The role of education upgrading and experience accumulation in driving labour productivity growth in Hong Kong

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Summary

(1) ***Over the 15 years from 1997 to 2011, Hong Kong's human capital stock embedded in our population aged 15+ has grown by an average of 2.7% per annum, much faster than the headcount population growth of 1.1% per annum.***

(2) The extent to which human capital is actively in use is a measure of how effective human capital is being utilized. This is because, if people with high education stop working or retire early, it will represent a "loss" in human capital which can otherwise be deployed. In Hong Kong, our **utilization rate of human capital stock is high, at around 69% in 2011,** near 11 percentage points higher than the headcount labour force participation rate.

(3) Apart from the education upgrading factor, a lot of Hong Kong's labour productivity growth impetus is also derived from on-the-job learning and experience accumulation. The education and experience factors actually interact together, in that the experience factor can play out much more in the group with higher education. In other words, ***the combined effect of education upgrading and experience accumulation on productivity growth is multiplicative***. They ***together account for around 2/3 of Hong Kong's labour productivity growth over the 15 years from 1997 to 2011***.

(4) Hong Kong's ***underlying human capital stock productivity growth (as measured by growth in output per unit of human capital stock) has also been remarkable, at around 1.0% per annum over the 15 years from 1997 to 2011.***

(5) One rather obvious outcome of the increasing earning wedge or premium of the higher education attainment group is ***the widening in income disparity over time.*** This widening trend is expected to continue in the years ahead, as the economy becomes more knowledge-based and the premium attached to knowledge, skill and experience increases. The rising share of the more educated groups in the workforce will also widen the spread, not only because they in general earn relatively more than their lesser-educated counterparts, but also due to changes in the age structure, given that the income gap between the more educated and less is much more obvious as workers mature and gather more experience.

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Introduction

Sources of economic growth have long been a subject discussed in economic literature. Starting from the ground-breaking working by Solow (1956)[1], various supply side factors driving long term economic growth potential were discussed and analysed in numerous studies. Some are more quantifiable, e.g., physical capital accumulation, natural resources endowment and labour force/population growth, but other factors like technological upgrading, social stability and changes in social infrastructure, are far less measurable and their effects on the supply side are much more difficult to quantify. Take the case of Hong Kong, despite the ups and downs in the 15 years from 1997 to 2011, on average the economy has grown at a trend average of 3.6%[2]. With total employment[3] rising at merely 0.8% per annum, it points to a process of productivity upgrading throughout the whole period, at an annual average of 2.8%. The uplifting effect brought about by capital deepening should be able to explain part of this productivity growth. Yet understandably, the total factor productivity growth[4] over the period should have been impressive, thereby leaving much of the productivity growth to be explained.

Labour force upgrading as a key source of total factor productivity growth

2. Total factor productivity growth can be attributed to a combination of not-so-easy-to-measure factors like technological advances, economic restructuring and upgrading, social and political stability, and upgrading of the quality of the workforce. On the latter factor about the quality of the workforce, a number of literatures have investigated the learning-by-doing effect[5], which acknowledges the productivity improvement gained through experience accumulation. Others have emphasized the importance of education[6]. Traditionally, to measure human capital stock and quantify its effects in driving productivity growth, the focus is on the amount of resources (e.g. investment in education and time spent in learning and gaining experience, both in "input cost" sense) that have been invested into the workforce. But there are two obvious limitations to this approach:

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(1) Solow, Robert M. (1956)
(2) Figures quoted in this paper refer to those at the time of writing. They are subject to revisions from time to time.
(3) Figures on population, labour force, employment, and earnings as used in this paper have excluded Foreign Domestic Helpers. This is to portray a clearer picture on the productivity growth and earning patterns among the "local" workers.
(4) Total factor productivity growth is that part of economic growth unexplained by the growth in headcount labour force and capital stock. There has been a whole array of literature providing estimations on the TFP in various Asian economies over different periods, since the famous work by Young, Alwyn (1992). A relatively recent example is in Park, Jungsoo (2010).
(5) A leading example is in Arrow, Kenneth J. (1962)
(6) Ederer, Peer (2006)

(1) Measuring human capital stock from the input cost angle, for example, in terms of how much money or subsidy in education put into each university graduate versus secondary school graduate, cannot reveal whether the investment is effective or not in uplifting the quality of the workforce. What if the education system fails to produce the workers that the economy requires?

(2) It can only take stock of the "initial" investment enshrined in the workforce, but fails to take account of the experience accumulation factor as workers gain in exposure and become more mature. What makes the picture more complicated is that this experience accumulation factor is likely to be very diverse amongst workers of different education attainment.

3. Consider two workers at the same age of late teens being in the labour market: The first one is an industrious school-leaver, while the second one, who is equally willing to work hard, has just gained entry to a place in university. What would happen in ten years' time when both are in their late 20s? In twenty-five years' time when they are in the early 40s? Would better education enlarge the opportunity set and widen the scope for possible productivity gains as the experience of an individual grows? The "education" and "experience" drivers as embodied in the labour force are examined in details in the following section based on Hong Kong data.

Income differentials of workers with different education background widens significantly as workers mature

4. **Chart 1(a)** illustrates the earnings profile of workers in different age-groups for three levels of educational attainments(7) in 2005. It is clear that:

(1) Within the same education attainment group, the difference in earnings power widens as workers become more mature, essentially a manifestation of the effects of experience accumulation. For example, the average income for a worker aged 45-49 with upper secondary school education is about 1.2 times higher than a young entrant aged 20-24. For tertiary-educated workers, the respective income gap between the age group 45-49 and that of 20-24 is considerably higher, at around 4.5 times.

(2) The earnings of workers with lower education tend to peak at an earlier period, at around 40-44 for the "lower secondary" group and around 45-49 for the "upper

(7) The 3 classes of education refer to (1) lower secondary and below; (2) upper secondary and matriculation; and (3) degrees and other diplomas. The 3 classes will be referred as "lower secondary", "upper secondary", and "tertiary" respectively in the remaining parts of the essay.

secondary" group, whereas the earnings of workers with higher education will continue to rise until 50-54. Again this highlights the differential effects from experience accumulation for different levels of education attainment.

(3) Comparing tertiary-educated workers and other workers of the same age group, the earnings difference widens even more significantly as workers become more mature and gain in exposure and experience. Presumably, at the start of the career when a worker is in his early 20s, the difference in earning power of a tertiary-educated worker may be rather small as against his peers who are with other educational attainments. Significant earnings gap only shows up in the more mature stage of his working life. For example, an average university graduate in his early 30s can earn around two times more than his contemporaries who have received only lower-secondary education. The gap widens all the way until 50+, effectively the end of full-time working for many ordinary workers, with an average degree holder earning four times more than an average worker with lower-secondary education.

Chart 1(a) Earning potential of workers varies significantly across age and education attainment

