk aversion (as measured by $A(C)$ the coefficient of absolute risk aversion) as the expected annual level of consumption for those opting to attend university falls with the imposition of fees. In part, the increase in the cost of uncertainty reflects the increase in the variability of lifetime income to those choosing to proceed to university as a result of the tertiary fees. Under LIB, in addition to the uncertainty with regards to future incomes, university attendees are also unsure about the fees they will need to pay in total, since, at the time of enrolment, they do not know the number of years they will spend in university. However, because the amount involved is relatively small, and because individuals can smoothen their consumption over time by borrowing and lending, the cost of this additional uncertainty is minuscule.

The cost of risk-bearing under HECS is about the same as that under the no-fee regime. Note, from the last row of Table 7.5, that the unadjusted NPV of higher education under HECS is almost identical to that under LIB. This implies that risk-neutral individuals would be almost indifferent between the two regimes, assuming that they can borrow and lend at an interest rate of 5%. For risk-averse
individuals, however, the cost of risk-bearing under HECS is slightly lower than under LIB. At R=3, the difference is almost $1,000. This increases to $1,650 at R=5. Hence, risk-averse individuals would prefer HECS to LIB, even if the expected payments (in present value terms) under the two regimes are identical.

It must be recognised, however, that the difference between the costs of risk-bearing under HECS and LIB, is not very large. This is, in part, due to the restriction of our sample to full-time full-year male workers. If individuals are uncertain about the number of hours they are likely to work when they leave university, or whether they will even participate in the workforce, then the difference in the cost of uncertainty under HECS and LIB will be larger. In Appendix 7.1, we present the cost of uncertainty under the various fee-regimes estimated using the full sample of all males who reported positive earned-income in 1985-86. The probability of receiving zero income in any one year is assumed to be 6% for those with degrees, and 9% for high-school leavers. The figures there show that at R=3 the difference in the costs of risk-bearing under the two regimes is $1,440. At R=5, the difference increases to $2,350. We expect the difference to be even larger for females who are statistically more likely to withdraw from the labour force at some stage of their careers.

With the full-fee regime, the cost of risk-bearing is $38,920 (at R=3), more than $12,000 higher than the no-fee case. In other words, the increase in the cost of risk-bearing is more than the equivalent of one year’s fees under this regime. The higher cost of

15. These are approximately the percentages across all ages (15-64) who report zero earned-income in the two educational groups.
risk-bearing reflects the increase in the cost of uncertainty associated with attending university. As in the LIB scheme, this increase is due to the increase in individuals' degree of risk aversion (as measured by A(C)) and the increase in the variability of the lifetime income associated with attending university. Our calculations, therefore, show that in moving from a no-fee regime to one where students pay full fees, not only are those choosing to attend university worse off because of the reduction in their expected earnings (by $40,140), they are made further worse off by the increased cost of uncertainty (to the tune of $12,000).

The adjusted private NPV of higher education under the various fee-regimes for different degrees of risk aversion can easily be derived from Table 7.5. For convenience, they are given in Table 7.6.

**TABLE 7.6: ADJUSTED PRIVATE NPV OF HIGHER EDUCATION (1988-89 DOLLARS) UNDER ALTERNATIVE FEE-REGIMES BY DEGREE OF RISK AVERSION**

<table>
<thead>
<tr>
<th>R</th>
<th>No Fees</th>
<th>HECS</th>
<th>LIB</th>
<th>Full Fees</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25500</td>
<td>21630</td>
<td>21500</td>
<td>-14640</td>
</tr>
<tr>
<td>1</td>
<td>16590</td>
<td>12730</td>
<td>12260</td>
<td>-27620</td>
</tr>
<tr>
<td>2</td>
<td>7680</td>
<td>3820</td>
<td>30300</td>
<td>-40590</td>
</tr>
<tr>
<td>3</td>
<td>-1220</td>
<td>-5080</td>
<td>-6210</td>
<td>-53560</td>
</tr>
<tr>
<td>4</td>
<td>-10130</td>
<td>-13990</td>
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<tr>
<td>5</td>
<td>-19040</td>
<td>-22890</td>
<td>-24680</td>
<td>-79510</td>
</tr>
</tbody>
</table>

Interestingly, under the zero-fee regime, the expected NPV of higher education without adjusting for the cost of risk-bearing is $25,500. This is significantly higher than the NPV given in Table 7.1 of $13,180 (in 1985-86 dollars), which is equivalent to $16,600 in

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16. Simulations holding A(C) constant across regimes reveal that the difference in the variability of lifetime income between the no-fee and the full-fee regimes is responsible only for a small fraction of the increase in the cost of uncertainty. In other words, it is the increase in A(C) as we switch from no fees to full fees which causes the cost of uncertainty associated with attending university to escalate.
1988-89 dollars. This discrepancy is caused by the different tax rates used. Compared to the 1985-86 personal tax rates, the tax rates operating in 1988-89 tend to be less progressive overall. For instance, the highest marginal rate in 1985-86 was sixty cents in a dollar. This was reduced to forty-nine cents in a dollar in the 1988-89 financial year. The change in the marginal tax rates has the effect of increasing the unadjusted profitability of higher education in real terms to individuals, as the figures clearly show.

In addition to its effect on the unadjusted NPV of higher education to private individuals, the change in tax rates also influences the cost of risk-bearing. The lower progressivity of the 1988-89 tax regime tends to increase the variability of individuals' after-tax incomes. This, in turn, raises the cost of uncertainty to individuals. Appendix 7.2 compares the costs of uncertainty associated with going, and not going to university, as well as the cost of risk-bearing under the two tax regimes (assuming zero fees). The results there show that, with the 1985-86 tax rates, the cost of uncertainty associated with attending university is $71,060 (1988-89 dollars) at R=3. When the 1988-89 tax rates are used, on the other hand, the cost of uncertainty increases to $92,010. The cost of uncertainty associated with not going to university also increases (in real terms) under the 1988-89 tax regime, although not by as much. It follows, therefore, that the cost of risk-bearing is higher (in real terms) under the 1988-89 tax regime.

The figures in the first row of Table 7.6 echo the results presented in Part I of the thesis.17 That is, ignoring the cost of

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17. Note, however, that the figures here take into account the probabilities of dropping out and taking longer than the minimum time to complete the degree.
risk-bearing, it is clear that in the absence of fees, ex-ante, higher education is a highly profitable investment to individuals. The profitability under the HECS and LIB regimes is reduced somewhat, but not by much, and higher education remains very attractive as a private investment. When full-fees are charged, however, it no longer appears attractive for individuals to pursue higher education from the investment point of view.

These conclusions are altered dramatically once the cost of risk-bearing is taken into account. With the tax rates operating in 1988-89, even if no fees are charged, higher education does not appear to be attractive to individuals who are moderately risk averse (R=3). The figures show that they will, in fact, be worse off by the equivalent of more than a thousand dollars (ex-ante) if they decide to pursue higher education. When fees are levied, even if the amount is small, such as in the HECS and LIB schemes, our figures suggest that from an investment point of view, risk-averse individuals (R=3) are clearly better off not going to university. The fact that there is still an excess demand for university places must reflect non-optimisation on the part of individuals, non-pecuniary benefits of higher education which have not been taken into account (and which may be quite large as Part 1 of the thesis suggests), a substantial number of individuals with R < 3, or some combination of all three. Alternatively, it could be the result of individuals over-estimating their own abilities and chance of good fortune. Smith (1937, p.109), for instance, observed that: "The contempt of risk and the presumptuous hope of success are in no period of life more active than at the age at which young people choose their professions". 18

Finally, in this section, we examine the attractiveness of HECS vis-a-vis a non-income-contingent scheme such as LIB when individuals are assumed to be aware of their abilities. For this exercise, we simulate the income and consumption streams of individuals from different parts of the ability distribution under both the HECS and LIB regimes. The cost of risk-bearing and the unadjusted NPV of higher education under each of these regimes are then calculated. The results are shown in Table 7.7 by the percentile of the degree-holders’ income distribution individuals expect to be placed if they decide to attend university.\textsuperscript{19} The coefficient of relative risk aversion in the calculations of the cost of uncertainty associated with attending university is assumed to be 3.

In comparing the attractiveness of HECS relative to LIB, the figures of interest are the adjusted NPV of higher education under the two schemes. These are given in columns (3) and (5). Interestingly, for individuals with high abilities, ex-ante, LIB is marginally more attractive than HECS. For instance, the expected adjusted NPV of higher education for those in the top tenth percentile of the ability distribution under LIB is $19,770. Under HECS, this figure is $19,150. In contrast, for individuals in the bottom tenth percentile of the ability distribution, the adjusted NPV of higher education under HECS ($12,290) is higher than under LIB ($10,710). Hence, for these individuals, HECS is preferred to LIB.

In summary, if individuals are aware of their respective abilities when deciding whether to pursue higher education, ex-ante, \textsuperscript{19} For simplicity, we assume that an individual who expects to be in the tenth percentile, say, of the degree-holders’ distribution also expects to be in the tenth percentile of the high-school leavers’ distribution depending on his or her educational decision.
<table>
<thead>
<tr>
<th>Percentile</th>
<th>HECS</th>
<th></th>
<th></th>
<th>LIB</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted NPV</td>
<td>Cost of</td>
<td>Adjusted NPV</td>
<td>Unadjusted NPV</td>
<td>Cost of</td>
<td>Adjusted NPV</td>
</tr>
<tr>
<td>10</td>
<td>28180</td>
<td>9030</td>
<td>19150</td>
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<tr>
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<td>15270</td>
<td>2980</td>
<td>12290</td>
<td>13920</td>
<td>3210</td>
<td>10710</td>
</tr>
</tbody>
</table>
those who are relatively more able will be better off under LIB than
under HECS (if they choose to attend university). Conversely, those
who are relatively less able will, ex-ante, prefer HECS to the LIB
scheme. It must be recognised, however, that the differences under
the two schemes are not very large.

It is also interesting to note that in present value terms, the
amount individuals in the top tenth percentile expect to repay under
HECS amounts to $4,720 (1988-89 dollars). Individuals in the bottom
tenth percentile, on the other hand, expect the present value of
their repayments to be only $2,720. In contrast, under LIB, the
present value of the fees expected to be paid in total is $4,070 for
all individuals. In this regard, it can be said that HECS
discriminates against the more able. Whether this is desirable from
the social point of view is difficult to say, and involves both
efficiency and equity considerations. From the point of social
equity, to the extent that it is considered more equitable for
individuals who have higher lifetime incomes to contribute more for
their education, then the higher implicit charge HECS imposes on the
more able may be justified. On the other hand, to the extent that the
amount of (positive) externalities flowing from each graduate is
larger, the higher the graduate’s ability, then from the efficiency
point, the discrimination against the more able may be undesirable.

20. This figure is obtained by comparing the expected lifetime
earnings of individuals pursuing higher education under HECS and
under the no-fee regime (not shown).

21. A case can be made, for instance, that graduates with higher
abilities are more likely to make research break-throughs which have
uncaptured benefits flowing to the rest of the community.

22. This argument assumes that the expected marginal cost to the
government is the same for all individuals. It also assumes that
there are no non-price rationing of university places.
A number of caveats to the analysis in this section should be noted. First, the analysis is not meant to be taken as an overall assessment of HECS (vis-a-vis other schemes). Important policy questions such as the relative attractiveness of the various schemes when potential students are subject to borrowing constraints have not been examined. Moreover, the analysis has been distinctly micro-oriented. It does not take into account, for instance, the different effects that various fee-paying schemes may have on the supply of graduates. The question of how individuals' leisure-labour choices may be affected under each fee-regime has also been ignored.

