Session Number: Poster Session 1
Time: Monday, August 25, 17:30-18:30

Paper Prepared for the30th General Conference of
The International Association for Research in Income and Wealth

Portoroz, Slovenia, August 24-30, 2008

Measuring Human Capital for Australia: Issues and Measures

Hui Wei

For additional information please contact:

Name: Hui Wei
Affiliation: Faculty of Business and Government, University of Canberra
Full mailing address: 45 Benjamin Way, ABS House, Belconnen, ACT, 2617, Australia
Email address: hui.wei@abs.gov.au

This paper is posted on the following website: http://www.iariw.org

Measuring Human Capital for Australia: Issues and Measures

By Hui Wei[1]

Faculty of Business and Government, University of Canberra, Australia

In this paper I discuss measurement issues of human capital from a national accounting perspective and present experimental estimates of human capital stocks and flows in Australia. The measurement framework draws on the Jorgenson and Fraumeni approach (1989, 1992) with a few modifications. Based on the concept of human capital measured as lifetime labour incomes, investment in post-school education and working experience are measured by the additions to lifetime labour incomes accrued to those who have obtained additional post-school qualifications and those with additional years in the labour market. This measurement framework is used to quantify the contribution of post-school education to human capital growth and the impact of population ageing on human capital development in Australia. The experimental estimates for this study show that (1) there has been a significant increase in the stock of human capital in Australia during the period 1981-2001 and this increase is largely due to increased proportions of more educated workers; (2) Due to the population ageing, the existing human capital stock has also depreciated at a faster rate and hence the growth of net human capital formation has slowed down significantly.

1 Introduction

Human capital theory has become a powerful tool in economic analyses for several decades since the publications of seminal work by Schultz (1961) and Becker (1964). Across-country studies of long term economic growth and personal income distributions are prevalent examples of its applications. The role of human capital and its associated determinants in economic activities are heavily studied, discussed and debated. Many theoretical studies rely on treating human capital as a well-defined concept that can be readily measured in practice.

Empirical studies suggest that how to measure human capital is an important but difficult issue. The measurement of human capital is the foundation of both theoretical and empirical studies of human capital. Without empirical measures of human capital, it is impossible to establish any quantitative relationship between human capital and other

[1] Views expressed in this paper are those of the author and do not represent those of his employer. Where quoted or used, they should be attributed clearly to the author, who can be contacted by post: Hui Wei, Locked Bag 10, Belconnen, ACT 2616; or E-mail hui.wei@abs.gov.au or Tel 61-2-6252-5754, Fax 61-2-62528015

variables, and hence the whole body of human capital theory could not empirically be tested and applied.

In official national accounts, measures of capital stocks are confined to physical capital. It is not yet standard practice for any official statistical agency to include human capital in their capital stock measures. Although human capital is one of the most important assets of a country and a key determinant of a nation's economic performance, it is left unaccounted for in the national accounts. This is because there is a lack of consensus about how this important economic variable should be measured. Even if such consensus were achieved, there would still be many methodological difficulties to overcome. Indeed, human capital is different from physical capital, and this lies at the foundation of the difficulties encountered in measuring human capital.

The objective of this paper is to review major issues in the measurement of human capital and present some empirical measures of human capital for Australia. This paper consists of three substantive sections, and it unfolds as follows. Section 2 surveys major issues and methodology adopted in the measurement of human capital, with a particular focus on lifetime labour income approach; Section 3 summarises my recent work in developing measures of human capital stock and accumulation accounts; Section 4 concludes.

2 Measurement Issues

In conventional labour economics literature, the concept of human capital refers to knowledge, skills, experience, attitudes and other attributes embodied in individuals. In much recent growth literature, the concept of human capital is extended to include disembodied human capital — knowledge, ideas and information that can be transmitted between individuals and over generations. When measuring human capital, the measurement can be narrowly based or broadly based. The conventional measures of human capital are limited to embodied human capital. The measurement of R&D can be viewed as a measure of disembodied human capital. My discussion of human capital in this paper focuses on the standard human capital theory, and the associated measurement issues are confined to those of measuring knowledge and skills embodied in human agents of production.

As those attributes related to productive capacity are difficult to identify and measure directly, economists have to use indirect measures. Educational attainment is often used as a measure of human capital: this rests on the assumption that the more educated an individual is, the more productive they are in undertaking market and non-market activities.

Human capital contributes enormously both to market and non-market activities. Because of greater difficulties associated with the valuation of non-market activities, this paper is focusing attention on valuing human capital that are applied in market activities.

