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Measuring the stock of human capital in Hong Kong

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Abstract

This article constructs two types of human capital indices for Hong Kong: one based on average years of schooling and another based on estimated lifetime income. The indices use General Household Survey data on age, gender, education attainment and income from 1993Q1 to 2019Q1. The lifetime income index has grown faster than the average years of schooling index over the sample period. Lastly, this article discusses the strengths and weaknesses of each approach.

測量香港的人力資本存量

摘要

本文以 1993 年第一季至 2019 年第一季綜合住戶統計調查中年齡、性別、教育程度和收入數據，使用平均受教育年限和終身收入法建構香港的人力資本指數。在樣本期內，以終身收入法建構的指數的增長速度超過了以平均受教育年限建構的指數。最後，本文討論每種方法的優缺點。

I. INTRODUCTION

1. Human capital is economists' term for investments in people (e.g. education, training, health) that increase an individual's productivity.[1] It can be raised through improved nutrition, health care, schooling and on-the-job training. On an aggregate level, human capital has long been recognized as being of major importance for promoting competitiveness and sustaining economic development. A government can promote the development of human capital through education policies, health programmes, worker and entrepreneur training, and other similar measures.

2. In the past three decades, there has been sustained interest in the role of human capital in economic growth. The idea that human capital could generate long-term sustained growth is a crucial feature of endogenous growth theories (Romer 1986; Lucas 1988).[2] Without human capital accumulation, economic growth driven solely by physical capital accumulation will eventually be constrained by diminishing returns to capital. In contrast, in an economy with human capital accumulation, each unit of physical capital would effectively work with more units of human capital, and the marginal product of capital need not decrease so that sustained growth is possible.

3. Empirically, there have been two main approaches in the literature to measure human capital. The first uses **average years of schooling** (Barro and Lee 1993; Wößmann 2003), which is a backward-looking approach based on the "education stock" in an economy.[3] This method has been widely adopted by academics and it remains popular today. The second approach is to measure **lifetime income** attributable to human capital investment (Le et. al. 2005), which is a forward-looking approach that measures human capital as the total income that could be generated in the labour market over an individual's lifetime. This alternative method has been used to estimate human capital stock for the U.S., Sweden and Australia (Jorgensen and Fraumeni 1989; Ahlroth et. al. 1997; Wei 2008).[4] This article will adopt both

[1] Goldin, C. (2016). "Human capital." *Handbook of Cliometrics*, 2016, 55-86.

[2] Romer, P.M. (1986). "Increasing returns and long-run growth." *Journal of Political Economy*, 94(5), 1002-1037. Lucas Jr, R.E. (1988). "On the mechanics of economic development." *Journal of Monetary Economics*, 22(1), 3-42.

[3] Barro, R.J., & Lee, J.W. (1993). "International comparisons of educational attainment." *Journal of Monetary Economics*, 32(3), 363-394. Wößmann, L. (2003). "Specifying human capital." *Journal of Economic Surveys*, 17(3), 239-270.

[4] Le, T.V.T., Gibson, J., & Oxley, L. (2005). "Measuring the stock of human capital in New Zealand." *Mathematics and Computers in Simulation*, 68(5-6), 484-497. Jorgenson, D.W. and Fraumeni, B.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*, Chicago: University of Chicago Press, 227-282. Ahlroth, S., Björklund, A., & Forslund, A. (1997). "The output of the Swedish education sector." *Review of Income and Wealth*, 43(1), 89-104. Wei, H.

approaches to measure Hong Kong's human capital stock, compare the resulting human capital indices, and discuss the strengths and weaknesses of each approach.[5]

II. METHODOLOGY

II.1 Years of Schooling Human Capital Index

4. The first method of constructing a human capital index is to use direct measures of levels of education attainment from census or survey data (Barro and Lee 1993). In particular, the human capital stock H_1 is proxied by average years of schooling in the employed population with the following formula:

$$H_1 = \sum_a [n_a (\sum_{i=1}^{a} D_i)] \quad (1)$$

where n_a is the fraction of employed persons for whom attainment level a is the highest schooling level attained ($n_a = \frac{N_a}{L}$ with N_a being the number of workers for whom a is the highest schooling level attained and L being total employment) and D_a is the number of years for the a-th level of schooling. This approach implicitly assumes that human capital is an output from education investment only, while other aspects like health, working experience and entrepreneurial skills are not counted.

