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Measuring human capital

Using the Jorgenson-Fraumeni approach to develop measures of human capital: the experience of the Australian Bureau of Statistics

Note by the Australian Bureau of Statistics

Summary

The current note provides an overview of using the Jorgenson and Fraumeni approach to measure human capital in Australia. First, it summarises the major research work undertaken by the Australian Bureau of Statistics on the measurement of human capital that has been completed since 2001. Second, it discusses the key modifications and extensions that the Australian Bureau of Statistics has made in applying the Jorgenson and Fraumeni approach to the Australian data. Third, the paper offers a few suggestions for future directions in turning this research effort into official statistics.

I. Introduction

1. The Jorgenson and Fraumeni (JF thereafter) (1989, 1992) lifetime labour income approach has become the standard methodology in the current research effort on the measurement of human capital.¹ Starting from 2001, the Australian Bureau of Statistics (ABS) employs the JF approach to develop measures of human capital including the stock of human capital, human capital formation through education and immigration, and economic benefits and option values of completing secondary education.²

2. The purpose of this paper is three-fold. First, it summarises the major research work undertaken by the Australian Bureau of Statistics on the measurement of human capital that has been completed since 2001. Second, it discusses the key modifications and extensions that the Australian Bureau of Statistics has made in applying the Jorgenson and Fraumeni approach to the Australian data. Third, the paper offers a few suggestions for future directions in turning this research effort into official statistics.

II. The Australian Bureau of Statistics work on the measurement of human capital

3. The objective of the ABS human capital project is to develop estimates of human capital from national economic accounting perspective, including the value of human capital stock and human capital formation (both gross and net). In particular, this research focuses on the contribution of investment in education to the growth of human capital. The measures of human capital developed in this project could serve the needs of various purposes. For example, these statistics could be used for assessing the impact of population ageing on human capital development, quantifying the contribution of investment in people to human capital growth and evaluating the economic benefits of government labour market policy designed to encourage old workers back into the labour force.

4. Since 2001, the ABS human capital project has produced four major works: (1) measuring the stock of human capital; (2) measuring human capital formation; (3) measuring economic benefits of completing secondary education; and (4) measuring rates of return to post-school education.

A. Measuring the stock of human capital

5. This study³ adopts a 'lifetime labour income approach'. The stock of human capital is measured as the discounted present value of expected lifetime labour market income. Expected income streams are derived by using cross-sectional information on labour income, employment rates and school participation rates. This study constructs a human capital database using six waves of Australian Censuses of Population and Housing from 1981 to 2006. Based on cross sectional age-earnings profiles, this study derives per capita measures of lifetime labour market incomes for each age/sex/education cohort, and applies

¹ For most recent studies, see Mira and Liu (2010), Christian (2010), Gu and Wong (2010) and Wei (2010b).

² See Wei (2004, 2007, 2008, 2010a, 2010b).

³ The early research paper is available at [http://www.ausstats.abs.gov.au/ausstats/free.nsf/0/925A1E99C62042E9CA256FC6007F9404/\\$File/1351055001_sep%202001.pdf](http://www.ausstats.abs.gov.au/ausstats/free.nsf/0/925A1E99C62042E9CA256FC6007F9404/$File/1351055001_sep%202001.pdf)

these per capita measures to the number of people in the corresponding cohort. It then aggregates across all cohorts to estimate the human capital stock for Australia.

6. The study results 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. It also shows that the value of human capital stock is significantly greater than that of physical capital.

B. Measuring human capital formation

7. This study⁴ focuses attention on the contribution of investment in education and net migration to the growth of human capital stock. Depreciation on human capital is measured through the impact of population ageing on the availability of human capital skills for labour market activities (as persons become older, they have less working life for using human capital in the labour market). Net human capital formation is the difference between gross human capital formation and depreciation.

8. The preliminary findings from this flow accounting exercise paint a mixed picture for Australian human capital development over the last two decades. The gross human capital formation, in particular investment in formal education, grew at a rapid pace. However, due to the ageing population, the existing human capital stock also depreciated at a faster rate, and as a result, the growth of net human capital formation slowed down significantly.

C. Measuring option values and economic benefits of completing secondary education

9. Heckman, Lochner and Todd (2006) draw attention to the concept of option value in estimating returns to education. Using the JF lifetime labour income approach, this study⁵ develops a method to estimate an option value as the difference between alternative lifetime labour incomes associated with the corresponding schooling choices upon completing a lower level education.

10. Using secondary education in Australia as the basic case, this study demonstrates how the total return to investment in secondary education can be decomposed into the direct return and an option value, which accrued from the opportunities for undertaking tertiary study programs. The empirical results show that the option values make up significant proportions of total returns to secondary education, ranging from 24.5% to 39.3% for men, and from 32.6% to 51.6% for women over the period 1986–2006. In particular, option values have become increasingly prominent in recent years, which have witnessed strong demand for more educated workers.

⁴ The research paper is available at [http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/9567CDD601B5AC0BCA2573F500152BE4/\\$File/1351055023_feb%202008.pdf](http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/9567CDD601B5AC0BCA2573F500152BE4/$File/1351055023_feb%202008.pdf)

⁵ The research paper is available at <http://www.iariw.org/papers/2010/8cWei.pdf>

D. Estimating rates of return to post-school education

11. This study⁶ estimates the rates of return to post-school education in Australia, with a focus on bachelor degrees. Both the financial method and Mincer's human capital earnings function method are applied.

12. The expected private rates of return from investment in bachelor degrees increased over time for males, from 13.1 percent in 1981 to 19.6 percent in 2001, and then dropped to 15.3 percent in 2006; the range was 18.0 percent to 17.3 percent for females over the same period. This study also compares the two estimation methods. The key difference is that the financial method can account for the effect on earnings of enriched working experience associated with higher educational attainment, while the Mincer's method assumes parallel earnings experience profiles across educational levels. This study argues that the growth of human capital through increased working experience are important economic benefits of investment in education, and therefore should be captured in calculating rates of return to education.

III. Key modifications

13. To apply the JF method to the Australian economy, two important modifications have been made to the original JF framework.

A. Confinement to working age population

14. 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.

15. 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.

B. Excluding non-market activities

16. Market and non-market 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.

17. 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

⁶ This research paper is available at [http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/FFF12BBAB5051BFFCA25778C001F6903/\\$File/1351055032_aug%202010.pdf](http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/FFF12BBAB5051BFFCA25778C001F6903/$File/1351055032_aug%202010.pdf)

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.

IV. Key extensions

18. We also have made a few extensions of the JF framework to consider scenarios based on alternative assumptions.

A. Cohort-based estimation of future earnings

19. One of the major concerns with the JF 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.

20. 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 JF 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 JF 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 JF framework is approximated by a linear combination of lifetime labour incomes of older age cohorts across all time periods. Just like the JF 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, income data across all time periods are chained together.

B. Measuring investment in on-the-job training

21. The JF 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. We further divide the gross depreciation component between the true depreciation and on-the-job investment due to increased working experience.⁷

⁷ Wei (2008) provides a detailed description of the estimation procedures and associated assumptions.

C. Educational credentials as measures of educational attainment

22. In the JF 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 JF 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.

V. Future development and challenges ahead

23. To move our research program forward, we have been developing measures of human capital at industry 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.

24. The JF 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 including earnings, education statistics and migration statistics. To reconcile inconsistencies between alternative data sources is a daunting task.

25. 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.⁸ 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 2008. 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.

⁸ 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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