Developments in the estimation of the value of human capital for Australia

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This paper offers a brief summary of the Australian Bureau of Statistics (ABS) research program on the measurement of human capital. We employ the Jorgenson and Fraumeni (1989, 1992) lifetime labour income approach. This paper shows how we have modified their approach and applied it to Australian Census data in developing measures of the value of human capital stock and constructing the corresponding human capital accumulation account. Throughout we highlight the key methodological issues confronting practitioners in incorporating measures of human capital within the national accounts.

Key words: human capital, national economic accounting, lifetime labour income

Introduction

In an effort to incorporate the stock of human capital and human capital formation within the national accounts, ABS has commenced on a research program on the measurement of human capital. The purpose of this paper is to offer a brief summary of this research program.[1] In particular, it summarises: (1) how the value of human capital stock is estimated; and (2) how the corresponding human capital accumulation account is constructed.

To impute the value of human capital, we employ the Jorgenson and Fraumeni (1989, 1992) lifetime labour income approach. This paper shows how we have modified the Jorgenson-Fraumeni approach and applied it to Australian data. In our discussion, we highlight the key methodological issues confronting practitioners in incorporating measures of human capital stock and human capital formation within the national accounts.

There is still no international consensus concerning how human capital should be measured by national economic accounting. It is hoped that this paper could help generate robust debate and stimulate research effort about where to start in order to move human capital into official statistics.

Valuation Models

The Jorgenson-Fraumeni lifetime labour income approach measures human capital per capita for a given sex/education/age group as the discounted present value of expected lifetime labour income per capita for that group. Expected income streams are derived from using current cross-sectional information on labour incomes, employment rates

[1] See Wei (2004, 2007, 2008)

and school participation rates. The lifetime labour incomes are projected by backward recursion, which works as follows: an individual's present value of his or her lifetime income is equal to the current period income plus the present value of his or her lifetime income in the next period. Of course, the present value of his or her lifetime income in next period is not readily available and has to be estimated. By working backward from the lifetime income of individuals with the highest level of education and oldest working age, the present value of an individual's next period income can be derived. Jorgenson and Fraumeni assume that all individuals retire at age of 75. Holding sex and education level as constant, for example, an individual's present value of lifetime labour income at age of 74 is just his or her current period's labour income; then, this individual's present value of lifetime labour income can be used to estimate the next period's present value of lifetime labour income for a 73 year old individual with the same sex and education level. By working backward in this way for all possible combinations of sex and education level, all individuals' present value of lifetime labour income in next period can be derived.

Denoting the lifetime labour income, or the value of human capital of an individual in year y of given sex s, age a, and educational attainment e, by $life_{y,s,a,e}$ gives the following equation:

$$life_{y,s,a,e} = ymi_{y,s,a,e} + \{senr_{y,s,a,e} sr_{y,s,a,a+1} life_{y,s,a+1,e+1} + (1 - senr_{y,s,a,e}) sr_{y,s,a,a+1} life_{y,s,a+1,e}\} \frac{1+g}{1+r} \qquad (1)$$

where ymi is the average labour income in the current year, which includes both market and nonmarket incomes, $senr$ is the school enrolment rate and $sr_{a,a+1}$ is the probability of this person at age a surviving to age $a+1$. The first term in the bracket is for those who will obtain an additional year of schooling by the next year, while the second term is for those who will remain at their current educational attainment. The real income growth rate and the discount rate during a one year period are denoted respectively by g and r.

To apply the Jorgenson-Fraumen method to the Australian economy, we have made a number of important modifications.

1. Confinement to Working Age Population

Of the total population, the working age group is the most important component in terms of its impact on market economic activities. Recent research and policy studies focus on the relative size of the work force in the population. The ratios of the working age group over other age groups have important implications for economic growth and development. That is one of the central issues of population ageing studies.

Confinement to working age population does not imply that other age groups have no human capital at all. What we argue here is that the human capital embodied in the working age population is most directly related to economic activities and need a separate treatment at the forefront of the measurement of human capital.

2. Excluding Nonmarket Activities

Market and nonmarket activities are different. Labour force participation rate is a very important economic indicator of concern to economists and policy makers. Encouraging people to participate in the labour market is a key policy initiative in Australia and many other industrialised countries. By focusing on market activities, we can evaluate the contribution of changing labour force participation rates to the growth of human capital stock measured in market lifetime labour incomes.