5. Applying this method to Hong Kong, there are five categories of schooling groups in the General Household Survey from the Census and Statistics Department: primary and below, lower secondary, upper secondary, post-secondary: non-degree and post-secondary: degree. The following durations of schooling are assumed:

$$D_a = \begin{cases} 9 \\ 12 \\ 15 \\ 17 \\ 19 \end{cases} \text{ if } a = \begin{cases} primary\ and\ below \\ lower\ secondary \\ upper\ secondary \\ post-secondary: non-degree \\ post-secondary: degree \end{cases} \quad (2)$$

(2008). "Measuring the stock of human capital for Australia: a lifetime labour income approach." Australia Bureau of Statistics Research Paper (cat. no. 1351.0.55.023).

[5] There are other measures of human capital in the literature. One is the adult literacy rate (Romer 1989), or the number of adult literates as a percentage of the population. Yet the problem with this measure is that educational investment on top of basic literacy, such as in logical and analytical reasoning or numerical, scientific and technical knowledge, are neglected. Another is the school enrolment rate, defined as the number of students enrolled at a grade level relative to the total population (Barro 1991). A problem here is that, since students currently enrolled in schools are not yet in the labour force, their education is not yet usable in production. See Wößmann (2003) for more details. Romer, P.M. (1989). "Human Capital and Growth: Theory and Evidence." NBER Working Paper No. 3173. Barro, R.J. (1991). "Economic growth in a cross section of countries." *The Quarterly Journal of Economics*, 106(2), 407-443. Wößmann, L. (2003). "Specifying human capital." *Journal of Economic Surveys*, 17(3), 239-270.

The human capital index H_1 is constructed by using equation (1) to take the weighted average of the durations of schooling in equation (2).

II.2 Lifetime Income Human Capital Index

6. The second approach to construct a human capital index is to proxy human capital stock as the sum of the discounted income streams of different cohorts as classified by age, gender and education attainment. This approach is based on the assumption that people would choose the level of human capital investment that maximizes the present value of their lifetime earnings. Hence, a person will keep investing in human capital, no matter whether it is in the form of education, health, knowledge or skills, until the marginal cost of doing so is equal to the expected increase in lifetime income.

7. Following Le et. al. (2005)'s approach, the value of human capital is measured by means of a recursive method. In particular, the average human capital $h^e_{a;f}$ of the cohort containing individuals of age a, gender f and education attainment e equals the cohort's earnings in the current period plus future income weighted by the probability of surviving to future periods and the growth of earnings linked to the evolution of the economy:

$$h^e_{a;f} = E_{a;f} Y^e_{a;f} + S_{a,a+1;f} h^e_{a+1;f} \left(\frac{1+g}{1+\delta}\right) \quad (3)$$

where $E_{a;f}$ is the employment rate of the cohort, $Y^e_{a;f}$ is the triple of the sum of average monthly income of employed individuals in the previous four quarters for that cohort, $S_{a,a+1;f}$ is the probability of surviving one more period from age a to age $a+1$, g is the per capita income growth rate and δ is the discount rate.[6] This formula says that the human capital acquired by a person aged a, gender f and education attainment e will be valued as current labour income plus the actuarial present value of the labour income in the next period, where the actuarial present value depends on survival probability as well as economic growth-adjusted discount rate. Starting with a worker at his/her retirement age, by backward recursion the remaining lifetime labour income at each age can be calculated. By aggregating the average human capital across all cohorts based on the actual number of employed persons, we can construct the human capital index H_2 for the whole economy:

[6] The average monthly incomes of employed individuals are converted to real terms with the three-month moving average of composite consumer price index.