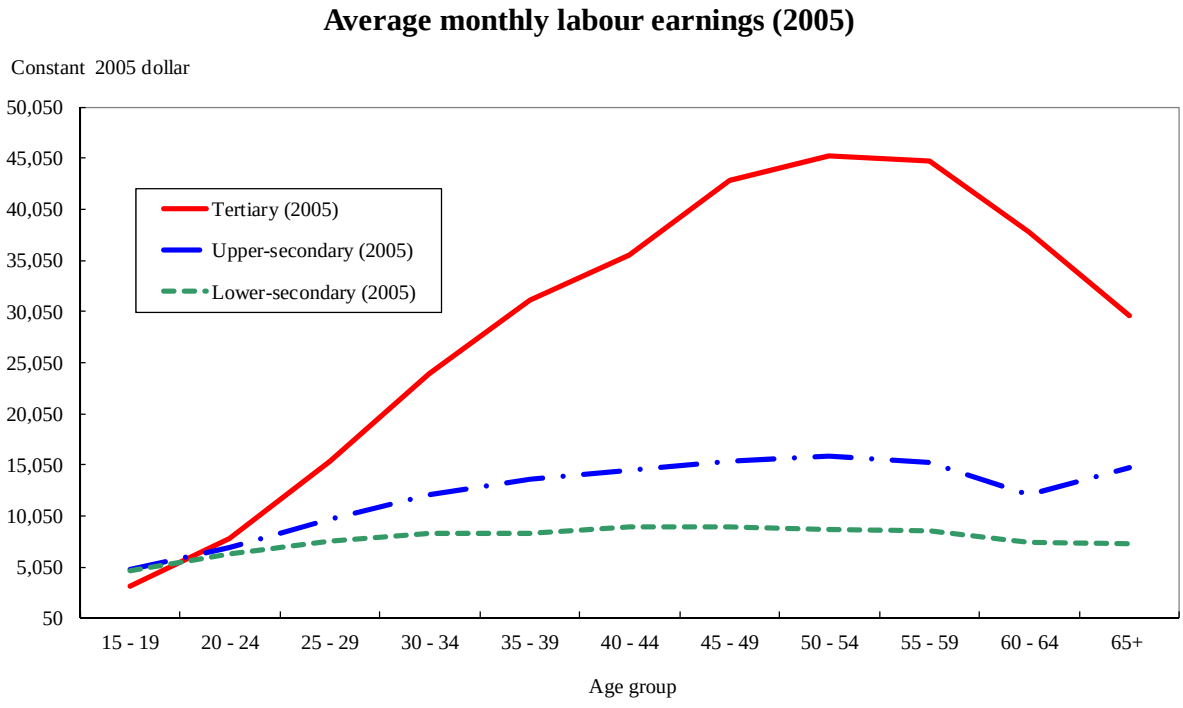
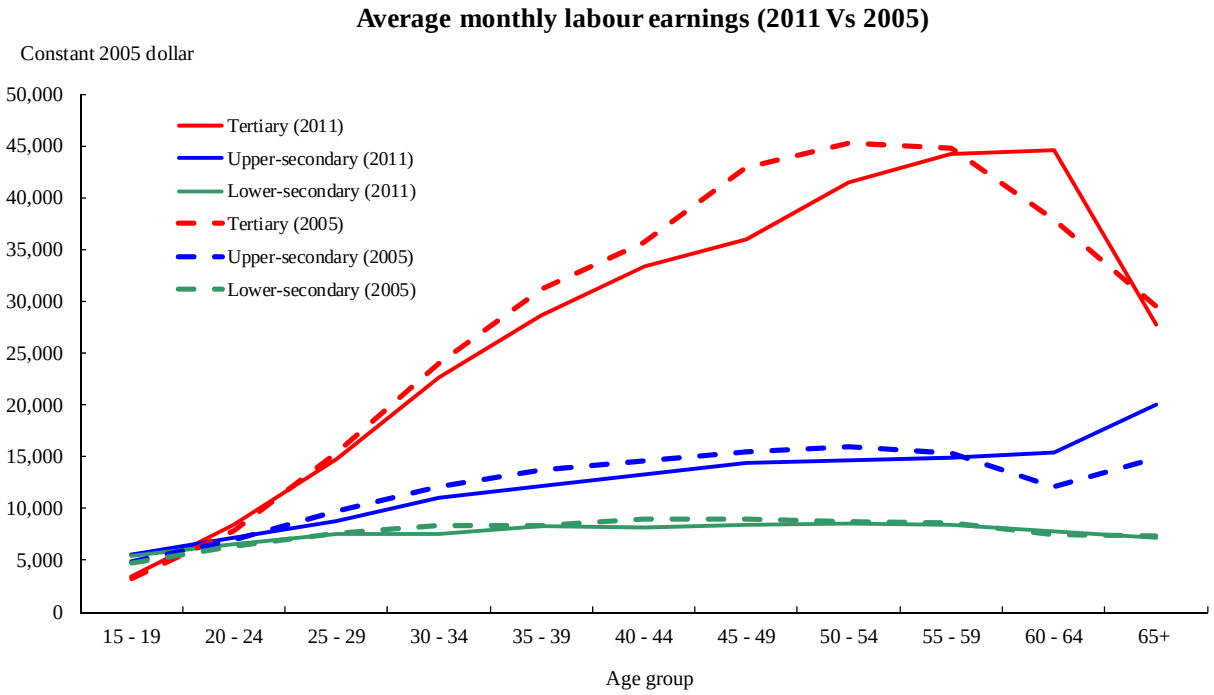


Chart 1(b) Relativity between the earning potentials of workers at different age and with various education attribute seems to hold



Are earnings profiles stable over time?

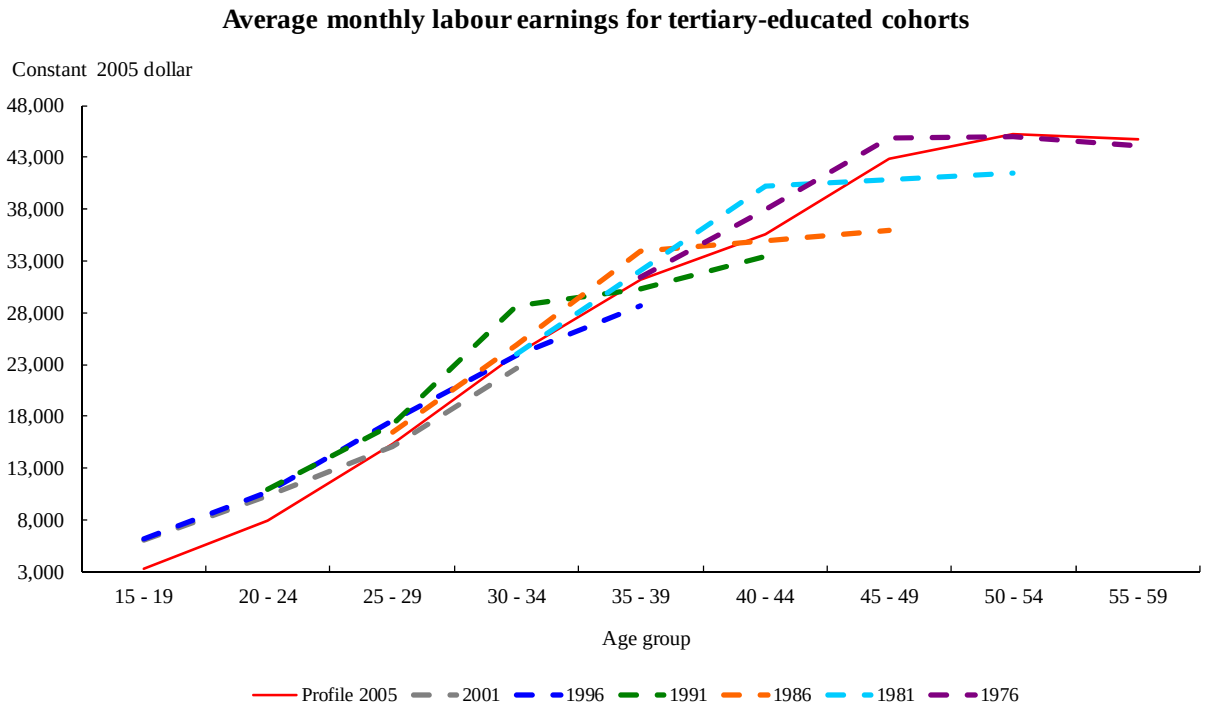
5. Is this relativity in earnings potential across the workers stable over time? A casual inspection with the more recent figures in 2011 in **Chart 1(b)** suggests that this relativity stays broadly the same. To carry the examination further, the life-time earnings profiles of workers sorted in "synthetic cohorts" are compiled, according to the year when they are at the age 20-24[(8)]. Comparison is then made between the earnings profiles of these cohorts and the earnings distribution in the reference year, i.e. 2005.

6. From **Chart 2**, it is apparent that while the real earnings[(9)] for an average worker with a particular level of education attainments may vary slightly over generations, the relativity of difference in earning potentials across various levels of education attainments and experiences roughly holds over time.

(8) The earnings profiles over the life-time of an average worker in a particular "cohort" are deduced from the earnings profile all through to 2005. For example, the earnings of the 1976 cohort for university graduates with 20 years of experience can be deduced from the 1996 profile for the group of degree holders aged 40-44. See ***Appendix I*** for details.

(9) Nominal earnings discounted by the consumer price inflation.

Chart 2 **Life-time profiles of earnings of workers in same education level seem to be largely the same over generations**



