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Working Paper No. 2004/1, Measuring the Stock of Human Capital for Australia

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Working Paper No. 2004/1, Measuring the Stock of Human Capital for Australia

February 2004

Hui Wei

This Working Paper is intended to make the results of current research available to other interested parties.The aim is to present accounts of developments and research work or analysis of an experimental nature so as to encourage discussion and comment.

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PREFACE

ABSTRACT

Human capital is an important concept in modern economics and in economic policy discourse. Unfortunately, direct measures of human capital stocks are available for very few countries. This paper provides experimental measures of the stock of human capital for Australia.

The paper adopts a 'lifetime labour income approach'. This method measures the stock of human capital as the discounted present value of expected lifetime labour market income. Expected income streams are derived by using cross-sectional information on labour income, employment rates and school participation rates. This approach is also able to account for the effect on human capital formation of current schooling activities — that is, it can account for additional human capital embodied in those individuals who are still participating in formal schooling and who anticipate improved employment and income prospects as a result.

Using the full Australian Census data for 1981, 1986, 1991, 1996 and 2001, this study provides five snapshots of age-earnings profiles for four categories of educational attainment for both men and women over this 20-year period. Based on these age-earnings profiles, this study derives per capita measures of lifetime labour market incomes for each age/sex/education cohort, and applies these per capita measures to the number of people in the corresponding cohort. It then aggregates across all cohorts to estimate the human capital stock for Australia. The study results show that there has been a significant increase in the stock of human capital in Australia over the 20-year period, characterised by sharply rising shares of total human capital attributable to more educated workers. It also shows that the value of human capital stock is significantly greater than that of physical capital.

It is emphasized that all computations of human capital in this publication represent experimental estimates. The Australian Bureau of Statistics welcomes feedback on this study. Comments should be provided to Hui Wei on email <hui.wei@abs.gov.au> or telephone (02) 6252 5754.

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Hui Wei

SECTION 1 INTRODUCTION

INTRODUCTION

In the Australian System of National Accounts (ASNA), measures of capital stocks are confined to physical capital. It is not yet standard practice for any official statistical agency to include human capital in their capital stock measures. Although human capital is one of the most important assets of a country and a key determinant of a nation's economic performance, it is left unaccounted for in the national accounts. This is because there is a lack of consensus about how this important economic variable should be measured. Even if such consensus was achieved, there would still be many methodological difficulties to overcome. Indeed, human capital is different from physical capital, and this lies at the foundation of the difficulties encountered in measuring human capital. The following quotation from the System of National Accounts 1993 (paragraph 1.52.) sheds light on the reason why measures of human capital are still missing from the ASNA:

> '...while knowledge, skills and qualifications are clearly assets in a broad sense of the term, they cannot be equated with fixed assets as understood in the System (of National Accounts)... Education assets are embodied in individuals as persons. They cannot be transferred to others and cannot be shown in the balance sheets of the enterprises in which the individuals work. Education assets could possibly be shown in balance sheets for the individuals in which they are embodied, but individuals are not enterprises. They would be difficult to value...'

Of course, a number of Australian Bureau of Statistics (ABS) publications provide statistics relevant to human capital formation in Australia, for example, statistics on education and training activities, the labour force, and expenditures on education by governments and households. This paper presents systematic but still experimental measures of the stock of human capital for Australia.

The concept of human capital has been popular in economic theory and practice for nearly forty years since the publication of seminal works by Schultz (1961) and Becker (1964). The human capital model is applied in many fields of economics for example, in economic growth theory, income distribution analysis, and labour market studies.[1] In empirical studies, economists have employed various measures of human capital to test theories and hypotheses. For instance, empirical analyses of international differences in growth rates have adopted various measures of formal education activities as proxies for human capital. Some of these measures include: school[2] enrolment rates, average years of schooling, educational attainment, and government expenditures on education.

1 Mincer (1995) provides a thoughtful discussion of the role of human capital theory in new growth theory and labour economics.

2 Here school is a generic term for all formal education. According to Becker (1964), 'A school can be defined as an institution specializing in the production of training, as distinct from a firm that offers training in conjunction with the production of goods.' The associated term 'schooling' should be interpreted in this context.

INTRODUCTION
continued

It would be hard to imagine that these investigations were not sensitive to alternative measures or proxies of human capital.[3] Hence one important issue that arises in considering the effect of human capital on other economic variables is how should the stock of human capital be measured? This study uses the lifetime labour income method as developed by Jorgenson and Fraumeni (1989, 1992a, 1992b) to measure the stock of human capital for Australia. The lifetime labour income method measures the human capital embodied in individuals as the total income that they could generate in the labour market over their lifetime. This approach views labour incomes as monetary returns to investments in human capital. As education is one of the most important forms of investment in human capital, the measures developed in this paper include not only the value embodied in 'finished products', but also the value inherent in 'unfinished products'. The 'finished products' are those individuals who have already obtained their highest educational attainment. The 'unfinished products' are those individuals who are still participating in formal schooling and who anticipate improved income and employment prospects as a result of this schooling. The contribution to income of investments in education is captured through comparing incomes of individuals with identical age/sex characteristics but different amounts of educational attainment. Estimates of the potential value of current schooling in addition to estimates of the value of past schooling are an important feature of this study.

Empirical estimates of physical capital stock, particularly that produced on 'own account', are often derived by cost methods, which value capital using information on expenses incurred in its production.[4] The method is popular because of the general availability of expenditure data on capital goods, and it is still a standard accounting practice in much financial and management reporting. However, there are a number of issues associated with the cost-based approach to measuring human capital. First, there is the assumption that the value of an output is equal to the costs of its inputs. This may not be an appropriate assumption for human capital where, for example, the value of wages foregone might be a poor proxy for the 'intellectual' input made by the student. Second, even if a reasonable value of human capital can be obtained from the cost-based approach at the time of the 'creation' of the human capital, there is the challenge of how to measure the reduction of the value of the asset over time (i.e., its depreciation). Third, the application of the cost method to valuing the human capital embodied in an individual encounters a particular problem: how to distinguish between the consumption and investment components of an educational expense?[5] The market returns to human capital — wages and salaries — are, however, readily observable in the labour market, and so the yield method, applied in this paper, may be a more suitable approach to measuring human capital.

The paper is structured as follows: Section 2 introduces the method used to estimate human capital and details the estimation procedures. Section 3 describes the data sources and presents summary information on key variables used. Section 4 shows experimental estimates of the stock of human capital for Australia. Section 5 summarises the findings and outlines some proposals for future research.

3 See Hanushek and Kimko (2000) for a discussion of the explanatory power of alternative measures of human capital for economic growth theory.

4 Kendrick (1976) is a seminal example of the cost approach applied to physical capital valuation.

5 Schultz (1961) provides a detailed discussion of this problem and suggests that because of this problem the cost method is less useful for measuring human capital than it is for measuring physical capital.

SECTION 2 METHODOLOGICAL APPROACH

2.1 JORGENSON AND FRAUMENI APPROACH

As noted in the Introduction, this study closely follows the method proposed by Dale Jorgenson and Barbera Fraumeni (hereafter referred to as JF), using expected future earnings to value human capital. Very broadly, the estimation follows these three steps:

1. Construct a database showing the economic value of market labour activities for various groups of people. This database includes demographic accounts for all individuals, cross-classified by sex, age, and educational attainment. The data items include the number of people, market labour income, employment rate and education participation rates.

2. Use this database to model the time-paths of the income stream for wage and salary earners. The basic notion is that individuals with a certain age and level of educational attainment will base their expectations of earnings next year on the observed earnings today of people who are one year older, possess the same educational qualifications and are the same sex. So, for example, one might assume that next year's income for 45-year-old men with PhDs is approximated by this year's income for 46-year-old men with PhDs. Of course, other factors are also considered in the estimation, such as the income growth rate, survival rate, employment rate and discount rate.

3. Apply per capita measures for wage and salary earners to all individuals in the population (including employers, the self-employed and people outside the labour force). Compute the discounted future income stream for each group of people, and sum them to estimate the aggregate value of human capital stock.

2.2 MODIFICATIONS

In applying the JF method to Australian data, a number of modifications have been made:

1. One important innovation introduced by JF is the imputed valuation of nonmarket labour activities from information on market labour activities. There are many other forms of returns to human capital, such as the values created in unpaid household production, and potentially, leisure. How to value nonmarket labour activities is a contentious issue. The JF model assumes that the value of time spent in unpaid household production or at leisure for any given age/sex/education group is the same as the value of time spent working. This choice attracts understandable criticism. For example, Rothschild (1992) 'doubt(s) that within the audience at a football game (or an opera) the quality of the experience varies directly with the market wage.' Or is it appropriate to value a PhD holder's work in the garden at a higher rate than that for someone who only completed secondary education? In order to avoid these complications, the estimates of human capital in this paper are confined to market

2.2 MODIFICATIONS *continued*

labour activities. The valuation of nonmarket activities is beyond the scope of the present study. A future extension of this study might address this issue.[6]

2. In the JF method, educational attainment is measured in calendar years of schooling. While a measure of formal schooling in calendar years can simplify mathematical manipulations and empirical computations, it does have the limitation of mixing up alternative kinds of education of the same length. For example, someone without a post-school qualification could choose to study for a Technical and Further Education (TAFE) qualification or a university degree. In the JF method, this individual's one year of study at TAFE or university is treated as identical, and thus the returns to TAFE or university study are assumed to be the same. In the present study, educational attainment is measured using various institutional qualifications. Using levels of highest qualification completed as a measure of formal schooling, we hope to capture the impacts of alternative levels of education on human capital formation.

3. Jorgenson and Fraumeni accounted for all individuals in the USA. However, this experimental study focuses on the Australian adult working age population, defined as everyone aged between 25 years and 65 years. Again there are other possibilities. The ABS Labour Force Survey, for example, looks at the 15–64 year age group. Others look at 18–64 year olds. The age someone has formed their basic productive capacity (human capital skills) and the age at which they cease productive activity are the key issues to consider. Obviously, there are no straightforward answers. As modern economies are characterized by rapid technological changes and increasing demand for skilled labour, more and more people choose to allocate more time to investments in their human capital and therefore delay joining the labour force. In the present study 25 years was chosen as the age at which individuals actively pursue productive activities and 65 years as the age at which they retire.[7] This somewhat arbitrary choice, while not crucial, could easily be relaxed and extended to other age groups. A future update may undertake sensitivity analyses of the impact of the choice of age groups on the stock value of human capital.

2.3 FORMAL MODEL

As this study is confined to the adult population, only two stages of the life cycle are considered: a work-study stage and a work-only stage. The work-study stage is defined as the age range 25–34 years, and the work-only stage as 35–65 years.

Consider any age/sex/education cohort in the work-only stage, whose members can, by assumption, take only one course of action: work. The present value of lifetime labour income per capita is given by:

$$(1) \qquad mi_{y,s,a,e_i} = ymi_{y,s,a,e_i} + sr_{y,s,a+1} * mi_{y,s,a+1,e_i} * (1+g)/(1+r)$$

6 In valuing unpaid household work, the ABS (ABS, 2000) recommends the market replacement cost approach, i.e. what it would cost households to hire others to do household work for them, in preference to the opportunity cost approach, i.e. what households would have earned in wages had they spent the same amount of time on paid work as actually spent on unpaid work.

7 OECD (1998) made the similar choice.

2.3 FORMAL MODEL *continued*

Where

mi = lifetime market labour income per capita,
y = Australian Census years (1981, 1986, 1991, 1996, 2001),
s = sex,
a = age (25, 26, ..., 64, 65),
e_i = educational attainment at level [i](higher degree, bachelor degree, skilled labour, unqualified[8]).
ymi = annual market labour income per capita,
sr_x = probability of survival to age x,
g = real income growth rate,
r = discount rate.

It is assumed that there exists an age limit a^* at which all individuals will retire and their lifetime labour incomes are set to zero (this study sets a^* at 66 years old). Once the age limit is set, Equation 1 is well defined by backward recursion: first, the lifetime labour income per capita of a cohort of the oldest working age (65 years) is estimated, followed by an estimate for the cohort with the next highest working age (64 years) and so on.

During the work-study stage, individuals pursue two possible courses of action: work and study. Since these two activities yield two possible earnings streams, annual labour incomes and hence lifetime labour incomes for any given cohort, are a linear combination of the two streams. Furthermore, study may take various forms and occur at different times. For instance, a youth with secondary qualifications may embark on university or TAFE study, and a university student may be in the first year or final year of study. All these scenarios are associated with alternative earnings streams. As a result, an earnings stream stemming from study activity is treated as a linear combination of earnings streams associated with various types of studies with different study periods. Hence, the present value of lifetime labour income per capita for any given cohort in the work-study stage is given by:

$$
\begin{aligned}
mi_{y,s,a,e_i} &= ymi_{y,s,a,e_i} \\
&\quad + (1 - \sum_{j \in E} \sum_{t \in T} senr^{jt}_{y,s,a,e_i}) * sr_{y,s,a+1} * mi_{y,s,a+1,e_i} * (1+g)/(1+r) \\
&\quad + \sum_{j \in E} \sum_{t \in T} senr^{jt}_{y,s,a,e_i} * sr_{y,s,a+t} * mi_{y,s,a+t,e_j} * \{(1+g)/(1+r)\}^t
\end{aligned}
\qquad (2)
$$

Where

$senr^{jt}$ =the percentage of those individuals with educational attainment e_i undertaking formal schooling at level e_j in its tth period (e_j is higher level than e_j),
E = all choices of additional advanced studies facing individuals with educational attainment e_i,
T = calendar years of study periods for obtaining educational attainment of level e_j.

Equation 2 is based on the assumption, often adopted in empirical human capital research, that during the study period students' direct schooling costs are exactly offset by their part-time earnings.[9] This simplifies the calculation process and is unlikely to have a major influence on the aggregate estimates of human capital stock.

