1351.0.55.023

Australian Bureau of Statistics

Research Paper

Measuring Human Capital Flows for Australia: A Lifetime Labour Income Approach

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New Issue

Research Paper

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Hui Wei

Economic Analysis and Reporting Branch

AUSTRALIAN BUREAU OF STATISTICS

EMBARGO: 11.30 AM (CANBERRA TIME) THURS 21 FEB 2008

ABS Catalogue no. 1351.0.55.023
ISBN 978 0 642 48418 5

Produced by the Australian Bureau of Statistics

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MEASURING HUMAN CAPITAL FLOWS FOR AUSTRALIA: A LIFETIME LABOUR INCOME APPROACH

Hui Wei
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ABSTRACT

This paper presents an experimental accumulation account for human capital for Australia. The proposed accounting system draws on the Jorgenson–Fraumeni human capital accounting system, with a few modifications. This study focuses on human capital formed through investment in post-school education and working experience. To separate the positive effect on lifetime labour incomes of ageing, this study makes use of wage differentials arising from age at the early stage of working life to estimate investment in working experience. To derive measures of net human capital formation, this study decomposes total depreciation into three elements: depreciation on education capital, depreciation on experience capital and ageing of base level capital. The contribution of the size of working age population to the growth of human capital stock is treated as other changes.

Using the full Census data from 1981 to 2001, this study estimates the changes in the number of persons in each sex/education/age cohort over the Census years. Combining these estimates of demographic changes with per capita measures of human capital flows paints a broad picture of the sources of the growth of human capital stock over this twenty years period. The most important empirical findings from this accounting exercise are: (1) education has become an increasingly important driver of the growth of human capital stock, and this is especially noticeable for women; (2) the impact of population ageing (depreciation) on the human capital stock has trended upwards strongly since the first half of the 1990s, and has significantly slowed down the growth of human capital stock.

1. INTRODUCTION

In May 2004 the ABS published a working paper on measuring the stock of human capital for Australia (Wei, 2004). The study adopted a 'lifetime labour income approach', developed by Jorgenson and Fraumeni (1989, 1992a, 1992b). This method measures the stock of human capital as the discounted present value of expected lifetime labour market income. Expected income streams are derived using cross-sectional information on labour income, employment rates and school participation rates. Using the full Australian Census data for 1981, 1986, 1991, 1996 and 2001, per capita measures of lifetime labour market incomes were derived for each age/sex/education cohort, applied to the number of people in the corresponding cohort and then aggregated across all cohorts to estimate the human capital stock for Australia. [1]

In order to provide a full account of the growth of human capital, it is necessary to establish an integrated stock–flow accounting system in which changes in the stock of human capital can be allocated among investment, depreciation, growth of working age population and revaluation. And so this paper, which presents experimental measures of human capital formation, is a natural extension to the 2004 stock measurement paper. Consistent with our measures of the human capital stock, this study again uses the Jorgenson–Fraumeni (JF hereafter) lifetime labour income approach to estimate human capital flows and integrate those flows with the corresponding changes in stocks for the census period 1981–2001.

The JF accounting system is based on the concept of human capital measured as the present value of lifetime labour incomes for all individuals in the economy. The change in human capital stock from period to period is viewed as the sum of human capital formation, net of depreciation and revaluation. Human capital formation itself comes from population growth (both births and immigration) and increments to lifetime incomes due to investment in formal education. Depreciation on human capital is due to population ageing, deaths and emigration. Net human capital formation is the difference between gross formation and depreciation. Revaluation of human capital is due to changes in lifetime labour incomes over time for each given age/sex/education group.

1 The estimation of human capital stock presented in Wei (2004) was based on the original Jorgenson–Fraumeni approach by which estimates of lifetime labour incomes were based on current cross-sectional information. One drawback with this approach is that projected future income streams are subject to short-term business cycle effects. In dealing with this issue, a simple moving average method is employed to incorporate uncertainties in projecting future income streams. These revised per capita measures of lifetime labour incomes are used in this paper.

As one major modification to the JF measurement framework, the 2004 stock measurement paper is confined to the working age population.[2] This choice has important implications for constructing an integral accumulation account complementary to the measurement of human capital stock. First, in the original JF accounting framework, all individuals in the population are included, and all education including primary and secondary is counted as investment in human capital. This study, by focusing on the human capital formation process occurring in the working-age population, only counts post-secondary education as investment in human capital formation.[3] The base level human capital embodied in the working age population, formed through primary and secondary education, is not produced during the current accounting period and thus should be excluded in the category of human capital formation. When a person turns working age with human capital not formed in the current accounting period, or a new migrant of working age comes to Australia with human capital formed somewhere else, this addition to the human capital stock is treated as an 'other change', equivalent to the category 'Other changes in assets account' in the SNA93.

As in the case of physical capital, the relationship between the price of an asset and its age – the lifetime labour income of a person and his age in the case of human capital, is essential for estimating the depreciation component. The original JF framework measures the depreciation on human capital as the changes in lifetime labour incomes with age. This measure may contain the component of on-the-job training, as it is suggested by Rosen (1989).[4] So as another major modification, this study attempts to separate the component of on-the-job training from the changes in lifetime labour incomes of individuals with age, and treat it as an investment component in the category of human capital formation, in parallel with post-school education.

The JF measurement system of human capital is based on a rich data base on market labour activities, which included "the number of employed persons, hours worked, and labour compensation for the United States on an annual basis, cross-classified by sex, age, education, employment class, occupation, and industry" (Jorgenson and Fraumeni, 1989, p. 231). In comparison, this study uses the full Australian Census data for the period 1981–2001. As there is no direct information on labour earnings in the Census data, this study uses the Census income variable, which contains all sources of incomes, as a proxy for labour earnings. Due to the lack of information on hours worked in the Census data for pre 2001 period, this study, at this stage, makes no attempt to separate hourly labour compensation and hours worked in the

2 The working age, defined as 25–65 years in the 2004 stock paper, has been revised to be 18–65 years in this update of human capital stock estimates.

3 Hill (2000) makes the similar recommendation in his proposed accounting system for human capital.

4 Rosen (1989) made the following comment on the JF framework: "the depreciation estimates (compiled in this way) … seem to include gross on-the-job investment as one of its components. It would be of substantial interest to present those estimates separately."

measurement of total labour earnings.[5] Finally, the human capital flows presented in this study are measured at the aggregate level without occupation/industry details.

The rest of the paper is structured as follows. Section 2 presents the accounting framework for constructing an accumulation account for human capital. Section 3 addresses the data issues and presents experimental results. Section 4 concludes.

5 At present, the ABS has no reliable estimates of hours worked for the Australian labour force by sex /education /age characteristics. Future research work may be undertaken to address this problem.

2. THE ACCOUNTING FRAMEWORK

The measurement of human capital from a national accounting perspective is guided not only by the economic theory on human capital, but also by the general theory of capital measurement and the associated accounting framework. As capital asset, investment and depreciation are central concepts of the capital measurement system, the following discussion of the accounting framework for human capital accumulation is undertaken along this line of thought.

Gross human capital formation

The accounting framework for human capital accumulation is based on the standard human capital theory. According to this theory, investment in human capital may take various forms. People may undertake additional education, they may obtain new skills at work, they may improve their health, or they may start searching for a job with better working and reward conditions. All these activities are undertaken looking forward to greater productive capacity and higher earning powers in the future. To identify and measure these different forms of investment in human capital is surprisingly difficult. At the conceptual level, there is still disagreement among labour economists as to what are the relative contributions of various factors to human capital formation, whether it is earlier childhood education, or upper secondary or tertiary education. At the practical level, data on various aspects of human capital investment are fragmented and difficult to aggregate over time. [6]

The bulk of empirical studies of human capital investment remains focused on formal post-school education and training, largely due to the availability of rich cross-sectional income/education statistics across countries over time. Accordingly, this study limits investment in human capital as formal post-school education and on-the-job training or working experience. [7] Using the standard human capital theory, this study regards the differences in labour earnings among alternative education groups as returns to the corresponding investment in education and training. Following the JF approach, investment in education is measured by the increments to lifetime labour incomes attributable to post-school qualifications obtained during the accounting period. The conventional method for measuring capital investment for national accounting purposes is cost-based. In theory, the cost-based and the return-based methods are identical under perfect capital market conditions. In reality, the capital market is rarely perfect and this is particularly true for the case of human capital. Empirical measures of human capital investment may therefore vary significantly according to the methods used.

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6 See Appendix B for a more detailed description of how human capital is defined in the ABS work on the measurement of human capital.

7 In this paper, working experience and on-the-job training are used interchangeably.

Investment per capita in a formal post-school qualification in a given year and sex, is given by

$$si_{a,e} = (mi_{a,e+1} - mi_{a,e}) \tag{1}$$

where subscripts a,e stand for age and educational attainment, $e+1$ denotes the next higher educational attainment than the current level, *si* is investment per capita in education, *mi* is lifetime labour income per capita. $si_{a,e}$ denotes the average value of one unit of investment from educational attainment e to $e+1$ for a person in age cohort 'a'. The scope of post-school education is defined in Section 3.3.1, where empirical estimates of investment in post-school education for Australia are reported.

The earnings differentials among alternative age groups with the same level of educational attainment are attributed to the corresponding differences in their working experience, and hence treated as returns to their investment in working experience. Investment in working experience is measured by the increments to lifetime labour incomes attributable to increased working experience with age. Such an increment is given by

$$oji_{a,e} = \sum_{j=a+1}^{65} \frac{\max\left\{ 0 , \left(ymi_{j,e} - ymi_{j-1,e} \right) \right\}}{(1+r)^{j-a}} \tag{2}$$

where *oji* is investment per capita in working experience, *ymi* is annual labour income per capita and r is the discount rate.

Equation (1) and equation (2) suppress the time and sex dimensions for the sake of simplicity. They can be applied separately for men and women, as well as for each calendar year of observations (1986, 1991, etc.).