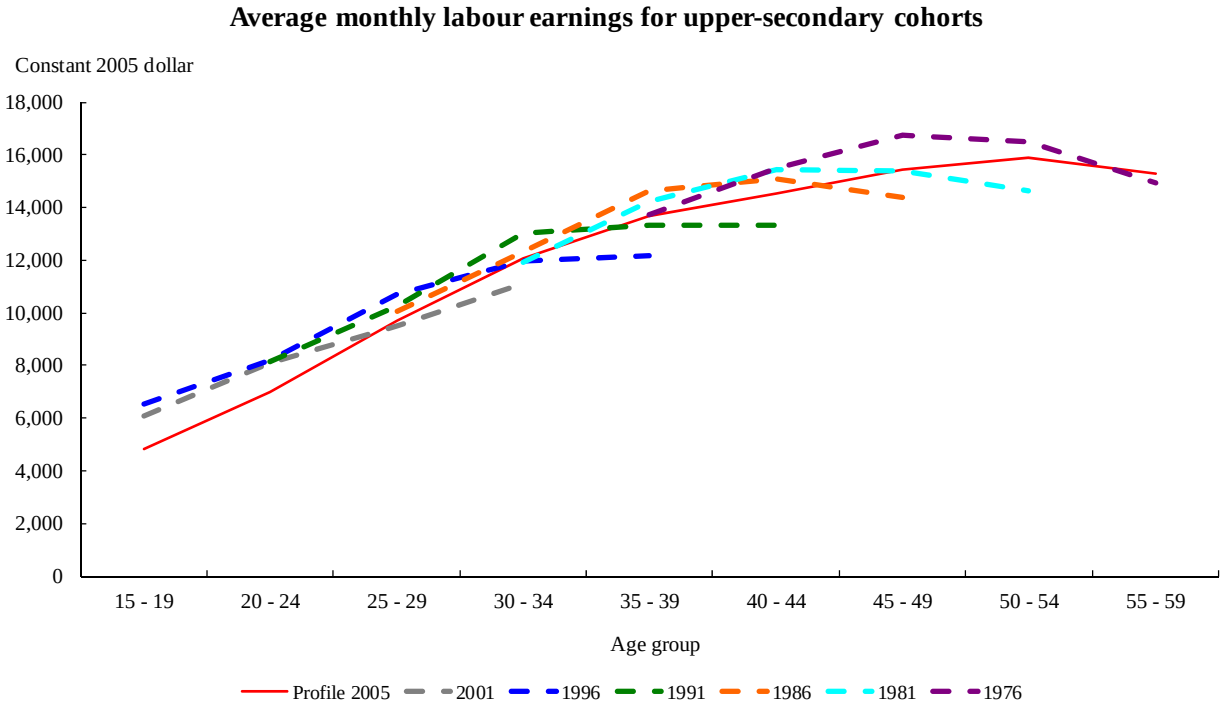
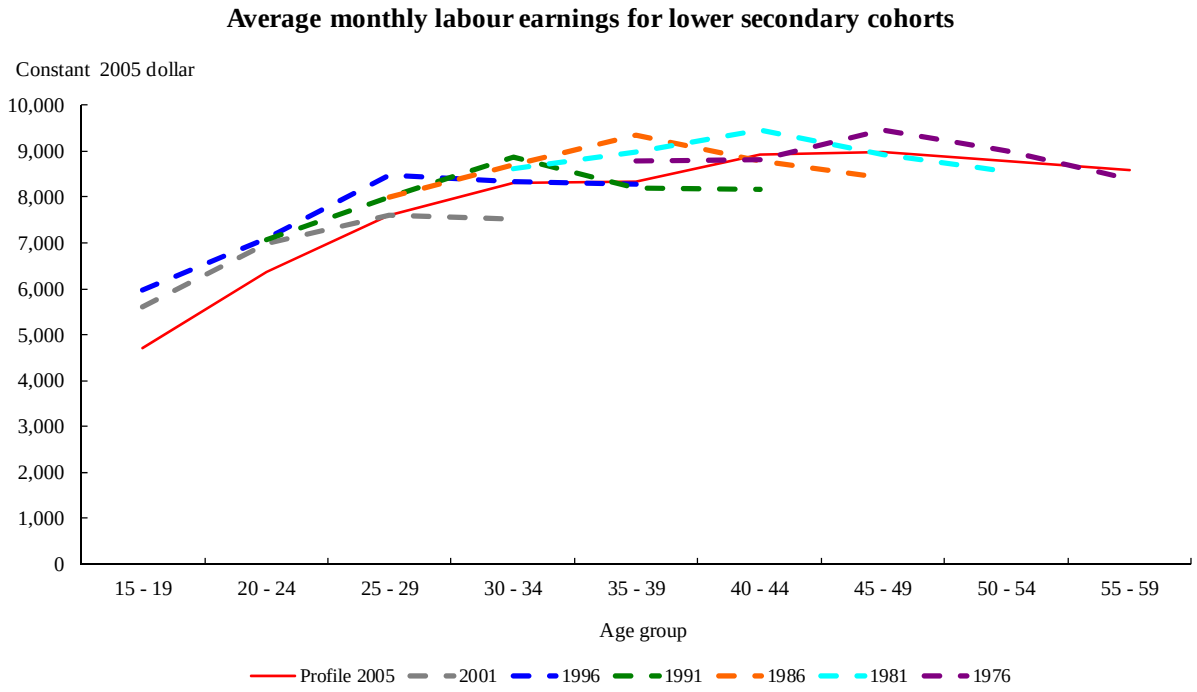


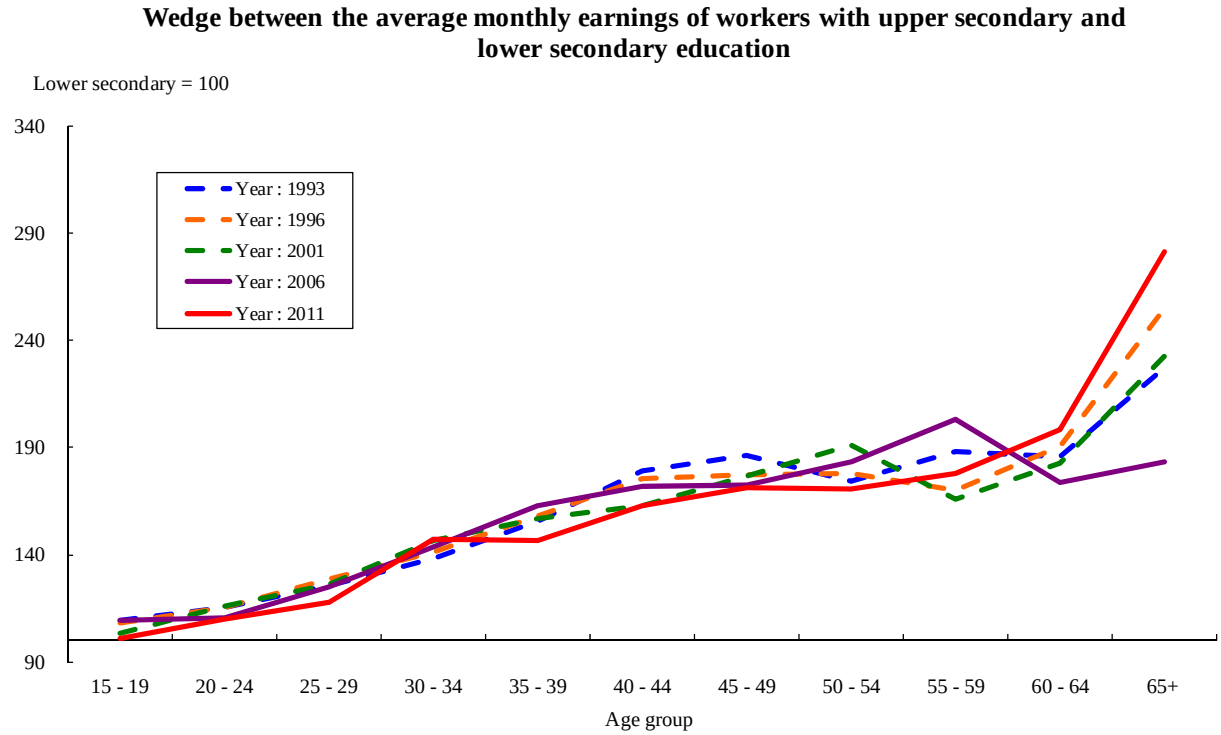
Chart 2(cont'd)



How have the earnings wedges changed over time because of transition to a knowledge-based economy?

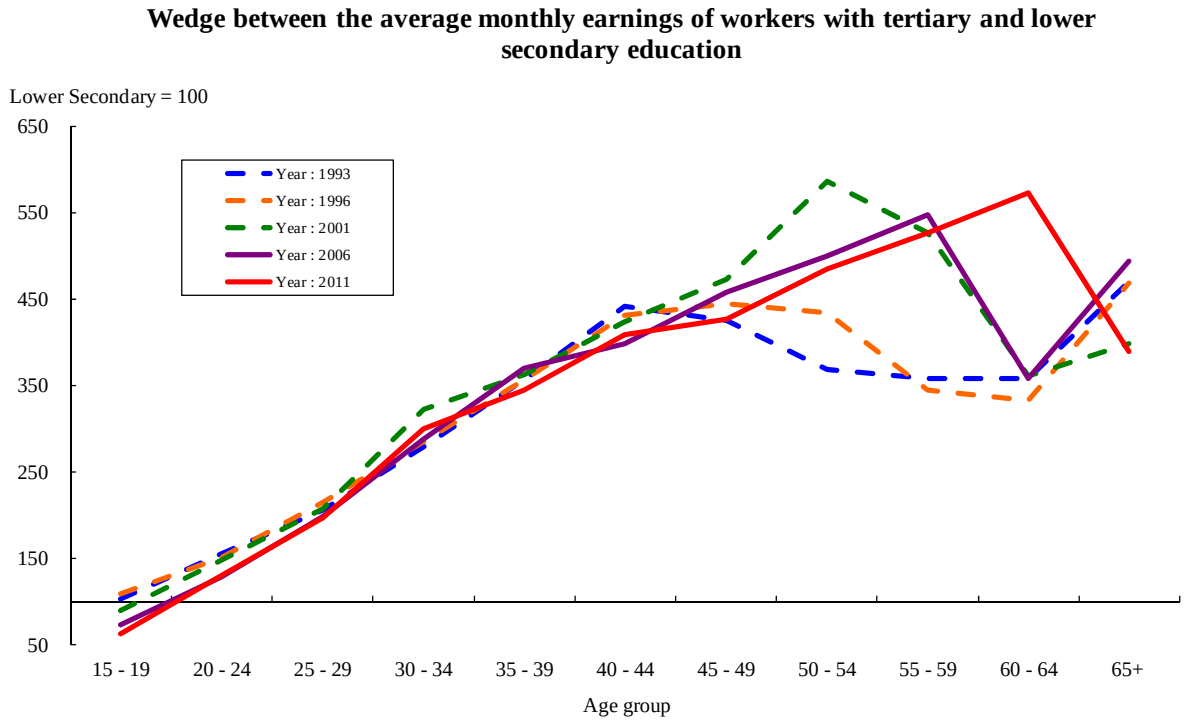
7. Another way of analyzing the earnings differentials amongst workers of different education levels is to examine how the earnings wedges (over the lower secondary school attainment group) change over time. As **Chart 3(a)** below indicates, the earnings wedge of the upper secondary education group (over their lower secondary counterpart) tends to be rather stable over the years for all the prime working age groups.