7.5 Conclusion

In this, the final chapter of Part II, we bring together both the stochastic and permanent individual-specific components of the residuals from the earnings function. It is found that if individuals are uncertain of their abilities, then allowing for the cost of risk-bearing, higher education is no longer as profitable as commonly thought. We conclude that under these circumstances, higher education is, at best, only marginally attractive to moderately risk averse individuals. On the other hand, if individuals are assumed to be aware of their abilities, then the importance of the adjustment for the cost of risk-bearing to each individual's ex-ante value of higher education depends on both the individual's ability as a graduate, and his or her ability as a high-school leaver.

From the social point of view, the question of whether society has over- or under-invested in higher education depends heavily on whether individuals are ignorant of their abilities, and whether

23. See, however, the analysis in Chapter 3.5.
their Year 12 performance is related to their later years labour market outcomes. If we believe that individuals are uncertain of their abilities at the time of deciding whether to attend university, and that the relationship between individuals’ Year 12 performance and their later years earnings is weak, then it would appear that there is an under-investment in higher education, assuming that the social discount rate is 5%.

In the penultimate section of this chapter, we examined the attractiveness of HECS to individuals vis-a-vis other fee-paying regimes. The results show that if individuals are ignorant of their respective abilities when deciding whether to proceed to university, HECS is relatively more attractive than the scheme proposed by the Liberal-National Parties. This is because the expected repayments under HECS are lower. Secondly, the cost of uncertainty to risk-averse individuals is lower under HECS because of the income-contingent nature of its repayment arrangements. If individuals are aware of their abilities, then ex-ante whether they are better off under HECS than under LIB depends on their abilities. Ex-ante, HECS is less attractive, the more able the individual is.
PART III

ANALYSIS OF CHANGES OVER TIME
The analyses in both Parts I and II of the thesis are based on cross-sectional earnings profiles. These profiles are, of course, an artifact, and do not represent the true experience of any particular cohort, as was pointed out in Chapter 2. We argued, however, that in the absence of lifetime earnings data, the reliance on cross-sectional profiles is unavoidable. Moreover, it was suggested that in some cases -- such as in estimating the ex ante profitability of education when students are assumed to base their decisions on the cross-sectional evidence -- cross-sectional profiles may even be more relevant than life-cycle profiles. Notwithstanding these arguments, the weaknesses of using cross-sectional data are well recognised.

Bowman (1987) has demonstrated how two completely opposite situations may be represented by the same cross-sectional earnings profile. One is where the economy is static, and an expansion in education leads to falling rates of return to schooling, and the other is where the economy is dynamic, and investments in inputs complementary to well-educated people keep pace with the expansion in schooling, so that successive cohorts receive rising rates of return. Yet, the policy implications in these two situations are clearly quite different. Moreover, as Bowman has shown, the cross-sectional rate of return would overstate the true rates of return to current and future cohorts in the first case, and understate them in the second case.

With this in mind, it would be useful to complement our cross-sectional analysis with an investigation of how the profitability of higher education has changed over time. In any case, the question of how successive cohorts of graduates fare in the labour market
relative to non-graduates is of considerable interest for its own sake.

Part III of the thesis considers then how the value of a degree has changed, particularly over the last ten years. Our concern here is with the experience of degree-holders as a group, and as such, the analysis focuses on the aggregate figures. As well, to abstract from changes arising from differences in tax rates over time, gross earnings figures are used.
CHAPTER 8

CHANGES IN THE ECONOMIC VALUE OF A DEGREE OVER TIME

8.1 Introduction

In 1968-69, only 3.2% of all full-time, full-year workers had tertiary degrees. By 1978-79, this figure rose to 7.3%. Latest data from the 1985-86 Income Distribution Survey indicate that 11% of all full-time, full-year workers now hold degrees. Hence, in a short span of just 15 or so years, the proportion of degree-holders in the work-force has increased almost three and a half times.

Several authors have argued that this rapid increase in the number of graduates has led to a deterioration in the position of graduates in the labour market.¹ This has important policy implications, especially at a time when the government is planning to expand the higher education system substantially, and when students are being asked to contribute towards the cost of their education. So far, this view of the falling returns to higher education has gone unchallenged, and has been canvassed widely by both those arguing against the need for an expansion of the higher education system, as well as those who accept the aim of expansion but argue against students having to bear a part of the cost.

The aims of the chapter is two-fold. First, it shows that analysis of the change in the economic value of a degree over time requires much more than a simple comparison of the rates of return estimated from cross-sectional data at different points in time. We demonstrate analytically, how such a comparison can lead to

misleading conclusions not only with respect to the magnitude of change, but also with respect to the direction of change. Secondly, we examine critically the empirical evidence, and challenge the conventional wisdom that the value of a degree has been falling, particularly over the last ten years.

The chapter is structured as follows. In the next section, the methodological problems associated with the comparison of cross-sectional rates of return over time are discussed. In Section 8.3, we present Miller's (1982) estimates of the rate of return for the years 1968/69, 1973/74 and 1978/79, and extend them to 1981/82 and 1985/86. Section 8.4 examines the labour market performance of successive cohorts of new graduates between 1977 and 1986 in terms of their employment statuses, starting salaries, industry of employment, and the kinds of work that they do. Concluding comments are given in Section 8.5.

8.2 Methodological Problems with the Comparison of Cross-Sectional Rates of Return Over Time

The comparison of cross-sectional rates of return\(^2\) over time has been used by a number of economists in their analyses of changes in the returns to education.\(^3\) There are, however, some fundamental methodological problems with this procedure. Consider the following illustration.

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2. The cross-sectional rate of return is defined as the IRR estimated using cross-sectional earnings profiles.

Let the cross-sectional incremental profiles\(^4\) for 1970 and 1975 be as shown in Figure 8.1. The cross-sectional rates calculated from these profiles (assumed to be X\% and Y\%, respectively) would suggest that the returns to higher education have fallen, i.e. X > Y. This is usually taken to mean that, as an investment, higher education is ex post less profitable for those who obtained their degrees in 1975 than it is for those who obtained them in 1970.

For the magnitudes X and Y to be meaningful, the required assumption is that those who obtained their degrees in 1970 have life-cycle earnings profiles given by the 1970 cross-sectional profile, and those who obtained their degrees in 1975 by the 1975 cross-sectional profile. This assumption is clearly wrong in the case we have here. Note that the 21 year-old cohort in the 1970 cross-section is also the 26 year-old cohort in the 1975 cross-section. The true life-cycle earnings profile for this cohort is, therefore, AC for the first five years of their working lives, and not AB as is assumed (incorrectly) in the calculation of the 1970 rate of return. Hence, unless the cross-sectional profiles over time are virtually identical\(^5\), estimates of the ex post rate of return from other than the most recent cross-section would be incorrect.\(^6\) But if the cross-

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4. These give the earnings increment to degree-holders over high-school leavers at each age.

5. Only the incremental-earnings of the cohorts not included in the previous cross-section are allowed to be different. Hence, in the comparison of cross-sectional rates 5 years apart, only the incremental-earnings for the first five years can be different.

6. Estimates of the ex post rate of return using the most recent cross-section may also be wrong for the same reasons. However, until we have even more recent data, we cannot be certain.
FIGURE 8.1: CROSS-SECTIONAL AND COHORT RATES OF CHANGE

This could be due to the fact that the supply of graduates has increased over the years, which leads to a decrease in the quality of graduates as a result. If the supply of graduates has increased, it would also lead to an increase in the number of graduates. However, in this case, we would see a decrease in the number of graduates as a result. If the supply of graduates has increased, it would also lead to an increase in the number of graduates. However, in this case, we would see a decrease in the number of graduates as a result.
sectional profiles were identical, there would not be a need to compare the rate over time.7

Not only can the magnitude of the change be wrong, there is also a danger that even the direction of change suggested by changes in the cross-sectional rate over time may be incorrect. Let us suppose that the life-cycle earnings profiles of successive cohorts of graduates have been displaced vertically downwards, relative to the life-cycle earnings profiles of high-school leavers in their respective cohorts, in each year from 1955 to 1975.8 Suppose also, that this decline in the income increment to graduates has ceased since 1975 and that, the life-cycle incremental-earnings profiles have remained unchanged since then. Figure 8.2 shows what the 1975, 1980 and 1985 cross-sectional profiles would look under these circumstances. Note, interestingly, that each successive cross-sectional profile is lower than the previous one. Estimates of the returns to higher education from these cross-sections would, therefore, lead to the wrong conclusion that the returns have been falling between 1975 and 1985 when, in fact, they have remained unchanged.9

7. Note, however, that if the question is how the ex ante rates of return have changed over time, and if individuals in each cohort are assumed to base their educational decisions on cross-sectional data, the comparison of cross-sectional rates of return over time would be a valid exercise.

8. This could be due to, say, the rapid increase in the supply of graduates over the years, which leads to 1) the lowering of the quality of graduates on average; and 2) new graduates filtering downwards into less well-paying jobs. It could also be due to new graduates being less well paid compared to earlier cohorts in the same jobs but, in this case, it would be difficult to explain why the life-cycle paths of earlier cohorts are not affected.

9. We could even have allowed the life-cycle profiles for the post-1975 cohorts to be rising and still have cross-sectional estimates of the return falling. In this case, however, the cross-sectional profiles would no longer be lower everywhere.
FIGURE 8.2: CROSS-SECTIONAL AND LIFE-CYCLE INCREMENTAL EARNINGS PROFILES
In summary, the comparison of the cross-sectional rate of return over time appears to be a dangerous practice which could lead to conclusions which are wrong not only with respect to the magnitude of the change, but also, with respect to the direction of change.

8.3 Results From the Income and Housing Surveys

In this section, we examine what the cross-sectional evidence would have suggested about changes in the profitability of higher education. This aim of this exercise is to enable the cross-sectional evidence to be contrasted with the time series evidence to be presented in the next section.

Using information on full-time full-year male workers from the Income and Housing Surveys, Miller (1984) estimated that the cross-sectional rate of return to higher education fell from 24% in 1968/69 to 22.4% in 1973/74, and to 19.4% in 1978/79. It would be of considerable interest to know if this decline has continued into the 1980s. Using data from the later Income and Housing Surveys, we have found the rates to have fallen further to 18.3% in 1981/82 and 16.8% in 1985/86.10 Hence, on the basis of these cross-sectional estimates, it would appear that the rate of return to higher education has been

10. Following Miller, we assume that the number of years taken to complete the course is 3.3. For simplicity, however, we have assumed that the direct cost of education (books, stationery, union fees, etc.) is exactly equal to the income (from part-time work or Tertiary allowances) received while studying, so that the cost of education is equal to the foregone income. This resulted in our estimates being somewhat lower than Miller's estimates. Our estimate for the years 1978/79, 1981/82 and 1985/86 were 17.2%, 16.2% and 14.9%, respectively. For comparability with Miller's results, we spliced our estimates to his series. Note that the figure for 1985/86 is higher than that presented in Chapter 3. This is because of the shorter length of study assumed here (3.3 instead of 3.5), and the use of pre-tax rather than post-tax figures.
falling since 1968/69, and that this decline has continued into the 1980s.

Figure 8.3 plots the cross-sectional profiles of the income increment to degree-holders from which these rates of return were calculated. It is interesting to note the degree of similarity between these profiles and those hypothetical cross-sectional profiles constructed in Figure 8.2. In both cases, the difference between cross-sections lies, not in the youngest age group, but in the older age groups. Figure 8.3 shows that the real income increment to degree-holders in the 15-24 age category increased from 1968/69 to 1973/74 but has remained about the same since then. In contrast, the income increment in both the 25-34 and 35-44 age groups has fallen with each successive cross-section, with the sole exception of that in 1985/86 for the 25-34 age category. It appears, therefore, that it is the decline in the income premium of the older graduates that has led to the observed fall in the cross-sectional rate of return. This is despite the fact that the income premiums of the older age groups are much more heavily discounted in the internal rate of return calculation.