Aggregate measures of investment in post-school education/working experience are obtained by applying these per capita investment measures to the corresponding number of persons in each sex/education/age cohort and aggregating across these cohorts.

It should be noted that the links between experience and earnings reflect not only investment behaviour, such as workplace training and learning by doing, but also institutional influences. Accordingly, various alternative theories have been developed for studying wage differentials among workers of different age groups.[8] Examining the effect of institutional reform on earnings is beyond the scope of this paper.

8 For detail, see Norris' (2000) discussion of alternative models of the labour market.

Treatment of early childhood and school education

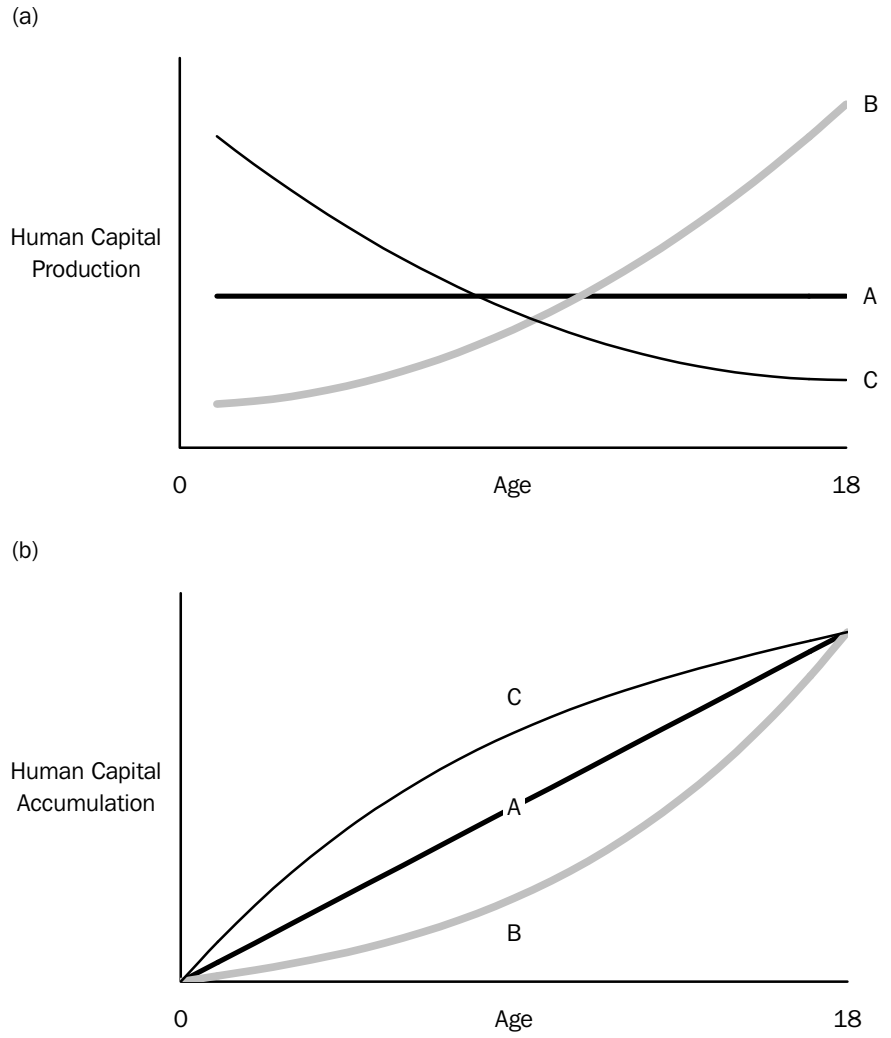
Early childhood education including primary and secondary school plays a fundamental role in the development of human capital skills. For example, Heckman and Krueger (2004) demonstrate that gaps in cognitive and non-cognitive (socio-emotional) skills across groups open up early and are related to early childhood environments. Therefore, it would be ideal to be able to objectively impute the value created by investment in under-working age population. However, the measurement of investment in early childhood education with the framework of lifetime labour income poses significant problems.

The conceptual basis of the lifetime labour income approach for valuing knowledge and skills (human capital) embodied in young children seems straight forward enough: it is equal to the discounted present value of lifetime labour market earnings of those employees with the similar knowledge and skills. However, the empirical application of this approach to a developed economy, such as Australia, encounters a practical difficulty: it is almost impossible to find employees among the young and middle-aged groups in the present-day labour market with little or no education. Even if some elderly employees could serve as a proxy group, their patterns of lifetime labour earnings are hardly relevant for that of today's children.

In the absence of relevant proxy groups for projecting lifetime labour incomes for children, one needs to make various assumptions. Figure 2.1 shows various growth patterns of knowledge and skills (human capital) of children from birth to age 18 years. Flows are represented in part (a). The corresponding stocks are represented in part (b). Three scenarios – A, B and C – are depicted for the growth rates of knowledge and skills: A, B and C respectively represent constant, increasing and decreasing rates of knowledge and skills growth for children. Empirical studies on the technology of human capital skills formation for children could provide us with very limited guidance on which curve should be chosen for imputing increments to expected lifetime labour incomes during early childhood education.[9] Of course, we could make a choice based on certain assumptions. Once again estimates derived in this way are of very little value for decision making and policy purposes. Due to these considerations, we exclude imputation of investment in under working age population from the measurement of human capital investment at this stage. The contribution of this earlier investment in education to the aggregate stock of human capital is brought to account under the category '*Other changes in human capital stock',* which is to be discussed later in this section.

9 According to Heckman and Krueger (2004), economists are only beginning to understand the human skills functions which generate skills gaps and dynamics through life cycle.

2.1 Human capital investment and accumulation patterns



Depreciation on education and experience capital

Like any other type of assets produced or acquired, human capital is subject to depreciation. All produced capital has a finite working life, deteriorates and may become obsolete. Human capital is no different. Skills may become rusty and knowledge may be forgotten, while technological change can render certain skills obsolete. As these factors cause the productive capacity of human capital to decline, its economic value is inevitably depreciated in parallel.

To obtain the measure of net human capital formation by education, depreciation on education capital is measured by changes in the *additional* lifetime labour incomes attributable to post-school qualifications with age, holding time as constant. Similarly, to obtain the measure of net human capital formation by working experience, depreciation on experience capital is defined as the change in the *additional* lifetime labour incomes attributable to working experience with age, while holding time as constant.

The measurement of economic depreciation for physical capital is a complex business involving several thorny issues that have attracted numerous research efforts.[10] In the case of human capital embodied in an individual, whose human capital is measured as the discounted present value of income stream over the life cycle, it seems relatively straightforward to measure the value loss of lifetime labour income due to this person's ageing: the depreciation of his or her human capital during an accounting period is the change in his or her lifetime labour income over this period. As Graham and Webb (1979) observe: "This represents a significant advantage of the present-value approach over the cost approach, which must assume an arbitrary depreciation pattern to derive (net human capital) stock estimates (p. 220)."

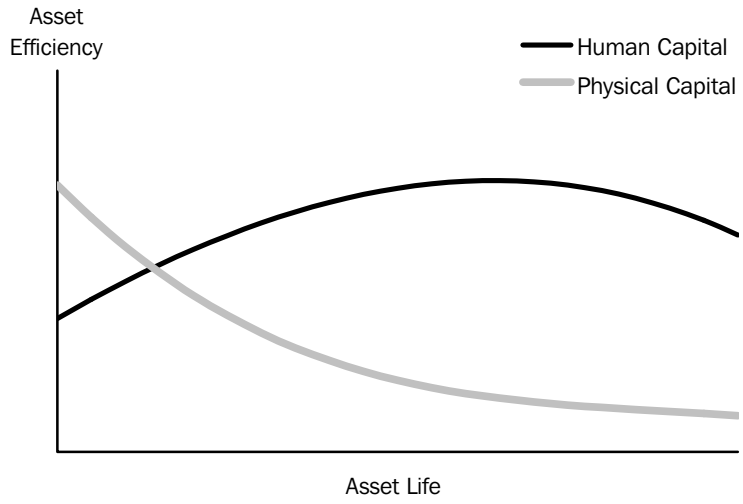
However, unlike physical capital, the efficiency of which generally starts to decline from the moment it enters the production process, human capital can grow through regular use and increased working experience. This feature complicates the measurement of depreciation for human capital, as the change in lifetime labour income (projected on the basis of observed cross-sectional earnings profiles) over time for individuals may contain elements of working experience and revaluation, which should be separated from real depreciation of human capital due to ageing.

Figure 2.2 illustrates the different age–efficiency functions for human and physical capital. Initially human capital's efficiency improves as labour market experience increases, and then starts to decline as workers become less active in the labour market as they near retirement age.[11] Of course, an individual's human capital efficiency function can be quite different from this broad picture. The age–efficiency function for physical capital is assumed to be in the geometric form, which declines from the moment an asset is used in the production process.

10 Hulten and Wykoff (1995) provided a succinct summary of important issues in the empirical measurement and analysis of economic depreciation for capital goods. For more recent discussions on this matter, see Ahmad, Aspden and Schreyer (2005).

11 This hypothetical curve is based on the shapes of annual labour incomes by age groups graphed in figure 1 in Wei (2004).