Like its counterpart — physical capital, human capital can be measured physically and monetarily. In accounting for physical capital, the productive attributes play important roles, buildings, machinery and so on. In contrast, the level of skills, knowledge and competences embodied in people can be taken to represent the physical aspect of human capital. There are many attributes of human capital: diligence, experience, problem-solving skills and so on. On the other hand, like physical capital, the accumulation and the stock of human capital can be measured in monetary terms: how much a worker would be worth if he or she could be 'sold' on the market, or with the entire labour force in a country taken together, what would be the economic value of its human resources?

Because human capital is a produced asset, economic theory suggests that its value might be directly measured through observing its production cost (including opportunity cost) or the returns it generates[2]. In theory, both methods are equivalent. But empirical measures may differ substantially because of different data sources and alternative assumptions. There are pros and cons associated with each approach. One obstacle to the cost-based approach is to distinguish between consumption and investment components of an educational expense. The major challenge to earnings-based approach is to determine the effect of investment in human capital on labour market earnings. Such a task is not an easy one, since education and training and other forms of investment in human capital are inter-related with other factors which have caused changes in worker's

[2] In his seminal paper, Schultz (1961) suggested two methods to estimate investment in human capital: the first one is to estimate the magnitude of capital formation by expenditures made to produce the capital goods; the second one is to estimate human capital by its yield rather than by its cost.

earnings and contributed to improved workers' productive capacities. In spite of the advancement in statistical techniques and the availability of large samples of data, quantifying the relative importance of these factors remains a knotty problem.

Given the foregoing thorny issues and various choices, my strategy for accomplishing the task of developing systematic measures of human capital has been to begin with modifying a well-established and empirically computable methodology — lifetime labour income approach, developed by Jorgenson and Fraumeni (JF thereafter) (1989, 1992).

The main points of the JF approach could be summarised as follows:

1. At the disaggregate level, human capital embodied in an individual is measured as the lifetime labour incomes over the life cycle, and human capital grows in the form of additional schooling, measured by an increment to the lifetime labour income due to the investment in education. This value of this increment is derived from current earnings/age/education relationships that are projected into the future and discounted back into the present, with employment perspectives, income growth and survival rates being taken into account.

2. At the aggregate level, human capital stock in the economy is measured by the sum of human capital of all individuals in the population. The changes in the aggregate human capital stock over time take place due to various factors — investment in education and training, net migration and demographic changes such as ageing population.

The JF approach is based on a number of controversial assumptions, and attracts a few reservations. In order to avoid some of these complications, I make number of modifications:

1. The JF approach includes non-market activities in measuring human capital by making use of market wage rates. The valuation of human capital in my study is confined to market activities.

2. The JF approach measures educational attainment in calendar years of schooling. This has the limitation of mixing alternative kinds of education of the same length. My study measures educational attainment by using various institutional qualifications. Using levels of highest qualification completed as a measure of formal schooling, the impact of alternative kinds of education on human capital formation could be captured.

3. The Jorgenson and Fraumeni's accounting framework covers all individuals in the population. My study is confined to the working age population aged 18-65 years. Therefore, only post-secondary education is accounted as investment in human capital formation.[3] Accordingly, other factors causing changes in the human capital stock, such as additions of turning-working-age persons and immigrates to the working-age population, are treated as other volume changes, equivalent to the category 'Other changes in assets account' in the SNA93.

4. The Jorgenson and Fraumeni's accounting system only considers formal education in its estimates of investment in human capital that enhances individuals' skills and knowledge, with the component of on-the-job training being mixed with its estimation of depreciation on human capital. The standard human capital theory also emphasizes the role of on- the-job training in human capital formation. This study provides separate estimates of investment due to working experience.

The Jorgenson and Fraumeni's measures of human capital for the U.S. economy are based on the rich data base on market labour activities. In contrast, my study uses the Australian Census data for the period 1981 - 2001. As there is no direct information on labour earnings in the Census data, my research has to use the Census income variable, which contains all sources of incomes, as a proxy of labour earnings. In the lack of information on hours worked in the Census data for pre 2001 period, my study makes no attempt to separate hourly labour compensation and hours worked in the measurement of total labour earnings. Further more, my study is based on the aggregate level without

[3] Hill (2003) makes the similar recommendation in his proposed accounting system for human capital.

occupation/industry details.

3 Models and Empirical Measures

The original JF framework counts all individuals in its measurement of human capital and distinguishes among five stages of life cycle. As my study is confined to the working age population, only two stages of the life cycle are considered: a work-study stage and a work-only stage. The work-study stage is defined as the age range 18 to 34, and the work-only stage as 35 to 65.