Chart 3(a) The earnings wedge between the lower-secondary and upper-secondary educated workers in prime working age has not changed much over the years



8. The earnings wedge of the tertiary education group over the lower secondary attainment group is also rather stable over the years for the prime working age 25-44 but tends to be rising after 44+, all the way through to the age 60-64. The implied earnings gap between a more educated worker and his less educated counterpart during the latter part of their working life has thus widened distinctly over time, conceivably a reflection of the evolution of the economy towards knowledge based economy leading to a significant increase in earnings premium for workers with higher education.

Chart 3(b) The relativity in earnings between the tertiary and lower-secondary workers widened over the years



Measuring human capital stock in the "output value" sense

9. What does the huge gap in earnings potential mean for Hong Kong's productivity and economic growth? First, it means that as the education attainment of the workforce improves over time, it will be a major source of income and hence productivity growth for the Hong Kong economy. Secondly, the effects of ageing on earning potential tend to be smaller for degree holders than for workers with lower education. From this angle, the dragging effects of ageing can be relieved to some extent as the workforce keeps upgrading itself towards the group with higher education. Again, this highlights the importance of education in mitigating the effects of ageing on productivity growth.

10. Given the huge gaps in productivity and earnings potentials amongst workers with different education and demographic profiles, measuring the supply side just by the headcount of labour force will leave a big gap in accounting for the quality upgrading of the workforce and the source of economic growth. In this study, a number of human capital stock series for the Hong Kong economy has been constructed in order to measure human resources in the "output value" sense, that is, in terms of the income or earning ability of the workforce, instead of the conventional approach of focusing on the input cost, i.e. the amount of education and post-education training that have been invested in the workforce. Education and on-the-job-learning would actually show up in the human capital stock, to the extent that they are effective in enhancing the skills and knowledge and earnings potential of workers. The methodology is explained in details in ***Appendix II***. Essentially it involves adjusting the headcount numbers of workers of different age profiles and at different education attainment by their productivity ratios as proxied by their income ratios(10), setting the numeraire to the income of an average worker in 2005(11).

11. In this construct, the human capital stock embodies the productivity premium/discount accrued to different subgroups of the workforce. Their trends over and above the headcount change in workforce can therefore reveal a lot about how effective the education system is, how well the human capital is being utilized, and how productive is the workforce. It will also shed light on the effects of education and experience accumulation in lifting Hong Kong's labour productivity growth. This paper suggests that the joint effects of education combined with experience accumulation on Hong Kong's productivity growth are more than multiplicative. Indeed, they were one key source of total factor productivity growth in Hong Kong over the 15 years from 1997 to 2011.

(10) In this study, it is assumed that the differences in labour earnings between workers reflect the relativities in their productivity. This should be a reasonable assumption, given the general consensus that Hong Kong has a highly efficient labour market.

(11) 2005 is taken as the base year for benchmarking productivity/income ratios, for two reasons: (1) 2005 is a year when the economy has by and large fully recovered from the previous downturn (which started in late 1997 and ended in 2003), and hence a cyclically neutral position. One of the indications is that 2005 was the first year in which the economy recorded mild inflation after 68 months of deflation. This cyclical neutrality is important as the earnings ratios for weighing up the headcount workforce have to be distilled from cyclical fluctuation. (2) 2005 is a relatively recent period that satisfies condition (1). This property of being up-to-date is also significant as the distribution of earnings is supposed to reflect the productivity difference across various groupings of workers.

Human Capital Stock series

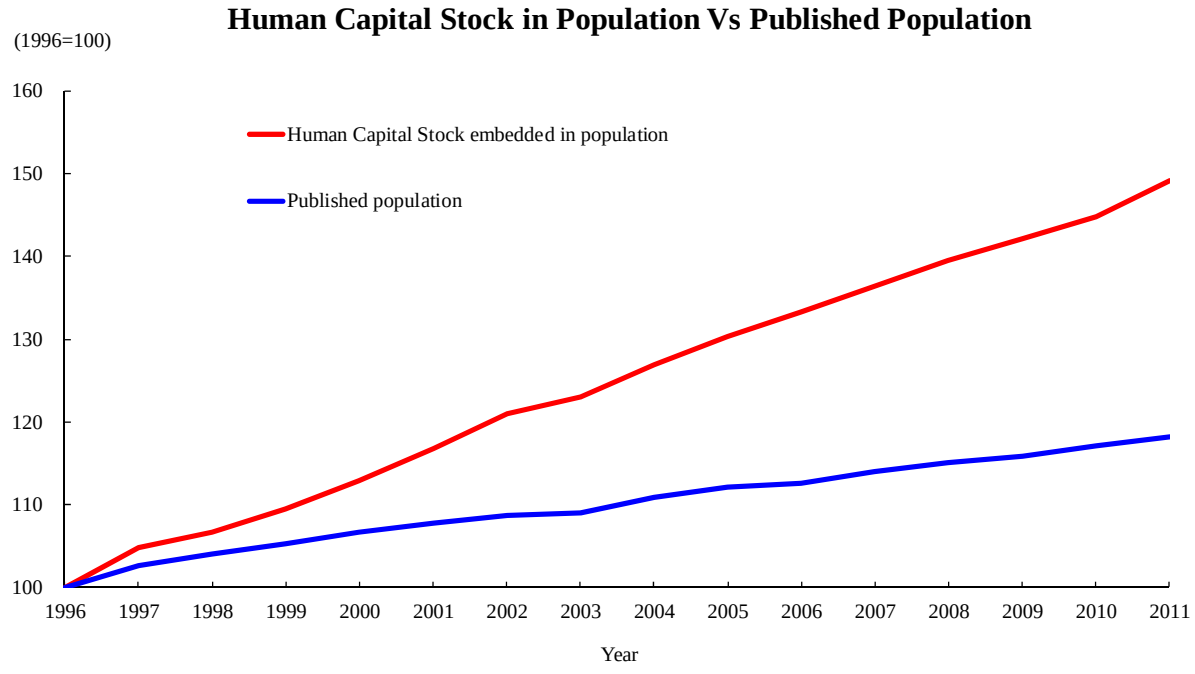
12. Following the methodology as discussed in Para. 10, human capital series which takes into account differences in productivity/earnings amongst different segments of the workforce are constructed for each of the following population aggregates :

(1) Population aged 15+ (population of working age);
(2) Labour force;
(3) Total employment.

(1) Total human capital stock embedded in the population (based on population aged 15+)

13. **Chart 4** shows the movements of human capital embedded in the total population aged 15+ over the years 1996 – 2011. What it represents is the total human capital in Hong Kong's population that can be mobilized to yield income for the economy, including not only people who are working but also those who are now out of the workforce but can re-join the labour market any time. From the chart, it is clear that the growth in total human capital stock persistently exceeds the growth in headcount population aged 15+, suggesting rapid accumulation of human capital in the working age population, in tandem with the significant job upgrading and rise in education standards in aggregate terms.