Notwithstanding the criticisms in the previous section, some useful information can, nevertheless, be extracted from cross-sectional earnings profiles associated with different points in time. Using the five cross-sections in Figure 8.3, we can construct a number of life-cycle income profiles, albeit incomplete ones, in the same manner as in Figures 8.1 and 8.2. These are shown in Figure 8.4. Firm conclusions cannot be drawn from these life-cycle profiles because they are all incomplete (particularly those corresponding to the more recent cohorts), and do not overlap each other completely
Fig. 8.3: Real Income Increment to Degree-Holders (1968/69 Dollars)
Fig. 8.4: Real Income Increment to Degree-Holders (longitudinal)
over the same ages. Nevertheless, the constructed life-cycle profiles suggest that the returns to higher education appear to have fallen up to 1973, and perhaps, even up to 1978. Beyond that, the profiles are too short to form any objective judgement. Hence, for changes in the returns over the last ten years, we have to look elsewhere for evidence.

For the more recent cohorts of graduates, all the evidence that we typically have of them is information on their labour market outcomes for the few years since graduation. Inevitably, unless we are willing to wait until they retire from the workforce, we have to make some assumptions regarding their future earnings. That their future earnings follow the cross-sectional profile in the year in which they entered the workforce is one possibility. We have argued in the previous section, however, that this assumption may lead to some serious difficulties in the comparison of changes over time.

An alternative is to compare the labour market experiences of successive cohorts of new graduates in terms of their employment statuses, starting salaries, sectors and industries of employment, as well as the types of work that they do, and assume that their relative successes at the start of their careers would adequately reflect their prospects over their entire careers. There are several reasons why this may not be an unreasonable assumption.

First, to the extent that the income premiums to graduates at the start of their careers have changed because of differences in the characteristics of each successive cohort, then these changes would be expected to persist over their entire working lives.
Secondly, as Freeman (1977) has argued strongly, at any one time there is a much greater number of new graduates seeking employment than there are experienced ones. Moreover, employers are more liable to alter the hiring wage than to change the wages of existing workers. Hence, the performance of new entrants would be a sensitive indicator of the conditions in the market for their respective skills. The types of jobs new graduates are able to obtain are, undoubtedly, highly dependent on the state of the market at the time of their entry. To the extent that job-ladders are pervasive in the labour market, this would, in turn, determine their lifetime earnings potentials.

Finally, the performance of graduates relative to non-graduates in the first years of their careers is important for its own sake, since, the income-increments to graduates for these years are most heavily weighted in the calculation of the internal rate of return.


8.4.1 Employment Status

An examination of the employment status of new graduates is of interest for two reasons. First, part of the earnings advantage to the more highly educated may come from their lower incidence of unemployment. As such, the difference in unemployment rates between graduates and non-graduates is an important element in the economic value of a degree.

11. One explanation is that employers and workers have "implicit contracts" with each other. See, for instance, Azariadis (1975).


Secondly, unemployment may have permanent "scarring effects" which affect individuals' later earnings.\textsuperscript{14} To the extent that these "scarring effects" are important, the employment status in the first years after graduation will have an important effect on individuals' lifetime incomes.

For leavers from educational institutions, the period 1976 to 1986 is one which is characterised by an increase in the unemployment rates up to 1983, before a slight improvement in the final three years.\textsuperscript{15} Although the employment prospects of all new entrants to the labour market have generally deteriorated over the period, there is evidence to suggest that as a group, degree-holders appear to have suffered relatively less. Table 8.1 presents the unemployment rates for young degree-holders and those with no post-school qualifications\textsuperscript{16} in 1976, 1981 and 1986, derived from the Australian Censuses.

Comparing the unemployment rates of the 20-24 year-old graduates with their peers in the same age-cohort with no post-school qualifications, it can be seen that the differential in the rates for males has widened from 2.72 percentage points in 1976 to 6.13 percentage points in 1981, and to 12.38 percentage points in 1986. For females, the differentials for the three years were 2.17, 4.81 and 8.62 percentage points, respectively. In comparison with the 15-

\textsuperscript{14} See, Miller and Volker (1987) for a discussion.

\textsuperscript{15} See A.B.S., Transition from Education to Work, Cat. No. 6227.0 (various issues).

\textsuperscript{16} Ideally, we would like to compare the unemployment rates of degree-holders to high-school leavers instead of individuals with no post-school qualifications. At the time this analysis was carried out, however, information on high-school leavers was not available for the 1986 Census.
19 year-olds with no post-school qualifications, which roughly corresponds to the group which entered the market at the same time as the 20-24 year-old graduates, the advantage to the latter for both males and females has increased as well. Hence, in terms of improving employment prospects, the value of a degree appears to have risen over the last ten years.17

**TABLE 8.1: UNEMPLOYMENT RATES OF YOUNG DEGREE-HOLDERS AND PERSONS WITH NO POST-SCHOOL QUALIFICATIONS**

<table>
<thead>
<tr>
<th></th>
<th>1976</th>
<th>1981</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MALES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree-Holders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-24 yr-old</td>
<td>4.78%</td>
<td>4.64%</td>
<td>6.17%</td>
</tr>
<tr>
<td>No Post-School Qual. 15-19 yr-old</td>
<td>11.63%</td>
<td>13.48%</td>
<td>23.38%</td>
</tr>
<tr>
<td>No Post-School Qual. 20-24 yr-old</td>
<td>7.50%</td>
<td>10.77%</td>
<td>18.55%</td>
</tr>
<tr>
<td><strong>FEMALES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree-Holders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-24 yr-old</td>
<td>4.36%</td>
<td>5.72%</td>
<td>6.79%</td>
</tr>
<tr>
<td>No Post-School Qual. 15-19 yr-old</td>
<td>14.17%</td>
<td>18.05%</td>
<td>22.32%</td>
</tr>
<tr>
<td>No Post-School Qual. 20-24 yr-old</td>
<td>6.53%</td>
<td>10.53%</td>
<td>15.41%</td>
</tr>
</tbody>
</table>

**SOURCES:** MTX32, 1976 Census  
MTX51, 1981 Census  
CX0015, 1986 Census

17. Another important consideration is that the deteriorating unemployment situation among young school-leavers also implies that the opportunity cost to investing in higher education is lower. This, too, would increase the profitability of higher education.
8.4.2 Starting Salaries

Guthrie and Coyte (1987) have examined the starting salaries of graduates in Australia for the years 1977 to 1986. Their analysis suggests that, in this context, new graduates entering the labour market are becoming increasingly worse off. They reported that over the ten years the ratio of graduate starting salaries to average weekly earnings has fallen from 1.00 in 1977 to a low of 0.878 in 1983, before recovering slightly to 0.896 in 1986 (see Figure 8.5). This result has been widely cited as evidence that the returns to higher education have been falling over the last ten years. However, there are several problems with the Guthrie and Coyte analysis, arising from their use of the average weekly earnings series as a bench-mark with which graduate starting salaries are compared.

First, even if the relative incomes between workers with different levels of education had remained the same, the shift in the distribution of the work-force towards the more educated end of the spectrum (either as a result of the population being more educated, or an increasing rate of unemployment among the less educated) would, ceteris paribus, lead to a decline in the ratio of graduate starting salaries to average weekly earnings.

Secondly, there could be shifts in the age (or experience) distribution of the work-force over time as well. A shift of the work-force towards the more experienced end (which, again, could be a result of demographic changes or an increasing rate of unemployment among the young) would, ceteris paribus, also lead to a fall in the ratio of graduate starting salaries to average weekly earnings.
Figure 8.5: Starting Salary of Graduates as a % of A.W.E. (all ages)

![Graph showing starting salaries of graduates as a percentage of A.W.E. (all ages).](image)

- Male
- Female
- All

Year:
- 1976
- 1978
- 1980
- 1982
- 1984
- 1986
- 1988

% of A.W.E.:
- 110
- 100
- 90
- 80

Initially, the relationship within the graduate starting salaries and the salaries of other new labour market entrants seems to follow weekly earnings across all ages. It is certainly quite possible that youth unemployment is higher among graduates as a result of education. It is only since the 1970s that weekly earnings have risen and fallen as a result of the end of a prolonged period of steady growth. It would be interesting to investigate the effect of education on the ratio of graduate starting salaries to average weekly earnings. The figures show that by the end of the ten-year period, new graduates are better off compared to other new entrants to the labour market, and so women are better off compared to other similarly aged individuals. For example, the figures show that women are no longer classified as earning off compared to men. Even with the decrease in women, however, as starting salaries are increased, the differences seem to support the view that there has been a "reality check". Although the position of these salaries in the labour market appears to have improved between 1970 and 1989, much of the best graduates has been removed since then. As graduates, the figures show that by 1989, weekly earnings were at about the same position relative to unemployment as of the early 1970s. In 1970, the unemployment rate was below 5%.
Thirdly, the relevant comparison should be between graduate starting salaries and the salaries of other new labour market entrants, or of similarly aged individuals, and not with the average weekly earnings across all ages. It is certainly quite possible for youth wages across the entire educational spectrum to fall relative to the wages of older workers, with the relativities across educational levels remaining unchanged. In this case, the ratio of graduate starting salaries to average weekly earnings would fall, but it would be incorrect to conclude that degree-holders have lost ground in the labour market.

Our analysis reveals that the fall reported by Guthrie and Coyte is due mainly to the last two factors. Figures 8.6 and 8.7 show the changes in graduate starting salaries as a ratio of the average weekly earnings of 15-19 year-olds (corresponding to other new market entrants) and 20-24 year-olds (corresponding to similarly aged individuals), respectively, between 1977 and 1986. For males, these figures show that, by the end of the ten year period, new graduates are better off compared to other new market entrants, and no worse off compared to other similarly-aged individuals. For females, new graduates are not noticeably worse off compared to either group. Hence, insofar as starting salaries are concerned, the evidence does not support the view that there has been a "steady decline" in the rewards to higher education. Although the position of degree-holders in the labour market appears to have slipped a little between 1976 and 1981, much of the lost ground has been recovered since then, so that by 1986, degree-holders were in about the same position (relative to non-graduates of the same age or experience) as they had been in 1976.
Figure 8.6: Starting Salary of Graduates as a % of A.W.E. (15-19 yrs)

![Graph showing starting salary of graduates as a % of A.W.E. (15-19 yrs).]

Figure 8.7: Starting Salary of Graduates as a % of A.W.E. (20-24 yrs)

![Graph showing starting salary of graduates as a % of A.W.E. (20-24 yrs).]
8.4.3 Industry and Occupational Mix

Although the analysis of changes in the starting salaries of graduates over time is informative, it does have certain limitations. From an investment perspective, it is earnings over the lifetime that matters. Individuals might, therefore, have opted for jobs which have low starting salaries, but rapid wage-growth potentials. On the other hand, starting salaries might be high simply because individuals have chosen jobs which are associated, for instance, with little on-the-job training. Hence, if the job-mix of successive cohorts of new graduates are significantly different, then starting salaries alone may not be a good indicator of the changes in the returns to higher education over the period. It is, therefore, imperative that we examine the kinds of jobs that new graduates have been taking up.

To test the sensitivity of this potential problem, information from the 1976, 1981 and 1986 Australian Censuses was used. Our analysis focuses on males. The wage-growth potential by industry and occupation is first obtained by estimating the increase in wages in advancing from age 20-24 to 25-29 in each industry and occupation.