2.2 Age–efficiency functions: Human vs. physical capital

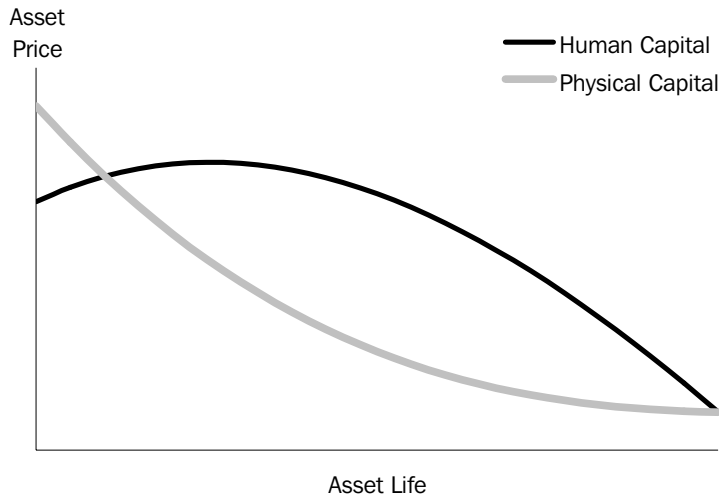


The age–price function for capital goods is a related concept. It refers, in the case of human capital, to the relationship between the imputed economic value of human capital (measured as lifetime labour income in this study) and the number of years of working life remaining. Like the age–efficiency functions, the age–price function for human capital is considerably different to that for physical capital. An additional year of working experience means improved productive capacity, but comes at the cost of one less year available to work (as every worker has a finite working life). And so the net impact on human capital of being one year older depends on the combination of age and education characteristics. Ageing can increase human capital among younger more educated groups, but will eventually have a negative effect as they get older. This explains why the age–price function curve, graphed in figure 2.3, is concave in contrast to physical capital's convex curve. [12]

Age–efficiency and age–price functions for physical capital are different, but closely-related concepts: the economic value of a physical asset is clearly related to that asset's productivity. And so the age–price function and hence depreciation of an asset is calculated using information on an asset's age–efficiency function. The value of an asset in economic theory is equal to the present value of its future earnings. And as the asset ages, that value declines, all else remaining equal. And this is 'economic depreciation'. In the official System of National Accounts (SNA), depreciation of capital goods (or consumption of fixed capital) is measured as the difference between the real economic value of the asset at the beginning and end of the accounting period (ABS, 2000, p. 250).

12 This hypothetical curve is based on the shapes of per capita lifetime labour incomes graphed in figure 2 in Wei (2004).

2.3 Age–price functions: Human vs. physical capital



But the two functions behave rather differently for human capital, as demonstrated in figure 2.2 and figure 2.3. In the light of this context, the economic depreciation for human capital should be estimated independently from its efficiency function, as it may not represent decline in the productive efficiency of human capital.[13]

Given the preceding discussion, the change in the stock value of human capital for an individual with no further investment in post-school education, measured by his or her lifetime labour income (*mi*), between period t to period $t+1$, is determined by three factors: on-the-job investment (*oji*), depreciation (D) and revaluation (G). A mathematical expression for this relationship can be written as follows:

$$mi_t - mi_{t-1} = oji_t - D_t + G_t \qquad (3)$$

As mi_t and mi_{t-1} are given, and oji_t and G_t can be separately estimated, D_t can be derived through equation (3) as a residual. The sex, education and age dimensions are suppressed in equation (3) for the sake of simplicity.

Other changes of human capital stock

As the preceding discussion indicates, additions to the human capital stock during an accounting period also occur from the growth of working age population, that is, persons turning working age and new migrants flowing into the existing labour force. In contrast to the JF approach, which treats such changes as an integral part of human capital formation, this study categorises such changes as *other changes* in human

13 This point also has important implications for alternative concepts and measures of human capital stock. The human capital stock, defined and measured as the sum of lifetime labour incomes for all working age individuals in this project, refers to the *economic capital stock*. Another possible concept and measure is the *productive human capital stock*, which is beyond the scope of this study at this stage.

capital assets. Human capital embodied in persons just turning working-age has been produced over the years before they join the working-age population, and as this study is confined to the working-age population, their additions to the human capital stock is of the nature similar to economic appearance of produced assets under the category 'other changes in assets account' in the SNA93.

The items 'ageing of base level human capital' and 'revaluation' are also classified as *other changes*. The former measures decreases in lifetime labour incomes attributable to base level human capital skills, the latter measures changes in real lifetime labour incomes from period to period for individuals with given sex/education/age characteristics.

Structure of human capital accumulation account

In summary, our accumulation account for human capital is summarized by the following accounting identity:

(a) The net value of human capital stock in the opening balance sheet;

Plus

(b) Gross human capital formation in post-school education for the working age population;

Minus

(c) Depreciation on human capital formed by post school education;

Equals

(d) Net human capital formation in post-school education;

Plus

(e) Gross human capital formation in on-the-job investment;

Minus

(f) Depreciation on human capital formed by on-the-job investment;

Equals

(g) Net on-the-job investment;

Plus

(h) Persons turning working age;

Minus

(i) Ageing of base level human capital;

Plus

(j) Immigrants;

Plus

(k) Revaluation;

Adjusted by

(l) Omissions & errors (including emigrants);

Equals

(m) The net value of human capital at the closing balance.

Each element in the above accounting identity could in theory be measured directly (and independently of the others). But if there is missing information for any single element, the value of that element can be determined residually. Because revaluation and depreciation can be directly estimated, it might be more convenient to residually calculate some of the other items. Conceptually, any single element of change in human capital stock can be derived from information on other elements. But in practice, measurement errors and inconsistencies lead to an inevitable statistical discrepancy. These possible inconsistencies might be problematic when estimating human capital flows.

The estimation method used for measuring human capital is quite different from that conventionally used for physical capital, where the directly available information covers the quantity of new capital goods added to the existing capital stock. The magnitude of the stock is indirectly derived by the perpetual inventory method. As the owners and users of capital goods are often one and the same, the quantity of capital services has to be imputed indirectly as well. [14]

For human capital, it is the value of labour services that is directly observable (from labour market transactions), and the stock of human capital can be directly estimated from the present value of discounted lifetime labour income streams. Because the changes in the human capital stock between the beginning and the end of an accounting period must equal to the sum of human capital flows, the amount of investment in human capital is indirectly derived by decomposing the stock changes into various components.

14 Hulten (1990) provides an excellent discussion of the measurement issues of physical capital facing the statistical agencies.

In summary, the focus on the working age population adopted by this study makes four noticeable changes from the original JF accounting framework:

1. Human capital formation is defined as the sum of investment in post-school education and working experience;

2. The total effect of ageing on lifetime labour incomes is decomposed into two components – depreciation and investment in working experience;

3. A person's human capital is decomposed into two broad components – base level (secondary school qualifications) and additional advanced level (post-school qualifications). Accordingly, depreciation of this person's human capital is defined as decreases in additional lifetime labour income attributable to his post-school qualification(s) with age. Decreases in this person's lifetime labour income at his base level human capital is treated as other volume changes, because this component needs to be matched against additions to human capital stock from persons turning working age;

4. An extra category 'other changes' is created to account for demographic flows including new members to the working-age population through maturity of under working age persons, ageing of base level human capital and immigration.

3. DATA AND PRELIMINARY RESULTS

3.1 Data issues

Using the accounting framework presented in the preceding section, we compile an experimental human capital accumulation account for the census years 1981, 1986, 1991, 1996 and 2001. Like previous ABS work on measuring the stock of human capital, this study uses the Australian Census for the corresponding periods as the major data source.

It may be appropriate to mention some of the limitations associated with using Census data to measure human capital flows at this moment. To obtain an accurate and comprehensive estimation of human capital flows and integrate them with changes in the human capital stock during the accounting period, we need to know the numbers of persons who have achieved additional post-school qualifications, the numbers of persons who have immigrated into and emigrated out of Australia, age structure changes, etc.. We also need to know at which points of time these events take place and the associated 'unit prices' (per capita lifetime labour incomes) during the accounting period. As the Census data provide only snapshots of stock information at intervals of every five years, we have to use information on net changes in the numbers of persons observed for each given sex/education/age cohort between Census collection years to extrapolate the total flows occurred during the accounting periods.

In terms of quantities, net changes between any two Census collection years are usually smaller than the total flows that occurred during the same period. For example, if one person completes both his or her bachelor and masters degrees during one Census period, the investment in the bachelor study cannot be captured in our measures of investment in post-school education. If a person obtains a post-school qualification and then leaves the country, this investment in post-school education will also be missed out in our measures.

In terms of unit 'prices', we only have income information available for the time when the Census data were collected. This implies that it is not possible to obtain estimates of human capital values in historical or acquisition prices that parallel those of physical capital, for which valuation at historical or acquisition prices is the usual starting point.

For each intercensal period, the estimated total number of people who obtained a certain higher educational attainment may be expressed by the following equation:

$$\sum_{1}^{5} n_i = n_1 + n_2 + n_3 + n_4 + n_5 \qquad (4)$$

where n_i is the number of people who obtained a particular post-school qualification in the i-th year after the Census.

The total investment in human capital through obtaining that qualification during the accounting period should ideally be measured by:

$$\sum_{1}^{5} n_i \Delta mi_i = n_1 \Delta mi_1 + n_2 \Delta mi_2 + n_3 \Delta mi_3 + n_4 \Delta mi_4 + n_5 \Delta mi_5 \qquad (5)$$

where Δmi_i = additional lifetime labour income attributable to that post-school qualification obtained.

However, there is not sufficient information from the Census data to allow us to measure the investment flow using equation (5). Only the additional lifetime labour income and the net total number of persons at the end of the accounting period, N, could be estimated from the Census data. As a result, the total investment in human capital between two census periods has to be measured by equation (5) with the following outcome:

$$N \Delta mi_5 \leq \sum_{1}^{5} n_i \Delta mi_i \qquad (6)$$

Despite the above limitations, the measures of human capital flows derived from the Census data are useful for two reasons. First, they are experimental figures for testing the proposed accumulation account for human capital; second, they do provide broad pictures of major human capital development in human capital stock and various factors underlying them.

3.2 The basic accounting equation and valuation of flows

For any sex (s) / age (a) / education (e) cohort, the number of people at the end of the accounting period (y–t to y) is given by

$$n_{y,s,e,a} = n_{y-t,s,e,a-t} + n^{in}_{y,s,e,a} - n^{out}_{y,s,e,a} + n^{im}_{y,s,e,a} - n^{em}_{y,s,e,a} \qquad (7)$$

where subscripts y, s, e and a stand for year, sex, educational attainment and age, and t is the number of years in an accounting period, and where

n^{in} = number of persons who have moved into this education group from a lower education group;

n^{out} = number of persons who have left this education group to join a higher education group;

n^{im} = number of immigrants; and

n^{em} = number of emigrants.