8 See Appendix 3 for details in regard to the definitions of these educational categories.
9 See Mincer (1974), pp. 7–8.

2.3 FORMAL MODEL *continued*

The aggregate human capital stock, embodied in the adult-population in a given year, is given by

$$
\begin{aligned}
mi_{y,s,a,e_i} &= ymi_{y,s,a,e_i} \\
&+ (1 - \sum_{j \in E} \sum_{t \in T} senr^{jt}_{y,s,a,e_i}) * sr_{y,s,a+1} * mi_{y,s,a+1,e_i} * (1+g)/(1+r) \\
&+ \sum_{j \in E} \sum_{t \in T} senr^{jt}_{y,s,a,e_i} * sr_{y,s,a+t} * mi_{y,s,a+t,e_j} * \{(1+g)/(1+r)\}^t
\end{aligned}
\qquad (3)
$$

Where

EA = all categories of educational attainment — higher degree, degree, skilled labour and unqualified,

N = the number of people in a cohort.

2.4 RELATED ISSUES AND PRACTICAL CHOICES

The formal model presented above leaves many related issues unspecified. These include the way expectations of future income paths are formed, the average lengths of study, and the scope of people who should be evaluated when accounting for human capital.

(1) *Expectations of future incomes.* The ideal computation of lifetime labour income requires information on the future. Because such information does not exist, one has to settle for making inferences about future income from observations on current and past income. Equation 2 implies that the expectations of future income are best approximated by observing current cross-section age-income profiles and long-term real income growth. This assumption is problematic if the current period is not in a steady state: in recession years, higher unemployment and depressed wages mean expectations of future income are pessimistic and lead to the underestimation of the true value of human capital. In booming years, expectations are optimistic and lead to the overestimation of the true value of human capital. Moreover, there may be some cohort effect, which means a degree holder born in the late 1950s for example, might not be expected to follow the same income stream as their counterparts born in the early 1960s. One might try to estimate any cohort effect by using a regression based approach which uses all available current and past observations on cross-sectional age-incomes profiles to estimate future income streams. However, this too poses a problem: past information is less relevant than current information when estimating expected future income, and historical patterns might not repeat themselves. This is a tricky issue that we might research further in time.

We are unaware of a problem-free approach, and so this study generally follows the JF method of projecting future income streams from current cross-sectional age-income profiles. One modification has been made to use average unemployment rates over the long term to try to remove some of the biases in the estimates induced by the business cycle. This approach removes the influence of changes in unemployment, but changes in wages brought on by recession, for example, still have an influence. Specifically, the average unemployment rate over the period 1981 to 2001 has been used for calculating human capital in any of the intervening census years. One school of thought might argue that, for each estimate year, an average unemployment rate using data for earlier years should have been used, rather than one that has a forward looking element. This is because, in 1991 for example, people would have based their decision on whether to invest in human capital on the information available to them at the time; they would not

2.4 RELATED ISSUES AND PRACTICAL CHOICES *continued*

have known the unemployment rate for degree holders in 1996 or 2001. Section 4.1 provides details on how the practical choices have been made.

(2) *Population or the Labour Force*. As is well known, all individuals in the population are classified as either 'in the labour force' or ' not in the labour force', with the former category further divided into 'employed' and 'unemployed'. Should all individuals in the population or only those in the labour force be accounted for in our measurement of the stock of human capital at any point in time? To address this issue, we need to discuss the importance of human capital for economic prosperity and social development.

The conventional approach of human capital theory, originated and developed by classical economists, such as Schultz (1961) and Becker (1964), links the acquisition and development of skills embodied in human agents of production to productivity growth and the personal distribution of earnings. For example, the basic objective of Mincer (1974) " is to gain some understanding of the observed distributions and structures of earnings from information on the distribution of accumulated net investments in human capital among *workers*". The recent growth literature, represented by Lucas (1988), has emphasized the importance of human capital formation through education and training in the process of economic growth and development. In doing so, these growth models include the stock of human capital as a key explanatory variable in accounting for economic growth and development differentials between many countries over different periods: it is the human capital embodied in those who are in the labour force which is of interest for the purposes of growth or productivity analyses.

Some empirical measurements of human capital are confined to the labour force. For example, in their measurement of aggregate human capital for the United States, Mulligan and Sala-i-Martin (1997) only account for economically active workers. Marchand and Thelot (OECD,1998) only use the numbers of individuals in the labour force to construct an index of aggregate human capital for France, with the changing numbers of economically active individuals being treated as one key element for the growth of human capital stock over the last 200 years for France.

While the conceptual basis for excluding those not in the labour force in accounting for aggregate human capital is straight forward enough, this practice is somewhat controversial considering only the human capital of those in the labour force is a lower bound on the potential human capital in the population. The importance of human capital goes far beyond the conventional economic boundary. For example, the human capital embodied in parents not in the labour force (perhaps women especially), has a key role in human capital formation through those people's contribution to educating children. Some authors include all individuals in the population in their accounting for the aggregate human capital. Jorgenson and Fraumeni (1989) is an extreme example: not only do they account for those not in the labour force but also for children including newly born babies.

Population-based measures of human capital are an upper bound on the potential value of human capital. There will probably always exist some people who have never, or will never again, be in the labour force and so could be excluded from the estimates.

2.4 RELATED ISSUES AND PRACTICAL CHOICES *continued*

Accordingly, two sets of estimates of human capital have been constructed for Australia: the first is based on the number of people in the labour force; the other is based on everyone in the Australian population (aged 25–65 years).

(3) *Lengths of Investment Periods in Education*. To empirically implement Equation 1 and Equation 2 specified in section 2.3, one needs to specify the categories of educational attainment and age groups and one also needs to make certain assumptions about length of study.

For users of ABS education and training data, it should be remembered that the classifications and terms used in the human capital literature are different to the standard ABS education and training classifications and terms. The classifications used in this paper are broader than the Australian Standard Classification of Education classifications, to allow some comparability over time. The way the standard classifications have been aggregated is outlined in Appendix 3. Because of this, the presentation of education and training statistics in this paper is not consistent with education and training statistics presented in other ABS education and training publications.

As in any investment analysis that requires information on the length of alternative investment options, one needs to specify the study periods for obtaining different educational qualifications. This study uses the following assumptions about investment periods in education:

1. The study period for a higher degree is two years, conditional on holding a bachelor degree.
2. The study period for a bachelor degree is three years for an unqualified person, two years for a skilled labourer.
3. The study period for a skilled labour qualification is two years.
4. Individuals can only study for an educational qualification higher than one they already have. For example, if someone with a science degree later studies for an economics degree, the model will treat this kind of schooling (schooling in addition to the science degree) as higher degree study.
5. The number of students enrolled in any kind of education that requires more than one period are evenly distributed among different study stages. For example, half of the higher degree students are assumed to be in their first year, the other half in their last year of study.

Many of these assumptions are somewhat arbitrary, and alternative estimates could be generated using different assumptions. As discussed later, further work could assess the sensitivity of the experimental findings to the assumptions made.

(4) *Constant Price Measurements*. In order to compare measures of human capital over time, current price measures have to be converted into constant price measures. In doing so, the ABS Consumer Price Index (CPI) has been used. There are alternative deflators, such as the GDP deflator. But given that consumption is one of the main objectives of labour income, it seems appropriate to use the CPI.

(5) *Gross Measures of Human Capital Stock*. Whether maintenance costs should be deducted from the gross measures of human capital stock is a debatable issue. If human capital is measured analogously to physical capital, then consumption expenditure associated with 'maintenance' of the asset should be deducted from labour

2.4 RELATED ISSUES AND PRACTICAL CHOICES *continued*

compensation. Some argue that if human capital is a produced asset, maintenance expenditure should be treated as an intermediate input in the production of the services from the asset. This raises two difficult questions. The first concerns the nature of maintenance costs: how much of consumption expenditure is maintenance? The food a person eats, for example, is necessary to their survival. But there is generally a utility beyond this when people consume food. On the other hand, travel to one's employment in order to secure an income stream probably provides little if any additional utility. And how does any maintenance cost vary with alternative age/sex/education groups over the different stages of the life cycle? The second more fundamental question is whether standard production theory, developed for analyzing producer behavior of normal(non-human) goods and services, should be applied to the analysis of production of human capital? Do the differences between human and non-human capital warrant different treatments? One may argue that gross measures of human capital are sufficient for reflecting the productive capacity of individuals. There are no easy and quick answers to these thorny questions. For the sake of avoiding complications, maintenance costs have not been deducted from the measures of human capital.[10]

10 Graham and Webb (1979) support the gross estimates for human capital by arguing "Given that consumption is the ultimate raison d'etre of both investment and production, it seems reasonable to consider all consumption expenditure as an end in itself rather than as a means to an end."

SECTION 3 THE CONSTRUCTION OF THE BASIC DATASET

CONSTRUCTION OF THE BASIC DATASET

To measure the stock of human capital, a database has been constructed for measuring lifetime labour incomes for all age/sex/education cohorts of the Australian adult population. The basic data come from Australian Censuses of population and housing conducted in 1981, 1986, 1991,1996 and 2001. For each age/sex/education cohort, the following variables have been derived: annual gross income, employment rate, school enrolment rate and the number of people in each cohort.

3.1 GROSS ANNUAL INCOME

Ideally, one needs labour compensation data as a measure of the price of labour services. Unfortunately, the census data only contain information on gross personal income from all sources. And so this study had to use gross income as a proxy for labour market earnings.[11] Furthermore, since the focus of this study is on the price of labour services, annual labour income per capita from weekly income data for employees has been applied to the income-age-educational qualification structure to employers and the self-employed. Appendix 4 includes results using net labour income. Here, only income tax is deducted: other levies are not deducted, and other forms of labour compensation such as superannuation are not added.

Table 3.1 reports estimated gross annual incomes in current dollars of those employed, by sex and educational attainment. These gross annual income figures were calculated as the weighted averages of the income ranges from the corresponding census questionnaire. There were substantial income disparities among the different education groups as well as between men and women. Differences in income (earnings) by education are suggested by human capital theory and are used to identify compositional change in human capital.

3.1 GROSS ANNUAL INCOMES PER CAPITA, By educational attainment and sex: **Current dollars**

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	23 599	37 874	52 217	63 316	74 019
Bachelor degree	20 629	32 269	43 897	51 835	62 856
Skilled labour	15 275	23 871	32 195	37 419	46 245
Unqualified	13 038	20 326	27 656	32 380	39 335
Female					
Higher degree	17 174	27 488	38 504	46 227	56 664
Bachelor degree	14 905	23 067	30 255	35 392	44 188
Skilled labour	10 912	16 434	22 540	26 191	31 674
Unqualified	8 551	12 987	17 528	21 862	26 933

Source: Australian Census 1981, 1986, 1991, 1996, 2001.

11 For example, Dockery and Norris (1996) adopt the same approach.

3.1 GROSS ANNUAL INCOME *continued*

Table 3.2 presents gross annual incomes in constant prices (2001 dollars), derived using the ABS Consumer Price Index.[12] Real gross annual incomes have followed a similar pattern for all male and female education groups — increasing between 1981 and 1986, falling between 1986 and 1991, and then increasing fairly rapidly from 1996 onwards.[13] The low figure for 1991 may be attributable to the recession occurring at that time.

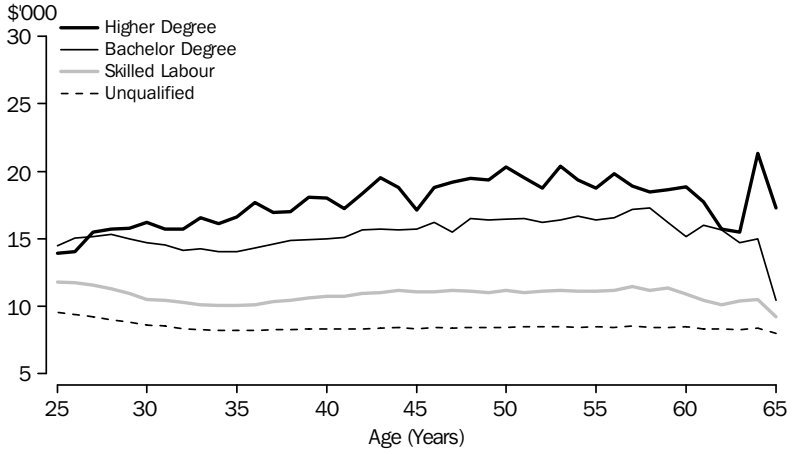
3.2 GROSS ANNUAL INCOMES PER CAPITA, By educational attainment and sex: **2001 dollars**

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	63 245	68 173	65 793	70 281	74 019
Bachelor degree	55 285	58 084	55 310	57 536	62 856
Skilled labour	40 938	42 969	40 566	41 535	46 245
Unqualified	34 941	36 586	34 847	35 941	39 335
Female					
Higher degree	46 025	49 479	48 515	51 312	56 664
Bachelor degree	39 944	41 521	38 121	39 285	44 188
Skilled labour	29 244	29 581	28 401	29 072	31 674
Unqualified	22 917	23 377	22 085	24 267	26 933

Source: Australian Census 1981, 1986, 1991, 1996, 2001.

Graphs 3.1–3.10 display gross annual income per capita for all 328 cohorts constructed from the five 1981–2001 Australian Censuses to illustrate the age-earnings profiles. The greatest jump in income occurs between those without degrees and those with degrees. The educational differences in income between the bottom two education groups are relatively small. It also shows that the annual income of more educated groups increases more sharply with age than for less educated groups. This suggests a wage premium may exist for more educated workers associated with time spent in the labour market.