---

18. Several explanations for differences in the shape of the life-cycle earnings profiles between jobs exist. One explanation is that jobs with greater amounts of worker-financed specific training are associated with lower starting salaries and steeper life-cycle profiles. (See Becker (1975), Chapman and Tan (1980)). Another explanation is that in jobs where the worker’s effort cannot be easily monitored, the firm has an incentive to steepen the slope of the life-cycle profile to raise the "penalty" to workers who "cheat". See, for instance, Shapiro and Stiglitz (1984).

19. At the time this analysis was carried out, some information on females were unavailable.
The following regression is estimated on a sample of 20-29 year-old male graduates:20

\[
\log(\text{INC}) = \sum a_i \text{IND}_i + \sum b_j \text{OCC}_j + \sum c_i \text{AGE} \times \text{IND}_j \\
+ \sum d_j \text{AGE} \times \text{OCC}_j + u
\]

where INC is the annual income;
IND\_i\ are industry dummies (i = 1 to 9);
OCC\_j\ are occupational dummies (j = 2 to 5);
AGE\ is a dummy which equals 1 for the age group 25-29; and
u is a random error term.

Bearing in mind our earlier discussion, the slopes of the industry earnings profiles estimated from a single cross-section may be biased. To overcome this difficulty, we drew on the 1976 cross-section for the 20-24 year-olds and the 1981 cross-section for the 25-29 year-olds.21 In effect, we estimated the slope with AC in Figure 8.1, instead of AB or DC. Regression results are presented in Table A8.1 in Appendix 8.1.

Table 8.2 shows the percentage of new male graduates in each industry/occupation for 1976, 1981 and 1986. Assuming that the wage-growth potential by industry and occupation is constant over the period, it is possible to examine what the changes in the job-mix of new graduates over time mean in terms of the wage-growth potential of the jobs they are taking up.

20. Definitions of industry and occupational variables and the method of estimation are given in Appendix 8.1.

21. With income figures converted to 1976 dollars.
TABLE 8.2: INDUSTRY/OCCUPATIONAL MIX OF NEW MALE GRADUATES

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agric &amp; Mining</td>
<td>1.77</td>
<td>5.38</td>
<td>5.31</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>11.63</td>
<td>15.70</td>
<td>12.56</td>
</tr>
<tr>
<td>Elec, Gas, Water, Construc</td>
<td>6.84</td>
<td>4.48</td>
<td>6.28</td>
</tr>
<tr>
<td>Wholesale, Retail, Trade</td>
<td>7.84</td>
<td>8.97</td>
<td>8.21</td>
</tr>
<tr>
<td>Transp, Stor, Communication</td>
<td>3.50</td>
<td>3.14</td>
<td>4.83</td>
</tr>
<tr>
<td>Finan, Prpty, Busns Svcs</td>
<td>17.78</td>
<td>22.87</td>
<td>28.50</td>
</tr>
<tr>
<td>Public Admin, Defence</td>
<td>15.23</td>
<td>11.69</td>
<td>9.66</td>
</tr>
<tr>
<td>Health</td>
<td>7.66</td>
<td>6.73</td>
<td>8.21</td>
</tr>
<tr>
<td>Commun &amp; Personal Svcs</td>
<td>27.76</td>
<td>21.08</td>
<td>20.77</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occupation</th>
<th>1976</th>
<th>1981</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers &amp; Administrators</td>
<td>2.64</td>
<td>3.14</td>
<td>5.80</td>
</tr>
<tr>
<td>Professionals</td>
<td>65.91</td>
<td>61.88</td>
<td>62.32</td>
</tr>
<tr>
<td>Para-Professionals</td>
<td>5.29</td>
<td>7.62</td>
<td>7.25</td>
</tr>
<tr>
<td>Clerks, Salespersons &amp; Personal Service Workers</td>
<td>17.85</td>
<td>19.73</td>
<td>19.36</td>
</tr>
<tr>
<td>Others</td>
<td>8.30</td>
<td>7.62</td>
<td>6.28</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Using the estimated parameters of the regression, the predicted income of 20-24 year-old graduates corresponding to, say, the 1976 job-mix can be obtained. This involves using the figures in Table 8.2 (under the 1976 column) as specific values of the explanatory variables (IND and OCC) and calculating the predicted income. The variable AGE is set to 0, since we are interested in the predicted income of 20-24 year olds. The predicted income (for 20-24 year-old graduates) corresponding to the 1981 and 1986 graduate job-mixes can be obtained in the same way.

Similarly, the predicted incomes of 25-29 year-old graduates corresponding to job-mixes in 1976, 1981 and 1986 can be generated. For these calculations, however, the variable AGE in the regression

22. The regression is semi-logarithmic. Hence, to obtain the predicted starting salary (in levels), the exponential is calculated.
is set to 1. From these two sets of figures, the percentage wage-growth (as measured by the increase in earnings in advancing from the 20-24 age group to the 25-29 age group) corresponding to the industry and occupational mixes in each of the three years can be calculated. The results are given in Table 8.3. Also reported in Table 8.3 are the equivalent figures for high-school leavers.23

| TABLE 8.3: PREDICTED WAGE GROWTH (%) CORRESPONDING TO JOB-MIX |
|-----------------|-----------------|-----------------|
|                 | 1976            | 1981            | 1986            |
| Degree-Holders  | 26.53           | 32.65           | 32.60           |
| High-School Leavers | 21.22          | 20.33           | 20.96           |

The results suggest that the later cohorts of new graduates appear to be entering into jobs which are, on average, associated with higher wage-growth potentials. In contrast, applying the same method to high-school leavers, we found the later cohorts to be taking up jobs which are, on average, associated with lower wage-growth potentials. This further reinforces our earlier findings based on graduate starting salaries and employment status, that relative to their non-graduate peers, the labour market outcomes of recent cohorts of graduates do not appear to have deteriorated over the last decade. In fact, the position of graduates may have improved somewhat.

In summary, our time-series evidence suggests that contrary to the conventional wisdom, and what the changes in the cross-sectional rate over time suggest, the value of a tertiary degree does not

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23. The regression results for this group and the job-mix in the three years are given in Appendix 8.1.
appear to have fallen in the last ten years. There are several possible explanations. First, it might be due to the slowing down in the growths of both the flow and stock of graduates in the labour market over the last ten years. Secondly, technology over the last decade might have changed in such a way as to make graduates relatively more valuable in the labour market. Finally, it might be due to degrees being used primarily as screening devices in the labour market. The last explanation implies that an increase in the supply of graduates would lead to a 'filtering' down of both graduates and non-graduates in the job-ladder. Hence, relative to past cohorts, both degree-holders and non-degree-holders might, on average, be worse off. However, within each cohort, graduates might still maintain their advantage over their non-graduate peers. A complete analysis of these hypotheses is beyond the scope of the present paper, but they would provide much fertile ground for further research.

8.5 CONCLUSION

In this chapter, it was argued that an assessment of how the value of a degree has changed requires more than a simple comparison of cross-sectional rates of return over time. It was shown that such a comparison might lead to misleading conclusions with regards the magnitude, and even the direction of change over time.

In the empirical part of the chapter, Miller's finding of the decline in the cross-sectional rates of return to higher education from 1968/69 to 1978/79 was shown to continue into the 1980s. These cross-sectional rates would, on the surface, suggest that the returns to higher education have been falling over the last 15 to 20 years. Our analysis using time series evidence on the labour market
performances of successive cohorts of new graduates, however, indicate otherwise.

Although the unemployment rates of all leavers from educational institutions have generally risen over the last ten years, degree-holders tend to have been less severely affected. It was shown that the differential between the unemployment rates of young degree-holders and those with no post-school qualifications has, in fact, widened over the period. This suggests that in terms of protecting oneself against unemployment, the value of higher education has increased. Moreover, the higher unemployment rates among young school leavers also indicate that the opportunity cost of investing in higher education has fallen. This would, also tend to increase the profitability of higher education.

An examination of graduate starting salaries from 1977 to 1986 reveals that relative to the wages of other new market-entrants, and similarly-aged persons, graduate starting salaries did not change by much over the period, contrary to the suggestions by some researchers. The possibility of successive cohorts of new graduates moving into industries and occupations with high starting salaries and low wage-growth potentials was also investigated. It was found that, if anything, new graduates appeared to be increasingly taking up jobs with greater wage-growth potentials.

Hence, contrary to the widespread belief, and what the cross-sectional rates indicate, these results suggest that the returns to higher education does not appear to have fallen over the last ten years.
CHAPTER 9

SUMMARY AND CONCLUSION

This thesis has examined the financial returns to higher education in Australia from the private and social points of view. While some of the issues have been explored in other studies, several contributions are made in this thesis in areas of both methodology and policy analysis. Essentially, these relate to the incorporation of risk into conventional measures of educational profitability, and to the investigation of individual ability differences as determinants of educational profitability. The technical contributions allow a richer understanding of the impact of changes in contemporary policy approaches to the financing of higher education in Australia.

Part I of the thesis focussed on the aggregate figures. The analysis is based on the comparison of mean earnings outcomes of degree-holders and high-school leavers. Using data from the 1985-86 Income and Housing Survey, it was found that from the point of individuals, higher education appears to be a worthwhile investment.

The higher earnings of graduates compared to high-school leavers are, in part, due to their higher participation rate, lower incidence of unemployment, and longer hours worked. Restricting the sample to only those who worked full-time and for the full year led to a reduction in the estimated rate of return, particularly, in the case of females. Nevertheless, higher education remains an attractive investment.

It was found also that the rate of return to individuals pursuing their degrees on a part-time basis is extremely high. This
prompted the question of why students would pursue higher education on a full-time basis, given that part-time study was so much more profitable. One explanation is that full-time students are able to enjoy the consumption benefits of higher education to a greater extent. The difference in profitability between the part- and full-time modes of study suggests that these benefits could be valued as high as $5,000 to $7,000 per year of study.

The effect of various fee-regimes on individuals' incentives to invest in higher education was considered. It was found that the Higher Education Contribution Scheme (HECS), Higher Education Administrative Charge (HEAC), and the fee-scheme proposed by the National-Liberal Parties (LIB) have little impact on private rates of return. Under the Full-fee and the Bond University fee-regimes, however, it may no longer be financially profitable for individuals to invest in higher education.

Consideration of whether society should, at the margin, expand investment in higher education has been hampered by a lack of consensus of what the appropriate social discount rate is. Using the commonly used rule-of-thumb figure of 10%, it was found that the case for expansion would rest on the externalities associated with higher education being sufficiently large. Unfortunately, there is little agreement among economists as to the magnitude of the externalities.

A novel approach adopted in this thesis is to infer the marginal value of externalities from the fee-structure of the recently introduced tertiary tax, assuming that in setting the charge, the Government is concerned solely with allocative efficiency. Using a 10% social discount rate, it was estimated that the marginal value of externalities implied by HECS amounts to $1,400.
to $1,500 per year. It was further found that if 10% were indeed the appropriate social discount rate, then the level of the charge in HECS is not consistent with an expansion of higher education from an efficiency view-point. At lower social discount rates, however, there is no inconsistency.

In Part II of the thesis, we considered the implications of the dispersion in individual incomes around the mean income profile. One interpretation of the dispersion is that it represents the effects of luck. This suggests that there may be considerable risks attached to investing in higher education. A model was developed which enabled risks to be incorporated into conventional measures of educational profitability, such as the NPV. The empirical results showed that the attractiveness of higher education as an investment is reduced when risks are taken into account. For moderately risk averse individuals, however, higher education is still an attractive investment.