Chart 4 Human capital stock embedded in population aged 15+ persistently growing faster than the headcount population

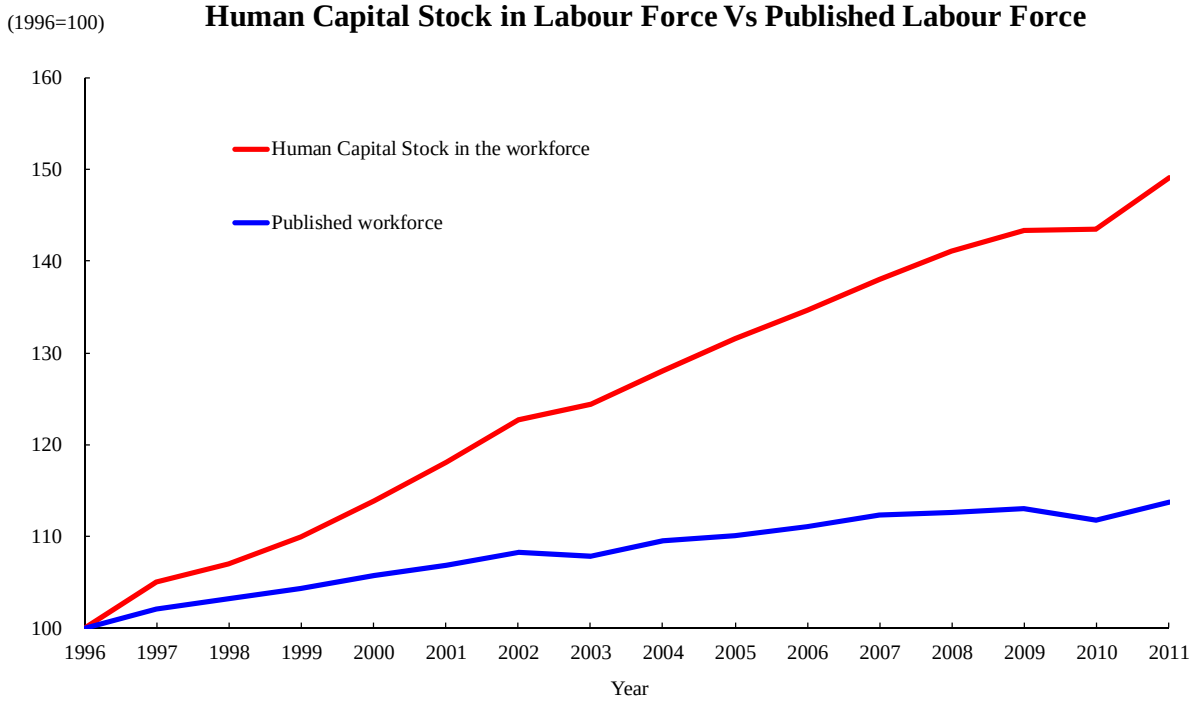


(2) Active or utilised portion of total human capital stock (based on labour force)

14. Total human capital stock as constructed from population aged 15+ shows the capital stock embedded in the total population. But if a large number of population stays out of the workforce for whatever reason, or if workers with high education attainment choose to retire early, they would represent a loss to human capital stock. The loss would be bigger for higher drop-outs in the higher income groups. Hence, the second human capital series as constructed here looks at the active portion of total human capital stock, covering only those workers who are in the workforce. The non-active portion corresponds to that part of the human capital stock for economically inactive people who choose to stay out of the workforce, e.g. full-time students aged 15+, non-working housewives, and retirees.

15. **Chart 5** compares the human capital embedded in the labour force and its headcount counterpart over the years 1996 – 2011. Again the published headcount labour force series is consistently outgrown by the human capital stock embedded in it. While the labour force suffered a dent in 2003 due to the negative impact on economic activities from SARS which discouraged some people to leave the workforce, the human capital embedded in it was still growing, albeit at a slower rate. The same can be said for 2010. This divergence shows the resilience in the accumulation of human capital even in face of sudden shock in the economy. Also, the rapid growth in human capital stock accumulation embedded in the labour force quickly resumed once the negative shocks in those two years waned. This shows Hong Kong's strength and depth in its pool of human capital, which in turn underlined the economy's resilience against external shocks.

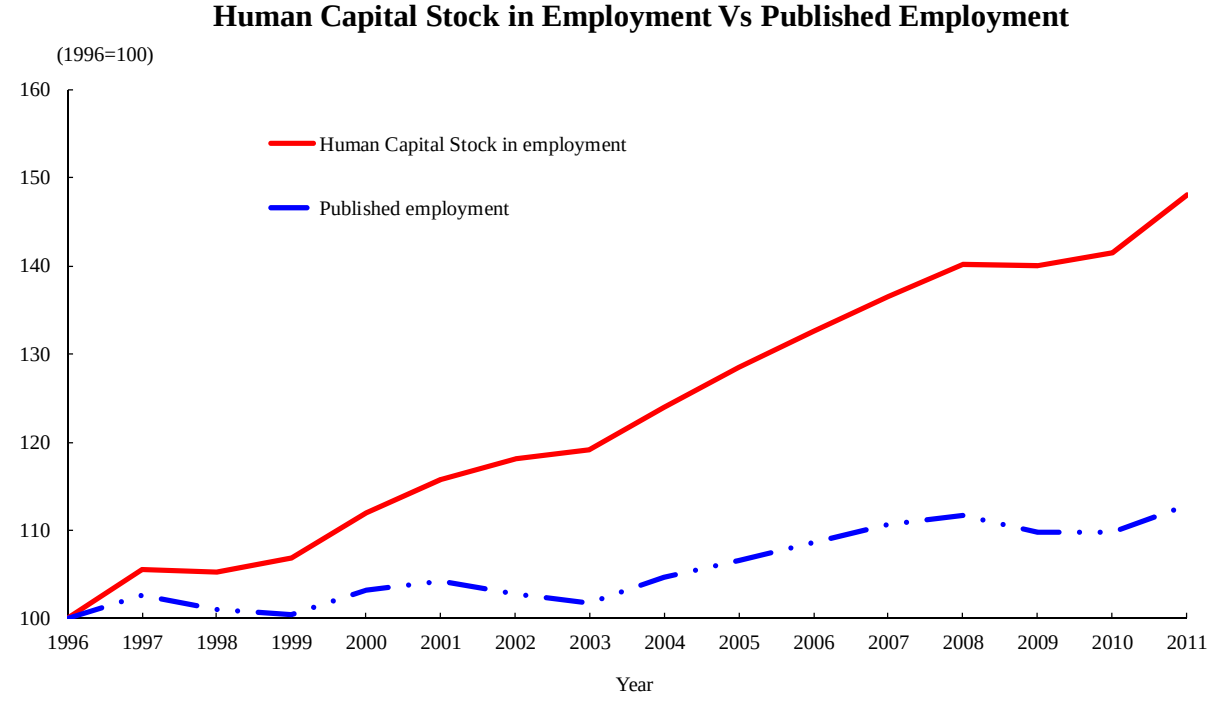
Chart 5 Active portion of human capital stock based on the productivity augmented labour force series keeps growing faster than headcount labour force



(3) Human capital stock in employment (based on total employment)

16. If a large pool of degree holders stays unemployed for a long period of time, what it signals is poor utilization of human capital stock and the corollary is the ineffectiveness of education in producing the workforce the economy requires. Another way of looking at how well labour force is being deployed or utilized is to construct a human capital stock series on employment. **Chart 6** shows the movements of human capital stock constructed based on employment series, versus that of the published employment series. The difference between the population sets involved in **Chart 5** and **Chart 6** is that the population in **Chart 5** includes the unemployed, where **Chart 6** does not. The resilience in the actually utilized human capital is even more pronounced here. Even during the economic downturns, when the total employment actually fell in 1998-99, 2002-03 and 2009, the human capital stock being deployed or utilized was either still on the rise (in the former two period) or fell just marginally (in 2009). It is also worthy to note that the growth in the utilized human capital stock has been much faster during other years, presumably reflecting the persistent evolution of the workforce in adapting to the "knowledge economy", where the source of economic growth is more determined by the ability to generate intangible assets (ideas, skills and networks that channel flows of ideas, knowledge and funds) rather than amassing a large number of homogenous workers with investment in machinery and physical assets oriented to produce tangible goods.

Chart 6 Human capital stock in employment still grew during the years of economic downturn when employment fell



Analysing the human capital stock series

(1) How effective is human capital being utilized in the economy?

17. As discussed in Para 14, it would be a waste of human capital if a highly seasoned professional retired at late his 40s, or a university graduate stopped working after getting married in late 20s. Other constraints such as prejudice against new entrants and immigrants, discrimination against the old or disabled hence discouraging the elderly from seeking work, and poor regulatory and institutional environments that prevent or slow down the take-up of new technologies and innovation, would also hamper the deployment of human capital. To gauge how well human capital is being deployed in the economy, two ratios are analysed in the present study, the utilization rate and the employment rate of human capital, which are parallels to the labour force participation rate and the employment rate of headcount labour force.