(4) $$H_2 = \frac{\sum_a \sum_f \sum_e n^e_{a;f} h^e_{a;f}}{\sum_a \sum_f \sum_e n^e_{a;f}}$$

where $n^e_{a;f}$ is the number of employed persons for individuals age a, gender f and education attainment e. Lastly, the human capital index is normalised by the total employed persons term $\sum_a \sum_f \sum_e n^e_{a;f}$ (unlike in Le et. al. (2005)'s paper) so that H_2 can be compared to H_1.

8. There are important conceptual differences between the two human capital indices H_1 and H_2. H_1 measures human capital with a backward-looking approach based on the "education stock" in an economy, while H_2 is based on a forward-looking approach that measures human capital as the total income that could be generated in the labour market over an individual's lifetime. Also, ceteris paribus, H_2 will decline with age as the expected working life declines; population aging thus reduces H_2 but not H_1.[7] Lastly, in H_2, the value-added of a year of education depends on the type of education (it is not just 1 as in H_1).

9. Applying the lifetime income methodology to Hong Kong, the employment rates and average monthly incomes are available from the General Household Survey, while survival probabilities are taken from the Life Tables published by the Census and Statistics Department.[8] The earliest year for which average monthly incomes for different cohorts are available is 1996. There are altogether 88 cohorts, classified by age (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65+), gender (female and male) and education (lower secondary and below, upper secondary, post-secondary: non-degree, post-secondary: degree). We assume all individuals retire when they reach 70 years old. Starting from the current income of individuals aged 69, the average human capital for all individuals aged below 69 can be calculated using equation (3). Then, the aggregate human capital index can be calculated with equation (4). The per capita income growth rate is set at 1.6% which is the annualised growth rate of the real index of payroll per person engaged in 1996-2018, and the discount rate is set at 4%.[9]

[7] The second measure H_2 implicitly assumes that the younger generations of individuals expect the same (or even faster) income growth over time, as compared to their earlier generations of individuals with the same educational attainment. This should be noted as one of the caveats of the methodology.

[8] For simplicity, the survival probabilities are computed as the ratio of number of survivors at a particular age divided by that age minus five from Tables 12-13 of Hong Kong Life Tables 2011–2066. The survival probabilities are assumed to be the same across all years within the sample period.

[9] We have considered various income growth assumptions, including the annualised per capita real GDP growth rate of 2.6% in 1996-2018, the annualised growth rate of real payroll per person engaged of 1.6% in 1996-2018, and annualised real wage growth of employees up to supervisory level (excluding managerial and professional employees) of 0.8% in 1996-2018, all available from the Census and Statistics Department. The difference in the empirical results between using a 1.6% or 2.6% per capita income growth rate is negligible. The real wage index is less suitable because it excludes higher-level employees and certain types of compensation like overtime and discretionary bonuses.

III. EMPIRICAL RESULTS

10. ***Chart 1*** depicts the human capital indices constructed from the average years of schooling approach (H_1; 1993Q1-2019Q1) and the lifetime income approach (H_2; 1996Q2-2019Q1). ***Table 1*** further shows the annualised growth rate of the two human capital indices and per capita real GDP over 1996Q4-2019Q1, as well as over three sub-periods (1996Q4-2003Q4: Asian financial crisis period; 2003Q4-2009Q4: post-SARS period; 2009Q4-2019Q1: post-global financial crisis period).

Chart 1: Human capital indices constructed according to the average years of schooling approach (H_1) and the lifetime income approach (H_2)