Another important finding is that taking into account the risks of dropping out or requiring longer than the minimum time to complete the degree, reduces the profitability of higher education quite substantially. This is both because the expected returns are smaller, and because the uncertainty associated with attending university increases when the risk of failure is recognised.

An alternative interpretation of the dispersion in individual incomes is that it reflects differences in individual-specific characteristics, such as ability. From this perspective, the profitability of higher education to each individual would depend on his or her endowment of these characteristics. If individuals are assumed to be aware of their abilities, educational self-selection may occur. It was demonstrated that under these circumstances
estimates of the rate of return based on the comparison of mean profiles may be seriously biased.

It was argued, however, that it might be more plausible to assume that individuals are not aware of their abilities when deciding whether to pursue higher education. In this case, the mean earnings profiles conditional on education would be unbiased estimates of what individuals could expect to earn ex ante depending on their educational choice. Of course, the fact that individuals’ ex post earnings could deviate substantially according to their abilities has to be taken into account. Using the model developed previously, it was found that the uncertainty in abilities reduced the profitability to such an extent that higher education was only marginally profitable to the moderately risk averse.

In the final chapter of Part II, the two components of individual income variation -- stochastic and individual-specific -- were brought together. Using Miller’s (1989) results, it was assumed that the observed variation in individual incomes is half stochastic and half individual-specific. The implication of the variation on individuals’ ex ante educational profitability clearly depends on whether individuals are aware of their respective abilities when making their educational choice. Assuming that they are unaware, it was found that uncertainty reduces the private NPV (assuming a discount rate of 5%) from more than $13,000 (1985-86 dollars) to less than $3,000 for moderately risk averse individuals (R=3). Although higher education is still profitable, it is far from the lucrative venture it was thought to be when risks were ignored.

If individuals are assumed to be aware of their abilities, the riskiness of higher education as an investment and the cost of this
riskiness depend on their income-generating abilities both as graduates and as high-school leavers.

It was argued in this thesis that calculations of the social profitability of higher education should be adjusted for risks, to the extent that these risks are borne privately. As in the calculations of ex ante private profitability, the importance of the risk adjustment depends on whether individuals are aware of their respective abilities. An additional consideration in the social calculations is whether individuals' Year 12 performances are systematically related to their abilities. It was shown that if individuals are ignorant of their abilities and if the relationship between their Year 12 performance and later earnings in the labour market is weak, then even after adjustment for risk, higher education appears to be profitable for the marginal graduate (assuming a social discount rate of 5%).

On the other hand, if individuals' Year 12 performances are positively related to their earnings as graduates, we would expect the marginal graduate to earn substantially less than the average graduate. It was shown that in this case the marginal social NPV (adjusted for risk) is likely to be negative at a 5% social discount rate.

An interesting feature of HECS which distinguishes it from other fee-schemes, such as LIB, is that the repayment of the charge under HECS is income-contingent. It was shown that this feature of HECS makes it slightly more attractive to risk averse individuals relative to LIB, assuming that individuals are uncertain of their abilities. However, if individuals are aware of their abilities, then the more able individuals may be financially better off under LIB.
In Part III of the thesis, the issue of whether the returns to higher education have fallen was investigated. It was demonstrated that misleading conclusions could result from a simple comparison of changes in the cross-sectional rates of return over time. Considering, instead, the labour market performance of successive cohorts of new graduates, it was found that contrary to conventional wisdom and what cross-sectional rates suggest, the value of a degree does not appear to have declined over the last ten years. If anything, the evidence appears to suggest that there has been an increase in the profitability of higher education.

The thesis suggests a number of areas where further research is required. First, in view of the very high returns to pursuing higher education on a part-time basis, a more in-depth analysis of the choice between part- and full-time studies is needed. In particular, the barriers preventing individuals from holding a full-time job and studying part-time should be investigated.

A second area where further research is required is the progress of students through university. It was shown that the risks of dropping out and repeating subjects have a major influence on the rate of return to higher education. It is, therefore, important to explore the factors which may lead to failure in university. Further, it is important to determine how students' progress in university is related to both their Year 12 performances, and to their earnings after graduation.

Our analysis suggests that risks play an important role in the profitability of higher education. The techniques developed in this thesis could be applied to a number of other related issues such as the comparison of the attractiveness between different fields of
study. This would then enable us to shed some light into whether the returns to some fields of study are higher than others in part because they are associated with a higher degree of riskiness.
BIBLIOGRAPHY


Australian Bureau of Statistics (ABS), Transition from Education to Work, Cat. No. 6227.0.


APPENDIX 2.1
THE SEPARATION THEOREM

This appendix demonstrates the proposition that with perfect capital markets, the attractiveness of educational investments is independent of individuals' intertemporal preferences and wealth.

Consider the investment decision of an individual deciding whether to undertake extra schooling. Assume that without the extra schooling, the individual can consume $C_1'$ in the first period, and $C_2'$ in the second. This is given by point A in Figure A2.1.1. Schooling reduces the individual's consumption in the first period by $c_1$, but in return, increases consumption in period two by $c_2$. This alternative consumption bundle is represented by point B in the diagram. Assume that the individual is restricted to a choice of either A or B. That is, there are no other means of transferring income from one period to the next. Quite clearly, under these conditions, whether the additional schooling is attractive to the individual depends on the shape of his or her indifference curves and the position of A. Two sets of indifference curves are shown in the diagram. If the individual’s preferences are represented by the steeper set of curves, A is preferred. In other words, the individual is better-off not acquiring the additional schooling. On the other hand, if the individual’s preferences are represented by the flatter set of indifference curves, the option of additional schooling will make the individual better-off. In this case, the individual will choose to acquire the additional schooling.

Hence, under the conditions set out above, the attractiveness of education as an investment cannot be evaluated without knowledge of the individual’s intertemporal preferences and his or her initial
FIG. A2.1.1: INTERTEMPORAL CONSUMPTION CHOICE WITH NO BORROWING/LENDING

CONSUMPTION IN PERIOD 2

CONSUMPTION IN PERIOD 1
endowments. This makes the evaluation of the attractiveness of education a particularly daunting task. Fortunately, under certain conditions, the evaluation can be simplified considerably.

Assume that individuals can freely borrow and lend at a constant rate of interest r. Given this assumption, any point along XX' (slope = -(1+r)) in Figure A2.1.2 is attainable if he or she chooses not to acquire the additional education. Similarly, if he or she chooses to acquire the additional schooling, the individual can choose to consume at any point along YY'. As drawn in Figure A2.1.2, the consumption set bound by YY' dominates the consumption set bound by XX'. In this case, as long as the individual's utility function is quasi-concave (and hence, indifference curves convex to the origin), the individual can attain a higher level of utility by choosing to acquire the additional schooling. Of course, if the interest rate is sufficiently high (which implies steeper XX' and YY' lines), the decision may be reversed.

Hence, with the assumption of perfect capital markets, the decision of whether to acquire additional schooling is reduced to a simple comparison of the relative magnitudes of OX' and OY'. These are, respectively, the present values of the income (or consumption) streams associated with acquiring and not acquiring the additional schooling. The difference, (OY' - OX'), is known as the Net Present Value (NPV) of the investment in the additional schooling. The decision rule can be stated as: Invest if NPV > 0.

Note, interestingly, that (OY' - OX') is independent of the individual's initial endowment point A. Therefore, the attractiveness of education as an investment is independent of the individual's initial level of wealth. Note also that knowledge of the individual's
FIG. 2.1.2: INTERTEMPORAL CONSUMPTION CHOICE WITH PERFECT CAPITAL MARKET

CONSUMPTION IN PERIOD 1

CONSUMPTION IN PERIOD 2
intertemporal preferences (beyond the fact that it is "well-behaved") is not necessary in order to evaluate the attractiveness of the educational investment. Hence, provided capital markets exist, an individual’s production decision (of whether to invest) can be made separately from his or her consumption decision (of how much to consume in each period). This is the separation theorem.
### APPENDIX 3.1

**INCOME DATA FROM 1985-86 INCOME AND HOUSING SURVEY**

**TABLE A3.1.1: AVERAGE AFTER-TAX TOTAL INCOME (1985-86 DOLLARS) & NUMBER OF OBSERVATIONS BY EDUCATION, SEX, AGE**

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<th>AGE</th>
<th>MALE</th>
<th>FEMALE</th>
<th>MALE</th>
<th>FEMALE</th>
</tr>
</thead>
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<td>$8,670</td>
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<tr>
<td></td>
<td>(79)</td>
<td>(77)</td>
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<tr>
<td>21-24</td>
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<td>$14,860</td>
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<td>$18,710</td>
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<td>(143)</td>
<td>(104)</td>
<td>(89)</td>
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<td>(46)</td>
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<td>(12)</td>
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<td>Total Obs.</td>
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<td>(766)</td>
<td>(630)</td>
<td>(419)</td>
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() number of observations
# TABLE A3.1.2: AVERAGE PRE-TAX EARNED-INCOME (1985-86 DOLLARS) & NUMBER OF OBSERVATIONS BY EDUCATION, SEX, AGE

<table>
<thead>
<tr>
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<td>(135)</td>
<td>(75)</td>
</tr>
<tr>
<td>40-44</td>
<td>$23,000</td>
<td>$9,560</td>
<td>$36,250</td>
<td>$21,210</td>
</tr>
<tr>
<td></td>
<td>(69)</td>
<td>(59)</td>
<td>(85)</td>
<td>(39)</td>
</tr>
<tr>
<td>45-49</td>
<td>$24,490</td>
<td>$9,000</td>
<td>$40,770</td>
<td>$20,510</td>
</tr>
<tr>
<td></td>
<td>(43)</td>
<td>(42)</td>
<td>(54)</td>
<td>(30)</td>
</tr>
<tr>
<td>50-54</td>
<td>$16,150</td>
<td>$4,270</td>
<td>$34,470</td>
<td>$23,290</td>
</tr>
<tr>
<td></td>
<td>(29)</td>
<td>(41)</td>
<td>(34)</td>
<td>(16)</td>
</tr>
<tr>
<td>55-59</td>
<td>$19,390</td>
<td>$6,460</td>
<td>$31,250</td>
<td>$15,430</td>
</tr>
<tr>
<td></td>
<td>(35)</td>
<td>(34)</td>
<td>(31)</td>
<td>(17)</td>
</tr>
<tr>
<td>60-64</td>
<td>$18,840</td>
<td>$3,080</td>
<td>$18,870</td>
<td>$5,910</td>
</tr>
<tr>
<td></td>
<td>(27)</td>
<td>(46)</td>
<td>(29)</td>
<td>(12)</td>
</tr>
<tr>
<td>Total Obs.</td>
<td>(770)</td>
<td>(766)</td>
<td>(630)</td>
<td>(419)</td>
</tr>
</tbody>
</table>

() number of observations
### TABLE A3.1.3: AVERAGE PRE-TAX EARNED-INCOME (1985-86 DOLLARS) & NUMBER OF OBSERVATIONS BY EDUCATION, SEX, AGE FOR FULL-TIME FULL-YEAR WORKERS