- **Human capital stock utilisation rate**

18. This is a measure of how much of the economy's human capital stock is actually utilized, and is given by the ratio of the utilized portion of human capital stock (Para 14-15) to that of total human capital stock(12) (Para 13) . **Chart 7** compares the utilization rate and its analogue in headcount series, the labour force participation rate (LFPR) over the years from 1996 to 2011. There has been a consistent wedge of around 10 percentage points between the human capital stock utilization rate and the headcount LFPR. This is in fact natural, because individuals with higher earning power are likely to be more inclined to work, as their opportunity cost of leaving the workforce is higher. This is also a signal of efficient functioning of the labour market, in encouraging those with higher productivity and higher earning power to participate in the labour force. In fact, as **Chart 8** shows, the human capital stock utilization rate in the tertiary education attainment group has been persistently higher than their upper and lower secondary counterparts for all age groups**.**

(12) Utilisation rate (u) in the human capital stocks refers to the extent to which the human capital in the population is economically active. It is defined as the human capital stock embedded in the labour force (K_L) divided by that in the working age population (K_P). This is analogous to the headcount series of LFPR:-

$$u = \frac{K_L}{K_P} \cdot 100\%$$

Chart 7 **Human capital utilization rate is persistently above its headcount analogue by around 10 percentage points over 1996 – 2011**

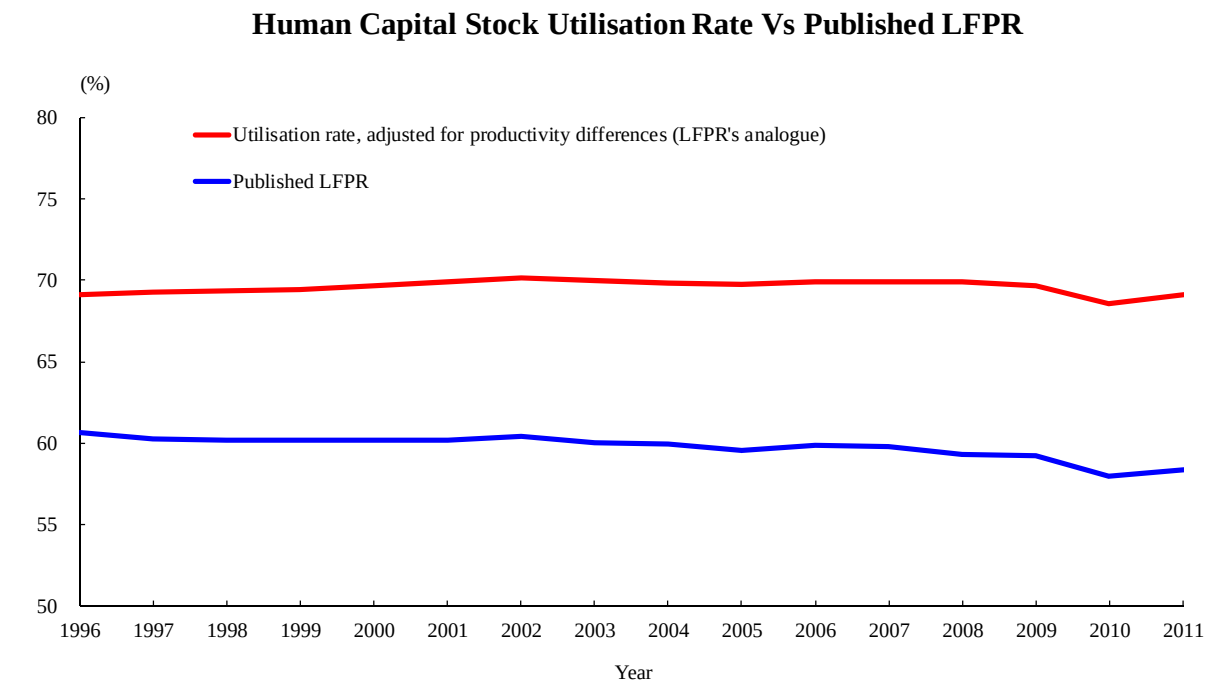
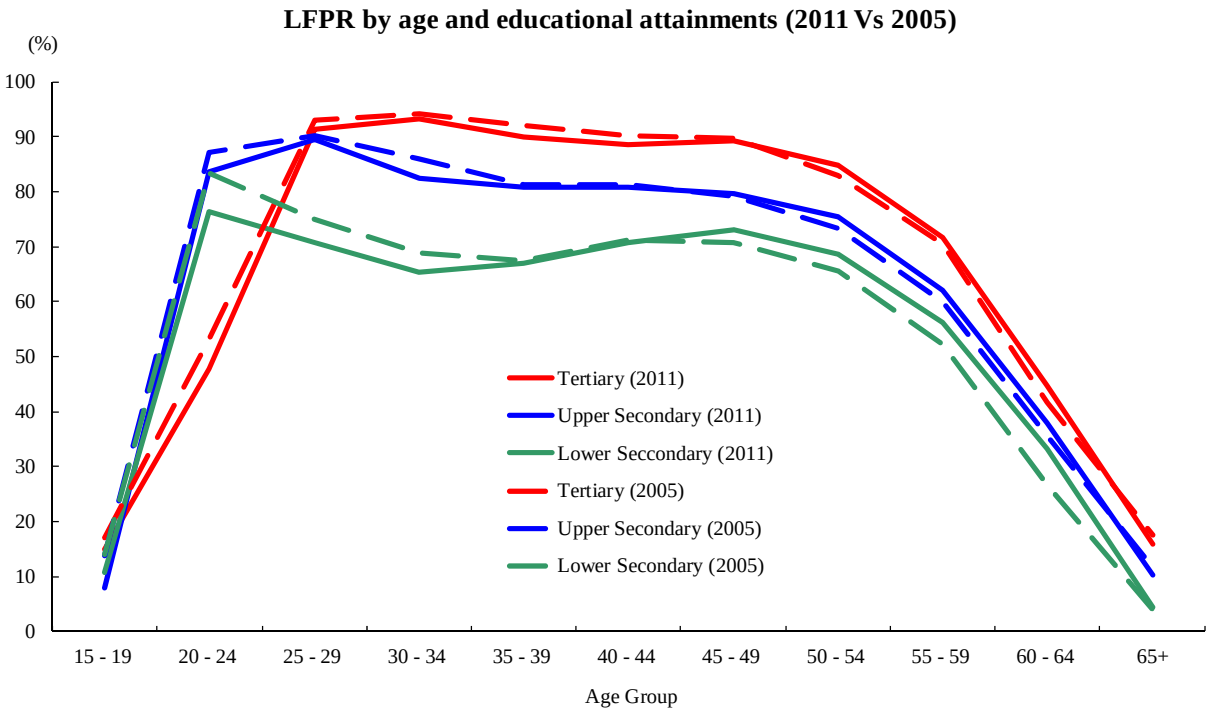


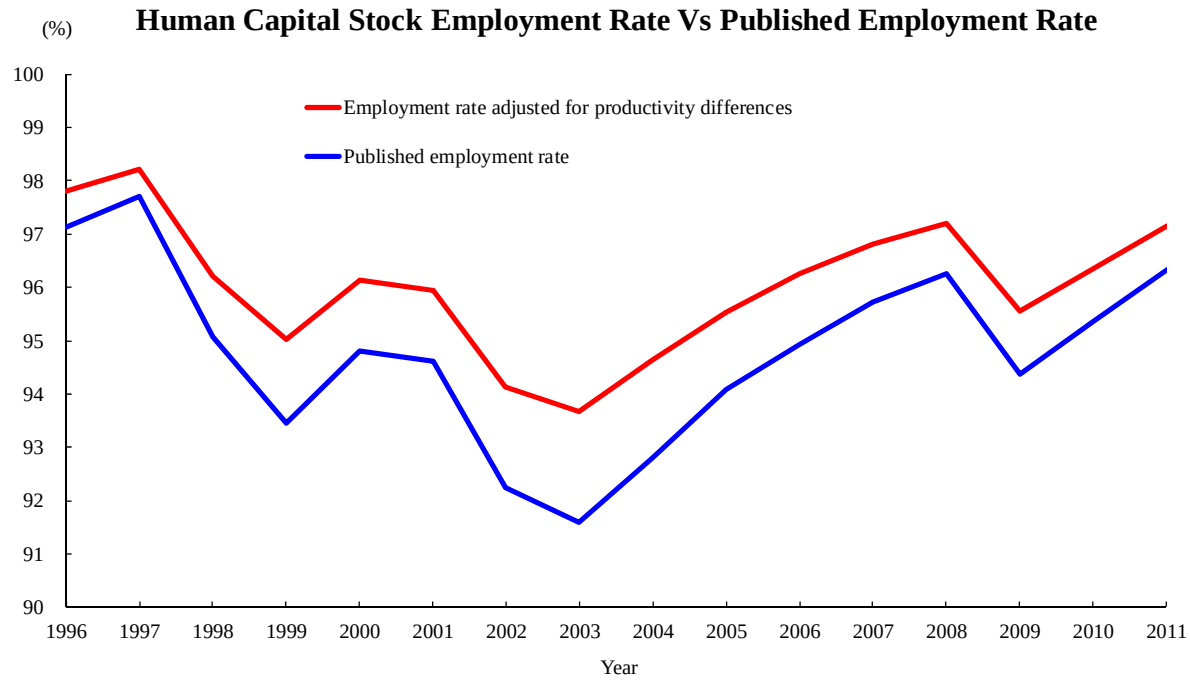
Chart 8 **Human capital stock utilization for tertiary education group has been higher than their upper/lower counterparts for all age groups**



- **Employment rate of human capital stock**

19. Another measure of how efficient human capital is deployed in the economy is the employment rate of human capital. This employment rate measures the extent to which the human capital among the economically active workers is actually deployed in the production process(13). The series is shown in **Chart 9.** Again, the employment rate of human capital stock is persistently higher than its headcount analogue. While this is again a reflection of an efficient labour market where the more productive workers are more likely to secure a job and get employed, it also mirrors the transition of the Hong Kong economy towards a knowledge-based economy, in which the demand for workers with higher degree of education and more experiences is more persistent than demand for those with lower education and lesser experience, regardless of different phases of an economic cycle.