In addition, how to value nonmarket labour activities is a contentious issue. The Jorgenson-Fraumeni model assumes that the value of time spent in unpaid household production or at leisure for any given age/sex/education group is the same as the value of time spent working. This choice attracts understandable criticism. For example, Rothschild (1992) ‘doubt(s) that within the audience at a football game (or an opera) the quality of the experience varies directly with the market wage.’ Or is it appropriate to value a PhD holder’s work in the garden at a higher rate than that for someone who only completed secondary education? In order to avoid these complications, the estimates of human capital in our study are confined to market labour activities. This makes comparison with physical capital stock measures easier. The valuation of nonmarket activities is a topic for future research.

3. Educational Credentials as Measures of Educational Attainment

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

4. Cohort-based Estimation of Future Earnings

One of the major concerns with the Jorgenson-Fraumeni approach is that estimation of lifetime labour incomes based on current cross-sectional information is subject to short-term business cycle effects: it tends to under-estimate lifetime labour incomes in recession years and over-estimate in booming years. This problem becomes obvious if the measurement of human capital is confined to labour market activities, which fluctuate with business cycles.

In addressing the business cycle effect on the projection of lifetime labour incomes, we use a cohort-based moving average method to derive ex-post or semi-ex-post income profiles over time for all groups (for some age cohorts their income profiles have to be based on combinations of observed and expected future incomes, so we term income profiles of this kind as 'semi-ex-post'). We start with the Jorgenson-Fraumeni method which decomposes lifetime labour incomes into two elements: current labour incomes and lifetime labour incomes for the group with the same sex/education characteristics but one year older. In the original Jorgenson-Fraumeni approach, the second element is approximated by current incomes of older age groups plus a uniform real income growth factor. By our simplified moving average method, the second element in the Jorgenson-Fraumenni framework is approximated by a linear combination of lifetime

labour incomes of older age cohorts between Census years. Just like the Jorgenson-Fraumeni approach which calculates the incomes by a backward recursion, we work backward from the lifetime incomes of individuals in the most recent period, then move on to the next recent period and so on. In this way, all Census income data are chained together.

Given the above modifications, equation (1) is modified as:

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

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; w is the average market labour income for employees; $empr$ is the employment rate, defined as the probability of engaging in paid work; sr_{a+1} is the probability of an average person at age a surviving to age $a+1$; $senr^{e_j}_{y,s,a,e_i}$ 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, and m is the average years to complete this study; g is the real income growth rate and r is the discount rate.

Constructing an Accumulation Account for Human Capital

In the Jorgenson-Fraumeni framework, the change in human capital stock from period to period is viewed as the sum of human capital formation, net of depreciation on human capital and the revaluation of human capital. Human capital formation results from population growth and increments to lifetime incomes due to investment in formal education. Depreciation on human capital is viewed to be due to ageing, deaths and emigration. The difference between gross human capital formation and depreciation on human capital is net human capital formation. Revaluation on human capital is viewed to be due to changes in lifetime labour incomes over time for each age/sex/education groups.

The Jorgenson-Fraumeni 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. In commenting on the Jorgenson-Fraumeni measurement of human capital, Rosen (1989, p. 284) suggests 'the depreciation estimates … seem to include gross on-the-job investment as one of its components. It would be of substantial interest to present those estimates separately'. The standard human capital theory also emphasizes the role of on-the-job training in human capital formation. Our study provides separate estimates of investment due to working experience.

Our study has focused on the Australian working age population, which has important implications for constructing an integral accumulation account complementary to the measurement of the human capital stock. In the original Jorgenson-Fraumeni accounting framework, all individuals in the population are included, and all education, including primary and secondary, is counted as investment in human capital. Our study, by focusing on the human capital formation of the working-age population, only counts post-secondary education as investment in human capital formation. 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 becomes of 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.

Our proposed accumulation account for human capital is summarized by the following accounting identity:

1. The net value of human capital stock in the opening balance sheet;
   Plus
2. Investment in Education
   - 2.1 Gross human capital formation in post-school education for the working age population;
     Minus
   - 2.2 Depreciation of human capital formed by post school education;
     Equals
   - 2.3 Net human capital formation in post-school education;

Plus

3. Experience Factor

3.1 Gross human capital formation in working experience;

Minus

3.2 Depreciation of human capital formed by working experience;

Equals

3.3 Net human capital formation by working experience;

Plus

4. Demographic Changes

4.1 Persons becoming of working age;

Minus

4.2 Ageing of base level human capital;

Plus

4.3 Immigrants;

Plus

5. Revaluation;

Adjusted by

6. Omissions & errors (including emigrants);

Equals

7. 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). However, 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. However, in practice, measurement errors and inconsistencies lead to 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 in the latter 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 using 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.

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 the sum of human capital flows, the amount of investment in human capital is indirectly derived by decomposing the stock changes into various components.