<table>
<thead>
<tr>
<th>AGE</th>
<th>MALE</th>
<th>FEMALE</th>
<th>MALE</th>
<th>FEMALE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HIGH SCHOOL</td>
<td>DEGREE HOLDERS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-20</td>
<td>$11,560</td>
<td>$12,720</td>
<td>$20,910</td>
<td>$18,630</td>
</tr>
<tr>
<td></td>
<td>(47)</td>
<td>(46)</td>
<td>(18)</td>
<td>(19)</td>
</tr>
<tr>
<td>21-24</td>
<td>$18,660</td>
<td>$16,660</td>
<td>$27,540</td>
<td>$24,190</td>
</tr>
<tr>
<td></td>
<td>(82)</td>
<td>(71)</td>
<td>(83)</td>
<td>(60)</td>
</tr>
<tr>
<td>25-29</td>
<td>$21,520</td>
<td>$16,780</td>
<td>$29,000</td>
<td>$25,460</td>
</tr>
<tr>
<td></td>
<td>(126)</td>
<td>(57)</td>
<td>(117)</td>
<td>(57)</td>
</tr>
<tr>
<td>30-34</td>
<td>$22,100</td>
<td>$17,330</td>
<td>$32,290</td>
<td>$25,630</td>
</tr>
<tr>
<td></td>
<td>(94)</td>
<td>(37)</td>
<td>(122)</td>
<td>(40)</td>
</tr>
<tr>
<td>35-39</td>
<td>$23,660</td>
<td>$16,920</td>
<td>$38,350</td>
<td>$24,890</td>
</tr>
<tr>
<td></td>
<td>(78)</td>
<td>(19)</td>
<td>(80)</td>
<td>(25)</td>
</tr>
<tr>
<td>40-44</td>
<td>$28,260</td>
<td>$19,910</td>
<td>$42,420</td>
<td>$26,180</td>
</tr>
<tr>
<td></td>
<td>(55)</td>
<td>(16)</td>
<td>(49)</td>
<td>(21)</td>
</tr>
<tr>
<td>45-49</td>
<td>$22,540</td>
<td>$13,900</td>
<td>$38,640</td>
<td>$32,050</td>
</tr>
<tr>
<td></td>
<td>(31)</td>
<td>(8)</td>
<td>(28)</td>
<td>(10)</td>
</tr>
<tr>
<td>50-54</td>
<td>$24,650</td>
<td>$12,710</td>
<td>$36,440</td>
<td>$26,690</td>
</tr>
<tr>
<td></td>
<td>(21)</td>
<td>(6)</td>
<td>(25)</td>
<td>(7)</td>
</tr>
<tr>
<td>55-59</td>
<td>$30,060</td>
<td>$13,470</td>
<td>$36,440</td>
<td>$26,690</td>
</tr>
<tr>
<td></td>
<td>(21)</td>
<td>(11)</td>
<td>(25)</td>
<td>(7)</td>
</tr>
<tr>
<td>60-64</td>
<td>$24,240</td>
<td>$22,920</td>
<td>$33,320</td>
<td>$14,580</td>
</tr>
<tr>
<td></td>
<td>(11)</td>
<td>(4)</td>
<td>(13)</td>
<td>(5)</td>
</tr>
<tr>
<td>Total Obs.</td>
<td>(566)</td>
<td>(275)</td>
<td>(535)</td>
<td>(244)</td>
</tr>
</tbody>
</table>

() number of observations
APPENDIX 3.2

EARNINGS OF PART-TIME STUDENTS

Data: 1981 Census Households Sample File

Sample: High-School Leavers aged less than 30

Dependent Variable: Log (Income)

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.437</td>
<td>0.622</td>
</tr>
<tr>
<td>Age^2</td>
<td>-0.781 x 10^-2</td>
<td>-0.134 x 10^-1</td>
</tr>
<tr>
<td>Enrolled Part-Time</td>
<td>0.960 x 10^-1</td>
<td>0.570 x 10^-1</td>
</tr>
<tr>
<td>Enrolled Full-Time</td>
<td>-1.200</td>
<td>-1.119</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.658</td>
<td>-2.246</td>
</tr>
<tr>
<td>R^2</td>
<td>0.45</td>
<td>0.20</td>
</tr>
<tr>
<td># obs.</td>
<td>3543</td>
<td>2796</td>
</tr>
</tbody>
</table>

() absolute t-statistic
### APPENDIX 3.3

**RESULTS USING THE FULL SAMPLE**

**TABLE A3.3.1: PRIVATE NET PRESENT VALUE OF HIGHER EDUCATION BY MODE OF STUDY (1985/86 DOLLLARS) -- FULL SAMPLE**

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>Full-time</th>
<th>PT1</th>
<th>PT2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRR 13.30%</td>
<td>13.30%</td>
<td>30.60%</td>
<td>36.46%</td>
</tr>
<tr>
<td>0%</td>
<td>$224,790</td>
<td>$237,760</td>
<td>$216,660</td>
</tr>
<tr>
<td>3%</td>
<td>$94,110</td>
<td>$106,870</td>
<td>$92,210</td>
</tr>
<tr>
<td>5%</td>
<td>$53,000</td>
<td>$65,580</td>
<td>$54,080</td>
</tr>
<tr>
<td>10%</td>
<td>$10,060</td>
<td>$22,060</td>
<td>$15,870</td>
</tr>
<tr>
<td>15%</td>
<td>$-52,930</td>
<td>$8,440</td>
<td>$5,240</td>
</tr>
<tr>
<td>FEMALES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRR 18.76%</td>
<td>18.76%</td>
<td>40.77%</td>
<td>40.01%</td>
</tr>
<tr>
<td>0%</td>
<td>$264,470</td>
<td>$271,360</td>
<td>$232,150</td>
</tr>
<tr>
<td>3%</td>
<td>$121,780</td>
<td>$129,330</td>
<td>$101,160</td>
</tr>
<tr>
<td>5%</td>
<td>$75,180</td>
<td>$83,020</td>
<td>$60,350</td>
</tr>
<tr>
<td>10%</td>
<td>$23,580</td>
<td>$31,840</td>
<td>$18,550</td>
</tr>
<tr>
<td>15%</td>
<td>$5,910</td>
<td>$14,250</td>
<td>$6,440</td>
</tr>
</tbody>
</table>

**TABLE A3.3.2: VALUE OF CONSUMPTION BENEFITS TO HIGHER EDUCATION (1985/86 DOLLARS) -- FULL SAMPLE**

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>Present Value</th>
<th>Annual Value</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>$12,970</td>
<td>$3,710</td>
<td>$6,890</td>
<td>$1,970</td>
</tr>
<tr>
<td>3%</td>
<td>$12,760</td>
<td>$3,890</td>
<td>$7,540</td>
<td>$2,300</td>
</tr>
<tr>
<td>5%</td>
<td>$12,570</td>
<td>$4,000</td>
<td>$7,840</td>
<td>$2,490</td>
</tr>
<tr>
<td>10%</td>
<td>$12,010</td>
<td>$4,220</td>
<td>$8,250</td>
<td>$2,900</td>
</tr>
<tr>
<td>15%</td>
<td>$11,370</td>
<td>$4,390</td>
<td>$8,340</td>
<td>$3,220</td>
</tr>
</tbody>
</table>

| FEMALES       |               |              |               |              |
| 0%            |               |              |               |              |
| 3%            |               |              |               |              |
| 5%            |               |              |               |              |
| 10%           |               |              |               |              |
| 15%           |               |              |               |              |
TABLE A3.3.3: PRIVATE INTERNAL RATES OF RETURN AND NET PRESENT VALUES (1989 DOLLARS) OF HIGHER EDUCATION UNDER VARIOUS FEE-REGIMES --FULL SAMPLE

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>No Fees</th>
<th>HEAC</th>
<th>LIB</th>
<th>HECS1</th>
<th>HECS2</th>
<th>Full-Fees</th>
<th>Bond Uni.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>11.01%</td>
<td>10.81%</td>
<td>10.25%</td>
<td>10.50%</td>
<td>10.06%</td>
<td>6.25%</td>
<td>6.57%</td>
</tr>
<tr>
<td></td>
<td>$265,940</td>
<td>$264,850</td>
<td>$261,740</td>
<td>$259,640</td>
<td>$260,580</td>
<td>$223,940</td>
<td>$231,130</td>
</tr>
<tr>
<td>3%</td>
<td>$106,500</td>
<td>$105,490</td>
<td>$102,570</td>
<td>$101,920</td>
<td>$101,490</td>
<td>$67,230</td>
<td>$72,750</td>
</tr>
<tr>
<td>5%</td>
<td>$56,470</td>
<td>$55,510</td>
<td>$52,710</td>
<td>$52,730</td>
<td>$51,680</td>
<td>$18,860</td>
<td>$23,400</td>
</tr>
<tr>
<td>10%</td>
<td>$4,630</td>
<td>$3,770</td>
<td>$1,240</td>
<td>$2,310</td>
<td>$310</td>
<td>$-29,310</td>
<td>$-26,790</td>
</tr>
<tr>
<td>15%</td>
<td>-$10,560</td>
<td>-$11,330</td>
<td>-$13,640</td>
<td>-$12,050</td>
<td>-$14,490</td>
<td>-$41,380</td>
<td>-$40,440</td>
</tr>
<tr>
<td>0%</td>
<td>14.94%</td>
<td>14.63%</td>
<td>13.78%</td>
<td>14.76%</td>
<td>13.49%</td>
<td>8.10%</td>
<td>8.34%</td>
</tr>
<tr>
<td>3%</td>
<td>$304,260</td>
<td>$303,170</td>
<td>$300,060</td>
<td>$297,960</td>
<td>$298,900</td>
<td>$262,260</td>
<td>$268,010</td>
</tr>
<tr>
<td>5%</td>
<td>$135,320</td>
<td>$134,300</td>
<td>$131,390</td>
<td>$132,020</td>
<td>$130,310</td>
<td>$96,040</td>
<td>$100,280</td>
</tr>
<tr>
<td>10%</td>
<td>$80,400</td>
<td>$79,430</td>
<td>$76,640</td>
<td>$78,190</td>
<td>$75,600</td>
<td>$42,780</td>
<td>$46,140</td>
</tr>
<tr>
<td>15%</td>
<td>-$20,080</td>
<td>$19,220</td>
<td>$16,690</td>
<td>$19,170</td>
<td>$15,750</td>
<td>-$13,860</td>
<td>-$12,330</td>
</tr>
<tr>
<td>10%</td>
<td>-$140</td>
<td>-$920</td>
<td>-$3,220</td>
<td>-$580</td>
<td>-$4,070</td>
<td>-$30,970</td>
<td>-$30,850</td>
</tr>
</tbody>
</table>
APPENDIX 5.1

VARIANCES OF DISCOUNTED LIFETIME INCOMES AS MEASURES OF RISK

The purpose of this appendix is to substantiate a point made in Section 5.2.1 that variances of discounted lifetime incomes may be misleading indicators of riskiness. Using the model developed in Section 5.3, we demonstrate how two income streams with present values which have the identical means and variances may be regarded quite differently in terms of their relative riskiness by individuals.

For simplicity, let \( r = 0 \), so that the present value is just the sum of the income stream. Consider two 5-period income streams, as given in Table A5.1.1.

<table>
<thead>
<tr>
<th>STREAM</th>
<th>PERIOD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>(0.5; 0.20)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10 (0.5; 0.20)</td>
</tr>
</tbody>
</table>

\((q; X,Y)\) denotes a gamble which pays \( X \) with probability \( q \), and \( Y \) with probability \( 1-q \). Hence, \((0.5, 0.20)\) describes a binomial probability distribution which has equal chances of 0 and 20. Note that the means and the variances of the present values associated with the two income streams are exactly the same. Using the model developed in Section 5.3, the consumption streams associated with the income streams will be as given in Table A5.1.2.
The variances of consumption in each period for the two streams are, respectively, (4, 4, 4, 4, 4) and (0, 0, 0, 0, 100). Using (5.5), the cost of risk, as measured by the annual risk premium, \( p \), which is associated with stream 1 is 10A, compared to 50A with stream 2. It is clear, therefore, that risk-averse individuals (\( A > 0 \)) would prefer income stream 1 to income stream 2, despite the present values of the two streams having identical means and variances.
APPENDIX 5.2

SENSITIVITY ANALYSIS OF RESULTS

This appendix examines the sensitivity of the results in Table 5.6 of the text to the following assumptions: a) the specification of the utility function in (5.9); b) the specification of the earnings function in (5.8); and c) the normality of the error term in (5.8).