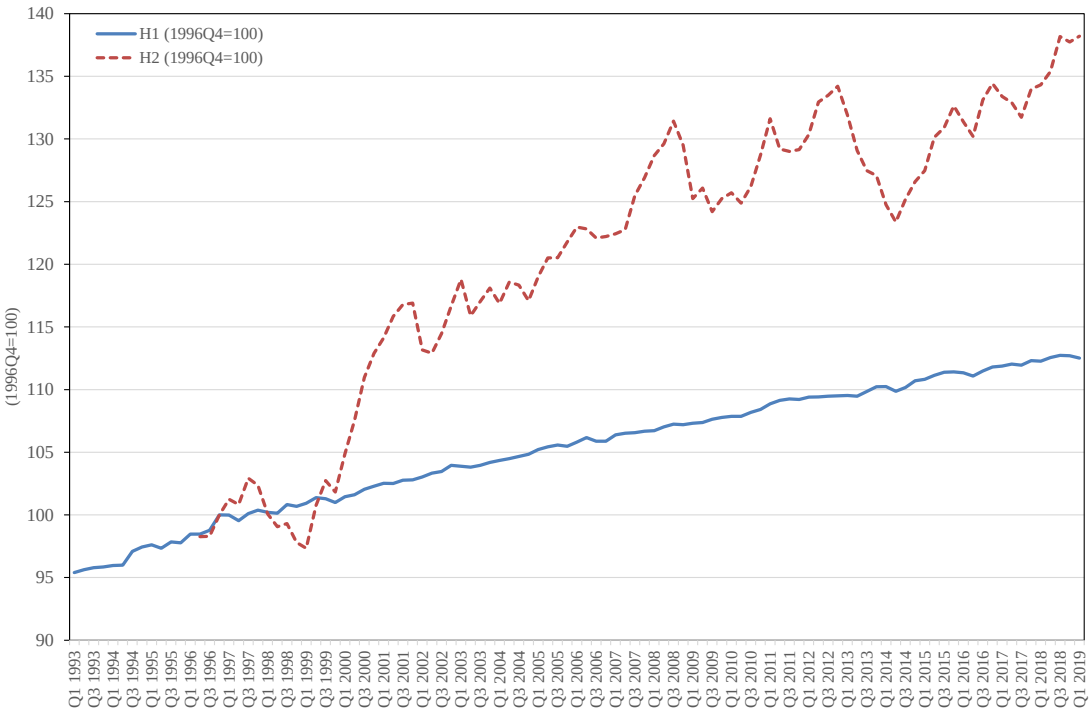

Table 1: Comparison of annualised growth rates of H_1, H_2 and per capita real GDP

	Annualised H_1 growth rate	Annualised H_2 growth rate	Annualised per capita real GDP growth rate ^
1996Q4-2003Q4	0.6%	2.4%	1.3%
2003Q4-2009Q4	0.6%	1.0%	4.2%
2009Q4-2019Q1	0.5%	1.1%	1.5%
1996Q4-2019Q1	**0.5%**	**1.5%**	**2.2%**

Note : (^) Per capita real GDP are calculated as GDP in chained (2017) dollars divided by the number of employed persons.

11. Some major observations about the two indices are summarised below:

- Both indices were in general rising over time, with H_2 rising faster than H_1. This observation is perhaps not surprising given that the construction of H_1 assumes that human capital accumulates as a result of education investment only, but other factors like health, on-the-job training and entrepreneur skills are not counted, and these factors are theoretically included in the construction of H_2.[10]

- The human capital index H_1 rose at a stable pace of 0.5-0.6% per annum over 1996Q4-2019Q1, slower than the per capita real GDP growth rate of 2.2% per annum over the same period. This reflects the continuous reshaping of Hong Kong's employed population by the growing number of secondary school and university graduates and the retirement of older workers with generally less years of schooling, though it has been challenging to keep average years of schooling rising at a pace on par with the per capita real GDP growth rate.

- The human capital index H_2 rose at a decelerated pace over the sample period (1996-2003: 2.4% per annum; 2003-2009: 1.0% per annum; 2009-2019: 1.1% per annum), compared with the per capita real GDP growth rate (1996-2003: 1.3% per annum; 2003-2009: 4.2% per annum; 2009-2019: 1.5% per annum). Mainly, this reflects the relatively faster growth in real wages which occurred in the deflationary period after the Asian financial crisis.