3.1 GROSS ANNUAL INCOME PER CAPITA, FEMALES, 1981

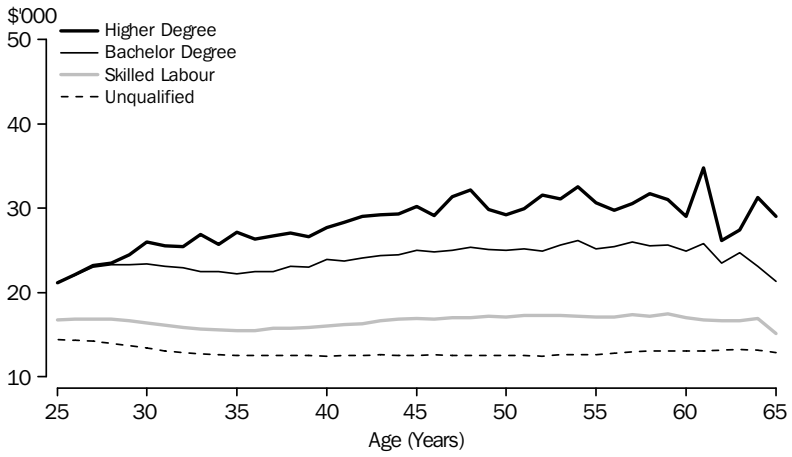


12 The alternative might be the Gross Domestic Product deflator. Given that consumption is the ultimate objective of labour income, it seems more appropriate to use price indexes of consumer goods to deflate current prices into constant dollars. See section 2.4.

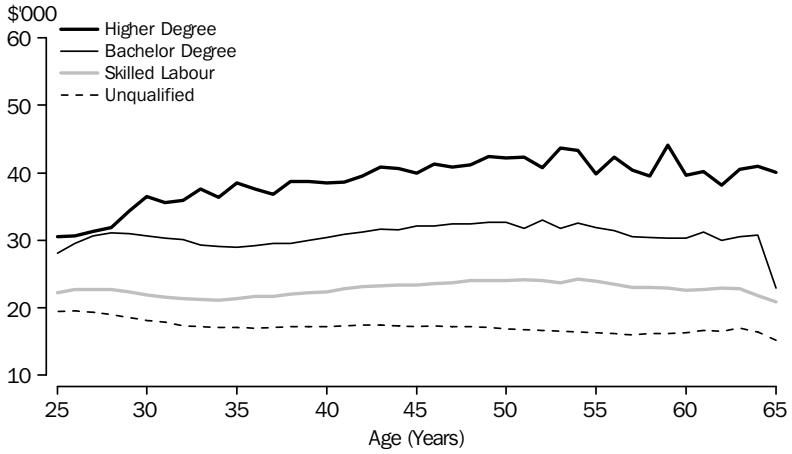
13 The fall in real labour incomes between mid-1980s and earlier 1990s in Australia was also observed by other researchers, such as Borland and Wilkins (1996).

3.1 GROSS ANNUAL INCOME *continued*

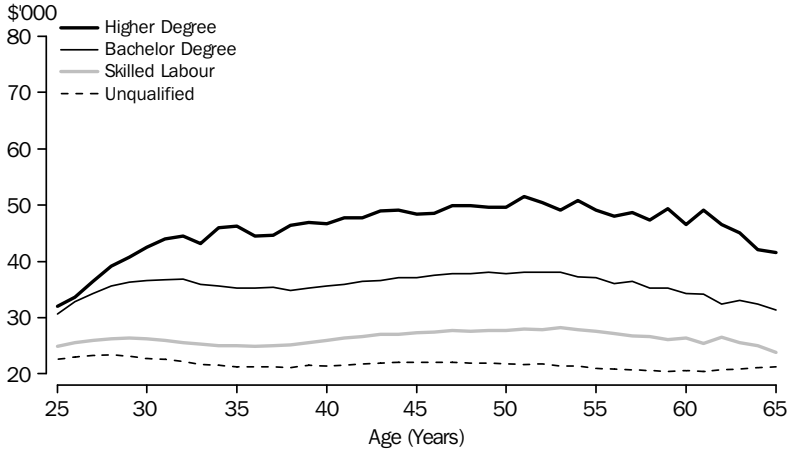
3.2 GROSS ANNUAL INCOME PER CAPITA, FEMALES, 1986



3.3 GROSS ANNUAL INCOME PER CAPITA, FEMALES, 1991



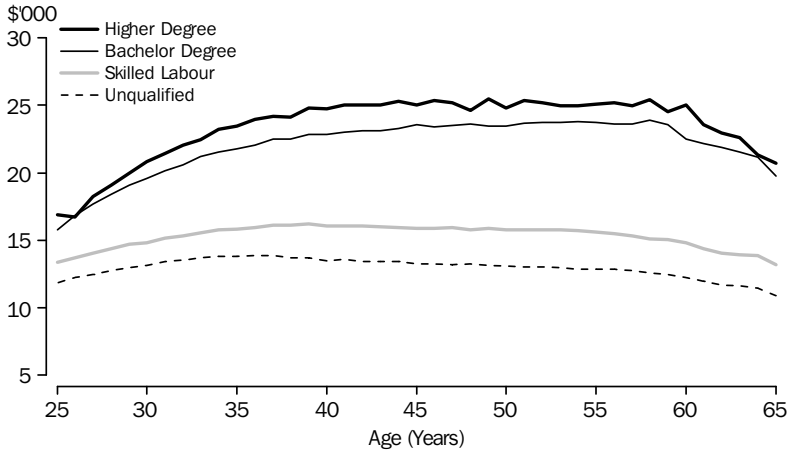
3.4 GROSS ANNUAL INCOME PER CAPITA, FEMALES, 1996



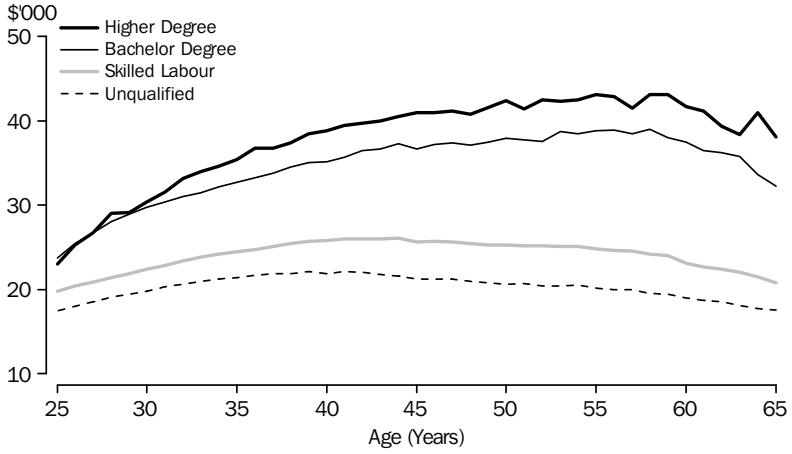
3.1 GROSS ANNUAL INCOME *continued*

3.5 GROSS ANNUAL INCOME PER CAPITA, FEMALES, 2001

3.6 GROSS ANNUAL INCOME PER CAPITA, MALES, 1981

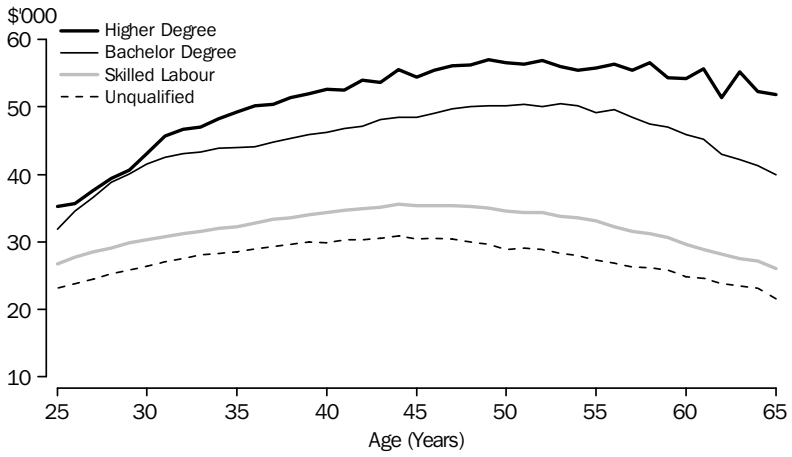


3.7 GROSS ANNUAL INCOME PER CAPITA, MALES, 1986

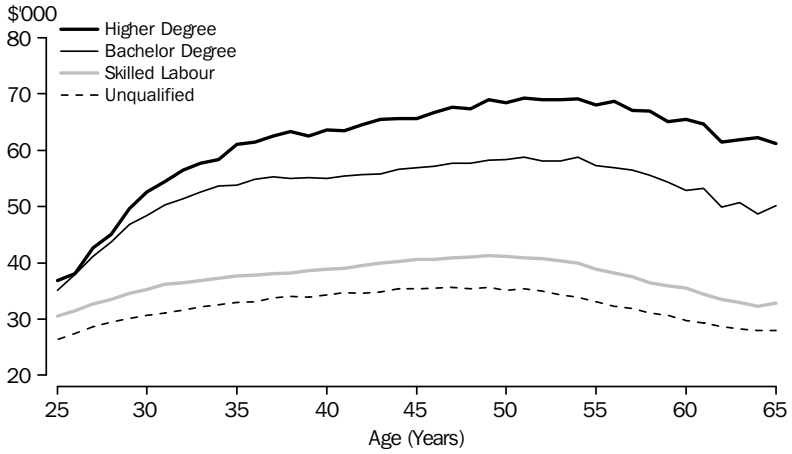


3.1 GROSS ANNUAL INCOME *continued*

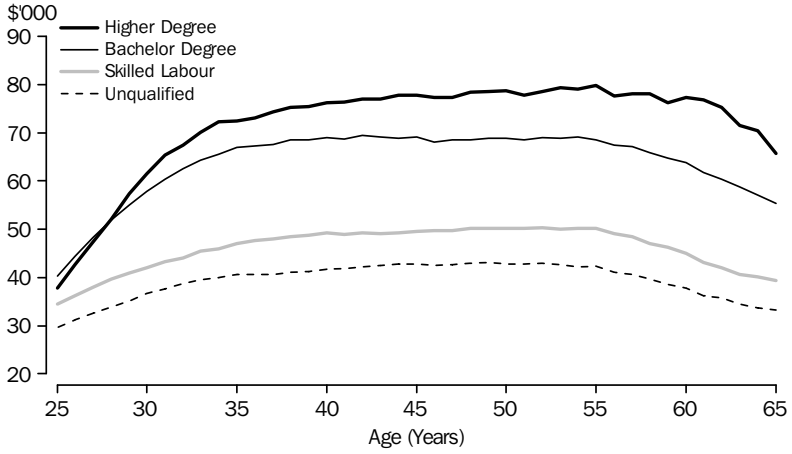
3.8 GROSS ANNUAL INCOME PER CAPITA, MALES, 1991



3.9 GROSS ANNUAL INCOME PER CAPITA, MALES, 1996



3.10 GROSS ANNUAL INCOME PER CAPITA, MALES, 2001



3.2 EMPLOYMENT RATES

Table 3.3 presents employment rates for the four education cohorts, measured as percentages of employed people among the corresponding labour force.[14] One can make three observations from these figures. First, higher educational attainment appears to be associated with higher employment rates. Second, those with lower educational attainment are hardest hit when the general employment situation worsens (especially

14 The employment rate is the inverse of the unemployment rate.

3.2 EMPLOYMENT RATES *continued*

men). For example, the male employment rate dropped nearly four per cent for unqualified people in the recession year 1991, compared with the 1986; while the corresponding decrease is just over two per cent for higher degree holders over the same period. Third, women with lower educational attainment have lower unemployment than their male counterparts. For example, in 1986, the employment rate for unqualified men is 86.6 per cent, while for unqualified women the rate is 3.6 per cent higher at 90.2 per cent. This might in part be influenced by a greater tendency among women to leave the labour force rather than remain unemployed.

3.3 EMPLOYMENT RATES, By educational attainment and sex: **Per cent**

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	98.75	98.18	96.15	96.46	96.71
Bachelor degree	98.35	97.70	95.63	96.06	96.55
Skilled labour	97.37	95.22	91.87	93.73	95.01
Unqualified	94.92	90.62	86.64	88.47	90.63
Female					
Higher degree	96.68	95.86	94.36	95.77	96.62
Bachelor degree	96.88	96.34	95.45	96.43	97.26
Skilled labour	97.13	95.20	94.15	94.72	95.15
Unqualified	95.29	91.47	90.21	91.77	93.38

Source: Australian Census 1981, 1986, 1991, 1996, 2001.

3.3 HIGHER EDUCATION ENROLMENT RATES

The proportions enrolled at higher education institutions are the most important indicators of the dynamics of educational attainment, and are commonly used as a proxy for human capital. Tables 3.4 and 3.5 present higher education enrolment rates, measured as proportions of those currently enrolled in higher education institutions among those who are qualified for undertaking that level of study. Part-time students are converted into full-time equivalents by assuming that two part-time students are equivalent to one full-time student. These figures are used for estimating the proportion of people changing income streams due to additional schooling over the life cycle. The bachelor degree enrolment rates, presented in table 3.4, are constructed as the proportions of people with no qualifications, who are attending university. It is assumed that a person, without qualifications, studies for a bachelor degree, if they are enrolled at a university. Two patterns are very noticeable from these figures. First, in the 1986–2001 period, the percentages of those enrolled at universities doubled both for men and women. Second, the percentages of the young women enrolled at universities outnumbered their male counterparts by as much as one half. This explains why, since 1996, there have been more women with bachelor degrees than men. See section 3.4 for details.