By definition, if educational attainment is the lowest, then n^{in} equals zero; if educational attainment is the highest, then n^{out} equals zero. When any five elements in equation (7) are known, the sixth can be determined residually. In reality, empirical

observations for n^{in}, n^{out}, n^{im} and n^{em} are rarely available, and are a challenge to estimate. And so the sum of estimated flow components may not exactly equal changes in human capital stock over the accounting period.

For example, to estimate the numbers of persons who obtained additional (higher) education qualifications during the accounting period from Census data, we could use the information contained in the variables "Is the person attending a school or any other educational institutions?" and "What type of educational institution is the person attending?" Such information alone could not enable us to directly derive these numbers, and certain assumptions have to be made in regard to the lengths and completion rates of students.

Estimating the numbers of migrants is another practical problem for solving equation (7). The numbers of migrants could be estimated by using the variable in the Census: "In what year did the person first arrive in Australia to live here for one year or more?" Between two consecutive Censuses, a person who had previously lived in Australia for more than one year, however, might actually migrate to Australia during the current period. Under these circumstance, they would not be counted as a migrant in these accounts, and we would have underestimated the number of migrants.

The measures of human capital flows are based on certain assumptions about the changes in the numbers of persons for each sex/education/age cohort during an accounting period. And so the sum of individual elements may not be fully reconciled with the observed changes. Besides, some measurement errors associated with variables such as educational attainment are inevitable.[15] Though the measurement errors do not directly affect our measures of the human capital stock, they do compromise the decomposition of changes in the stock in each accounting period and so these data should be treated with some caution.

As discussed in Section 3.1, only the 'year-end' prices are available in the Census data, which makes it impossible to value human capital flows at the current prices using the 'year average' prices. However, because the purpose of this study is to construct an accumulation account for human capital, and all entries in the balance sheet should be measured by the market values at the end of accounting periods, then using the 'year-end' prices to value human capital flows is an acceptable approximation. In measuring human capital flows, we first calculate them at constant 2001 dollar prices and then deflate them to current year prices using the ABS Labour Price Indexes (LPI).[16]

15 A recent U.S. study (Black *et al.*, 2003) suggests that there are serious measurement errors associated with educational attainment in the US Census and population surveys. According to that research, people tend to over-report their education levels. The existence of this kind of measurement error has significant implications for estimating returns to education for the U.S.. In Australia, no such findings have been reported yet.

16 In the previous work on measuring the stock of human capital, the ABS Consumer Price Indexes (CPI) was used for calculating constant prices of human capital values. However, we now believe the LPI is more appropriate. The ABS LPI series starts from 1997, and for pre-1997 periods, a synthetic estimation of the LPI was used.

3.3 The estimates of human capital formation

This section presents estimates of the growth of human capital attributable to post-school education and working experience for the working age population during the accounting period. Two main drivers underlie the magnitude of human capital investment flows: enrolment rates of post-school education and earnings gaps between the more and less educated as well as the more and less experienced workers. Depreciation on the education/experience capital stocks is measured as decreases in additional lifetime labour incomes attributable to post-school qualifications/working experience with age. Other factors causing changes in the human capital stock during the accounting period are treated as other changes.

3.3.1 Human capital formation by post-school education

Gross investment in post-school education

Using equation (7), we derive estimates of the number of people who obtained various post-school educational qualifications [17] over various intercensal periods, which are reported in table 3.1. As discussed in Section 3.1, these figures do not account for people who obtained an educational qualification and then emigrated out of Australia, and for people who obtained two educational qualifications during an intercensal period, only the higher one is accounted for during the accounting period. In addition, following the JF assumption, formal education undertaken by people older than 34 is also excluded from the measurement of investment in post-school education. [18] Furthermore, those enrolled in post-school study programs who do not complete during the accounting period are also not counted in our measures. This is because educational attainment is measured in this study by highest qualification. The JF approach is based on the measurement of educational attainment by years of completed schooling, regardless of whether this contributed to completion of that level of education qualifications enrolled for. In this way, JF measures included all those undertaking additional schooling activities, while this study only accounts those who complete their study programs.

17 The post-school qualifications defined in this study are higher degree, bachelor degree and skilled labour, consistent with the measures of educational attainment adopted in the stock paper (Wei, 2004). For a detailed description of educational categories used in the ABS measurement of human capital, please see the Appendix B of Wei (2004).

18 This confinement to certain age groups is justified by Ben-Porath (1967) formulation of human capital theory.

3.1 Number of persons who obtained higher qualifications

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	7,256	16,436	19,977	25,564
	Bachelor degree	69,507	107,913	139,759	136,600
	Skilled labour	185,971	172,297	187,960	189,410
Female	Higher degree	3,078	8,796	14,860	23,487
	Bachelor degree	60,379	138,342	190,623	195,943
	Skilled labour	164,520	154,588	173,788	171,355

While the figures in table 3.1 could be essentially interpreted as estimates of the net increases in the numbers of persons aged 18–34 years who obtained additional educational qualifications brought about by additional educational activities, they can also be used to assess the long-term trend of investment in post-school education. One obvious pattern revealed by table 3.1 is that the growth of skilled labour was largely stagnant throughout the 1980s and 1990s, in particular for men, while the same periods witnessed rapid growth of university educated persons, in particular for women. This pattern may be consistent with the widespread claim that Australia has been experiencing a shortage of skilled labour.

3.2 Lifetime labour income per capita for 25 year olds (2001 constant dollars)

		1986	*1991*	*1996*	*2001*
Male	Higher degree	1,435,222	1,478,077	1,509,794	1,524,047
	Bachelor degree	1,282,212	1,328,027	1,363,598	1,393,223
	Skilled labour	909,942	941,988	974,550	996,057
	Unskilled labour	758,585	785,217	815,322	835,248
Female	Higher degree	1,132,388	1,171,986	1,207,409	1,225,723
	Bachelor degree	918,244	956,132	990,515	1,019,827
	Skilled labour	650,116	676,679	695,868	708,662
	Unskilled labour	516,821	549,324	578,711	599,399

Table 3.2 and table 3.3 present lifetime labour income per capita in constant and current dollars respectively for 25 year olds, classified by sex and educational attainment.[19] The information on differences in per capita lifetime labour incomes among people with different educational attainment can be used for estimating the extra value created by investing in education. For example, for a male without post-school qualifications, the average discounted lifetime monetary gain in 2001 dollars from investing in a bachelor degree, would have been around $523,627 in 1986, $542,810 in 1991, $548,276 in 1996 and $557,975 in 2001.

19 These figures are derived on the basis of a revised lifetime labour income projection method. Wei (2004) provides a detailed description of the procedures about how lifetime labour income per capita for each sex/education/age group are calculated under the original approach.

3.3 Lifetime labour income per capita for 25 year olds (current dollars)

		1986	*1991*	*1996*	*2001*
Male	Higher degree	875,135	1,173,077	1,312,864	1,524,047
	Bachelor degree	781,837	1,053,990	1,185,737	1,393,223
	Skilled labour	554,843	747,610	847,435	996,057
	Unskilled labour	462,552	623,188	708,976	835,248
Female	Higher degree	690,480	930,148	1,049,921	1,225,723
	Bachelor degree	559,905	758,835	861,317	1,019,827
	Skilled labour	396,412	537,047	605,103	708,662
	Unskilled labour	315,135	435,971	503,227	599,399

Recall that investment in education is measured by the incremental increases in lifetime labour incomes due to obtaining educational qualifications. In terms of education pathways, this estimation assumes that a bachelor degree is a prerequisite for a higher degree, but that individuals may proceed from school to obtain either a vocational qualification (skilled labour) or a bachelor degree. Thus the incremental lifetime labour incomes per capita are calculated as follows: for higher degree holders as the lifetime income gaps between higher degree and bachelor degree groups; for bachelor degree holders as the lifetime income gaps between bachelor degree and unskilled labour groups; for those who have completed skilled labour qualifications, the lifetime income gaps between skilled labour and unskilled labour groups are used. Obviously there are various theoretical and practical issues in using the lifetime labour income approach for valuing investment in education, such as the issue of selectivity by ability.

To estimate aggregate investment in post-school education, I apply the per capita measures of investment for each category of post-school education by using equation (1) and aggregate to total numbers by using the corresponding number of persons who have obtained post-school qualifications during the accounting period. Table 3.4 and table 3.5 present estimates of investment in post-school education in constant and current dollars respectively. An examination of these figures leads to the following observations. First, investment in post-school education in Australia increased sharply for the period 1981–2001 (94 percent in constant dollars and 219 percent in current dollars) and this growth largely took place between 1981 and 1996. Second, the overall growth is characterised by the rising share of investment in university degrees, from 59 percent during 1981–1986 to 75 percent during 1996–2001 for men, and from 65 percent during 1981–1986 to 92 percent during 1996–2001 for women. Third, increases of investment in university degrees were much faster for women than for men, and the investment magnitudes for women have exceeded those for men since the period 1991–1996.