Specification of the Utility Function

Two alternative specifications of the utility function are considered here. The first is the Constant A(C) Utility function, which is given by:

\[ U(C) = -\alpha e^{-\beta C} \]

The second is the Quadratic Utility function, which is given by:

\[ U(C) = -(\alpha - \beta C)^2 \]

In the tables that follow, to facilitate comparison, the degree of risk-aversion is measured by the coefficient of relative risk-aversion evaluated, arbitrarily, at \( C = $20,000 \), i.e. \( R(20,000) \). For simplicity, however, this is simply denoted by \( R \).

Table A5.2.1 shows the risk-adjusted NPV at various degrees of risk-aversion, corresponding to the Constant A(C) and the Quadratic specifications of the utility function. For ease of comparison, the results corresponding to the Constant R(C) Utility function (from Table 5.6) are also reported in the table.
TABLE A5.2.1: RISK-ADJUSTED NPV OF HIGHER EDUCATION UNDER ALTERNATIVE UTILITY SPECIFICATIONS

<table>
<thead>
<tr>
<th>Utility Specification</th>
<th>R</th>
<th>Constant R(C)</th>
<th>Constant A(C)</th>
<th>Quadratic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>13180</td>
<td>13180</td>
<td>13180</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>11720</td>
<td>11770</td>
<td>11840</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10260</td>
<td>10360</td>
<td>10630</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8800</td>
<td>8950</td>
<td>9560</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>7340</td>
<td>7550</td>
<td>8600</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5880</td>
<td>6140</td>
<td>7750</td>
</tr>
</tbody>
</table>

In general, the results under alternative utility specifications are not vastly different. In all cases, the adjustment for risk reduces the NPV somewhat, but higher education remains a profitable private investment. At R=3, the reduction in the NPV under all three specifications is around 30%.

Specification of Earnings Function

On the question of the appropriate functional form, there are two related issues to be considered. The first concerns the shape of the age-earnings profile. That is, does the quadratic function (in age) sufficiently capture the overall shape of individuals' earnings profiles? To resolve this, we increased the power of the polynomial to the fourth- and sixth-orders. That is, the earnings function for each educational level, k is specified as:

\[
\log (\text{Earnings})_i = a_k + \sum_{j=1}^{N} b_{kj} \text{AGE}_i^j + u_{ki}
\]

where \(a_k, b_{kj}\) are constants;

\(u_{ki}\) is a random disturbance term which is independently and identically distributed across individuals within each educational group;

\(N (=4\text{ or }6)\) is the order of the polynomial.
FIG. A5.2.1: AGE–EARNINGS PROFILES
BY POLYNOMIAL–ORDER

1985–86 DOLLARS

AGE

degree(2) high–sch(2) degree(4) high–sch(6)
high–sch(4) degree(6) high–sch(6)
Figure A5.2.1 plots the predicted earnings profiles corresponding to these higher-order polynomials for degree-holders and high-school leavers. The number in the parenthesis indicates the degree of the polynomial. The predicted profiles corresponding to the second-order (i.e. quadratic) are also given for ease of comparison.

On the whole, the age-earnings profiles all look quite similar, particularly for high-school leavers, with the higher-order profiles being a little more wave-like. It could be argued that given the limited amount of information individuals have when deciding whether to proceed to university, the simple quadratic may be a more appropriate representation of their expectations of future incomes. Nevertheless, it would be interesting to see how much difference the choice of the specific functional form makes to the final calculations. The NPVs corresponding to the fourth- and sixth-order earnings functions at various degrees of risk-aversion are presented in Table A5.2.2. Again, for ease of comparison, the results for the quadratic are given alongside. The figures presented include adjustments for the risk of failure.

<table>
<thead>
<tr>
<th>Polynomial-Order</th>
<th>R=0</th>
<th>R=1</th>
<th>R=2</th>
<th>R=3</th>
<th>R=4</th>
<th>R=5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NPV</td>
<td>NPV</td>
<td>NPV</td>
<td>NPV</td>
<td>NPV</td>
<td>NPV</td>
</tr>
<tr>
<td>2</td>
<td>$13180$</td>
<td>$15510$</td>
<td>$17150$</td>
<td>$15620$</td>
<td>$14080$</td>
<td>$12550$</td>
</tr>
<tr>
<td>4</td>
<td>$11720$</td>
<td>$13990$</td>
<td>$15510$</td>
<td>$14080$</td>
<td>$12550$</td>
<td>$11010$</td>
</tr>
<tr>
<td>6</td>
<td>$10260$</td>
<td>$12470$</td>
<td>$14080$</td>
<td>$12550$</td>
<td>$11010$</td>
<td>$9480$</td>
</tr>
</tbody>
</table>

The calculations reveal that quantitatively, the profitability of higher education as an investment appears to be fairly sensitive
to the choice of the functional form of the earnings function. At the zero risk aversion level for instance, the NPV using the sixth-order earnings function is some 30% larger than that obtained by using the Quadratic. Qualitatively, however, our main conclusions remain unchanged. That is, accounting for risk makes higher education less profitable (to risk-averse individuals), but for the moderately risk-averse, higher education is still an attractive investment.

The second issue of importance with regards to the choice of the functional form is that of omitted variables. The issue of bias to the estimated parameters aside, omitted variables may seriously distort our estimates of the relative riskiness in the alternative income profiles. Suppose for instance, that the entire unexplained component in degree-holders' income is due to an omitted variable $Z$. In contrast, suppose that $Z$ is irrelevant in the determination of the incomes of high-school leavers, and that the unexplained component for this group is genuinely due to luck. In this extreme case, if individuals are aware of their respective values of $Z$, then the income profile corresponding to the choice of attending university is known with complete certainty (apart from the risks of failing). In other words, provided that the risk of failure is small, higher education is risk-reducing, and is even more attractive than in a world without risk, ceteris paribus. Accounting for risk would, therefore, increase the (risk-adjusted) NPV to higher education in this example. Conversely, if $Z$ completely explains the residual in high-school leavers' incomes, but is irrelevant to degree-holders' incomes, then the risk adjustment would drive the (risk-adjusted) NPV to higher education down even more than the estimates in Section 5.4 suggest.
In this respect, we focus our attention on a group of variables which has a long standing in the economics literature, namely, job-specific variables. There are a number of competing hypotheses regarding wage differentials across jobs. For instance, economists as early as Adam Smith have recognised the importance of the non-pecuniary aspects of jobs ("...the wages of labour vary with the ease or hardship, the cleanliness or the dirtiness, the honourableness or the dishonourableness of the employment"). The pioneering work of Becker (1975) and Mincer (1962, 1974), emphasises the role of on-the-job training instead. More recently, a number of economists have developed "efficiency wage" models which focus on monitoring and turnover costs as an explanation of wage differentials.  

Ideally, we would like to have direct measures of the amount of on-the-job training individuals undertake, the non-pecuniary aspects and the costs of turnover and monitoring in their respective jobs. Unfortunately, these are not available. As proxies, we have included in the regressions a set of eleven industry dummy variables, a set of six occupational dummy variables, and a dummy for government jobs in the earnings functions to capture these job-specific differences. The dummy variables are entered in two ways. First, they are entered simply as intercept dummies. In the second model, they are each

1. Individual-specific variables (such as innate ability, individual motivation, and family background) are explicitly assumed away in this chapter, and will be considered in the chapter 6.

2. Smith (1776) Book 1, Chapter 10, Part 1.

FIG A5.2.2: AGE-EARNINGS PROFILES WITH JOB-SPECIFIC VARIABLES

1985-86 DOLLARS

<table>
<thead>
<tr>
<th>Age</th>
<th>Degree</th>
<th>High-school</th>
<th>Degree(A)</th>
<th>High-school(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>x</td>
<td>O</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>39</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>44</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>49</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>54</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>59</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>
interacted with $\text{AGE}$ and $\text{AGE}^2$, and included in the regression. The models are referred to as A and B, respectively.

The predicted earnings profiles corresponding to these two models are shown in Figure A5.2.2. For comparison, we have also included the profiles from the simple quadratic earnings function (without the job dummies).

It is clear from Figure A5.2.2 that the predicted income profiles obtained using these two more complicated specifications are very similar to the original profiles. Therefore, we do not expect the unadjusted NPV to differ vastly across the three specifications. The NPV to higher education at various degrees of risk aversion are presented in Table A5.2.3 for the models A and B, as well as for the original model.

<table>
<thead>
<tr>
<th>R</th>
<th>Original</th>
<th>Model A</th>
<th>Model B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>13180</td>
<td>15030</td>
<td>15200</td>
</tr>
<tr>
<td>1</td>
<td>11720</td>
<td>13430</td>
<td>13550</td>
</tr>
<tr>
<td>2</td>
<td>10260</td>
<td>11830</td>
<td>11910</td>
</tr>
<tr>
<td>3</td>
<td>8800</td>
<td>10220</td>
<td>10270</td>
</tr>
<tr>
<td>4</td>
<td>7340</td>
<td>8620</td>
<td>8620</td>
</tr>
<tr>
<td>5</td>
<td>5880</td>
<td>7020</td>
<td>6980</td>
</tr>
</tbody>
</table>

Not surprisingly, the expected NPVs in the three specifications are close to each other. As well, the dollar reductions in the risk-adjusted NPVs as the degree of risk aversion increases are also very similar across all three specifications. For instance, the reduction in moving from $R=0$ to $R=3$ is $4,380$ in our original specification, compared with $4,810$ and $4,930$ for Models A and B, respectively. Hence, our basic conclusions concerning the profitability of higher
education and how it is affected by adjustments for risks are not altered by the inclusion of job dummies.

Finally, in this section, we consider the sensitivity of the results to the distributional assumption of the residuals. Recall that in Section 5.4, the income distribution of a particular educational group at each age is generated by first obtaining the variance of the residual $\sigma^2$ from the OLS regression. By repeatedly sampling the error terms from a normal distribution with zero mean and variance $\sigma^2$, then adding each of these errors to the OLS prediction of the log of earnings at that age, and finally taking the exponential of the sum, the income distribution is generated. This procedure requires the assumption that the earnings of individuals at each age (in logarithms) be normally distributed. An alternative non-parametric procedure for generating the income distribution at each age is to save the actual residuals from the regression in a set. The error term is then randomly drawn from this set (with replacement), instead of from the normal distribution. In this way, we let the data dictate the shape of the distribution. Table A5.2.4 shows the risk premiums corresponding to the alternative income streams as well as the NPV to higher education calculated using this procedure. As with the other tables in this section, the risk of failure is included in the calculations.
TABLE A5.2.4: RISK PREMIUMS & NPV OF HIGHER EDUCATION WITH NON-PARAMETRIC ERROR DISTRIBUTIONS

<table>
<thead>
<tr>
<th>R</th>
<th>RISK PREMIUM</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>140</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>280</td>
<td>190</td>
</tr>
<tr>
<td>3</td>
<td>420</td>
<td>290</td>
</tr>
<tr>
<td>4</td>
<td>560</td>
<td>390</td>
</tr>
<tr>
<td>5</td>
<td>700</td>
<td>480</td>
</tr>
</tbody>
</table>

Three major points of interest may be noted from the figures presented in the above table. First, the magnitude of the risk premiums are notably smaller than the corresponding figures in Table 5.6. This is probably the result of the normal distribution being unbounded, whereas the error distribution generated from the actual residuals is bounded.