3.3 HIGHER EDUCATION ENROLMENT RATES *continued*

3.4 BACHELOR DEGREE ENROLMENT RATES(a), By age and sex: **Per cent**

Age (years)	*1986*	*1991*	*1996*	*2001*
Male				
18	10.24	14.30	19.32	20.52
19	11.65	17.65	20.62	23.30
20	11.74	17.89	20.48	24.46
21	10.20	15.72	18.21	22.19
22	7.26	11.52	13.88	17.08
23	4.79	7.82	9.84	11.67
24	3.20	5.25	6.91	8.16
25	2.32	3.72	4.78	5.76
26	1.81	2.92	3.53	4.40
27	1.59	2.37	2.86	3.55
28	1.46	1.99	2.28	2.86
29	1.32	1.72	1.94	2.50
30	1.21	1.62	1.66	2.06
31	1.12	1.54	1.47	1.84
32	1.01	1.33	1.28	1.64
33	0.93	1.31	1.24	1.44
34	0.84	1.24	1.09	1.29
Female				
18	14.16	22.13	29.60	31.51
19	15.07	25.78	31.24	35.97
20	12.67	23.70	29.72	36.97
21	7.99	15.97	22.62	30.68
22	4.56	9.13	13.86	19.77
23	2.60	5.34	7.93	11.71
24	1.63	3.42	5.06	7.73
25	1.20	2.52	3.43	5.28
26	1.01	1.93	2.72	4.01
27	0.95	1.54	2.15	3.40
28	0.82	1.42	1.88	2.52
29	0.80	1.32	1.59	2.26
30	0.80	1.23	1.42	1.95
31	0.75	1.14	1.30	1.79
32	0.73	1.06	1.17	1.68
33	0.72	1.07	1.19	1.54
34	0.71	1.08	1.15	1.34

(a) Those enrolled for degrees as a percentage of people with no post-school qualifications. The 1981 Census did not collect information on types of educational institutions attended.

Source: Australian Census, 1986, 1991, 1996, 2001.

3.3 HIGHER EDUCATION ENROLMENT RATES *continued*

3.5 HIGHER DEGREE ENROLMENT RATES(a), By age and sex: **Per cent**

Age (years)	*1986*	*1991*	*1996*	*2001*
Male				
22	20.37	22.43	22.06	25.50
23	15.54	18.05	18.63	21.83
24	12.56	15.31	15.96	19.35
25	10.99	13.76	14.86	16.97
26	9.91	12.67	13.46	14.49
27	9.26	11.43	12.65	12.82
28	8.50	10.91	11.99	11.32
29	7.60	10.05	10.95	10.19
30	6.98	9.18	10.31	9.37
31	6.86	8.40	9.52	8.61
32	6.60	7.91	9.04	8.10
33	6.12	7.43	8.46	7.82
34	5.61	7.01	8.02	7.08
Female				
22	17.66	19.15	19.16	21.43
23	12.72	14.56	15.46	18.19
24	9.42	12.45	13.21	15.80
25	8.13	10.99	12.30	13.92
26	7.59	10.02	11.60	12.04
27	6.83	9.17	10.57	10.33
28	6.88	8.63	9.76	8.97
29	5.86	7.91	9.01	8.02
30	5.91	7.58	8.62	7.45
31	5.87	7.14	8.06	6.86
32	5.50	6.69	7.57	6.48
33	6.24	6.22	7.24	6.22
34	6.27	6.03	7.05	5.98

(a) Those enrolled for higher degree studies as a percentage of those qualified for a higher degree study.

Source: Australian Censuses 1986, 1991, 1996, 2001.

Table 3.5 presents higher degree enrolment rates, constructed as the proportion of those who have obtained bachelor degrees who are currently enrolled at university. (It should be recalled that it is assumed that an individual with a bachelor degree who is enrolled at a university is studying for a higher degree.) These figures show that the percentages of those undertaking further study, after obtaining bachelor degrees, increased significantly between 1986 and 2001 for both young men and young women. Another point to note is that the proportions of young men enrolled for higher degree studies are consistently higher than their female counterparts throughout the entire period.

3.4 ADULT POPULATION AND LABOUR FORCE

As discussed in section 2.4, when estimating human capital stocks, one can consider valuing the human capital only of those in the labour force or one can value the entire population. This section compares information on all 25–65 year olds and those in the labour force.

3.4 ADULT POPULATION AND LABOUR FORCE *continued*

3.6 ADULT POPULATION (25–65 YEARS), By educational attainment and sex: '000

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	39.7	48.0	85.6	116.5	150.6
Bachelor degree	204.3	274.4	389.9	517.8	642.5
Skilled labour	1 102.9	1 257.9	1 367.9	1 482.7	1 660.6
Unqualified	2 226.2	2 371.7	2 493.5	2 530.5	2 527.8
Female					
Higher degree	10.9	15.8	33.8	60.2	98.3
Bachelor degree	111.6	179.8	353.0	543.4	772.8
Skilled labour	565.7	718.6	713.1	806.3	924.1
Unqualified	2 833.4	2 986.7	3 227.8	3 275.5	3 287.9
Persons	7 094.6	7 853.0	8 664.5	9 332.8	10 064.7

Source: Australian Census 1981, 1986, 1991, 1996, 2001.

Table 3.6 presents the total population aged between 25–65 years, classified by sex and educational attainment. These figures account for all individuals in the age range, including those not in the labour force. One can observe an increase in the working-age population of nearly 42 per cent over the period 1981–2001, with marked differentials in the growth rates of subgroups by level of educational attainment. The number of people with tertiary qualifications increased by 354 per cent over the period 1981–2001. The number of women with tertiary qualifications increased by the greatest amount, 611 per cent for the period as a whole. As a consequence of more rapid growth rates of people with higher educational attainment, the proportion of people with higher educational attainment increased dramatically, from just over five per cent in 1981 to 16.5 per cent in 2001. This increase is even stronger among women, soaring nearly 14 percentage points over this period. Consistent with this, the proportion of those with no qualifications has declined significantly over the period, with a decline of over 11 percentage points for men and nearly 16 percentage points for women.[15]

Not all individuals participate in the labour market. Table 3.7 presents the labour force in the same format as table 3.6, while table 3.8 presents labour force participation rates, derived as ratios between the corresponding figures from table 3.7 and table 3.6.

3.7 LABOUR FORCE (25–65 YEARS), By educational attainment and sex: '000

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	37.4	45.0	80.2	107.8	138.8
Bachelor degree	193.9	259.8	367.2	482.1	592.4
Skilled labour	1 016.6	1 135.9	1 241.4	1 316.1	1 453.6
Unqualified	1 898.6	1 921.4	1 994.1	1 912.2	1 828.3
Female					
Higher degree	8.5	12.7	28.4	51.2	84.6
Bachelor degree	84.7	143.9	289.7	450.0	637.4
Skilled labour	354.7	481.9	521.9	593.3	687.2
Unqualified	1 212.1	1 377.3	1 697.1	1 761.5	1 780.9
Persons	4 806.4	5 377.8	6 220.1	6 674.1	7 203.1

Source: Australian Census 1981, 1986, 1991, 1996, 2001.

15 The general trend depicted here is consistent with other studies, such as Maglen et al. (1994).

3.4 ADULT POPULATION AND LABOUR FORCE *continued*

Not surprisingly, the well-known pattern that more educated individuals are more likely to participate in the labour market than those with lower educational attainment is very evident from these figures.[16] The participation rates for university-educated men is markedly higher than that for men with lower or no qualifications. And the differences in labour force participation rate by level of educational attainment are much wider for women. Even in the 1990s, when the gaps narrowed significantly, the labour force participation rates for university-educated women are higher than women without qualifications, by an average of over 30 percentage points. An interesting feature of these figures is the opposite trends in participation for men and women over the past twenty years. The labour force participation rate for men without qualifications has declined nearly 13 percentage points from 85.3 in 1981 to 72.3 in 2001. Decreases are also evident for other male education groups, though the extent lessens as the level of educational attainment becomes higher. On the contrary, labour force participation among unqualified women increased by over 13 percentage points during the same period, and increases are also very strong for other education groups. Since the decline among men is offset by the rise among women, labour force participation overall has been stable at the 71–72 percentage level since 1991.

3.8 LABOUR FORCE PARTICIPATION RATES, By educational attainment and sex: **Per cent**

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	94.3	93.6	93.8	92.5	92.2
Bachelor degree	94.9	94.7	94.2	93.1	92.2
Skilled labour	92.2	90.3	90.8	88.8	87.5
Unqualified	85.3	81.0	80.0	75.6	72.3
Female					
Higher degree	78.1	80.4	84.0	84.9	86.0
Bachelor degree	75.9	80.1	82.1	82.8	82.5
Skilled labour	62.7	67.1	73.2	73.6	74.4
Unqualified	42.8	46.1	52.6	53.8	54.2
Persons	67.8	68.5	71.8	71.5	71.6

Source: Australian Census 1981, 1986, 1991, 1996, 2001.

16 Blondal, Field and Girouard (2002) present the similar picture of labour force participation rates across many OECD countries.

SECTION 4 EMPIRICAL RESULTS

4.1 LIFETIME LABOUR INCOME

This study estimates lifetime labour income for all 338 age/sex/education cohorts using Equations 1–3. One simple procedure for estimating lifetime income patterns is to use current cross-section age-income profiles to set relative patterns of incomes across age/education groups, and apply the long-term real income growth rate. As current economic variables are subject to short-term macro-economic fluctuations, lifetime income streams derived from current cross-sectional information may lead to overestimates in booming years and underestimates in recession years. To account for the business cycle effect on the projected lifetime income streams, one needs to look into the factors within the estimates that are subject to fluctuations — namely wages and unemployment rates. Both theory and empirical evidence suggest that wage rates are less sensitive to the effects of the business cycle than unemployment rates. In this study unemployment rates averaged over the longer-term (using average unemployment rates over the 1981–2001 Census period) have been used to project lifetime labour income per capita for all age/sex/education groups. The calculations assume a discount rate of 4.58 per cent and an expected income growth rate of 1.32 per cent for all cohorts.[17] These should be thought of as real rates (i.e. after the effect of inflation has been removed). They are the same rates that Jorgenson and Fraumeni used in their calculations, and seem to be in line with Australian data.

The information on differences between lifetime labour incomes for cohorts with alternative educational attainment is useful for estimating the extra value created by investing in additional education. Table 4.1 presents lifetime labour income per capita in current dollars for 25 year-olds, classified by sex and educational attainment, and table 4.2 presents the corresponding figures in 2001 dollars, which are derived from current dollars by using the ABS Consumer Price Index. According to the JF general framework (1992a), the product of the education industry is investment in human capital, and the output of education is thus defined as the addition to lifetime labour income from additional schooling. Within this framework, per capita measures of lifetime labour income could be used to estimate investment in human capital and the output of education. For example, for a male bachelor degree holder, the total gain from investment in a higher degree, would be around $28,000 in 1981, $53,000 in 1986, $98,000 in 1991, $136,000 in 1996 and $132,000 in 2001 (using nominal dollars).

17 These assumptions relate to 'real' interest rates and wage growth.

4.1 LIFETIME LABOUR INCOME *continued*

4.1 LIFETIME LABOUR INCOME PER CAPITA FOR 25 YEAR-OLDS: '000 current dollar

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	490.28	778.21	1 068.19	1 283.25	1 529.29
Bachelor degree	461.93	725.01	969.48	1 147.24	1 396.91
Skilled labour	321.61	507.20	685.25	798.94	991.23
Unqualified	262.56	419.40	578.13	681.01	832.68
Female					
Higher degree	376.46	597.58	827.67	982.61	1 217.25
Bachelor degree	335.19	526.61	688.23	808.95	1 012.79
Skilled labour	236.03	365.94	503.13	583.85	709.54
Unqualified	179.67	279.62	380.24	476.58	595.14

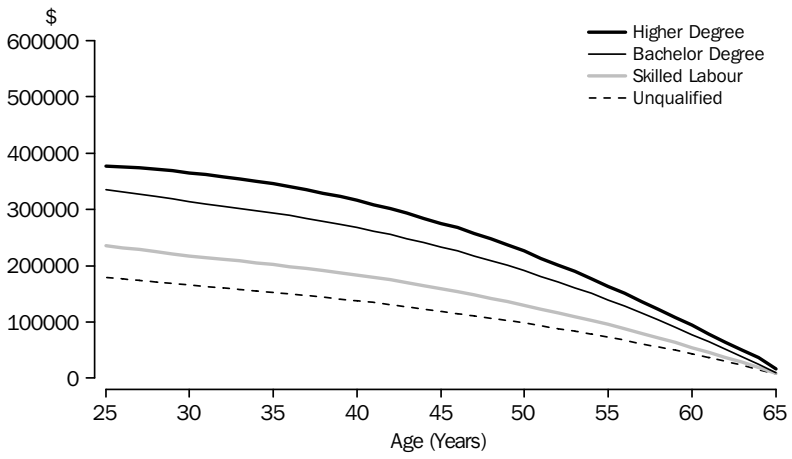
4.2 LIFETIME LABOUR INCOME PER CAPITA FOR 25 YEAR-OLDS: '000 of 2001 dollars

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	1 313.94	1 400.77	1 345.92	1 424.41	1 529.29
Bachelor degree	1 237.97	1 305.02	1 221.54	1 273.43	1 396.91
Skilled labour	861.92	912.96	863.41	886.82	991.23
Unqualified	703.65	754.92	728.44	755.92	832.68
Female					
Higher degree	1 008.92	1 075.65	1 042.87	1 090.70	1 217.25
Bachelor degree	898.30	947.90	867.17	897.93	1 012.79
Skilled labour	632.56	658.69	633.94	648.07	709.54
Unqualified	481.51	503.31	479.10	529.01	595.14

Graphs 4.1–4.10 plots gross lifetime income per capita for men and women computed from the 1981–2001 Census data. These charts show the present value of the discounted income stream of income for four levels of educational attainment for men and women aged 25–65 years. A few factors affect the shape of the lifetime income curves. The first factor is the age range at which annual income peaks. The age-income profiles charted in graphs 3.1–3.10 demonstrate that the income (earnings) premiums generated by higher educational attainment increases with time spent in the labour market.