3.4 Total investment in post-school education (millions of 2001 constant dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	1,340	3,085	3,597	4,191
	Bachelor degree	35,468	55,895	74,187	73,461
	Skilled labour	25,252	22,584	25,684	25,286
	Subtotal	62,060	81,564	103,468	102,938
Female	Higher degree	718	2,171	3,685	5,682
	Bachelor degree	23,673	52,878	74,819	77,892
	Skilled labour	13,201	8,828	9,260	7,176
	Subtotal	37,593	63,876	87,765	90,750
Total		99,652	145,441	191,232	193,689

3.5 Total investment in post-school education (millions of current dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	817	2,448	3,128	4,191
	Bachelor degree	21,627	44,361	64,510	73,461
	Skilled labour	15,398	17,924	22,334	25,286
	Subtotal	37,841	64,733	89,972	102,938
Female	Higher degree	438	1,723	3,204	5,682
	Bachelor degree	14,435	41,967	65,060	77,892
	Skilled labour	8,049	7,006	8,052	7,176
	Subtotal	22,923	50,695	76,317	90,750
Total		60,763	115,429	166,289	193,689

The investment magnitudes are determined mainly by two factors: economic returns to post-school education and corresponding enrolment rates. Accordingly, the differences of these investment figures across education categories and over time are attributable to the changes underlying these two factors. With reference to the information on higher education enrolment rates presented in the 2004 stock paper (Wei, 2004, pp. 16–17), which shows that university enrolment experienced significant growth between 1981–1996, it is noted that the growth of investment in education, in large part, was due to large increases in university enrolments during this period. The other possible source of the growth of investment in higher education could be increasing returns to higher education over time. The information on per capital lifetime labour incomes by alternative education categories for the 25 years old groups presented in table 3.2, though only a snapshot of those young cohorts still at the ages apt to undertake further post-school studies, indicates that the contribution of increasing returns would be relatively minor.

Depreciation on education capital

To match the definition of investment in post-school education, depreciation on education capital is defined as the reduction of additional lifetime labour incomes for those individuals with post-school educational qualifications due to their ageing. For the higher degree group, its depreciation is measured by the differentials between the depreciation of human capital embodied in higher degree holders as persons and the depreciation of human capital embodied in bachelor degree holders as persons with the same sex/age characteristics. For the bachelor degree group, its depreciation is measured by the differentials between the depreciation of human capital embodied in bachelor degree holders as persons and the depreciation of human capital embodied in those without post-school qualifications. For the skilled labour group, its depreciation is measured by the differentials between the depreciation of human capital embodied in individuals with skilled labour qualifications and the depreciation of human capital embodied in those without post-school qualifications.

3.6 Total depreciation on education capital (millions of 2001 constant dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	736	866	1,617	2,215
	Bachelor degree	10,123	14,830	25,942	38,072
	Skilled labour	19,518	20,077	23,809	27,961
	Subtotal	30,378	35,773	51,368	68,249
Female	Higher degree	226	345	821	1,572
	Bachelor degree	4,251	7,422	16,134	26,861
	Skilled labour	6,941	7,993	7,429	9,209
	Subtotal	11,419	15,760	24,384	37,642
Total		41,796	51,533	75,752	105,891

Table 3.6 and table 3.7 present estimates of depreciation on the component of human capital accumulated by post-school education in constant and current prices respectively. For each sex/education/age group, depreciation of post-school education human capital is measured as changes in the differentials between per capita lifetime labour incomes with age of higher degree group and bachelor degree group of the same sex/age characteristics, holding time and working experience as constant. Applying these per capita measures of depreciation to the corresponding number of persons and aggregating across all age groups within the same sex/education category gives the depreciation magnitudes in table 3.6 and table 3.7. As the number of persons in each age/education group is the major determinant of these magnitudes, these figures basically reflect the investment behaviour in earlier accounting periods.

3.7 Total depreciation on education capital (millions of current dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	449	687	1,406	2,215
	Bachelor degree	6,173	11,770	22,558	38,072
	Skilled labour	11,901	15,934	20,703	27,961
	Subtotal	18,523	28,391	44,667	68,249
Female	Higher degree	138	274	714	1,572
	Bachelor degree	2,592	5,890	14,030	26,861
	Skilled labour	4,232	6,343	6,460	9,209
	Subtotal	6,963	12,508	21,204	37,642
Total		25,486	40,899	65,871	105,891

Net human capital formation by post-school education

In order to show net changes in human capital skills, we need to measure the net human capital formation by post school education. This is measured by the difference between gross investment in post school education and depreciation on the component of human capital produced through post school education. Table 3.8 and table 3.9 present the estimates of net human capital formation by post-school education in constant and current dollars respectively.

The picture for the net human capital formation in the form of post-school education has some similarities to the gross figures, but there are important differences. First, the growth of net human capital formation is significantly smaller than the corresponding gross figures: 52 percent against 94 percent in 2001 constant dollars, 149 percent against 219 percent in current dollars. Second, the net figures reveal much larger imbalances of growth between university degrees and skilled labour than the gross figures. For example, net investment in university education was up strongly till the period 1991–1996 and then was down for the period 1996–2001, while net investment in skilled labour shrank throughout the entire period (with an exception for women in the 1991–1996 period), and even experienced negative growth for the 1996–2001 period.

3.8 Total net investment in post-school education (millions of 2001 constant dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	604	2,219	1,980	1,976
	Bachelor degree	25,345	41,065	48,245	35,389
	Skilled labour	5,734	2,507	1,875	(2,675)
	Subtotal	31,682	45,791	52,100	34,689
Female	Higher degree	492	1,826	2,864	4,110
	Bachelor degree	19,422	45,456	58,685	51,031
	Skilled labour	6,260	835	1,831	(2,033)
	Subtotal	26,174	48,116	63,381	53,108
Total		57,856	93,908	115,480	87,798

3.9 Total net investment in post-school education (millions of current dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	368	1,761	1,722	1,976
	Bachelor degree	15,454	32,591	41,952	35,389
	Skilled labour	3,496	1,990	1,631	(2,675)
	Subtotal	19,319	36,342	45,305	34,689
Female	Higher degree	300	1,449	2,490	4,110
	Bachelor degree	11,843	36,076	51,030	51,031
	Skilled labour	3,817	663	1,592	(2,033)
	Subtotal	15,960	38,187	55,114	53,108
Total		35,278	74,530	100,417	87,798

3.3.2 Human capital formation by experience factor

Gross investment in working experience

On-the-job training is an important part of investment in human capital. As direct data on training and its effect on earnings are difficult to obtain or estimate, one can instead assess the impact of working experience on earnings. The estimation of investment in experience consists of the following steps: first one derives estimates of years of working experience through education/age information. Given estimated experience/earnings profiles, magnitudes of investment in experience are extrapolated through variations of earnings with experience.

Data on actual work history is rarely available and the usual practice in the literature is to estimate potential working experience through information on age and educational attainment. To obtain estimates of years of working experience for each education group, I make the following assumptions: the higher degree group starts working at

age 23, the bachelor group at age 21, the skilled labour group at age 20 and unskilled labour group at age 18. Empirical studies [20] show that potential experience is a good proxy for the actual labour market experience of men, but not for that of women, because many women leave the labour market some time during their life cycle for family duties. As a result, the measurement error in estimating years of working experience is more serious in the case of women than in the case of men.

To estimate investment in working experience, earnings differentials between two different age groups of a given sex/education cohort are treated as returns to on-the-job training undertaken by the senior age group during the accounting period; per capita magnitudes of investment are measured as the discounted present value of these return flows over the remaining work life cycle; aggregate investment in working experience is obtained by multiplying these per capita estimates with the numbers of persons in each sex/education/age cohorts and aggregate over the population. Earnings eventually peak with age, depending education and sex. Beyond this point, it is assumed that there is no investment in working experience.

Table 3.10 and table 3.11 present the estimates of investment in working experience by sex/education groups in constant and current dollars respectively. The magnitudes of investment obtained for each sex/education group over time are results of per capita investment in working experience times the number of persons in each age group summed across all age groups within the education category. Accordingly, understanding the patterns underlying these estimates requires examining overtime changes both in age–earnings profiles for each sex/education groups and in the distribution of persons across age/education groups. As those age–earnings profiles remain relatively stable [21] during these accounting periods, the number of persons is the key determinant and the variation of these investment magnitudes across education groups basically reflects the distribution of working age population among the four education categories. The lower investment in working experience for women compared with men is partly due to the relatively flat age/earnings profiles for women. This may reflect the discontinuous nature of labour market engagement by women. Furthermore, in contrast to men, the overall upward trend observed for women is largely driven by their increasing labour force participation rates over time. This is particularly the case for the less educated groups.

20 For example, Heckman and Hotz (1986).

21 These age–earnings profiles were displayed in graphs 3.1–3.10 of Wei (2004), pp. 11–14.

3.10 Total investment in working experience (millions of 2001 constant dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	3,298	3,915	4,120	5,250
	Bachelor degree	37,160	36,014	34,770	44,273
	Skilled labour	65,378	69,153	56,961	52,705
	Unskilled labour	213,723	199,817	201,045	172,198
	Subtotal	319,558	308,898	296,896	274,426
Female	Higher degree	738	835	1,186	2,033
	Bachelor degree	9,004	11,004	16,068	25,537
	Skilled labour	17,765	13,778	14,534	17,829
	Unskilled labour	96,278	84,396	108,694	100,422
	Subtotal	123,785	110,013	140,482	145,821
Total		443,343	418,911	437,378	420,247

3.11 Total investment in working experience (millions of current dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	2,011	3,107	3,583	5,250
	Bachelor degree	22,659	28,582	30,234	44,273
	Skilled labour	39,864	54,883	49,531	52,705
	Unskilled labour	130,319	158,585	174,822	172,198
	Subtotal	194,853	245,157	258,170	274,426
Female	Higher degree	450	662	1,031	2,033
	Bachelor degree	5,490	8,733	13,972	25,537
	Skilled labour	10,833	10,935	12,638	17,829
	Unskilled labour	58,706	66,981	94,516	100,422
	Subtotal	75,479	87,312	122,158	145,821
Total		270,331	332,469	380,328	420,247

Depreciation on experience capital

Table 3.12 and table 3.13 present estimates of depreciation on the component of human capital accumulated by working experience in constant and current prices respectively. For each sex/education/age group, depreciation of experience capital is measured as changes in the differentials between per capita lifetime labour incomes with age of those with working experience and those without of the same sex/age characteristics. Per capita annual earnings of the youngest age cohort for each education group are used to extrapolate per capita lifetime labour incomes for those with no working experience, assuming these annual earnings will last throughout working life. Applying these per capita measures of depreciation to the corresponding number of persons and aggregating across all age groups within the

same sex/education category gives the depreciation magnitudes in table 3.12 and table 3.13. As in the case of estimates of the investment in working experience, the key factors in shaping the patterns underlying these figures are the age–earnings profiles for each sex/education group and the distribution of working age population among the four education categories in each accounting period.