Chart 9 Employment rate in human capital stock also higher than its headcount analogue



(13) Employment rate (e) in the human capital stocks refers to the extent to which the human capital stock among those economically actives are actually employed. It is defined as the human capital embedded in the employment (K_E) divided by that in the labour force (K_L). This is analogous to the headcount series of employment rate:-

$$e = \frac{K_E}{K_L} \cdot 100\%$$

(2) Productivity boost from education upgrading and demographic changes

20. As discussed in Paras. 9 and 10, human capital stock as constructed in this paper is based on headcount employment adjusted for the age-education specific productivity content or earning potential, the gap between the growth in human capital stock and that of headcount employment can thus be taken as a rough measure of the productivity growth due to education upgrading and experience accumulation (For details of the methodology, see ***Appendix III***). This is now given in **Table 1** (3rd column). The unaccounted-for productivity growth due to various other factors is given in the bracket.

21. For comparison sake, an alternative human capital stock series is constructed by adjusting headcounts with education-specific income ratios (instead of age-education specific income ratios), for gauging the separate effect of education upgrading on productivity. Similarly, a third human capital stock series is constructed using age-specific income ratios, so that the gap between this series and the headcount series represents the uplifting effect on productivity due to demographic changes. Their contributions to productivity growth from education upgrading and changes in age structure are given in the 1st and 2nd columns respectively.

Table 1 Productivity gain is much more obvious when taking the effects of education uplifting and change in age structure together

Productivity lift due to demographics and education upgrading

Period	Education (%)		Experience (%)		Education & Experience (%)	
Average p.a. growth (%)						
1997 - 2001 (5 years)	1.4	(-0.4)	0.6	(0.5)	2.1	(-1.1)
2002 - 2006 (5 years)	1.3	(3.4)	0.1	(4.6)	1.9	(2.7)
2007 - 2011 (5 years)	0.9	(1.8)	0.0	(2.7)	1.5	(1.2)
1997 - 2011 (15 years)	**1.2**	**(1.6)**	**0.2**	**(2.6)**	**1.8**	**(1)**

( ) Underlying human capital productivity growth after discounting for the lift due to demographic shifts

22. From the first two columns in **Table 1**, the education factor alone accounted for an average growth of 1.2% annually over the 15 years from 1997 to 2011. The age structure factor (presumably a close proxy of experience accumulation factor) only contributed an average

annual growth rate of 0.2% when being considered separately over the same period. However, either factor when separately assessed tends to ignore the substantial synergy effect that may arise when a more educated worker can make more gains as his experience grows, be it through the learning-by-doing process or other forms of training and learning. This synergy effect is actually sizable, as shown in the third column of the table. When both education and experience effects are considered, their uplifting effects on productivity growth taken together is a remarkable 1.8% per annum over 1997 – 2011. As such, ***the interaction between education and experience on labour productivity uplifting is multiplicative*** - when a worker is highly educated, the marginal gain in his productivity as his experience grows is much higher than that of a less-educated worker, as seen from the steeper curve of earning potentials for tertiary-educated workers in **Charts 1(a) and (b)**.

23. From the above decomposition analysis, it is apparent that the two big sources that have underpinned the impressive labour productivity growth over the past 15 years are (1) rising proportion of workforce with higher education; and (2) experience accumulation as the workforce mature (median age of Hong Kong's workforce is around 41, only approaching the peak of the life-time earning profile especially for the tertiary education group).

24. The demographic factors in the earlier phase of the 15-year period are analysed in greater details in **Chart 10(a)**, which compares the employment share distributions across the sub-groups divided by age and education in 2005 and 1996. Several observations can be made: (1) the overall share of higher-educated workers, who in general possess higher productivity, has increased as per total employment; (2) the increase in the proportion of higher-educated workers aged 40+, who possess a significantly higher productivity than an average worker and their less-educated counterparts, has been notable; and (3) the workforce overall has become more experienced. While in 1996 the age-groups which dominate the headcounts in employment are those younger than 40-44, the age distribution in 2005 seems to have a more balanced pattern.

Chart 10 (a) Demographic shift and education upgrading factors have been conducive to overall productivity growth…

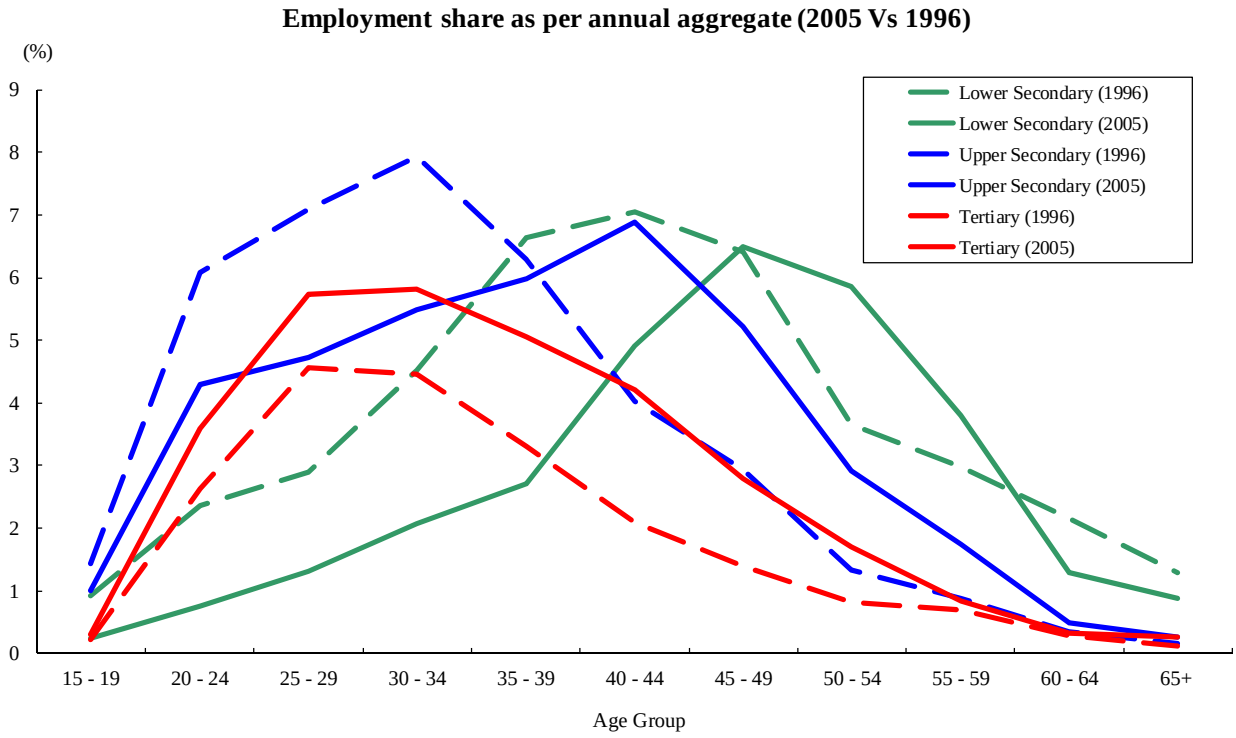
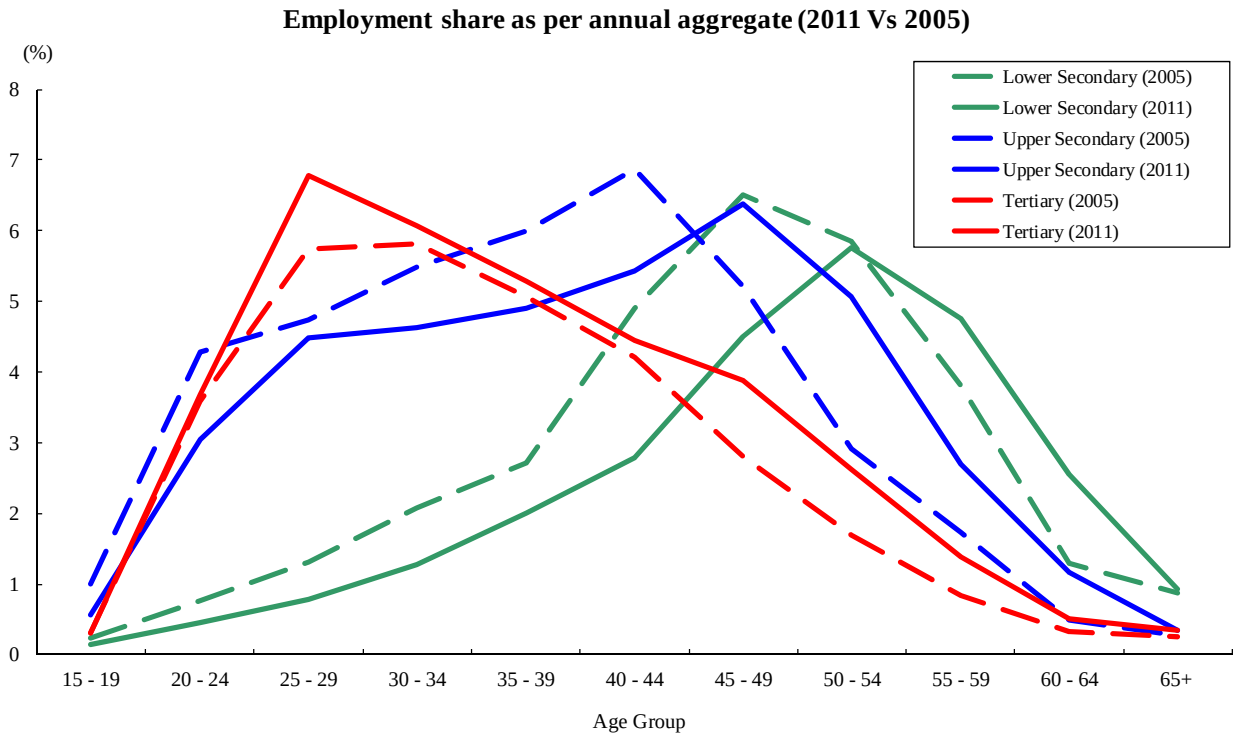