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

$$mi_{y,s,a,e_i} = ymi_{y,s,a,e_i} empr_{y,s,a,e_i} + mi_{y,s,a+1,e_i} sr_{y,s,a+1}(1+g)(1+r)^{-1} \quad (1)$$

where mi is the per capita market lifetime labour income, with the subscripts y,s,a,e_i denoting year, sex, age and educational attainment at level i, ymi is the average market labour income, $empr$ is the employment rate, defined as the probability of engaging in paid work, sr_{a+1} is the probability of this person at age a surviving to age $a+1$, g is the real income growth rate and r is the discount rate.

The present value of lifetime labour income per capita for people in the work-study stage is given by:

$$\begin{aligned} mi_{y,s,a,e_i} = {} & ymi_{y,s,a,e_i} empr_{y,s,a,e_i} + (1 - \sum_{e_j=2}^{4} senr_{y,s,a,e_i}^{e_j}) sr_{y,s,a+1} mi_{y,s,a,e_i} (1+g)(1+r)^{-1} \\ & + \sum_{e_j} \sum_{n=1}^{m} senr_{y,s,a,e_i}^{e_{jn}} sr_{y,s,a+m} mi_{y,s,a+n,e_j} (1+g)^{1+n} (1+r)^{-(1+n)} \end{aligned} \quad (2)$$

where $senr_{y,s,a,e_i}^{e_j}$ is the percentage of those individuals with educational attainment e_i studying for a higher educational attainment e_j. The symbol n represents the index of years taken to obtain a higher educational qualification, m is the average years to

complete this study. Equation (2) is based on the assumption that during the study period students' direct schooling costs are exactly offset by their part-time earnings. This simplifies the calculation process and is unlikely to have a major influence on the aggregate estimates of human capital stock.

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

Given the variables constructed above, combined with information on life expectancy, per capita lifetime labour incomes for all sex/education cohorts are projected by using equations (1) and (2). One simple procedure for estimating lifetime income patterns is to use current cross-section age-income profiles to set relative patterns of incomes across age/education groups, and apply the long-term real income growth rate. As current economic variables are subject to short-term macroeconomic fluctuations, lifetime income streams derived from current cross-sectional information may lead to overestimates in booming years and underestimates in recession years. To account for the business cycle effect on the projected lifetime income streams, one needs to look into the factors within the estimates that are subject to fluctuations - namely wages and unemployment rates. Both theory and empirical evidence suggest that wage rates are less sensitive to the effects of the business cycle than unemployment rates. In my study unemployment rates averaged over the longer-term have been used to project lifetime labour income per capita for all age/sex/education groups. The calculations assume a discount rate of 5 percent and an expected income growth rate of 1.75 percent for all cohorts. These should be thought of as real rates (that is, after the effect of inflation has been removed). They are the same rates that have been adopted by the Australian Government Treasury (2002) in projecting future national incomes.

The information on differences between lifetime labour incomes for cohorts with alternative educational attainment is useful for estimating the extra value created by investing in additional education. Table 1 presents lifetime labour income per capita in 2001 dollars for 25 years-olds, classified by sex and educational attainment. According to the JF general framework (1992), the product of the education industry is investment in human capital, and the output of education is thus defined as the addition to lifetime labour income from additional schooling. Within this framework, per capita measures of lifetime labour income could be used to estimate investment in human capital and the output of education. For example, for a male bachelor degree holder, the total gain from investment - analogous to the total amount of investment - in a higher degree, would be around $28,000 in 1981, $53,000 in 1986, $98,000 in 1991, $136,000 in 1996 and $132,000 in 2001.

Applying per capita measures of lifetime labour income derived above to the number of persons in the corresponding cohort and aggregating across all cohorts, we obtain the estimates of the human capital stock for Australia. Table 2 presents the experimental estimates of the human capital stock for Australia in 2001 dollars. Two patterns are noticeable from these figures. First, the stock of human capital in Australia has increased by 60 per cent between 1981 and 2001, characterized by sharply rising share of aggregate human capital attributable to more educated workers. Second, increases in the more highly qualified components of human capital have been much faster for women than for men. For example, the value of female higher degree holders' human capital has increased nearly ten-fold during the twenty year period. The human capital of men with higher degrees has nearly quadrupled over the same period. The value of female bachelor degree holders' human capital is over six times higher in 2001 than 1981, while during the same period the corresponding value for men has tripled.