3.12 Total depreciation on experience capital (millions of 2001 constant dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	3,074	3,970	7,879	11,463
	Bachelor degree	12,671	19,192	31,444	44,929
	Skilled labour	48,230	57,853	68,765	79,572
	Unskilled labour	114,963	144,399	168,556	177,748
	Subtotal	178,938	225,414	276,644	313,712
Female	Higher degree	457	761	1,832	3,587
	Bachelor degree	4,206	7,832	17,008	27,810
	Skilled labour	13,117	17,140	18,426	22,290
	Unskilled labour	93,263	126,033	158,620	166,554
	Subtotal	111,043	151,766	195,887	220,242
Total		289,981	377,180	472,531	533,953

3.13 Total depreciation on experience capital (millions of current dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	1,875	3,151	6,851	11,463
	Bachelor degree	7,726	15,232	27,342	44,929
	Skilled labour	29,409	45,915	59,796	79,572
	Unskilled labour	70,099	114,602	146,570	177,748
	Subtotal	109,109	178,900	240,560	313,712
Female	Higher degree	278	604	1,593	3,587
	Bachelor degree	2,565	6,216	14,789	27,810
	Skilled labour	7,998	13,604	16,023	22,290
	Unskilled labour	56,868	100,026	137,931	166,554
	Subtotal	67,709	120,449	170,337	220,242
Total		176,818	299,350	410,897	533,953

Net human capital formation by working experience

Table 3.14 and table 3.15 present estimates of net human capital formation by working experience, measured by differences between gross investment in working experience

and depreciation on the component of human capital produced by working experience in constant and current dollars respectively.

3.14 Total net investment in working experience (millions of 2001 constant dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	224	(56)	(3,759)	(6,213)
	Bachelor degree	24,489	16,822	3,326	(656)
	Skilled labour	17,148	11,299	(11,804)	(26,867)
	Unskilled labour	98,760	55,418	32,489	(5,550)
	Subtotal	140,620	83,484	20,251	(39,286)
Female	Higher degree	281	73	(646)	(1,554)
	Bachelor degree	4,798	3,173	(940)	(2,273)
	Skilled labour	4,648	(3,362)	(3,893)	(4,462)
	Unskilled labour	3,015	(41,637)	(49,927)	(66,132)
	Subtotal	12,742	(41,754)	(55,405)	(74,420)
Total		153,362	41,730	(35,154)	(113,706)

3.15 Total net investment in working experience (millions of current dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	136	(44)	(3,269)	(6,213)
	Bachelor degree	14,932	13,351	2,892	(656)
	Skilled labour	10,456	8,968	(10,265)	(26,867)
	Unskilled labour	60,219	43,983	28,251	(5,550)
	Subtotal	85,744	66,257	17,610	(39,286)
Female	Higher degree	171	58	(562)	(1,554)
	Bachelor degree	2,926	2,518	(817)	(2,273)
	Skilled labour	2,834	(2,668)	(3,385)	(4,462)
	Unskilled labour	1,838	(33,045)	(43,414)	(66,132)
	Subtotal	7,770	(33,138)	(48,178)	(74,420)
Total		93,514	33,119	(30,568)	(113,706)

Unlike the case of net investment in post-school education which shows net additions to the stock of human capital, though at a slowing pace, net investment in working experience displays negative growth for all sex/education groups in the period 1996–2001, and this negative net growth starts much earlier for the male higher degree groups and female skilled and unskilled labour groups since the period 1986–1991. There are two plausible explanations. One obvious explanation is the impact of population ageing on human capital formation in working experience, with depletion of working experience embodied in old workers not being adequately

replaced by those accumulated in young workers. A second possible explanation on offer is the impact of the 'knowledge economy', in which new capital goods are introduced into the economy at a fast pace, which could accelerate the obsolescence of experience based human capital skills embodied in old workers.

3.4 Other changes in the human capital stock

Other changes in the human capital stock are changes in the human capital stock over the accounting period arising from events other than investment in post-school education and working experience.

3.4.1 Persons turning working age

This item measures the additions to the human capital stock from persons who have turned working age from the under working age population during the accounting period. Table 3.16 presents the estimated numbers of *new* workers (i.e. workers who have entered the labour force for the first time after completing their education). The focus here is on 'raw bodies'. The 'intellectual' and 'working experience' components are captured in accounting for investment in post-school education and investment in working experience respectively. Therefore, these estimates include all education categories.

3.16 Numbers of new workers

	Age	*1981–86*	*1986–91*	*1991–96*	*1996–2001*
Male	18 years	124,792	131,077	121,174	128,581
	19 years	121,272	136,367	121,683	125,560
	20 years	119,746	138,519	120,892	123,395
	21 years	120,426	130,929	124,452	119,557
	22 years	123,691	124,563	125,358	115,830
	Subtotal	609,927	661,455	613,559	612,923
Female	18 years	118,954	125,865	115,725	122,667
	19 years	115,931	131,696	117,502	120,955
	20 years	115,342	135,120	116,858	119,012
	21 years	116,869	127,172	120,606	114,722
	22 years	119,815	122,218	121,435	112,421
	Subtotal	586,911	642,071	592,126	589,777
Total		1,196,838	1,303,526	1,205,685	1,202,700

3.17 Economic values of persons turning working age (millions of 2001 constant dollars)

	Age	*1981–86*	*1986–91*	*1991–96*	*1996–2001*
Male	18 years	98,222	107,272	104,080	112,399
	19 years	97,329	115,513	106,853	113,160
	20 years	96,532	118,239	106,983	112,919
	21 years	96,344	110,674	109,239	108,656
	22 years	97,294	102,935	107,707	102,828
	Subtotal	485,721	554,633	534,861	549,963
Female	18 years	70,448	79,391	77,785	84,116
	19 years	69,449	85,754	80,685	86,014
	20 years	68,133	87,431	80,094	85,667
	21 years	66,663	78,888	79,776	80,277
	22 years	66,204	72,562	76,517	74,419
	Subtotal	340,898	404,026	394,857	410,493
Total		826,619	958,658	929,719	960,456

3.18 Economic values of persons turning working age (millions of current dollars)

	Age	*1981–86*	*1986–91*	*1991–96*	*1996–2001*
Male	18 years	59,891	85,137	90,504	112,399
	19 years	59,347	91,677	92,915	113,160
	20 years	58,861	93,840	93,028	112,919
	21 years	58,746	87,836	94,991	108,656
	22 years	59,326	81,694	93,658	102,828
	Subtotal	296,171	440,185	465,097	549,963
Female	18 years	42,956	63,009	67,639	84,116
	19 years	42,347	68,059	70,161	86,014
	20 years	41,544	69,389	69,647	85,667
	21 years	40,648	62,610	69,371	80,277
	22 years	40,369	57,589	66,537	74,419
	Subtotal	207,864	320,655	343,354	410,493
Total		504,036	760,840	808,451	960,456

Table 3.17 and table 3.18 present the additions to the human capital stock from persons turning working age in constant and current prices respectively. In valuing these new workers, the lifetime labour income per capita for the baseline education group (the unskilled labour group) is used as a 'unit' price for each age/sex group. For example, the base level value of a 22 year old bachelor degree holder (new to the work force) is valued in the same way as his/her unskilled 22 years old counterpart assuming no working experience. The additional human capital they have

accumulated through tertiary education and working experience are captured by accounting for their investment in education and working experience.

Table 3.16 shows that the number of young workers aged 18–22 years joining the workforce increased between the first two accounting periods, and decreased since then. The measures in constant dollars terms presented in table 3.17 paints a similar picture for the first three accounting periods, but shows slight increases in value terms to the human capital stock for the period 1996–2001. This difference in patterns between the two tables is purely due to price effects.

3.4.2 Ageing on base level human capital

This item captures the impact of population ageing on the human capital stock treating all working age individuals at base level human capital. This is measured by decreases in lifetime labour incomes for all individuals with age on the basis of their base level human capital (decreases in additional lifetime labour incomes with age attributable to post-school qualifications and experience are captured in the measurement of depreciation on education and experience human capital respectively).

Table 3.19 and table 3.20 report estimates of ageing on base level human capital for selected age groups in constant and current dollars respectively. The magnitudes obtained for each selected sex/age groups are results of per capita depreciation of base level human capital times the number of persons in each corresponding group summed up with the same age range group. Generally speaking, base level human capital embodied in those aged 41–55 years displays an upward trend in depreciation, and this pattern is particularly notable for the male groups. As per capita measures of depreciation on base level human capital for each sex/age group are relatively stable, the main driver underlying the upward trend of depreciation is the increased births that occurred in late 1940s to early 1960s, the so called baby boom. The relatively slower pace of depreciation observed for female groups may be due to relatively lower labour force participation rates for its old age groups, especially for those 46+ age groups.

The gauge of the net human capital formation in base level human capital skills will be discussed when the complete accumulation account for human capital is presented later in the paper.