IV. DISCUSSION

12. The increasing discrepancy between the two human capital indices H_1 and H_2 (see ***Chart 1***) shows that, human capital in the form of education attainment might contribute less to the overall *actual* human capital accumulation in Hong Kong over time. Given the difficulty of raising the average years of schooling at rates comparable to per capita real GDP growth (***Table 1***), this might indicate that other human capital aspects, such as quality of education, on-the-job knowledge, innovation capability, or health would become more important for Hong Kong's economic development in the future.

[10] Although in the construction of the human capital index H_1, no distinction is made between first degree courses and postgraduate courses in the post-secondary: degree classification, the qualitative result of H_2 rising faster than H_1 should remain valid even if this distinction is made.

13. The strength of the human capital index constructed by the lifetime income approach H_2 is that it theoretically includes all types of human capital investment in the compilation of the index. The basic proposition of the lifetime income approach is that people would choose the level of human capital investment, no matter in what form of human capital, that maximizes the actuarial present value of their lifetime earnings. This proposition would imply that the lifetime earnings, which are in monetary units that can be summed up, could be used by economists to summarise various forms of human capital in a number (equations (3)-(4)) that could be readily analysed by mathematical tools e.g. by comparing the index H_2 with per capita real GDP growth rates as in ***Table 1***), thereby enabling economists to understand more deeply the situation of human capital evolution in Hong Kong.

14. However, there are also drawbacks for the human capital index constructed by the lifetime income approach H_2. This approach implicitly assumes that differences in the actuarial present value of income reflect differences in human capital (supply-side factor) only. Yet, as the incomes involved in the calculation of actuarial present values in H_2 are measured in market prices, the difference in the measured human capital stock H_2 might reflect fluctuations in demand-side factors (e.g. trade unions raising wages, or economic downturns causing wages to drop, which would in turn affect average monthly income and the index H_2) rather than differences in worker productivity originating from ability, effort, or professional qualifications (Folloni and Vittadini 2010).[11] Hence, the lifetime income approach would yield a human capital index that could be swung by demand-side factors from time to time.

15. Even setting aside the demand-side factors, there is another problem in that the human capital index H_2 assumes that differences in actuarial present value of income reflect differences in human capital only. In reality, workers' income might increase due to factors other than rise in human capital. For example, workers' income might rise because of their higher marginal product by working with more physical capital, or simply because of increased economy-wide productivity originating from adopting inventions or innovations. In other words, while on the one hand, the human capital index constructed by the lifetime income approach H_2 should theoretically include all factors that would influence an individual's income, it cannot separate the effects of demand-side factors and supply-side factors outside human capital accumulation on income fluctuations. This might be one crucial reason preventing the wide adoption of such methodology in measuring human capital stock.

[11] Folloni, G., & Vittadini, G. (2010). "Human capital measurement: a survey." *Journal of Economic Surveys*, 24(2), 248-279.

16. Lastly, neither of the human capital indices are able to capture non-monetary factors—for example, altruism, moral standards, social network ties—which are valuable aspects of an economy's labour force. A more comprehensive human capital stock measure that can also include these factors would be a challenging topic for researchers to improve our understanding on the competitiveness of an economy's workforce and its implication for growth and policies in the future. We leave this as a topic for future research.

V. CONCLUSION

17. This article constructs human capital indices for Hong Kong according to two approaches: the average years of schooling approach and the lifetime income approach, using the information on age, gender, schooling and income available from the General Household Survey from 1993Q1 to 2019Q1. The lifetime income index, which aims to be more comprehensive in scope, grew faster than the average years of schooling index over this time. Nevertheless, both lag the real per capita GDP growth rate, which is aided by physical capital accumulation and total factor productivity growth in addition to the growth of human capital.

18. While the human capital index constructed by the average years of schooling approach just focuses on one aspect of education, the one constructed with the lifetime income approach cannot separate the effects of demand-side factors and supply-side factors outside human capital accumulation on income fluctuations. Conceivably, this has prevented the wide-adoption of the second approach in measuring human capital stock. Also, neither index takes into account non-monetary factors like altruism and moral standards which are valuable aspects of an economy's labour force.