In order to provide a full account of the growth of human capital over time, it is necessary to establish an integrated stock-flow accounting system in which changes in the stock of human capital can be fully explained by investment and other flows in human capital. In contrast to the original Jorgenson and Fraumeni’s accumulation account for human capital, which measures human capital formation as comprising of all types of education

and demographic changes as well, my modified accumulation account focuses attention on the contribution of post-school education and working experience to the growth of human capital stock, with demographic changes being treated as other volume changes.

Table 3 presents the experimental estimates of human capital accumulation account in 2001 dollars. The numbers in the opening balance are taken from the subtotals in Table 1. The investment in post-school education, measured as incremental increases to lifetime labour incomes due to additional schooling activities, includes schooling activities for bachelor, higher degree and vocational studies. To match the definition of investment in human capital, depreciation is defined as deletions of additional lifetime labour incomes of those individuals with post school education due to their ageing. The investment in working experience is measured as incremental increases in lifetime labour incomes to those with additional years of working experience. The key assumption underlying such estimation is that increases in labour earnings as people get older are attributable to on-the-job training.

Depreciation of on-the-job investment is measured similarly as in the case of investment in education. The item 'Persons Turning Working Age' measures the additions to the existing human capital stock from the under-working age sub-population of the previous accounting period that have joined the workforce in the current accounting period, as the base level education group. The growth of human capital beyond the base level for this group of population during the current accounting period is accounted in the category of investment in post-school education. The item 'Ageing of the Base Level Human Capital' measures deletions of lifetime labour incomes of all individuals (including those with post school education attainments) as unskilled labour (depletions of the corresponding additional human capital skills are covered in the depreciation estimates for the investment in education and experience factor categories). The item 'Revaluation' measures the changes in lifetime labour incomes over time (holding age as constant). As there is no sufficient information to derive estimates of emigrants, the item 'Omissions &Errors' includes the deletions of the human capital stock caused by emigration.

The accumulation account sheds light on the sources of growth of human capital stock over time. Through this accumulation account, we can allocate the change in the human

capital stock during an accounting period among three factors: quality change, quantitative change and revaluation factor. The quality factor consists of two elements: net investment in post-school education and net investment in working experience. The quantitative factor consists of two elements: net population growth, which is measured by the sum of the item 'persons turning working age' and the item 'ageing of base level human capital'; net migration, which is approximated by the sum of the item 'immigrants' and the item 'Omissions &errors (including emigrants)'. Revaluation factor reflects the impact of other unaccounted factors on the growth of human capital over time.

Post-school education and working experience are two sources of quality growth in human capital. The gross human capital formation, in particular investment in formal education, grew at a rapid pace: its contribution to the growth of human capital stock rose from 19% for men and 16% for women during the early 1980s, to 36% for men and 34% for women in the period 1996–2001. However, the magnitudes of depreciation also have trended upwards strongly since the first half of 1990s, which significantly have slowed down the growth of human capital stock. As a result, the growth of net human capital formation slowed down significantly. This phenomenon essentially reflects the impact of population ageing on long-term growth prospect of human resources available for sustainable economic growth and development.

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. The different patterns of net investment in working experience for men and women may be due to the much flatter earnings-age profiles for women.

The quantitative changes in human capital can be assessed by examining the items on other changes in human capital stock. The differences between the item 'persons turning working age' and the item 'ageing of base level human capital' are indicative of contributions of natural population growth to the growth of human capital stock. As the

item ‘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.

Finally, revaluation of human capital represents net gains of human capital, which gauges the impact of other unaccounted factors on the growth of human capital over time. These factors include increasing quality of schooling over time, intergenerational externalities of human capital, investment in health and formation of social capital. These factors played increasingly important role in the growth of human capital for both men and women. To quantify the contributions of these factors to the growth of human capital stock are interesting future topics in the measurement of human capital.

4 Concluding Remarks

This paper discusses issues surrounding measurement issues for human capital and presents preliminary estimates of human capital stock and investment in human capital using lifetime labour income approach. These estimates shed light on the size of human capital stock for Australia and the relative contributions of education, working experience and demographic changes to human capital formation, and more broadly to changes in human capital stock over time. It also provides estimates of the impact of ageing and through-time changes in human capital value (revaluation) on the human capital stock for Australia. This kind of statistics could be very useful for research and policy in the areas of education, migration, ageing and other social and economic issues.

The proposed accounting system draws on the JF human capital accounting system, with a few modifications designed to be more consistent with the SNA conventions and suitable for the Australian circumstances. As this measurement framework is based on a number of controversial assumptions, the limitations of its estimates are obvious. First, this paper treats the differences in the existing wage structure as reflecting the different amounts of human capital invested through education and training. In the Australian institutional setting, this assumption could be questioned. Second, human capital plays an equally important role in non-market activities. As the estimates of human capital

presented in this paper are confined to market activities only, the full value of human capital for women is obviously underestimated.