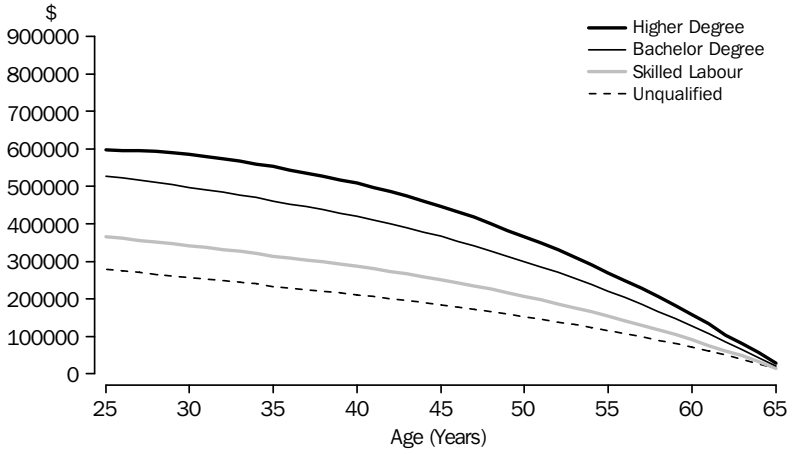
Gross lifetime income per capita (current dollars)

4.1 GROSS LIFETIME INCOME PER CAPITA, FEMALES, 1981

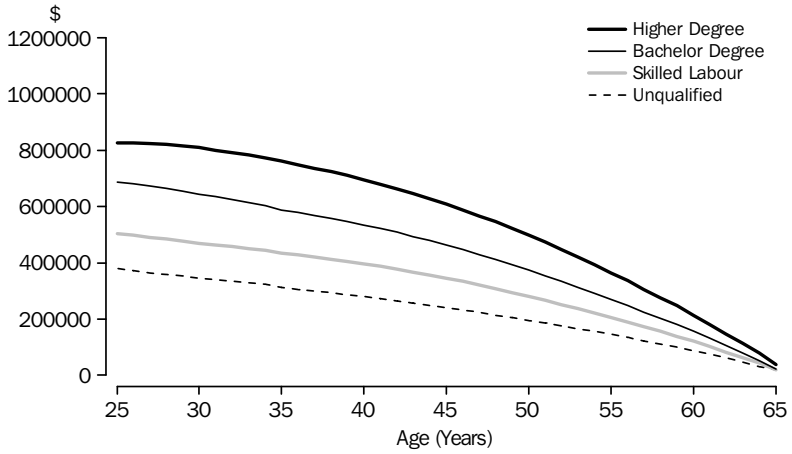


Gross lifetime income per capita (current dollars) continued

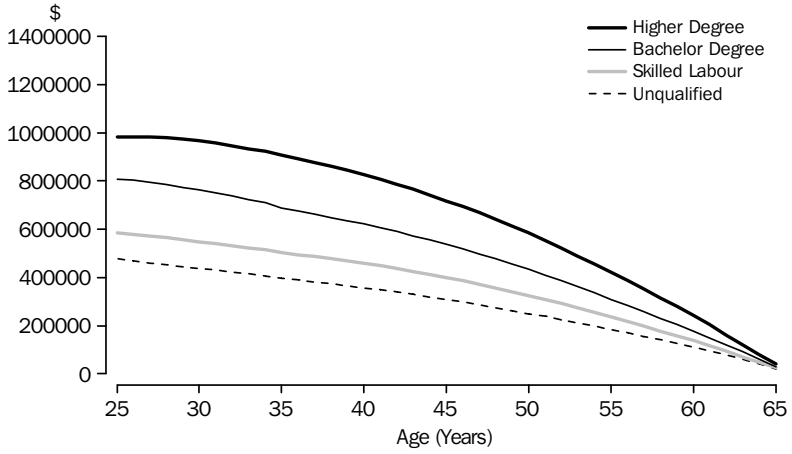
4.2 GROSS LIFETIME INCOME PER CAPITA, FEMALES, 1986



4.3 GROSS LIFETIME INCOME PER CAPITA, FEMALES, 1991

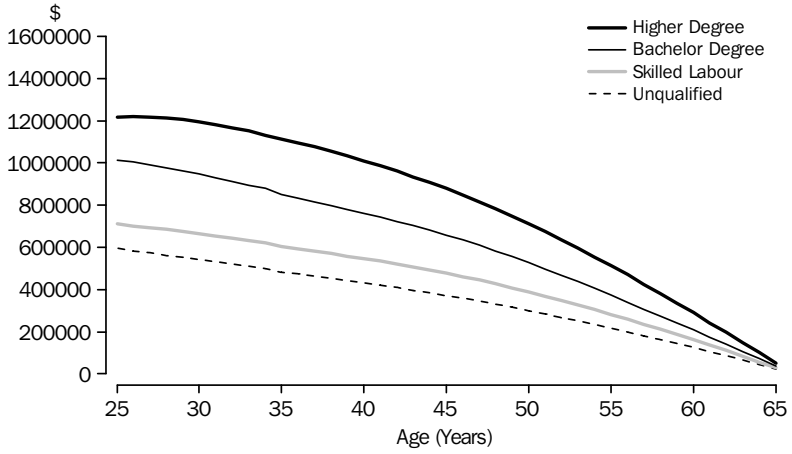


4.4 GROSS LIFETIME INCOME PER CAPITA, FEMALES, 1996

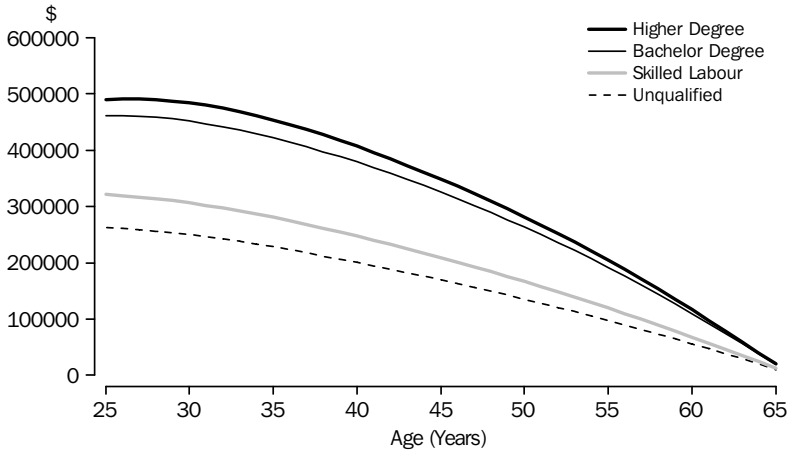


Gross lifetime income per capita (current dollars) continued

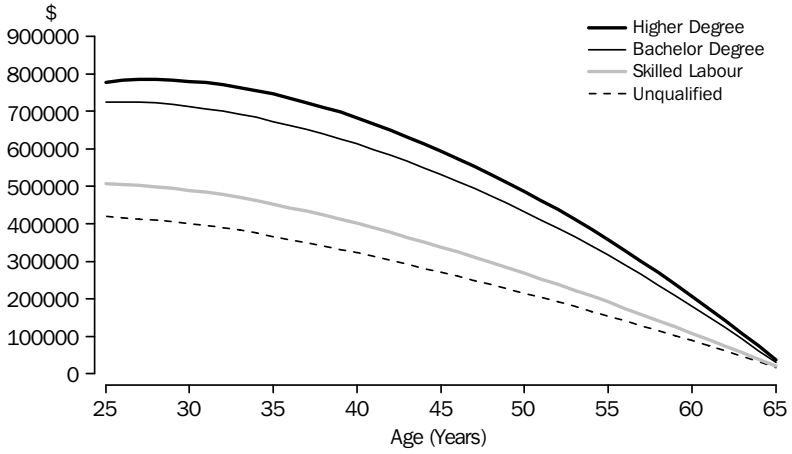
4.5 GROSS LIFETIME INCOME PER CAPITA, FEMALES, 2001



4.6 GROSS LIFETIME INCOME PER CAPITA, MALES, 1981

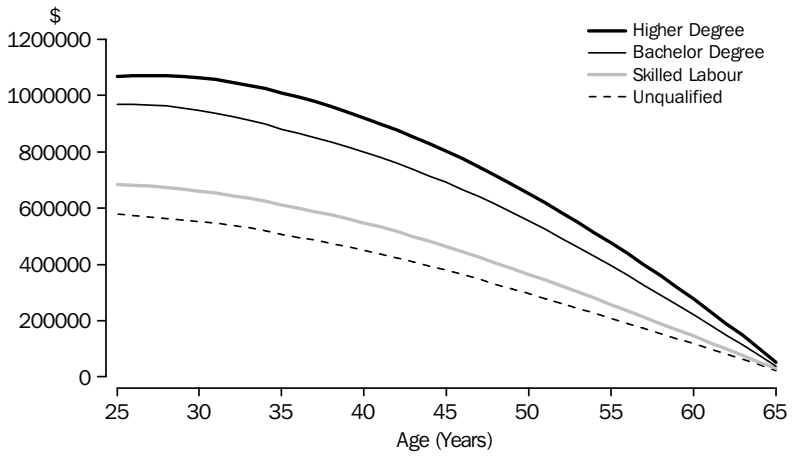


4.7 GROSS LIFETIME INCOME PER CAPITA, MALES, 1986

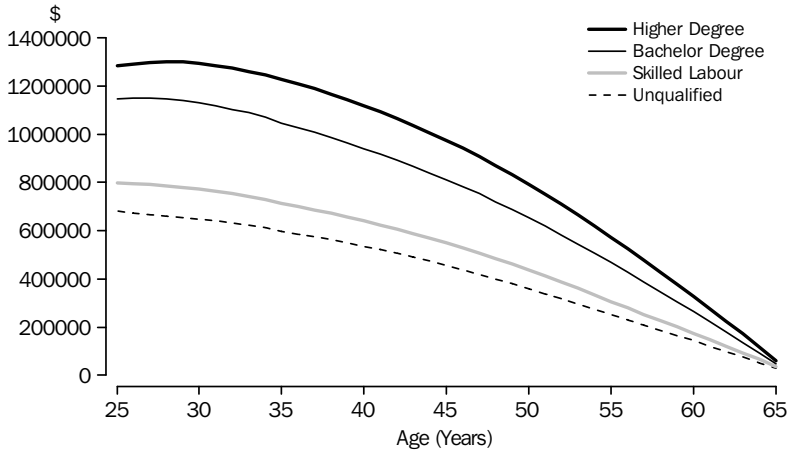


Gross lifetime income per capita (current dollars) continued

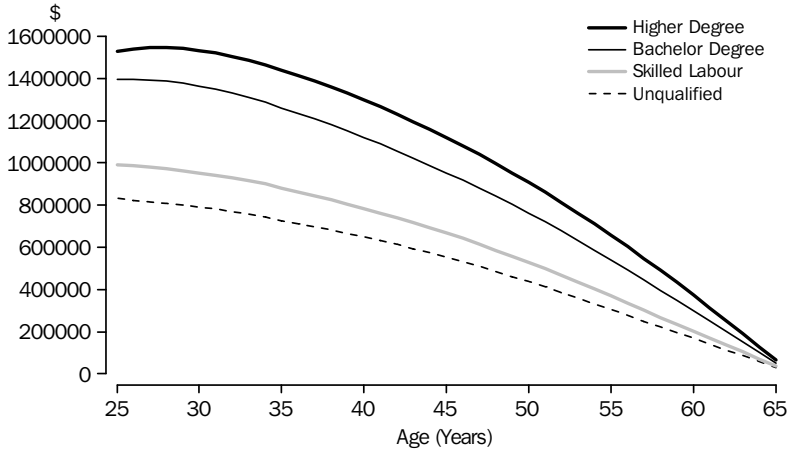
4.8 GROSS LIFETIME INCOME PER CAPITA, MALES, 1991



4.9 GROSS LIFETIME INCOME PER CAPITA, MALES, 1996



4.10 GROSS LIFETIME INCOME PER CAPITA, MALES, 2001



For any given discount rate, the shapes of the lifetime income curves critically depend on the age at which people earn their highest annual income. For higher educated young cohorts (in their earlier 20s say), the highest annual incomes come when they reach their mid-50s. These incomes are a long way off from the present. But as they grow older, these higher annual incomes get closer to the present, and so become less discounted and therefore contribute more heavily to their remaining lifetime income

Gross lifetime income per capita (current dollars) continued

stream. This explains why the lifetime labour income curves for some of the more highly educated cohorts rise slightly among young people before gradually declining.

The discount rate also affects the shape of lifetime labour income curves through its effect on the value of future annual incomes. The higher the discount rate, the lower the values of future incomes, and the earlier lifetime labour incomes peak. In the extreme case of a zero discount rate, lifetime labour income would continuously decline.

For less educated groups, time left in the labour force plays the most important role in determining the shapes of their lifetime labour income curves. The age-earnings profiles of these groups are relative flat. The younger the cohorts are, the longer they can remain in the labour force. This explains why the lifetime labour income curves for the lower educated groups decline straight away with age.

4.2 HUMAN CAPITAL STOCK

The ultimate objective of this paper is to compute aggregate measures of human capital that could serve as counterparts to the measures of physical capital that are recorded in the Australian National Accounts. For this purpose, the paper applies per capita measures of lifetime labour income to total numbers of people in many different age-sex-education cohorts to derive estimates of the stock of human capital in corresponding categories. In doing so, two measures are produced: one is based on the adult population, and the other is based on the labour force.[18] Broadly speaking, the population based measures can be regarded as an upper bound of the stock value of human capital (for the age groups considered in the study), while the labour force based measures are a lower bound.

Table 4.3 presents the population based measures of human capital stock in current dollars, and the corresponding constant dollar measures are reported in table 4.4. Going through these figures, the following observations can be made. First, the stock of human capital in Australia increased by nearly 370 per cent in current dollars and over 75 per cent in constant dollars between 1981 and 2001. Growth was slow between 1986 and 1991, reflecting the recession and falls in real wage rates in this period (recall that average unemployment rates for the twenty year period are used). Second, the overall growth in the stock of human capital is characterised by the rising share of aggregate human capital among more educated people. Even the recession year of 1991 witnessed sharp rises for the degree-qualified components of human capital, compared with little or negative real growth among the low skilled components. Third, increases in the more highly qualified components of human capital were much faster for women than for men. For example, the constant dollar value of female higher degree holders' human capital increased nearly tenfold during the twenty year period. The human capital of men with degrees nearly quadrupled over the same period. The constant dollar value of female bachelor degree holders' human capital is close to seven times higher in 2001 than 1981, while during the same period the corresponding value for men tripled.