3.19 Total depreciation on base level human capital (millions of 2001 constant dollars)

	Selected age group	*1981–86*	*1986–91*	*1991–96*	*1996–2001*
Male	41–45 years	17,151	30,254	35,883	31,261
	46–50 years	14,475	17,644	24,585	27,836
	51–55 years	14,497	16,070	17,949	22,161
	56–60 years	16,791	15,702	16,644	18,517
	61–65 years	19,875	18,978	17,307	18,822
Female	41–45 years	18,410	21,114	23,874	26,646
	46–50 years	12,761	14,818	19,257	21,091
	51–55 years	12,202	12,690	14,588	18,908
	56–60 years	14,952	14,363	13,565	15,846
	61–65 years	18,761	17,287	15,300	16,712

3.20 Total depreciation on base level human capital (millions of current dollars)

	Selected age group	*1981–86*	*1986–91*	*1991–96*	*1996–2001*
Male	41–45	10,458	24,011	31,203	31,261
	46–50	8,826	14,003	21,379	27,836
	51–55	8,839	12,754	15,608	22,161
	56–60	10,239	12,462	14,473	18,517
	61–65	12,119	15,062	15,050	18,822
Female	41–45	11,226	16,757	20,760	26,646
	46–50	7,781	11,760	16,745	21,091
	51–55	7,440	10,071	12,685	18,908
	56–60	9,117	11,399	11,796	15,846
	61–65	11,439	13,720	13,304	16,712

3.4.3 Immigrants

This item measures additions to the human capital stock from the working age immigrants during the accounting period. Table 3.21 reports the estimates of number of migrants by highest educational qualifications achieved before they arrived in Australia. Tables 3.22 and 3.23 present the additions to the human capital stock from migration in constant and current dollars respectively. Migrants are valued by the corresponding per capita lifetime labour incomes of the Australian counterparts with the same sex/education/age characteristics.

3.21 Estimates of migrants to Australia aged 18–65 years

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	3,656	8,327	8,984	8,551
	Bachelor degree	11,614	25,628	23,963	28,571
	Skilled labour	42,728	43,173	29,188	31,398
	Unskilled labour	134,102	201,559	130,424	153,183
	Subtotal	192,100	278,687	192,559	221,703
Female	Higher degree	1,616	3,900	4,999	5,117
	Bachelor degree	8,417	22,173	25,220	30,473
	Skilled labour	26,764	29,096	21,059	23,672
	Unskilled labour	158,256	234,714	166,351	176,870
	Subtotal	195,053	289,883	217,629	236,132
Total		387,153	568,570	410,188	457,835

3.22 Economic values of migrants (millions of 2001 constant dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	4,276	9,801	11,109	10,542
	Bachelor degree	12,194	27,885	26,457	32,462
	Skilled labour	31,205	32,912	22,777	24,560
	Unskilled labour	89,085	138,300	95,275	116,483
	Subtotal	136,760	208,898	155,619	184,047
Female	Higher degree	1,495	3,718	5,016	5,252
	Bachelor degree	6,400	17,191	20,048	24,862
	Skilled labour	14,198	15,958	11,756	13,322
	Unskilled labour	68,907	109,073	83,628	93,492
	Subtotal	90,999	145,939	120,448	136,928
Total		227,759	354,838	276,066	320,975

3.23 Economic values of migrants (millions of current dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	2,608	7,779	9,660	10,542
	Bachelor degree	7,435	22,131	23,006	32,462
	Skilled labour	19,027	26,120	19,806	24,560
	Unskilled labour	54,320	109,762	82,848	116,483
	Subtotal	83,390	165,792	135,320	184,047
Female	Higher degree	911	2,951	4,362	5,252
	Bachelor degree	3,902	13,643	17,433	24,862
	Skilled labour	8,657	12,665	10,222	13,322
	Unskilled labour	42,016	86,566	72,720	93,492
	Subtotal	55,487	115,825	104,737	136,928
Total		138,878	281,617	240,058	320,975

3.4.4 Revaluation

Conceptually the item 'revaluation' measures changes in lifetime labour incomes over time for working age persons initially in the population with a given sex/education/age characteristics. In practice what is measured is observed changes in lifetime labour incomes for cohorts of a given sex/education/age characteristics. As there is not sufficient information on hours worked and compositional changes within a given sex/education/age cohort during an accounting period, measures of revaluation may contain elements of combinational changes due to migration, changes in hours worked over time, as well as price changes. Table 3.24 and table 3.25 present estimates of revaluation for human capital in constant and current dollars respectively.

3.24 Revaluation of human capital (millions of 2001 constant dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	2,154	1,625	2,928	951
	Bachelor degree	4,414	10,756	16,234	15,088
	Skilled labour	15,287	37,996	46,877	39,711
	Unskilled labour	54,825	81,212	85,195	65,175
	Subtotal	76,679	131,589	151,234	120,925
Female	Higher degree	519	595	1,198	1,098
	Bachelor degree	2,848	5,754	12,632	15,328
	Skilled labour	5,239	18,215	13,622	11,377
	Unskilled labour	46,471	89,221	101,312	61,913
	Subtotal	55,078	113,785	128,765	89,715
Total		131,757	245,374	279,998	210,640

3.25 Revaluation of human capital (millions of current dollars)

		1981–86	*1986–91*	*1991–96*	*1996–2001*
Male	Higher degree	1,313	1,289	2,546	951
	Bachelor degree	2,691	8,536	14,116	15,088
	Skilled labour	9,321	30,155	40,763	39,711
	Unskilled labour	33,430	64,454	74,082	65,175
	Subtotal	46,756	104,435	131,508	120,925
Female	Higher degree	317	472	1,042	1,098
	Bachelor degree	1,737	4,567	10,985	15,328
	Skilled labour	3,195	14,456	11,845	11,377
	Unskilled labour	28,336	70,811	88,098	61,913
	Subtotal	33,584	90,306	111,969	89,715
Total		80,340	194,741	243,477	210,640

Revaluation for human capital is comparable to holding gains for physical capital in the Australian Systems of National Accounts. These changes in values are decomposed into nominal gains and real gains. The nominal gain is defined as changes in monetary value over time, and the real gain is defined as the nominal gain net of any price change effect. The constant dollar estimates of revaluation for human capital presented in table 3.24 presents the net gains of human capital, which rose to a peak for the period 1991–1996 and then declined for the period 1996–2001, especially for male higher degree education group.

3.4.5 Omissions & errors (including emigrants)

This item largely includes the deletions of the human capital stock attributable to emigration, which cannot be reliably estimated from the Census data at a fine sex/education/age level. Given the direct measures of human capital stock,[22] this study derives flow measures from the decomposition analysis of changes in the human capital stock across accounting periods. As a result, measurement and statistical discrepancies and other factors are inevitable as well.

3.5 The accumulation account for human capital

This section integrates various measures of human capital flows into the accumulation account outlined in Section 2. Table 3.26 and table 3.27 present this accumulation account for human capital in constant and current dollars respectively. The accumulation account allocates the change in the human capital stock during an accounting period among three major elements: quality changes (investment in education and experience), quantitative changes (persons turning working age and migration) and price effect (revaluation).

The accumulation account sheds light on the relative importance of post-school education versus on-the-job training as two sources of quality growth in human capital. In terms of net human capital formation, post-school education exceeds on-the-job training from the period 1991–2001 to become the dominant driver of quality growth in human capital for men. For women, post-school education is the main driver of quality growth in human capital for all accounting periods.

22 In contrast, under the perpetual inventory method, the measurement of capital stocks is based on the sum of past net investment. As a result, the magnitude of investment flows is always equal to changes in capital stocks during any accounting period.

3.26 Human capital accumulation account (millions of 2001 constant dollars)

	1981–86	*1986–91*	*1991–96*	*1996–2001*
		Males		
Opening balance	2,668,736	2,997,060	3,470,005	3,828,618
Investment in education				
Gross investment in post-school education	62,060	81,564	103,468	102,938
Depreciation on education capital	–30,378	–35,773	–51,368	–68,249
Net formation by post-school education	31,682	45,791	52,100	34,690
Experience factor				
Gross investment in working experience	319,558	308,898	296,896	274,426
Depreciation on experience capital	–178,938	–225,414	–276,644	–313,712
Net investment in working experience	140,620	83,484	20,251	–39,286
Persons turning working age	485,721	554,633	534,861	549,963
Ageing of base level human capital	–432,825	–437,324	–427,979	–410,168
Immigrants	136,760	208,898	155,619	184,047
Revaluation	76,679	131,589	151,234	120,925
Omissions & errors (including emigrants)	–110,314	–114,125	–127,473	–157,034
Changes in human capital stock	328,323	472,945	358,613	283,136
Closing balance	2,997,060	3,470,005	3,828,618	4,111,754
		Females		
Opening balance	1,717,170	1,948,398	2,334,262	2,658,080
Investment in education				
Gross investment in post-school education	37,593	63,876	87,765	90,750
Depreciation on education capital	–11,419	–15,760	–24,384	–37,642
Net formation by post-school education	26,174	48,116	63,380	53,108
Experience factor				
Gross investment in working experience	123,785	110,013	140,482	145,821
Depreciation on experience capital	–111,043	–151,766	–195,887	–220,242
Net investment in working experience	12,742	–41,754	–55,405	–74,420
Persons turning working age	340,898	404,026	394,857	410,493
Ageing of base level human capital	–226,040	–217,106	–255,622	–271,219
Immigrants	90,999	145,939	120,448	136,928
Revaluation	55,078	113,785	128,765	89,715
Omissions & errors (including emigrants)	–68,623	–67,143	–72,605	–78,243
Changes in human capital stock	231,228	385,864	323,818	266,362
Closing balance	1,948,398	2,334,262	2,658,080	2,924,442