Chart 10 (b) …and should remain so in the near future



25. **Chart 10(b)** provides a more recent picture on the demographic shifts, from 2005 to 2011. The favourable shifts in the overall educational attainment and experience in employment has continued, in the sense that the younger workers have been more educated in general, while the share of older workers with less educational attainments have continued to decline in the labour market. With these favourable shifts in the workforce expected to continue in the future, a ***partial relief to the negative impact from an aging population on productivity growth appears to be able to sustain in the next 5-10 years at least.*** Even the median age of the workforce is to rise by five more years in the distant future, the age of 46 still falls into the prime working age for the tertiary education group. The education uplifting effect should still be prominent and the older age segment of the educated group will still enjoy earnings growth. The negative effect on overall economic growth will however start to emerge as more of the working population move into the 55+ age, though still, with cushioning effects from the education uplifting in the population.

(3) Underlying human capital productivity (as measured by output per unit of human capital stock)

26. The labour productivity growth after discounting for the play-out of the education and changing age structure (figures in bracket in **Table 1**) is a measure of the underlying human capital stock productivity (see also ***Appendix III***). In the case of Hong Kong, it was 1% per annum from 1997 to 2011. Thus, ***the underlying human capital productivity growth in Hong Kong has also been impressive.***

Concluding remarks

27. This paper looks into different aspects of human capital stock in Hong Kong, examines the size of human capital stock that can potentially be deployed in the labour market and the extent it is actually deployed in our workforce; and analyses how well it is being utilized and the extent it has contributed to the labour productivity growth over the past 15 years. The analysis confirms that Hong Kong has been faring rather well in upgrading itself towards a knowledge-based economy, in that the human capital embedded in our population has been growing rapidly – thanks to the substantial expansion in tertiary education in the 1990s. Another finding is that our human capital stock is being used effectively, as can be seen from a high utilization rate. This is an indication of the effectiveness of our education system in training the people the economy needs. The fact that the underlying human capital productivity growth is likewise impressive also illustrates the point that Hong Kong's labour market is functioning rather well.

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Appendix I

Derivation of "Synthetic" Cohort from the Continuous Age-education Earnings Cross-sectional Data

The synthetic cohorts are worked out by simulating the life-time earnings profiles of an average school leaver of age 20-24 corresponding to different levels of education. This is useful for analyzing whether and how the "life-time" earnings profile may differ amongst different cohorts of graduates. For example, is the life-time earnings profile of an average university graduate in 1976 persistently higher or lower than that of another average person who graduates, enters the labour force and first gets employed at the same age in 1986?

As an example, the compilation of the "life-time" earnings profile of an average 1976 university graduate is worked out as follow :-

The respective age-group that a 1976 fresh graduate belongs at different years

Year	1993	1996	2001	2006	2011
Age-group	35-39	40-44	45-49	50-54	55-59

Similarly, this method can track the profile of "life-time" earnings of various cohorts which are in different generation with various education attainments. The earnings of a graduate aged 20 leaving school in Year T after x years of experience can be approximated by the earnings figures of the age group $(20+x)$ at Year $(T+x)$.

Implicit in this method of compiling "synthetic" cohorts is the assumption that the workers who are in the same "cohorts" are homogenous, sharing the same level of productivity. The productivity levels of those workers, who for whatever reason not being in employment, are the same as their counterparts in their respective "cohorts", whose earnings are being reflected here as proxy for productivity.

Appendix II

Methodology in the construction of human capital stock series

In the computational sense, the human capital stock is best described as an augmented headcount series, after having taken the productivity differences between groups of workers with difference experience levels and educational attainments. With the panel data of population, labour force and employment by age-group and educational attainment over the years, the number of respective headcounts falling in a certain age-group with a particular level of educational attainment in a certain year can be identified. These, when being matched with the set of productivity weighting factors, produce the human capital series of the Hong Kong economy. For example, the human capital embedded in Hong Kong's labour force, K_L at year t can be computed as:-

$$K_{L,t} = \sum_{i,j} L_{ij,t} \cdot p_{ij}$$

where

$K_{L,t}$ = Human capital stock embedded in the labour force at year t

$L_{ij,t}$ = Number of headcounts in labour force that fall into the age-group i with educational attainment j at year t

p_{ij} = Productivity weighting for those in age-group i with educational attainment j, as proxied by the income income

Under this framework, a productivity weighting to each group of workers is to be assigned. The actual average earnings of each group of workers are taken as the proxies of the relativity in productivity level. This is quite reasonable given the consensus that Hong Kong has a highly efficient labour market, in the sense that labour inputs are being compensated according to their relative productivities.

The base year is carefully chosen to be 2005 in the current study, a year which the economy has already recovered and is apparently close to the cyclically neutral position (i.e. output gap turns from negative to positive). The intention is to avoid using income ratios which are heavily distorted by big swings in the economic cycle. This is important because different groups of workers fare very differently during an economic down-cycle, and over the 15-year timeframe of this study (1997-2011), the Hong Kong economy experienced setback in many occasions.

Specifically, the productivity weighting for the group of workers in age-group *i* with educational attainment *j* is as follow:-

$$p_{ij} = w_{ij,05} / \overline{w_{05}}$$

where

$w_{ij,05}$ = Average income for workers in age-group *i* with educational attainment *j* in the reference year (2005)

$\overline{w_{05}}$ = Average income of total workforce in the reference year (2005)

Accordingly, the human capital stock embedded in the labour force/total employment is computed as follows: -

$$K_L = \sum_{i,j} \left(L_{ij} \cdot w_{ij,05} \right) / \overline{w_{05}}$$

where

K_L = Human capital stock embedded in the labour force

L_{ij} = Labour force/total employment in age-group *i* with educational attainment *j*

$w_{ij,05}$ = Average income level for workers in age-group *i* with educational attainment *j* in the reference year (2005)

$\overline{w_{05}}$ = Average income level of total labour force/employment in the reference year (2005)

Similarly, the series of human capital embedded in population aged 15+ is computed using the age-education distribution of population aged 15+ adjusted by their age-education income ratios.

Appendix III

Productivity Growth from Education Upgrading and Experience Accumulation

In common usage, labour productivity (*LP*) is defined as the output of the economy (*GDP*) divided by employment (*EMP*):-

$$LP = \frac{GDP}{EMP}$$

By simple algebra, the growth of labour productivity can be decomposed into two factors, one being the education upgrading and experience accumulation in the workers employed ($\hat{K}_{EMP} - \hat{EMP}$), the other being the residual or the underlying human capital stock productivity growth ($\hat{GDP} - \hat{K}_{EMP}$), which is analogous to labour productivity growth.

$$LP = \frac{GDP}{EMP} = \frac{GDP}{K_{EMP}} \cdot \frac{K_{EMP}}{EMP}$$

$$\hat{LP} = \underbrace{(\hat{GDP} - \hat{K}_{EMP})}_{\text{Underlying human capital productivity growth}} + \underbrace{(\hat{K}_{EMP} - \hat{EMP})}_{\text{Labour productivity growth from education upgrade and experience accumulation}}$$

where

$\hat{LP}$ = Labour productivity growth (y-o-y)

$\hat{GDP}$ = Real GDP y-o-y growth

$\hat{K}_{EMP}$ = Growth in human capital stock in employment (y-o-y)

$\hat{EMP}$ = Rate of increase in employment (y-o-y)

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