18 See section 2.4 for a detailed discussion of pros and cons associated with these two measures.

4.2 HUMAN CAPITAL STOCK *continued*

4.3 POPULATION BASED MEASURES OF HUMAN CAPITAL STOCK IN AUSTRALIA: **$b current dollars**

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	15.15	29.40	67.82	109.73	160.27
Bachelor degree	77.71	164.80	300.73	461.47	659.28
Skilled labour	250.77	452.89	662.91	827.02	1 104.18
Unqualified	378.91	651.66	941.76	1 133.31	1 351.96
Total	*722.54*	*1 298.75*	*1 973.21*	*2 531.53*	*3 275.69*
Female					
Higher degree	3.34	7.58	21.77	45.38	88.70
Bachelor degree	31.42	78.99	192.13	337.94	570.21
Skilled labour	100.25	194.72	266.89	342.22	463.99
Unqualified	331.10	538.15	777.47	996.05	1 177.07
Total	*466.11*	*819.44*	*1 258.26*	*1 721.60*	*2 299.97*
Persons	1 188.65	2 118.18	3 231.47	4 253.13	5 575.66

4.4 POPULATION BASED MEASURES OF HUMAN CAPITAL STOCK IN AUSTRALIA: **$b 2001 dollars**

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	40.61	52.92	85.45	121.80	160.27
Bachelor degree	208.26	296.63	378.92	512.23	659.28
Skilled labour	672.05	815.20	835.27	917.99	1 104.18
Unqualified	1 015.47	1 172.99	1 186.61	1 257.98	1 351.96
Total	*1 936.39*	*2 337.75*	*2 486.25*	*2 810.00*	*3 275.69*
Female					
Higher degree	8.94	13.64	27.43	50.37	88.70
Bachelor degree	84.21	142.18	242.08	375.12	570.21
Skilled labour	268.68	350.49	336.29	379.87	463.99
Unqualified	887.34	968.68	979.61	1 105.62	1 177.07
Total	*1 249.17*	*1 474.98*	*1 585.41*	*1 910.98*	*2 299.97*
Persons	3 185.57	3 812.73	4 071.65	4 720.98	5 575.66

As is well known, all individuals in the population are classified as either 'in the labour force' or 'not in the labour force', with the former category further divided into 'employed' and 'unemployed'. Should only those in the labour force be accounted for in the measurement of the stock of human capital? Some empirical measurements of human capital are confined to those individuals in the labour force. This paper also provides a measure of the human capital embodied in the labour force by applying per capita measures of lifetime labour income to those in the labour force only. These results are presented in table 4.5, and the corresponding constant dollar estimates are given in table 4.6.

Comparing the measures of the human capital stock among people in the labour force with those based of the total population, one notices that the ratio between the two figures increased from 77.9 per cent in 1981 to 80.4 per cent in 2001. This upward trend is partly driven by the rising proportion of more educated workers (there was particularly strong growth in numbers of more educated females), and partly by the increasing female labour force participation rates presented in table 3.8.

4.2 HUMAN CAPITAL STOCK *continued*

4.5 LABOUR FORCE BASED MEASURES OF HUMAN CAPITAL STOCK IN AUSTRALIA: $b current dollars

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	14.29	27.83	64.25	103.89	151.29
Bachelor degree	74.01	157.22	287.41	440.58	628.32
Skilled labour	236.05	426.02	624.63	777.65	1 034.89
Unqualified	318.92	549.30	795.45	956.32	1 138.23
Total	*643.27*	*1 160.38*	*1 771.74*	*2 278.44*	*2 952.73*
Female					
Higher degree	2.77	6.33	18.29	38.19	74.46
Bachelor degree	25.89	64.74	157.33	278.44	468.70
Skilled labour	72.97	141.83	195.27	251.04	339.29
Unqualified	181.29	296.05	431.10	552.60	650.14
Total	*282.92*	*508.94*	*801.99*	*1 120.27*	*1 532.59*
Persons	926.19	1 669.32	2 573.73	3 398.71	4 485.32

4.6 LABOUR FORCE BASED MEASURES OF HUMAN CAPITAL STOCK IN AUSTRALIA: $b 2001 dollars

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	38.31	50.10	80.96	115.32	151.29
Bachelor degree	198.34	283.00	362.14	489.05	628.32
Skilled labour	632.60	766.83	787.04	863.20	1 034.89
Unqualified	854.70	988.74	1 002.26	1 061.51	1 138.23
Total	*1 723.95*	*2 088.68*	*2 232.40*	*2 529.07*	*2 952.73*
Female					
Higher degree	7.43	11.40	23.04	42.39	74.46
Bachelor degree	69.38	116.53	198.24	309.07	468.70
Skilled labour	195.57	255.29	246.04	278.65	339.29
Unqualified	485.85	532.88	543.18	613.38	650.14
Total	*758.24*	*916.10*	*1 010.50*	*1 243.50*	*1 532.59*
Persons	2 482.19	3 004.78	3 242.90	3 772.57	4 485.32

4.3 SOURCES OF GROWTH IN HUMAN CAPITAL STOCK

Section 4.2 shows that there has been a significant increase in the stock of human capital, characterised by sharply rising shares of total human capital among more educated workers. This section quantifies the relative contribution to the growth of aggregate stock of human capital by different educational groups.[19] Table 4.7 shows the findings from a decomposition analysis, which is based on the population-based measures of human capital stock presented in table 4.3.

19 A simple decomposition method is employed here. The growth rate of the aggregate stock value between any two periods is expressed as $\frac{V_t - V_{t-1}}{V_{t-1}} = \sum s_{it-1}\left(\frac{f_{it} - f_{it-1}}{f_{it-1}}\right)$, where V_t is the aggregate stock value for period t, f_{it} is the stock value in period t for educational group i, while s_{it-1} is the share of f_{it-1} in V_{t-1}.

4.3 SOURCES OF GROWTH IN HUMAN CAPITAL STOCK *continued*

4.7 DECOMPOSITION ANALYSIS OF GROWTH IN REAL HUMAN CAPITAL STOCK: **Per cent**

	1981–1986	*1986–1991*	*1991–1996*	*1996–2001*
Male				
Total changes	20.73	6.35	13.02	16.57
Higher degree	0.64	1.39	1.46	1.37
Bachelor degree	4.56	3.52	5.36	5.23
Skilled labour	7.39	0.86	3.33	6.63
Unqualified	8.13	0.58	2.87	3.34
Female				
Total changes	18.08	7.49	20.54	20.36
Higher degree	0.38	0.94	1.45	2.01
Bachelor degree	4.64	6.77	8.39	10.21
Skilled labour	6.55	–0.96	2.75	4.40
Unqualified	6.51	0.74	7.95	3.74

The table can be summarized as follows: (1) In the early 1980s, human capital growth was largely driven by less educated workers, whose contribution exceeded two-thirds of the total growth in human capital stock. (2) For the 1986–1991 period, growth in human capital stock was almost entirely driven by increases among better educated workers. As a matter of fact, the less educated components of female human capital, if put together, experienced a slight decrease. (3) During the 1990s, better educated workers continued to contribute the most to the total growth in human capital stock, but with more significant contributions than during the 1980s.

The change in the stock value of each educational group can be further decomposed into two factors: changes in the number of people and changes in their average lifetime labour income. Table 4.8 presents the results of this exercise for bachelor degree holders.[20] The total changes column in table 4.8 is the total changes in stock values for bachelor groups, transferred from the figures in table 4.7. The next two columns decompose the total changes into effects from changes in the number of people and effects from changes in per capita lifetime labour income. One can make two observations: (1) increases in the stock value throughout the 1980s–90s were almost entirely due to increases in the number of people; and (2) the contribution of changes in lifetime labour income was marginal, and even negative in the 1986–1991 period.

20 For any sex/education group, the total stock value of human capital can be expressed as $V_{it} = life_{it} n_{it}$ where V_{it} is the total stock value for education group i at time t, $life_{it}$ is the average lifetime labour income per capita for education group i at time t, and n_{it} is the total number of people in education group i at the time t. The changes in the total stock value between any two periods can be expressed as $V_{it} - V_{it-1} = life_{it-1}(n_{it} - n_{it-1}) + n_{it}(life_{it} - life_{it-1})$. The first item on the right-hand side of the above identity accounts for the effect of changes in the number of people assuming that the average lifetime labour income remains the same. The second item accounts for the effect of changes from per-capita average lifetime labour income.

4.3 SOURCES OF GROWTH IN HUMAN CAPITAL STOCK *continued*

4.8 DECOMPOSITION ANALYSIS OF STOCK VALUE CHANGES IN BACHELOR GROUPS: **Per cent**

Period	*Total changes*	*Number of people effect*	*Average lifetime income effect*
Male			
1981–1986	4.56	3.69	0.87
1986–1991	3.52	5.34	–1.82
1991–1996	5.36	5.00	0.36
1996–2001	5.23	4.39	0.84
Female			
1981–1986	4.64	4.12	0.52
1986–1991	6.77	9.29	–2.52
1991–1996	8.39	8.23	0.16
1996–2001	10.21	8.29	1.92

One can go further. The change in average lifetime income for any education group depends on two factors: change in the age structure and change in per capita lifetime income for each age subgroup. Table 4.9 decomposes changes in average lifetime income for the bachelor degree groups into an age structure effect and a per capita lifetime income effect. The total changes column in table 4.9 is the total changes in average lifetime income from table 4.8. The fourth and fifth column decompose the total changes into age structure effect and per capita lifetime income effect respectively. One can make two observations here: (1) the contribution of per capita lifetime income factor was positive for most periods, except for the 1986–1991 period; (2) the age structure factor was negative, as the average age for bachelor groups was on the rise throughout the 1980s and 1990s.

4.9 SOURCES OF CHANGES IN AVERAGE LIFETIME INCOME FOR BACHELOR GROUPS: **Per cent**

Period	*Total changes*	*Age structure effect*	*Per capita lifetime income effect*
Male			
1981–1986	0.87	–0.15	1.02
1986–1991	–1.82	–0.36	–1.46
1991–1996	0.36	–0.52	0.88
1996–2001	0.84	–0.89	1.73
Female			
1981–1986	0.52	–0.12	0.64
1986–1991	–2.52	–0.61	–1.91
1991–1996	0.16	–0.60	0.76
1996–2001	1.92	–1.20	3.12

Age structure plays an important role in determining average weighted lifetime labour income for each educational group. With other things being equal, a higher share of older people will give a lower per capita lifetime labour income. Table 4.10 presents the evolution of average ages for each educational group over the past two decades. Among less educated workers, average ages either remained the same or increased slightly;

4.3 SOURCES OF GROWTH IN HUMAN CAPITAL STOCK *continued*

while for better educated workers, average ages increased significantly, by nearly four years on average, for both men and women.

4.10 AVERAGE AGES BY EDUCATIONAL ATTAINMENT

	1981	*1986*	*1991*	*1996*	*2001*
Male					
Higher degree	40.6	42.0	43.4	44.0	44.6
Bachelor degree	37.2	38.0	39.1	39.9	41.0
Skilled labour	41.0	41.4	41.4	42.0	43.1
Unqualified	43.2	43.0	43.0	43.1	43.8
Female					
Higher degree	38.8	40.1	41.0	41.5	42.1
Bachelor degree	35.2	35.9	37.6	38.5	39.7
Skilled labour	38.9	39.5	39.8	40.6	41.3
Unqualified	43.3	43.2	43.0	43.4	44.4

4.4 SENSITIVITY TESTS

The estimates of human capital stock presented above are based on a number of assumptions. The income growth rate is assumed to be constant at 1.32 per cent per year, and future incomes are discounted by 4.58 per cent per year to derive the present values of income streams. In order to assess the sensitivity of these experimental estimates, a series of alternative estimates are obtained using alternative income growth rates and discount rates.

In the first part of table 4.11, the sensitivity of the discount rate is tested. These tests assume a constant income growth rate at 1.32 per cent. Discount rates of 0%, 3%,4% 7% and 8% are tested. As expected, the choice of discount rate has a significant impact on the values of human capital stock. Generally speaking, a one percentage increase in the discount rate reduces the value of human capital stock by eight to eleven per cent, depending on the initial size of the stock.

4.11 HUMAN CAPITAL IN AUSTRALIA ALTERNATIVE DISCOUNT RATES AND GROWTH RATES: **$b current dollars**

	1981	*1986*	*1991*	*1996*	*2001*
Discount rate(a)					
0%	2 142	3 840	5 794	7 588	9 809
3%	1 423	2 541	3 865	5 079	6 630
4%	1 267	2 259	3 443	4 528	5 928
7%	938	1 667	2 551	3 364	4 435
8%	861	1 527	2 340	3 089	4 080
Growth rate(b)					
0%	1 033	1 838	2 809	3 702	4 869
0.5%	1 088	1 937	2 958	3 897	5 120
1%	1 148	2 044	3 121	4 108	5 390
1.5%	1 213	2 162	3 297	4 338	5 684
2%	1 283	2 289	3 488	4 588	6 003
Benchmark(c)	1 189	2 118	3 231	4 253	5 576

(a) Growth rate = 1.32% p.a.
(b) Discount rate = 4.58% p.a.
(c) Growth rate = 1.32% and discount rate = 4.58% p.a.

