Education as a Determinant of Economic Growth in East Asia: Historical Trends and Empirical Evidences (1965-2000)*

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Abstract

Using panel data from East Asian countries from 1965 to 2000, this paper concludes that panel estimates of the labour-augmenting Solow model for East Asian countries show a significant influence of human capital, measured by schooling years, on East Asian economic growth in addition to the importance of investment shares and population growth. Compared to the results based on pre-1997-crisis data, the results show increasing contribution of education, in contrast to less contribution of investment, to the economic growth in recent years. This indicates a possibility of education as a long-run policy tool to achieve sustainable growths.

This study also notes that there exists convergence in Asian region. But the convergence is not absolute convergence. Despite reaching the same level of income per capita, each East Asian economy reaches its respective steady state. The difference between the steady state level of GDP per capita for each economy and its actual income per capita is going to be halved in about 18 years. Without the inclusion of human capital, the period greatly changes to 64 years. The speed of convergence of East Asian economies is about two times slower than the speed of OECD countries.

JEL codes: C33, I20, J24, O47, O53, R11

Keywords: economic growth, East Asia, human capital, education

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1. Introduction

Recent trends in researches on growth rates have been focusing on the role of human capital, in particular education. Human capital was generally defined into five categories: health status, on-the-job-training, formal education, adult study programs and migration to find better job opportunities (Schultz 1961). It was then argued that the most important factor to increase the stock of human capital is education (Goode 1959; Schultz 1961). As a result, most empirical works on education uses average of formal schooling years as proxies due to limited data availability (Brist and Caplan 1999; Hanushek and Kimko 2000; Lau and Park 2003; Rada and Taylor 2006).[1]

However, being assumed as one important factor in economic growth does not necessarily lead human capital theory supported by consistent empirical evidences. Some studies conclude the stock of education are significant on economic growth, theoretically and empirically (Romer 1986; Romer 1990; Dougherty and Jorgenson 1996). But others find no evidence. Using data from up to hundred countries in the period 1960-1990, one study finds that labour-force quality has consistent, stable and strong causal relationship with economic growth, but the labour quality is not related to investment in formal schooling (Hanushek and Kimko 2000). Similarly, using data from eighty four countries in the period 1960-2000, another study observes the 2.3 % world growth of output per worker grew is contributed by 2% increases in physical capital per worker and technological progress and only 0.3 % contributed by increases in human capital, as measured by education (Bosworth and Collins 2003). Focusing on data from fifty eight lower-income countries in the period 1985-1993, another study concludes that schooling enrolment was unable to explain cross-country variation in the respective growth rates of real GDP per capita, life expectancy and fertility (Brist and Caplan 1999).

As most empirical works using growth regressions approach have been focused on large cross-country datasets (Romer 1986; Romer 1990; Sachs and Warner 1997; Bosworth and Collins 2003), one common problem is the assumption on identical aggregate production function for all the countries, which consequently leads to potential omitted variable bias. To solve this problem, the unobservable "country effects", which allow differences in production functions across countries, can be modelled in a panel data framework. Benefits of panel data also include giving more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency (Baltagi 1995).

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[1] There are also some studies using other human capital proxies such as life expectancy (Sachs and Warner 1997; Bloom, Canning et al. 2000), the youth dependency ratio (Bloom, Canning et al. 2000), fertility rates (Bloom, Canning et al. 2000) and the age structure (Kwack and Lee 2006). But these variables are not as frequently used as schooling variables.

The idea to apply panel analysis in economic growth research has attracted the interests of several researches using data from OECD countries (Lee, Longmire et al. 1998), the United States (Evans and Karras 1996) and multi-country data (Islam 1995). Unfortunately, there is little perhaps no existing literature on empirical works of the role of education in East Asian economic growth. This study therefore attempts to focus on this specific region motivated by an indication that the coefficient estimation is sensitive to country's inclusion in the datasets. This study also provides analyses using more recent data.

This paper is organised as follows. The next section presents reviews on education and its role in economic growth in East Asia. Section three discusses a theoretical framework showing how education might affect the economic growth. Section four describes the methodology and presents empirical results. Section five concludes.

2. Education and Economic Growth in East Asia

East Asia has been one of the most discussed region due to its rapid economic growth in the 1990s catching up to economic welfare of earlier industrialised countries and leaving the rest of developing world. Most economists agree that the most important reason to Asian success, especially during 1960s to 1990s, is the implementation of export-oriented industrialisation (EOI) policy (Morris 1996; Chen 1997). Of course, this idea cannot be separated from the fact that there has been notable technological progress within the region.[2] But, other argue that the EOI supporters have abandoned other country-specific crucial factors, such as education, which is the result of 'positive' impacts of colonialism on infrastructure and international network development in East Asia (Gulati 1992).