The second noteworthy point, which follows from the first, is that the adjustment for risk becomes relatively less important than with the normal distribution. Nevertheless, it is still true that higher education is less attractive as a result of the uncertainty in future incomes, and the risk of failure.

Finally, we note that the expected NPV (i.e. NPV at R=0) is slightly lower in the non-parametric case than in the case of the normally-distributed errors. For the range of degrees of risk-aversion presented here, however, higher education is still a profitable venture even for the most risk-averse.

Summing up, the results in this appendix show that quantitatively the estimates of the risk premiums and the risk-adjusted NPV to higher education in Section 5.4 are sensitive to the specifications of the utility and earnings functions, and the distributional assumption concerning the error term. Qualitatively,
however, the main conclusions appear to be quite robust. That is, taking into account uncertainty reduces the attractiveness of higher education, but for moderately risk-averse individuals, this reduction is small, and does not change the proposition that higher education is financially, a sound investment.
APPENDIX 7.1

COST OF RISK-BEARING WITH UNCERTAINTY IN HOURS WORKED UNDER ALTERNATIVE FEE-REGIMES

TABLE A7.1.1: COST OF RISK-BEARING WITH UNCERTAINTY IN HOURS WORKED (1988-89 DOLLARS)

<table>
<thead>
<tr>
<th>R</th>
<th>No Fees</th>
<th>HECS</th>
<th>LIB</th>
<th>Full Fees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7120</td>
<td>7100</td>
<td>7570</td>
<td>12600</td>
</tr>
<tr>
<td>2</td>
<td>14240</td>
<td>14190</td>
<td>15130</td>
<td>25200</td>
</tr>
<tr>
<td>3</td>
<td>21360</td>
<td>21290</td>
<td>22700</td>
<td>37790</td>
</tr>
<tr>
<td>4</td>
<td>28470</td>
<td>28390</td>
<td>30270</td>
<td>50390</td>
</tr>
<tr>
<td>5</td>
<td>35590</td>
<td>35480</td>
<td>37830</td>
<td>62990</td>
</tr>
</tbody>
</table>

(1988-89 DOLLARS)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost of Uncertainty associated with</td>
<td>Cost of Risk-Bearing</td>
<td>Cost of Uncertainty associated with</td>
</tr>
<tr>
<td></td>
<td>attending university</td>
<td>not attending university</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>23690</td>
<td>19340</td>
<td>4350</td>
</tr>
<tr>
<td>1</td>
<td>47380</td>
<td>38680</td>
<td>8690</td>
</tr>
<tr>
<td>2</td>
<td>71060</td>
<td>58020</td>
<td>13040</td>
</tr>
<tr>
<td>3</td>
<td>94750</td>
<td>77360</td>
<td>17390</td>
</tr>
<tr>
<td>4</td>
<td>118440</td>
<td>96700</td>
<td>21740</td>
</tr>
</tbody>
</table>
APPENDIX 8.1

DEFINITION OF VARIABLES AND REGRESSION RESULTS

DEFINITION OF VARIABLES

IND1 = Agriculture, Mining
IND2 = Manufacturing
IND3 = Electricity, Gas, Water, Construction
IND4 = Wholesale, Retail, Trade
IND5 = Transport, Storage, Communication
IND6 = Finance, Property, Business Services
IND7 = Public Administration, Defence
IND8 = Health
IND9 = Community and Personal Services
OCC1 = Managers, Administrators
OCC2 = Professionals
OCC3 = Para-Professionals
OCC4 = Clerks, Salespersons, Personal Service Workers
OCC5 = Other Occupations

AGE = dummy variable which takes the value 1 for 25-29 year-olds
TABLE A8.1.1: PARAMETER ESTIMATES OF EARNINGS FUNCTIONS

**DEPENDENT VAR:** Log(Annual Income)

**SAMPLE:**
- 20-24 yr-old males from 1976 cross-section
- 25-29 yr-old males from 1981 cross-section

**DATA DESCRIPTION:** See Estimation Procedure (below).

<table>
<thead>
<tr>
<th></th>
<th>Degree-Holders</th>
<th>High-School Leavers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IND1</strong></td>
<td>8.039 (0.248)</td>
<td>8.126 (0.112)</td>
</tr>
<tr>
<td><strong>IND2</strong></td>
<td>9.181 (0.197)</td>
<td>8.905 (0.114)</td>
</tr>
<tr>
<td><strong>IND3</strong></td>
<td>9.203 (0.213)</td>
<td>8.929 (0.128)</td>
</tr>
<tr>
<td><strong>IND4</strong></td>
<td>8.938 (0.200)</td>
<td>8.261 (0.107)</td>
</tr>
<tr>
<td><strong>IND5</strong></td>
<td>9.140 (0.239)</td>
<td>8.924 (0.127)</td>
</tr>
<tr>
<td><strong>IND6</strong></td>
<td>8.984 (0.198)</td>
<td>8.831 (0.119)</td>
</tr>
<tr>
<td><strong>IND7</strong></td>
<td>9.275 (0.201)</td>
<td>8.931 (0.123)</td>
</tr>
<tr>
<td><strong>IND8</strong></td>
<td>9.321 (0.214)</td>
<td>8.753 (0.190)</td>
</tr>
<tr>
<td><strong>IND9</strong></td>
<td>8.909 (0.194)</td>
<td>8.695 (0.123)</td>
</tr>
<tr>
<td><strong>Occ2</strong></td>
<td>0.061 (0.189)</td>
<td>-0.021 (0.157)</td>
</tr>
<tr>
<td><strong>Occ3</strong></td>
<td>-0.160 (0.225)</td>
<td>0.002 (0.128)</td>
</tr>
<tr>
<td><strong>Occ4</strong></td>
<td>-0.249 (0.198)</td>
<td>-0.019 (0.109)</td>
</tr>
<tr>
<td><strong>Occ5</strong></td>
<td>-0.734 (0.205)</td>
<td>-0.174 (0.106)</td>
</tr>
<tr>
<td><strong>Age*Ind1</strong></td>
<td>1.464 (1.218)</td>
<td>0.570 (1.017)</td>
</tr>
<tr>
<td><strong>Age*Ind2</strong></td>
<td>0.180</td>
<td>0.227</td>
</tr>
<tr>
<td>Variable</td>
<td>Coefficient 1</td>
<td>Coefficient 2</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Age*Ind3</td>
<td>0.132</td>
<td>0.182</td>
</tr>
<tr>
<td></td>
<td>(1.027)</td>
<td>(1.292)</td>
</tr>
<tr>
<td>Age*Ind4</td>
<td>0.473</td>
<td>0.176</td>
</tr>
<tr>
<td></td>
<td>(0.924)</td>
<td>(0.953)</td>
</tr>
<tr>
<td>Age*Ind5</td>
<td>0.245</td>
<td>0.219</td>
</tr>
<tr>
<td></td>
<td>(1.049)</td>
<td>(1.166)</td>
</tr>
<tr>
<td>Age*Ind6</td>
<td>0.300</td>
<td>0.304</td>
</tr>
<tr>
<td></td>
<td>(0.855)</td>
<td>(1.112)</td>
</tr>
<tr>
<td>Age*Ind7</td>
<td>0.198</td>
<td>0.215</td>
</tr>
<tr>
<td></td>
<td>(0.890)</td>
<td>(1.195)</td>
</tr>
<tr>
<td>Age*Ind8</td>
<td>0.312</td>
<td>0.350</td>
</tr>
<tr>
<td></td>
<td>(0.945)</td>
<td>(2.211)</td>
</tr>
<tr>
<td>Age*Ind9</td>
<td>0.235</td>
<td>0.322</td>
</tr>
<tr>
<td></td>
<td>(0.861)</td>
<td>(1.133)</td>
</tr>
<tr>
<td>Age*Occ2</td>
<td>-0.070</td>
<td>0.107</td>
</tr>
<tr>
<td></td>
<td>(0.796)</td>
<td>(1.432)</td>
</tr>
<tr>
<td>Age*Occ3</td>
<td>-0.162</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>(1.149)</td>
<td>(1.285)</td>
</tr>
<tr>
<td>Age*Occ4</td>
<td>-0.050</td>
<td>-0.079</td>
</tr>
<tr>
<td></td>
<td>(0.886)</td>
<td>(0.967)</td>
</tr>
<tr>
<td>Age*Occ5</td>
<td>0.295</td>
<td>-0.114</td>
</tr>
<tr>
<td></td>
<td>(1.138)</td>
<td>(0.965)</td>
</tr>
</tbody>
</table>

SEE: 0.631 (1.045)  SD (dep var): 1.391 (1.584)  n: 510 (734)

* standard errors in ()
Estimation Procedure

Data from the 1976 Census were available only in the form of cross-classified tables. MTX32 was used in this exercise. Only records pertaining to male degree-holders in the 20-24 age group were extracted. The data were then condensed so that they were cross-classified only by industry (9 categories), occupation (5 categories), and income (14 categories). Records for "not stated" or "not applicable" in any of the three factors were eliminated. This gave us a total of 630 records.

For 1981, the unit record was used. Only male graduates in the 25-29 age category were extracted. Income figures were converted to 1976 dollars, and the data were then transformed into a cross-classified tabulation similar to the 1976 data. This gave us another 630 records.

The two data sets were then merged, with a flag identifying the year, and records with zero frequencies (i.e. no individuals with that particular combination of factors) were eliminated. The total number of records after this procedure was 510. Each of these records was subsequently used as an observation point in the regression with the frequency associated with that record as the weight [see Kmenta (1971) Section 9.2].

The estimation for high-school leavers follows the same procedure.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agric &amp; Mining</td>
<td>5.74</td>
<td>6.89</td>
<td>4.79</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>16.97</td>
<td>21.59</td>
<td>16.22</td>
</tr>
<tr>
<td>Elec, Gas, Water, Construc</td>
<td>8.97</td>
<td>6.89</td>
<td>6.16</td>
</tr>
<tr>
<td>Wholesale, Retail, Trade</td>
<td>17.33</td>
<td>21.36</td>
<td>20.04</td>
</tr>
<tr>
<td>Transpt, Stor, Communication</td>
<td>9.21</td>
<td>8.90</td>
<td>9.31</td>
</tr>
<tr>
<td>Finan, Prpty, Busns Svcs</td>
<td>15.65</td>
<td>12.54</td>
<td>16.84</td>
</tr>
<tr>
<td>Public Admin, Defence</td>
<td>13.49</td>
<td>8.20</td>
<td>7.80</td>
</tr>
<tr>
<td>Health</td>
<td>2.18</td>
<td>2.09</td>
<td>1.60</td>
</tr>
<tr>
<td>Commun &amp; Personal Svcs</td>
<td>10.47</td>
<td>11.53</td>
<td>15.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occupation</th>
<th>1976</th>
<th>1981</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers &amp; Administrators</td>
<td>6.86</td>
<td>4.88</td>
<td>6.11</td>
</tr>
<tr>
<td>Professionals</td>
<td>4.14</td>
<td>4.64</td>
<td>6.12</td>
</tr>
<tr>
<td>Para-Professionals</td>
<td>10.50</td>
<td>6.42</td>
<td>7.27</td>
</tr>
<tr>
<td>Clerks, Salespersons &amp; Personal Service Workers</td>
<td>43.14</td>
<td>39.86</td>
<td>39.63</td>
</tr>
<tr>
<td>Others</td>
<td>35.36</td>
<td>44.29</td>
<td>40.87</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Number of observations: population 223 207