Experimental Estimates of Human Capital for Australia

To measure the stock of human capital and construct the corresponding accumulation account for human capital, a database has been constructed using the Australian Censuses of population and housing conducted in 1981, 1986, 1991, 1996, 2001 and 2006. 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 equation (2). The calculations assume a discount rate of 5 percent and an expected income growth rate of 1.75 percent for all cohorts. They are the same rates that have been adopted by the Australian Government Treasury (2002) in projecting future national incomes.

The Table 1 presents per capita human capital by sex and education groups in Australia for the period 1981-2001. The overall average annual growth rate of per capita human capital was 1.3% for this period, with a wide diversity between men and women. During the period 1981-2001, the average annual growth rate for men was 0.6%, while it was massive 2.8% for women. The major cause for narrowing gaps of per capita human capital between men and women is the opposite directions of changes in labour force participation rates: increasing for women and decreasing for men, in particular for the less-educated group.

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 2006 dollars. The stock estimates show that there has been a significant increase in the stock of human capital in Australia over the 20 year period, due to increased proportions of more educated workers. The overall average growth rate of the human capital stock was 2.8%, with 2.0% for men and 4.2% for women.

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 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 across 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 and 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. From 1981 to 2001, 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 have significantly slowed the growth of human capital stock. As a result, the growth of net human capital formation slowed 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, inter-generational externalities of human capital, investment in health and formation of social capital. These factors played an 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 is an interesting future topic in the measurement of human capital.

Future Development and Challenges Ahead

To move our research program forward, we have been developing measures of human capital at industrial and occupation levels. This research could shed light on the allocation of human capital among different industries over time and the process by which human capital grows from low skilled occupation toward high skilled occupations.

The Jorgenson and Fraumeni measurement system of human capital is based on a rich database constructed through decades of research effort. In contrast, our present study only uses Census data. Another possible research initiative is therefore to construct a comprehensive database, combining Census data, labour force statistics, data on labour earnings and hours worked, education statistics and migration statistics. To reconcile inconsistencies between alternative data sources is a daunting task.

Capital theory is one of the most difficult and contentious topics in economic theory, and accordingly the measurement of capital is one of the most complex dimensions in the official national accounting system.[2] It has taken many years for statisticians to develop and establish the existing physical capital measurement system as it is with the System of National Accounts 1993. Even so, there is still disagreement on several important issues. In the case of human capital, its measurement is probably more complex. Two aspects of human capital measurement differentiate it from that of physical capital: the productive capacity (human capital) embodied in an individual is typically not observed, and secondly, as an output of non-market activities, the value of human capital has to be imputed. The first aspect is the primary focus of the literature in understanding differences in human abilities and skills, their origins and their evolution over the lifecycle, while the latter raises many of the theoretical and practical issues in estimating returns to and investment in education and other ways of investing in people. It will be a long journey to reach significant international consensus on how to measure human capital by national economic accounting.

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[2] According to Triplett (1996), "Controversies in the theory of capital have had their counterparts in the measurement of capital, which Hulten (1990) and others have called one of the most difficult tasks in economics" (p. 93).

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Table 1 Per capita human capital in Australia: 1981-2001 (thousands of 2001 dollars)

	1981	1986	1991	1996	2001
Male					
Higher degree	1034.2	1051.2	1043.5	1050.9	1047.6
Bachelor degree	984.3	1019.3	1031.5	1041.2	1034.9
Skilled labour	618.7	636.9	659.5	663.0	657.7
Unskilled labour	481.5	485.3	501.5	497.2	490.9
Average	552.1	569.0	598.5	613.3	621.4
Female					
Higher degree	694.8	745.2	801.4	845.2	872.0
Bachelor degree	627.8	673.3	697.7	738.0	745.9
Skilled labour	360.2	394.3	443.3	456.4	472.3
Unskilled labour	202.2	231.3	273.2	289.5	300.9
Average	237.8	276.4	333.5	374.6	410.3
Total Average	396.3	424.0	466.4	493.8	515.3

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	-30,378	-35,773	-51,368	-68,249
Net formation by post-school investment	31,682	45,791	52,100	34,690
Experience Factor				
Gross on-the-job investment	319,558	308,898	296,896	274,426
Depreciation on the job investment	-178,938	-225,414	-276,644	-313,712
Net on-the-job investment	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
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	-11,419	-15,760	-24,384	-37,642
Net formation by post-school investment	26,174	48,116	63,380	53,108
Experience Factor				
Gross on-the-job investment	123,785	110,013	140,482	145,821
Depreciation on the job investment	-111,043	-151,766	-195,887	-220,242
Net on-the-job investment	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

Data source: Australian Census 1981-2001.