4.4 SENSITIVITY TESTS *continued*

In the second part of table 4.11, a series of alternative income growth rates and associated estimates of the human capital stock are presented. These estimates assume a constant discount rate of 4.58 per cent. The income growth rate ranges between zero to two per cent, reflecting the actual fluctuations of the growth rate of total factor productivity for Australia over the corresponding period. Varying the income growth rate has less of an effect on the resulting values of the human capital, with a 1% increase in growth rate equating to a five to six per cent increase in human capital stock.

4.5 COMPARING PHYSICAL AND HUMAN CAPITAL

It is instructive to compare these experimental measures of human capital with counterpart measures of physical capital from the ASNA. Table 4.12 presents estimates of human and physical capital in current dollars. The physical capital figures are taken from table 67 of the *Australian System of National Accounts (ASNA)* (cat. no. 5204.0) and are the total end-financial year net capital stock of all sectors. These physical capital measures include dwellings, other buildings and structures, machinery and equipment, software, mineral exploration, livestock and artistic originals. Table 4.12 shows that the size of human capital is much larger than that of physical capital for all years and that human capital has grown significantly faster than physical capital. For example, the ratio of human capital in the labour force to physical capital increased from 2.2 in 1981 to 2.5 in 2001.

4.12 COMPARISON BETWEEN HUMAN AND PHYSICAL CAPITAL: **$b current dollars**

Year	*Human capital (Labour force)*	*Human capital (Population)*	*Physical capital*(a)
1981	925	1 187	421
1986	1 673	2 125	751
1991	2 581	3 242	1 164
1996	3 428	4 291	1 373
2001	4 485	5 576	1 808

(a) *Australian National Accounts* (cat. no. 5204.0).

However, in making this comparison there are a number important caveats to keep in mind particularly as these experimental measures of human capital are confined to the working population and market labour activities:

- The concept of working population used in this paper is somewhat arbitrarily defined to be those aged between 25–65 years. The estimates of human capital are obviously subject to this definition. For instance, expanding the lower end of the age range from 18–25 years old, would significantly raise the estimates.
- Previous studies show that the value of nonmarket labour activity is significant. Adding the value of nonmarket labour activity to the estimates of the human capital stock would dramatically change the picture depicted in table 20.
- These estimates of human capital (just as in the studies mentioned earlier) are gross estimates (gross in the sense that maintenance costs are not deducted from labour incomes). But the estimates of physical capital, presented in table 20, are net figures. If maintenance costs (however defined) were netted out of human capital, as they are for physical capital, the estimates would be smaller.

SECTION 5 CONCLUDING REMARKS AND FUTURE DEVELOPMENTS

CONCLUSION

This paper has presented some experimental measures of human capital for Australia. The ABS hopes these measures (once refined) could serve as useful counterparts to measures of physical capital in establishing a more complete understanding of national 'capital'. Using the JF method, this study demonstrates how human capital can be estimated by a lifetime labour income approach and calculates experimental estimates of values of human capital stock embodied in the adult population of Australia for the census years 1981, 1986, 1991, 1996 and 2001. The results of this exercise show significant increases in the value of human capital and that the more educated components of the Australian human capital stock have increased dramatically, particularly for women.

However, the experimental estimates presented in this paper have many limitations including:

- These measures are based on the assumption that earnings differentials between workers reflect productivity differentials. As is well-known, non-market forces can exert important influences on wages. With this limitation in mind, the slow growth in the aggregate stock of human capital over the period 1986 to 1991 should be treated with caution. For example, did the significant decrease in real wage rates in 1991, shown in table 3.2, reflect structural or institutional change in wage rate arrangements, or temporary factors such as the business cycle? If these decreases were caused by institutional factors, then the estimates for 1991 might need to be reconsidered. Similar caveats apply to the estimates for other years.
- These experimental measures of human capital are calculated using market factors only. Human capital is also important for non-market activity. With this limitation in mind, one must exercise caution in interpreting the magnitude of the experimental measures. For example, the figures in table 4.1 and table 4.2 show that the value of human capital for men is much higher than for women in all age/sex/education cohorts. But this does not mean we can conclude that male human capital is more 'valuable' than female human capital.

If the methodology and data used in this paper prove to be sound, future refinement work could follow in a number of ways, including:

- The essence of the lifetime labour income approach to valuing human capital embodied in an individual is to measure his/her productive capacity in terms of their labour market earnings. But the income variable in the Australian Census includes non-labour income, and so the estimates of human capital are probably overestimated. (Of course, the full census income data has its merits, as it does not suffer from sampling errors which are prevalent among other earnings data.) Removing the non-labour income 'biases' from the current estimates is a possible step for refining this research.

CONCLUSION *continued*

- It has long been recognized in the literature that the issue of ability bias needs to be addressed in analysing the true effect of education on earnings from the cross-sectional correlation between education and incomes. The JF approach ignores this issue by assuming that differences in wages reflect differences in human capital produced by education. If the concept of an ability bias is real, the estimated effect on lifetime labour incomes of education is certainly overestimated. Addressing this issue is important work for the future, but measuring only ability bias will be challenging.
- This study does not take into account hours worked: variations in stock values across different education groups reflect in part variations in hours worked by different education groups. The information collected in the census on hours worked is too broad to measure accurately average hours worked for each sex/age/education cohort, and so this study could not use hours worked as a separate variable to account for the value of human capital. A possible future refinement is to incorporate hours worked information from other data sources, into the estimates of human capital.
- It may be possible to derive estimates for non-census years, using other sources of data, such as the *Survey of Income and Housing Costs* (cat. no. 6553.0) and *Demography* (cat. nos 3311.1–8).
- Per capita measures of the value of market labour could be to impute the value of nonmarket labour activity (including leisure) and incorporating these values into the measures of human capital.

Given the dataset constructed and the stock estimates produced in this study, there is a range of areas where further research would be useful for understanding the growth of human capital in Australia, including:

- Establishing an integrated stock-flow account. Among other things, an account would show what has influenced the growth of human capital in Australia — demographic changes (including changing age structure, immigration and emigration, and the like), labour market influences, education and training, and so on. From another perspective, an account would show how human capital accumulates in the long run, by looking at human capital formation and depreciation. Human capital formation results from two sources: quantitative inflow through population increases and qualitative inflow through investment in education and training. Depreciation on human capital comes from ageing. The net human capital formation is the difference between the gross human capital formation and depreciation on human capital.
- Compiling other analytical outputs, such as the value of investment in education, the output of the education sector, and rates of return to various types of investment in education.

APPENDIX 1 THEORETICAL BACKGROUND

THEORETICAL BACKGROUND

This Appendix provides an overview of Becker's (1964) analysis of measurement issues in human capital theory. Against this framework, Jorgenson and Fraumeni's contribution to measuring human capital is discussed, in particular, the national accounting perspective that Jorgenson and Fraumeni provide. By demonstrating the links between Jorgenson and Fraumeni's approach and earlier analyses, an intuitive explanation of the Jorgenson and Fraumeni method is provided.

BECKER'S ANALYSIS

Becker (1964) provides a theoretical framework within which earnings data can be used to estimate the costs of investment in human capital. A central theme of Becker's analysis is the derivation of rates of return, costs, and investments through comparing two average income streams of individuals differing by levels of schooling or training or any other investment in human capital. Becker shows that the costs incurred by an individual are twofold. First, the direct costs — tuition, fees, books, and other related expenses. Second, indirect or opportunity costs –- the difference between what could have been and is earned.[21] The investor's net earnings, W, can be defined as the difference between actual earnings, MP and the direct (outlays) costs, k, which gives

(1) $$W = MP - k$$

If MP_0 is the potential earnings the investor could have received if they did not undertake an investment at time 0, Equation (1) can be written as

(2) $$\begin{aligned} W &= MP_0 - \{(MP_0 - MP) + k\} \\ &= MP_0 - C \end{aligned}$$

where C is the total cost of the investment activity, which is the sum of direct costs and forgone earnings. Given data on net earnings, the total cost C can be estimated indirectly. Equation 2 can be extended to include various investments in human capital.

Let Y be an investment in human capital, with a net earnings stream of Y_0 during the first period, Y_1 during the next period, and so on until Y_n is provided during the last period. The present value of the net earnings stream $V(y)$ in Y, is given by

(3) $$V(y) = \Sigma_{j=0}^{n} \frac{Y_j}{(1+i)^{j+1}}$$

where is the market discount rate. Now let X be another kind of activity providing a net earning stream of $X_0, X_1, \ldots X_n$ with a present value $V(x)$. The present value of the gain d from choosing activity Y rather then X is given by

(4) $$d = \Sigma_{j=0}^{n} \frac{Y_j - X_j}{(1+i)^{j+1}}$$

Equation 4 is readily decomposed into the costs of investments in human capital and differences in the returns to these investments. For example, suppose that we have a very simple investment scenario: activity Y requires an investment outlay only in the first period while activity X requires no investment at all. The cost of choosing Y rather than X is simply the difference between net earnings in the first period. Differences in the income streams of Y and X are equal to the difference in the present value of the two activities. In this case Equation 4 could be written as

(5) $$d = \Sigma_{j=1}^{n} \frac{Y_j - X_j}{(1+i)^{j}} - C$$

21 The following discussion closely follows Becker (1964).

BECKER'S ANALYSIS *continued*

where $C = X_0 - Y_0$. If d is set to zero, then by definition the internal rate of return is equal to the discount rate i. When d is set to zero, Equation 5 has an important practical implication: if an investment in human capital is restricted to a single known period the cost of investment is equal to the return to investment. As the cost of investment is easily determined from information on net earnings in the initial period alone, the returns to investment are also easily derived.

Investments in human capital are often distributed over many periods. Therefore, the analysis needs to be generalised to cover distributed investment. The method of calculating the internal rate of return remains the same regardless of the amount and duration of the investment. If the rate of return of an investment in all periods is assumed to be the same throughout its life cycle, its internal rate of return can be estimated by setting the net present value of its earnings streams to zero.[22] Given the internal rate of return, the amount invested in each period could be estimated from the following relations

(6) $$C = X_0 - Y_0 C_0 = X_0 - Y_0 C_1 = X_1 - Y_1 + rC_0$$

Where r is internal rate of return, and m is the number of investment periods.

(7) $$C = \sum_{j=0}^{m-1} C_j$$

Relations 6 and Equation 7 show that the rate of return, investment cost in each period, and total costs of investment, could be estimated from information on net earnings. This is the approach that has been adopted by Jorgenson and Fraumeni (JF) in estimating the value created by undertaking an additional year of schooling.

JORGENSON AND FRAUMENI METHOD

According to JF, investment in one additional year of schooling is given by[23]

(8) $$\text{si}(y, s, a, e) = \text{life}(y, s, a, e+1) - \text{life}(y, s, a, e)$$

where

si = investment in one additional year of schooling
y= calendar year
s= sex
a = age
e = educational attainment, measured in years spent at school
life = lifetime labour income

For a typical individual in any given cohort, their (expected) lifetime labour income from market activity is given by

(9) $$\begin{aligned}\text{life}(y, s, a, e) &= \text{ymi}(y, s, a, e) \\ &+ [\text{senr}(y, s, a, e) \times \text{sr}(y, s, a+1) \\ &\times \text{mi}(y, s, a+1, e+1) \times (1+g)/(1+i) \\ &+ \{1 - \text{senr}(y, s, a, e)\} \times \text{sr}(y, s, a+1) \\ &\times \text{mi}(y, s, a+1, e)] \times (1+g)/(1+i)\end{aligned}$$

22 This is the actual earnings from an investment, where earnings are expressed as the proportion of the investment outlay. Under certain conditions, the rate of return is equal to the internal rate of return, though they are two different concepts in investment analysis.

23 Here we adopt the same notation as in JF with some minor adjustments.

JORGENSON AND FRAUMENI METHOD *continued*

where

ymi = annual market income per capita
senr = the probability that an individual with educational attainment e is enrolled in one additional year schooling
sr = probability of survival next year
si = investment in one additional schooling
mi = lifetime market labour income[24]
g = real income growth rate
i = market discount rate

Now let us set an individual's educational attainment to e +1, the highest possible years of schooling, then we have

(10) life (y, s, a, e +1) = ymi (y, s, a, e +1) +sr(y, s, a+1)× mi(y, s, a+1, e+1)(× 1+g)/(1+i)

Equation 10 – Equation 9 gives

(11) life (y, s, a, e+1) – life (y,s,a ,e) = {1-senr(y, s, a, e)}

×{mi(y, s, a+1, e+1)–mi(y, s, a+1, e)}

×sr(y, s, a+1)×(1+g)/(1+i)

– {ymi (y, s, a, e) –ymi (y, s, a, e+1)}

The terms in Equation 11 can be related to the terms in Equation 5. For example:

- (mi(y, s, a+1, e+1)-mi(y, s, a+1, e))× sr× (y, s, a+1)×(1+g)/(1+i) corresponds to $\Sigma (Y_j - X_j)/(1+i)^j$,
- ymi(y, s, a, e+1)' to Y_0, and
- ymi(y, s, a, e)' to 'senr(y, s, a, e)× Y_0' + (1-senr(y, s, a, e)) × X_0'.

Substitute these corresponding items into Equation 11, and in equilibrium we have

(12) $\{1\text{-senr}(y, s, a, e)\}X_0 + \text{senr}(y, s, a, e)Y_0 - Y_0 = \{1\text{-senr}(y, s, a, e)\}\times\Sigma (Y_j - X_j)/(1+i)^j$

Equation 12 is equivalent to Equation 5.

The preceding discussion demonstrated that the JF method could be related to conventional analysis of human capital theory. While the conceptual basis of the JF method remains the same, attention has been turned from backward-looking costs to forward-looking gains from investment in education. As noted earlier, the two methods can only be equal to each other when the internal rate of return equals the discount rate.

A number of empirical studies have tried to estimate lifetime labour income from cross-sectional data.[25] The basic notion underlying these studies is that an individual of age *t* with a certain level of educational attainment will base their expectations of earnings *n* years from now on the observed earnings of people *t*+*n* years old who have the same educational qualifications and are the same sex. Two innovations distinguish the JF method from previous empirical applications based on cross-section data. First, the JF method simplifies the procedure for discounting future income streams to the present value. Second, previous studies did not capture the potential additional human capital created by those individuals still undertaking formal schooling.