In spite of these reservations, this paper does draw attention to the issue of systematic measurement of human capital, with a pertinent policy implication: increasing investment in human capital including health (which could make work-life longer), faster labour productivity are the key choices for addressing the impact of population ageing on human capital development.

References

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

Becker, Gary S. (1964) *Human Capital*, First edition, Columbia University Press, New York.

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

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

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

Schultz, T.W. (1961) "Investment in Human Capital", *American Economic Review*, 51(1), pp.1-17.

Table 1 Lifetime labour income per capita for 25 years-olds (thousands of 2001 dollars)

	1981	1986	1991	1996	2001
Male					
Higher degree	1,313.94	1,400.77	1,345.92	1,424.41	1,529.29
Bachelor degree	1,237.97	1,305.02	1,221.54	1,273.43	1,396.91
Skilled labour	861.92	912.96	863.41	886.82	991.23
Unskilled labour	703.65	754.92	728.44	755.92	832.68
Female					
Higher degree	1,008.92	1,075.65	1,042.87	1,090.70	1,217.25
Bachelor degree	898.3	947.9	867.17	897.93	1,012.79
Skilled labour	632.56	658.69	633.94	648.07	709.54
Unskilled labour	481.51	503.31	479.1	529.01	595.14

Data source: Australian Census 1981-2001.

Table 2 The stock of human capital for Australia: 1981-2001 (millions of 2001 dollars)

	1981	1986	1991	1996	2001
Male					
Higher degree	42,917	52,562	92,185	127,009	161,362
Bachelor degree	244,123	315,558	448,212	607,439	733,190
Skilled labour	840,709	943,680	1,039,949	1,143,195	1,259,752
Unskilled labour	1,540,987	1,685,260	1,889,659	1,950,974	1,957,450
Subtotal	2,668,736	2,997,060	3,470,005	3,828,618	4,111,754
Female					
Higher degree	9,485	14,002	30,389	55,730	90,579
Bachelor degree	106,458	160,347	305,251	489,443	663,789
Skilled labour	349,437	420,986	429,201	488,993	553,664
Unskilled labour	1,251,790	1,353,062	1,569,421	1,623,914	1,616,411
Subtotal	1,717,170	1,948,398	2,334,262	2,658,080	2,924,442
Total	4,385,906	4,945,457	5,804,266	6,486,698	7,036,196

Data source: Australian Census 1981-2001.

Table 3 Human capital accumulation accounts (millions of 2001 dollars)

	1981–86	1986–91	1991–96	1996-2001
MALE				
Opening Balance	2,668,736	2,997,060	3,470,005	3,828,618
Investment in Education				
Investment in post-school education	62,060	81,564	103,468	102,938
Depreciation on post-school investment	-31,687	-34,465	-46,942	-61,551
Net formation by post-school investment	30,373	47,099	56,526	41,388
Experience Factor				
Gross on-the-job investment	319,201	300,113	277,664	251,974
Depreciation on the job investment	-47,128	-47,547	-47,055	-49,897
Net on-the-job investment	272,073	252,565	230,608	202,077
Persons Turning Working Age	485,721	554,633	534,861	549,963
Ageing of Base Level Human Capital	-584,722	-632,549	-670,121	-689,796
Immigrants	136,760	208,898	155,619	184,047
Revaluation	76,679	131,589	151,234	120,925
Omissions & Errors (including emigrants)	-88,561	-89,290	-100,114	-125,467
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
FEMALE				
Opening Balance	1,717,170	1,948,398	2,334,262	2,658,080
Investment in Education				
Investment in post-school education	37,593	63,876	87,765	90,750
Depreciation on post-school investment	-11,713	-14,312	-20,911	-31,295
Net formation by post-school investment	25,880	49,564	66,854	59,455
Experience Factor				
Gross on-the-job investment	123,785	110,013	140,482	145,821
Depreciation on the job investment	-19,635	-20,520	-25,380	-29,225
Net on-the-job investment	104,150	89,492	115,102	116,596
Persons Turning Working Age	340,898	404,026	394,857	410,493
Ageing of Base Level Human Capital	-334,273	-369,916	-451,445	-493,475
Immigrants	90,999	145,939	120,448	136,928
Revaluation	55,078	113,785	128,765	89,715
Omissions & Errors (including emigrants)	-51,504	-47,026	-50,762	-53,351
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

Data source: Australian Census 1981-2001.