Many support the above view. The 1993 World Bank report states one important factor of Asian success during 1965-1990 is getting the basics rights including accumulation human capital by providing universal primary and secondary education while tertiary education are largely met by self-financed system (World Bank 1993). Using international mathematics and science test scores in 1960-1990, a study concludes that the estimated growth effects of improved-labour force quality significantly drop when East Asian countries are exempted, supporting an argument for significant contribution of human capital to the growth of East Asian Economies (Hanushek and Kimko 2000). In addition, another study argues that East Asian miracle is stimulated by remarkable development in human capital, which is financed by efficient resource allocation (Mingat 1998). Faster growth of TFP in Hong Kong

[2] See (Chen 1997) for an excellent survey on the role of total factor productivity (TFP) as a growth determinant in East Asia.

associated with its higher-educated labours than Singapore also supports the importance of education in innovation accumulation (Young 1995). This argument is also supported by a study on the importance of other human capital measurements, life expectancy and dependency burdens in East Asia's economic success using data from 1965-1990 (Bloom, Canning et al. 2000).

The education sector in East Asia has experienced massive development during the last decades. Visible signs of rapid education development in East Asia are universal primary education and rapid increases in secondary and tertiary school enrolment rates (Table 1). Since the 1980s most East Asian economies had successfully been providing universal primary education, with Cambodia as one exception suffering the impacts of civil war in the 1970s.

Variation in the enrolment of secondary education shows the difference of economic stage of each economy. In the period 1985-96, while enrolments of secondary education in early developing countries such as Cambodia, Vietnam, and Philippines ranged between 22-30%, enrolment in newly industrialised countries such as Hong Kong and Singapore averaged 75%. The variation also seems to be associated with the size of population. Secondary education's enrolment in densely populated countries such as Indonesia and China, whilst their economies performed well in this period, were only below 50%. Unsurprisingly, in the same period, Japanese universal secondary education was well known.[3]

In regard to tertiary education, like secondary education, variation in the enrolment of secondary education shows the difference of economic stage of each economy. Singapore and Hong Kong tertiary education enrolments were about 30% over the entire period 1985-2006. Densely populated countries, Indonesia and China, experience lower enrolment percentage being about 15%. But, it should be pointed out between 1985 and 2006, China has been successfully improving the tertiary enrolment ratio nearly five times along with its impressive economic growth.

Of course, there are some periods in which countries experience stagnant or even decrease in educational development, such as during the Asian crisis in 1997 and the 1988 inflation which significantly lowered down the Chinese government financial supports for its higher education system impeding the education expansion in the late 1980s (Wang 2001).

The success of educational expansion is partly contributed by the role of government. In most East Asian countries, education systems are centralised,

[3] This paper does not discuss the education performances of Lao PDR and Myanmar. A further study needs to be conducted to explore this issue given that standard reasons are not applied. While their economic stages are not as impressive as other East Asian economies and the contributed government spending is relatively small, based on statistics these two economies perform very well in their educational sectors.

especially for primary and secondary education. Centralisation has successfully ensured the central government to impose equal standards of formal education including curriculum, administrative and financing system. As evidenced in China in 1970s, the massive expansion in education was primarily a result of educational restoration program initiated by the centralised leadership of Deng Xiaoping to assist his political and economic reform (Hayhoe 1989).

Similar to China, Indonesia traditionally adopted a fully centralised-education system. Compromising 17,500 islands with over 200 million populations, controlling the quality of the national education system was definitely problematic. But, under leadership of the President Suharto from 1967-1998, so called New Order, Indonesia reached outstanding education development. In 1973, Presidential instruction (INPRES) program was conducted to attain universal primary education. The goal was then completed in 1983, followed by the introduction of universal nine years basic education program in 1993.

Interestingly, despite its impressive development, the educational sector has been developed by using relatively small public spending compared to the total GDP. Between 1985 and 2006, the average contribution of government financial support was less than 5 % of total GDP, except for Malaysia which accounts 8 % in recent years (Table 2). This high government contribution might probably be the reason to why Malaysia has relatively high school enrolment and is at similar stage of education development with more developed countries like Hong Kong and Singapore.

Of course, there are also less optimistic views on the role of human capital in East Asia. Given no economy has a negative growth in secondary and tertiary enrolment rate, in the last fifteen years education in East Asia has been remarked by continuous expansion, but East Asian economic performances break into two phases: before and after the 1997 Asian crisis. In the period 1997-2000, there were significant decreases in GDP growth in some East Asian economies, especially Indonesia, Thailand, Korea and Macao China and moderate declines in economic growths of China, Hong Kong, Japan, Malaysia and Singapore. This structural break may be the main reason why the importance of education in East Asia is fully recognised, but its statistical relationship with economic growth is weakly correlated.