The first innovation of the JF method involves decomposing an individual's present value of lifetime labour income into their current income and the present value of their lifetime income in the next period. JF derive an individual's present value of lifetime income in the next period by working backwards from the lifetime income of people with the highest level of education and the oldest working age. For example, since JF

24 In the JF model, lifetime labour income is the sum of lifetime market labour income and lifetime nonmarket labour income. My discussion focuses on market labour activity, and hence set mi = life. See the appendix of Jorgenson and Fraumeni (1992a) for details.

25 For example, Graham and Webb (1979) and Ahlroth et. al. (1997).

JORGENSON AND FRAUMENI METHOD *continued*

assume that all individuals retire when they are 75 years old, a 74-year-old's present value of lifetime labour income is just their current labour income. The lifetime labour income of a 73-year-old individual with the same sex and education level as the 74-year-old is equal to the present value of lifetime labour income of the 74-year-old plus their current labour income. By working backwards in this way, for all possible combinations of sex and education level, everyone's lifetime labour income can be derived.

The second innovation of the JF method is that it incorporates the potential additional human capital of individuals still undertaking formal schooling by constructing expected lifetime labour income streams. In earlier studies individuals undertaking additional schooling were assumed to remain in their current cohort of educational attainment.

APPENDIX 2 ALTERNATIVE APPROACHES TO MEASURING HUMAN CAPITAL

ALTERNATIVE APPROACHES

'A strong message from the literature is that there is great difficulty in measuring human capital' Rogers (2003).

This Appendix outlines alternative approaches to measuring the stock of human capital.

As discussed in the Introduction, a variety of measures have been developed and used to measure the stock of human capital. Broadly speaking, these measures fall into two distinct approaches.[26] The first uses proxy indicators of productive capacity — such as educational attainment or skill levels — as measures of human capital stock. The second estimates the monetary costs or gross returns associated with the production and development of certain productive attributes embodied in people.

The OECD (1998) defines human capital as the skills, knowledge and competence of human beings. And so it appears that an ideal measure should take account of all these attributes. But that is difficult in practice. First, it is hard to define an exhaustive list of all relevant attributes. Even if such a list could be prepared, there is no guarantee that each attribute could be measured accurately. This paper focuses on developing measures of human capital that could sit alongside the System of National Accounts. We therefore restrict the review of other work to consider three studies from national account economists: Kendrick (1976), Hill (2002) and Aulin-Ahmavaara (2002).

Kendrick adopts the cost of production approach to produce comprehensive estimates of the human capital formation and stock for the US economy, including both tangible and intangible human capital components. Hill uses the same approach, but his measurement is confined to intellectual capital, believed to be the most important part of intangible human capital. Aulin-Ahmavaara employs a dynamic input-output model to measure human capital.

KENDRICK METHOD

Kendrick believes that capital should be measured as the value of resources devoted from past production to produce future output. He bases his estimates of human capital stocks on the accumulated costs incurred during the process of human capital formation. First, he distinguishes two types of human capital: tangible and intangible. The intangible investments in human capital, such as education and training, are embodied in the tangible human capital — the human beings.

Kendrick defines intangible investments in human capital as those made primarily to improve the productivity of the people in which they are embodied. According to Kendrick, there are three dimensions of investments in intangible human capital: (1) those used to educate and train individuals; (2) to provide them with better health and safety; (3) and to improve labour allocation via job search and mobility. The education and training investment covers not only expenditure on education and training, but also

26 Maglen (1994) classifies the measures of human capital from two perspectives: inputs versus outputs and physical versus monetary. The input measures attempt to estimate the accumulated investments in human capital while the output measures focus on estimating the contribution to production made by the stock of human capital. OECD (1998) summarises three approaches to estimating human capital stocks: (1) Measuring educational attainment, which is defined as the highest level of education completed; (2) Directly measuring certain skills and competences bearing on economic activity, such as adult literacy level; (3) Estimating the market values of certain attributes embodied in human beings and hence the aggregate value of human capital stock.

KENDRICK METHOD *continued*

the foregone earnings of students of working age (which are the larger part of educational costs).

In estimating the tangible human capital, Kendrick set the investment values as the rearing costs of those individuals under 14 years of age, based on consumption values and other resources devoted to them. He defines the human rearing span as the period from birth to working age, which is somewhat arbitrarily set at 14 years. The stock of tangible human capital is measured by the accumulated costs of rearing children to age 14 years.

Kendrick is critical of the simple expenditure approach to measuring human capital. Kendrick argues that it is inconsistent to count the costs of educating a person as investment without including the cost of producing the physical being whose mind is being educated. He lists two reasons for counting 'rearing costs' of human capital as investment. First, the returns on human capital should be estimated on the total cost of production, not just on the capital created by education and training alone . Second, the expense on rearing children competes not only with the parents' consumption but also with other forms of investment, including education and health care. The stock of tangible human capital is measured by the accumulated costs of rearing children to age 14 years. However, the foregone earnings of parents in raising children have to be excluded due to the lack of data.

HILL'S METHOD

In a recent discussion paper, Hill (2002) proposes a method by which human capital could be measured and treated in the System of National Accounts (SNA). Hill's basic approach is similar to that of Kendrick's in the sense that both of them use direct expenditure plus opportunity costs to value human capital investment and stocks.

But Hill is interested in the intangible intellectual component of human capital, defined as knowledge and skills possessed by people. He treats intellectual capital as an asset produced by the people acquiring the knowledge and skills. He suggests:

> 'From an SNA viewpoint, the production and acquisition of knowledge is a form of own account production and capital formation carried out by households. The education services produced by the education industry are consumed as intermediate inputs into the production of knowledge. '

In the production of intellectual capital, output is defined as acquired knowledge and skills. The teaching or training services provided by educational and training establishments and the work of students and trainees are inputs to the production of intellectual capital. In this way, students are viewed as '*working for themselves. They are self-employed*'.

Hill further proposes that, as the production of intellectual capital is an own account production, it should be treated in the same way as the household own dwelling production is treated in the SNA. In his view, '*the type of productive activity in which students are engaged is consistent with the broad definition of production given in the SNA*'.

Economists generally agree that education comprises both investment and consumption. But there is less agreement about the relative shares of each component, which will also depend on the type of education. Indeed, economists are divided over what types of education are mainly for investment or consumption and there is therefore not yet consensus about what types of education should be included in the measurement of human capital formation. Hill (2002) suggests:

HILL'S METHOD *continued*

> '...learning, study and practice may be partly vocational and partly non-vocational, but they tend to become increasingly vocational the older the student becomes. It is therefore proposed that the study and practice undertaken by young children should not be included within the production boundary (of human capital). Only the production that is undertaken by students above a certain age should be counted as own account of production and capital formation and included in GDP. '

Hill values the output of intellectual capital by its costs of production. These costs have three parts: (1) teaching and training service costs; (2) household capital services (such as electricity consumed for the purpose of study); and (3) the value of the student's work, which is measured by the opportunity cost (foregone earnings).

AULIN-AHMAVAARA'S METHOD

Aulin-Ahmavaara (2002) describes a theoretical input-output production model in which human capital is strictly treated as a produced asset, just like any other capital good. In this system, production is defined as any use of time by those individuals in the labour force with basic educational attainment. This system distinguishes among three kinds of 'industries': (1) market and non-market goods and services production (equivalent to the conventional industry defined in the SNA); (2) human capital production; (3) human capital services (human time) production.

Here, the production of human capital includes both tangible and intangible components. The production of tangible human capital depends on all goods and services consumed by people under working age. The production of intangible human capital depends on educational services consumed by individuals undertaking additional schooling. The production of human capital services (human time) depends on the goods and services consumed by people in the labour force. The relative values of investment or stocks of human capital are evaluated by equilibrium prices, which can be expressed in terms of the unit price of simple human time.

The essential feature of this system is its treatment of final consumption as inputs to the production of human capital. Aulin-Ahmavaara (2002) is critical of the Kendrick (1976) and Jorgenson and Fraumeni (1989) approaches because both studies fail to count intermediate inputs (goods and services consumed by individuals) in the production of human capital. She claims that this may lead to very high estimates of net rate of returns on human capital.

If human capital is measured in a way strictly analogous to physical capital, then consumption expenditure should be deducted from labour compensation. But some disagree that standard production theory and practice, developed for analyzing the production of normal (non-human) goods and services, should be applied to the analysis of the production of human capital. They argue that differences between human and non-human capital are such that they do not warrant the same treatment. There are no easy and quick answers to these questions.

APPENDIX 3 COMPARISON OF CATEGORIES OF EDUCATIONAL ATTAINMENT

REGROUPING CATEGORIES OF EDUCATIONAL ATTAINMENT

Educational attainment is measured by the highest post-school educational qualification recorded in the Australian Census. Over the past 20 years, the definitions of educational qualification have been revised, with more detailed classifications introduced. Reasons for these re-definitions include changes to (and upgrades of) courses at tertiary education institutions, particularly at TAFE colleges.

In order to make the categories of educational attainment comparable across different periods, some regrouping work had to be done. The following table shows how the detailed categories of educational qualification in each census year have been re-categorised into the four broader categories adopted in this paper.

A3.1

Category in paper	*1981 Census category*	*1986 Census category*	*1991 & 1996 Census category*	*2001 Census category*
Higher degree	Higher degree	Higher degree	Higher degree	Postgraduate degree level
Bachelor degree	Graduate diploma, Bachelor degree	Graduate diploma, Bachelor degree	Postgraduate diploma, Bachelor degree	Graduate diploma and Graduate certificate level, Bachelor degree level
Skilled labour	Diploma, Certificate-trade level, Certificate-other level	Diploma, Certificate-trade level, Certificate-other level	Undergraduate diploma, Associate diploma, Skilled vocational qualifications, Basic vocational qualifications	Advanced diploma and Diploma level, Certificate level
Unqualified	Not classifiable, Other, Not applicable	Level of attainment inadequately described, Not classifiable, Level of attainment not stated, No qualifications, Not applicable	Level of attainment inadequately described, Level of attainment not stated, Not applicable	Level of education inadequately described, Level of education not stated, Not applicable

This broad recategorisation is not ideal. For example, the category 'No Qualifications' might be recategorised as 'Completed Year 12 Certificate' and 'Not Completed Year 12 Certificate', while the 'Diploma' category could be split off from 'Skilled Labour'. The lack of detailed information, and the difficulty in drawing comparisons between some levels of educational attainment over time has prevented the use of more detailed categories.

APPENDIX 4 AFTER INCOME TAX MEASURES

INCOME TAX MEASURES

The following after-tax measures are derived by deducting tax payable from gross incomes. The tax payable on gross income is estimated by applying income tax rates for the corresponding financial year to the corresponding annual gross incomes. The after-tax measures of lifetime incomes are based on the corresponding annual after-tax incomes. The income tax rates are taken from various issues of The Australian Taxation Office publication Taxation Statistics.

A4.1 ANNUAL AFTER-TAX INCOMES PER CAPITA, By educational attainment and sex: **Current dollars**

	1981	*1986*	*1991*	*1996*	*2001*
Males					
Higher degree	16 449	24 707	35 434	42 939	48 617
Bachelor degree	14 818	22 144	30 974	36 751	42 669
Skilled labour	11 680	17 783	24 473	28 590	33 734
Unqualified	10 159	15 817	21 684	25 349	29 708
Females					
Higher degree	12 884	19 722	28 085	33 722	39 393
Bachelor degree	11 428	17 350	23 282	27 337	32 559
Skilled labour	8 713	13 278	18 538	21 264	24 883
Unqualified	7 108	10 865	14 998	18 406	21 754

A4.2 POPULATION BASED MEASURES OF HUMAN CAPITAL STOCK IN AUSTRALIA, After income tax: **$b current dollars**

	1981	*1986*	*1991*	*1996*	*2001*
Males					
Higher degree	10.56	19.18	46.02	74.42	105.27
Bachelor degree	55.82	113.09	212.19	327.19	447.54
Skilled labour	191.75	337.39	503.91	631.88	805.46
Unqualified	295.24	507.13	738.38	887.22	1 021.07
Total	*553.37*	*976.78*	*1 500.50*	*1 920.70*	*2 379.34*
Females					
Higher degree	2.50	5.44	15.88	33.10	61.66
Bachelor degree	24.09	59.41	147.85	261.02	420.14
Skilled labour	80.05	157.32	219.50	277.85	364.51
Unqualified	275.22	450.21	665.25	838.60	950.72
Total	*381.87*	*672.38*	*1 048.47*	*1 410.57*	*1 797.04*
Persons	935.23	1 649.16	2 548.98	3 331.28	4 176.37

INCOME TAX MEASURES

continued

A4.3 POPULATION BASED MEASURES OF HUMAN CAPITAL STOCK IN AUSTRALIA, After income tax: **$b 2001 dollars**

	1981	*1986*	*1991*	*1996*	*2001*
Males					
Higher degree	28.30	34.52	57.98	82.60	105.27
Bachelor degree	149.60	203.56	267.37	363.18	447.54
Skilled labour	513.89	607.29	634.93	701.39	805.46
Unqualified	791.24	912.83	930.36	984.81	1 021.07
Total	*1 483.03*	*1 758.20*	*1 890.64*	*2 131.98*	*2 379.34*
Females					
Higher degree	6.71	9.79	20.01	36.75	61.66
Bachelor degree	64.57	106.94	186.29	289.74	420.14
Skilled labour	214.54	283.18	276.57	308.41	364.51
Unqualified	737.58	810.38	838.21	930.84	950.72
Total	*1 023.40*	*1 210.29*	*1 321.08*	*1 565.73*	*1 797.04*
Persons	2 506.43	2 968.49	3 211.71	3 697.72	4 176.37

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