3.27 Human capital accumulation account (millions of current dollars)

	1981–86	*1986–91*	*1991–96*	*1996–2001*
		Males		
Opening balance	1,076,135	1,827,475	2,753,972	3,329,233
Investment in education				
Investment in post-school education	37,841	64,734	89,972	102,938
Depreciation on education capital	–18,523	–28,391	–44,667	–68,249
Net formation by post-school education	19,318	36,342	45,304	34,690
Experience factor				
Gross investment in working experience	194,853	245,157	258,170	274,426
Depreciation on experience capital	–109,109	–178,900	–240,560	–313,712
Net investment in working experience	85,744	66,257	17,610	–39,286
Persons turning working age	296,171	440,185	465,097	549,963
Ageing of base level human capital	–263,918	–347,083	–372,156	–410,168
Immigrants	83,390	165,792	135,320	184,047
Revaluation	597,900	655,579	394,931	620,310
Omissions & Errors (including emigrants)	–67,265	–90,576	–110,846	–157,034
Changes in human capital stock	751,340	926,496	575,260	782,522
Closing balance	1,827,475	2,753,972	3,329,233	4,111,754
		Females		
Opening balance	406,771	1,047,055	1,546,347	2,029,793
Investment in education				
Investment in post-school education	22,922	50,695	76,317	90,750
Depreciation on education capital	–6,963	–12,508	–21,204	–37,642
Net formation by post-school education	15,960	38,188	55,113	53,108
Experience factor				
Gross investment in working experience	75,479	87,312	122,158	145,821
Depreciation on experience capital	–67,709	–120,449	–170,337	–220,242
Net investment in working experience	7,770	–33,138	–48,178	–74,420
Persons turning working age	207,864	320,655	343,354	410,493
Ageing of base level human capital	–137,829	–172,306	–222,280	–271,219
Immigrants	55,487	115,825	104,737	136,928
Revaluation	532,876	589,598	595,415	718,002
Omissions & Errors (including emigrants)	–41,844	–53,288	–63,135	–78,243
Changes in human capital stock	640,284	805,534	765,026	894,649
Closing balance	1,047,055	1,546,347	2,029,793	2,658,080

The quantitative changes in human capital can be assessed by examining the items on other volume changes. The differences between *persons turning working age* and *ageing of base level human capital* are indicative of contributions of natural population growth to the growth of human capital stock. As *omissions & errors* largely represents the value of emigrants, its differences with immigrants may be indicative of contributions of net migration to the growth of human capital stock. Accordingly, table 3.28 reports these two indicators of quantitative changes in human capital on the basis of table 3.26, which show that quantity factors are still far larger than quality factors in the growth of human capital stock.

Finally, revaluation of human capital was the primary factor in the growth of human capital stock for men before the period 1996–2001 when it was overtaken by quantitative changes. For women, revaluation was the secondary factor behind the quantitative factor for the growth of human capital stock for all accounting periods.

3.28 Indicators of quantitative changes in human capital stock (millions of 2001 constant dollars)

	1981–86	*1986–91*	*1991–96*	*1996–2001*
Males				
Net natural population growth	52,896	117,308	106,883	139,795
Net migration	26,446	94,773	28,145	27,013
Females				
Net natural population growth	114,858	186,920	139,235	139,274
Net migration	22,376	78,796	47,843	58,685

4. CONCLUDING REMARKS

This paper proposes an accounting framework to measure human capital flows for Australia. The proposed accounting system draws on the Jorgenson–Fraumeni human capital accounting system, with a few modifications. The central departure from the original JF approach is its focus on the working age population and associated confinement to labour market activities. This departure has important implications for defining human capital formation in measuring human capital flows. This study defines human capital formation as investment in post-school education and on-the-job training. This definition dovetails well with the standard human capital theory, which focuses on contribution of education and training to the growth of human capital skills. To separate the positive effect on lifetime labour incomes of ageing, this study makes use of wage differentials arising from age at the early stage of working life to estimate investment in working experience. In this way, the total changes in lifetime labour incomes with ageing, which was defined as depreciation within the original JF measurement framework, can be decomposed further into on-the-job training and 'true' depreciation. To derive measures of net human capital formation, this study decomposes total depreciation into three elements: the depreciation on education capital, the depreciation on experience capital and the depreciation on base level capital. The contribution of population size to the growth of human capital stock is treated as other volume changes.

Using the full Census data for 1981, 1986, 1991, 1996 and 2001, this study estimates the changes in the number of persons in each sex/education/age cohort over these Census years. Combining these estimates of demographic changes with per capita measures of human capital flows paints a broad picture of the sources of the growth of human capital stock over this twenty years period. The most important empirical findings from this accounting exercise are: (1) education has become an increasingly important driver of the growth of human capital stock, and this is especially notable for women; (2) the impact of population ageing (depreciation) on the human capital stock has trended upwards strongly since the first half of the 1990s, which has significantly slowed down the growth of human capital stock.

The experimental statistics on human capital flows produced in this study could be useful for researchers and policy makers working in a variety of areas, including education, migration and ageing. The framework proposed in this paper, for example, could be used to assess how population ageing affects long-term growth prospect of human resources available for sustainable economic growth and development. It could be also used for quantifying and analysing the effects on the growth of human capital of various policy initiatives, such as a program designed for encouraging older people back to the labour force.

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ACKNOWLEDGEMENTS

I am deeply indebted to Peter Harper for his advice and guidance throughout this research work. I am also grateful to Marion McEwin, Carl Obst, Jon Hall, Alanna Sutcliffe, Jonathon Khoo, Donald Brunker, Ian Bobbin, Tony Johnson, Peter Rossiter, Derek Burnell and Derick Cullen, together with participants at several ABS seminars and the 33rd Australian Conference of Economists for helpful comments and suggestions. Of course, I am responsible for any remaining errors or omissions.

APPENDIXES

A. SELECTED GLOSSARY

Human capital — the productive capacity embodied in individuals due to knowledge, skills and personal attributes measured by the lifetime labour income of the working age population.

Gross human capital formation — additions to human capital stock through investment in post-school education and increases in working experience.

Investment in post-school education — the increase in the value of human capital through the completion of post-school qualifications at a formal educational institution including both TAFE and university, measured by the additional lifetime labour incomes accrued to those who have obtained these qualifications.

Investment in working experience — the increase in the value of human capital through on the job training, measured by the additions to lifetime labour incomes accrued to those with additional years in the labour market.

Depreciation on human capital — the decline in the value of skills and knowledge with age, measured by the reduction in lifetime labour income when time is held constant, and reflecting the reduced time available to work and the reduced ability to apply the skills and knowledge acquired or embodied.

Depreciation on post-school education capital — the decline with age in the value of that component of human capital arising through post-school education measured by the reduction in the *additional* lifetime labour incomes attributable to this education while holding time as constant.

Depreciation on working experience capital — the decline with age in the value of that component of human capital arising through additional years in the labour market, measured by decreases in the *additional* lifetime labour incomes brought about by these knowledge and skills while holding time as constant.

Base level human capital — the stock of knowledge and skills embodied in the individual prior to post-school educational activities and working experience, measured by the lifetime labour incomes of those without post-school qualifications and working experience.

Persons turning working age — the additions to the stock of human capital of those turning working age during the accounting period, measured by the lifetime labour incomes of those without post-school qualifications and working experience.

Ageing on base level human capital — the decline with age in the knowledge and skills obtained prior to post-school educational activities and working experience, measured by decreases in the lifetime labour incomes of all working age individuals valued as those without post-school qualifications and working experience while holding time constant.

Immigrants — the addition to the stock of human capital from those of working age who have migrated to Australia during the accounting period, measured by the lifetime labour incomes of their Australian counterparts with the same sex/education/age characteristics.

Revaluation of human capital — changes in the real and nominal value of human capital stock over time, measured by the sum of changes in lifetime labour incomes for those with the same sex/education/age characteristics initially in the working age population.

B. DEFINING HUMAN CAPITAL

Human capital can be defined in various ways, depending on the issues at hand. Human capital can be broadly defined as the productive capacity embodied in individuals. This definition is adopted by a recent report of the World Bank (2006, page 89). A person's productive capacity is related to a variety of factors, such as knowledge and skills, physical and mental conditions, life experience and attitude. As the 'knowledge and skills' is the most important determinant in a person's productive capacity, human capital can be also defined as the knowledge and skills embodied in individuals. This is the definition adopted by the OECD (1998, page 9).

The 'knowledge and skills' definition focuses attention on the contribution of education and training to a person's human capital formation. This is more in line with the conventional approach of the human capital theory, formulated by Schultz (1961) and Becker (1964) in the early 1960s. Some other authors extend the concept of human capital to consider the roles of health and other factors in a person's human capital formation. Ideally, all major factors that facilitate the formation and enhancement of productive capacities of human beings should be considered in developing comprehensive measurement of human capital. However, from a practical point of view, knowledge and skills are relatively easier to measure. In addition, there exist rich data sources on variables that could serve as proxies of knowledge and skills, such as educational attainment and labour market earnings. Due to these considerations, we adopt 'the knowledge and skills' definition of human capital in our research program on the measurement of human capital.

Human capital (knowledge and skills) can be accumulated in various forms: education, working experience, innate ability, etc.. Even within the category of education, it includes formal schooling activities including compulsory primary and secondary education, post-school education such as universities and vocational training institutions. It also includes informal education in the form of learning within family and early childhood settings and self studies. It would be a daunting task to include all these factors in the measurement of human capital in one go. To make our job more manageable, we focus attention on post-school education and working experience, two major contributors in human capital formation and the central themes of an enormous outpouring of literature in labour and growth economic studies.

Human capital (knowledge and skills) can be broadly categorized into two kinds: the baseline knowledge and skills, and advanced knowledge and skills. This categorization is similar to that used in the World Bank report which divides human capital into raw labour and skilled labour (World Bank, 2006, page 88). Our research work focuses on the growth of advanced knowledge and skills, defined as those

acquired through formal post-school studies including university degrees and vocational training programs.

Human capital plays an important role in market activities as well as in non-market activities. Education does not only have a positive effect on labour productivity and hence on labour market earnings, it also helps improve overall ability to undertake non-market activities and enrich personal lives. These non-economic returns to education are no less important as they impact on market labour activities and the economic success of both individuals and nations. Accordingly, human capital can be either defined as "… relevant to economic activities" (OECD 1998, page 9), or as "… facilitate the creation of personal, social and economic well-being" (OECD 2001, page 18). Since the ABS research work focuses on the role of human capital in enhancing economic performance, the market dimension of human capital is adopted in our research program at this stage. In valuing human capital produced by education, we exclude these non-economic benefits in projecting lifetime labour incomes, because human capital in non-market activities is harder to measure, and is subject to more controversies.

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2000001581841
ISBN 9780642484185

RRP $11.00