The insignificance of education impact on economic growth is also due to how economists vary in interpreting the most important factor of economic growth in East Asia. Emphasising the importance of association between structural change from agriculture to industry and services, one study also acknowledges the putative relationship between growth in education and economic, measured by GDP growth per capita and average schooling years, however it concludes that education in East Asia economies is necessary but not sufficient condition to maintain *sustained* growth (Rada and Taylor 2006).

Indeed, it is argued that despite outstanding economic growth during the 1990s, there is a decrease in productivity of schooling as a result of an increase in relative price of schooling and a decrease in student-teacher ratio (Gundlach and Wo[beta]mann 2001). This indirectly supports that East Asian economic growth has little connection to its human capital development. One possible reason is that resource allocation in schooling is not based on output-maximising principle as proposed by a positive theory of human capital (Pritchett and Filmer 1997). In a region like East Asia, in which most countries' educational systems are strictly ruled by the central governments, this argument seems to be relevant as education is considered as a public good with the government as the ultimate responsibility taker both for quality through curricula and public financing. This policy leaves the school with little incentive to stimulate their student's academic achievements and to manage their costs efficiently. Given the school's performance affects educational outcomes more rigorously than the government's curriculum, this circumstance can put pressure on East Asian economic growth.

The weak relationship between education and economic growth may also be due to the fact that education in East Asian can not be empirically evidenced as a productivity stimulant. Table 3 shows *unexpected* positive trends in shares of unemployment with tertiary degree in most East Asian economies. This fact returns us to the basic question on why students should undertake higher education. One possible 'easy' answer is because the higher education provides monetary benefit as those who hold higher degree can expect higher income (Kim 2002). But if the higher income is not based on higher productivity, this will imply that the role of education is actually only based on the traditional credence of the society. When all people believe it, the credence would be treated as the fact. Another possible answer is because education development in East Asia has been conducted to expand the quantity, rather than to improve the quality. It is commonly acknowledged that in the early stage of development the quantity of schooling is a more important policy concern than the quality, as evidenced in East Asia. It might be due to the nature of education as a public good, so the government is responsible to ensure all people have access to education.

Unfortunately, in East Asia this quantitative education expansion has commonly been accomplished by sacrificing the quality. Large and less effective classes and shortage of teachers combined who have limited skills and experience in dealing with heterogeneous students are some of the costs of high enrolment (Chang 1971). As a result, education is indeed a significant *income* determinant, but not necessarily a *productivity* determinant, as evidenced in Malaysia (Milanovic 2006), Korea (Jung 1992; Lee 2000; Zin 2005; Kwack and Lee 2006), and Vietnam (Kikuchi 2007).

As in other regions, there is a potential two-way causal relationship between education and economic growth in East Asia. There are at least two possible

channels how the economic growth in East Asia influences its education system. First, rapid economic growth between 1979 and 1994 increased demands for educated labour resulting massive expansion in school enrolment, which leads to an increase in competitiveness of educated worker in the labour marker resulting higher income and higher economic growth (Zin 2005).

Second, education systems in most East Asian economies are formed and expanded with close relation to their economic developments. Their close economic ties with the western countries lead to inevitable westernisation of their education systems due to essential needs to understand western knowledge to engage in Western-oriented international economic markets (Altbach 1989).

Nevertheless, to understand the role of education in economic growth requires analyses on individual country characteristics. This study therefore conducts cluster analysis to provide descriptive analysis on how countries vary and the impacts of some variables on their economic growths. Cluster analysis might be helpful because as the time changes, some countries may grow faster than others and finally 'join' the developed countries cluster. In other words, this analysis can be related to the issue of convergence, particularly to identify whether absolute convergence exists. The clusters show how the Asian countries are grouped by the characteristics of income level, population growth, investment share and human capital. To limit the analysis, this study focuses on the period of 1960-65, 1970-75, 1990-95 and 1996-2000. Figures 1 (i), (ii), (iii) and (iv) present the results in dendograms (cluster trees).

(i) The period 1960-65

In the period 1960-65, eight East Asian countries were likely to have more similar characteristics than in the period 1995-2000, suggested by lower dissimilarities measures (Figure 1 (i)). In this period, East Asian economies can be divided into three clusters, including Japan as the only member in the first cluster.

Japan performed as an outlier given its distinguished economic growth. Highest income per capita, highest shares of investment as percentage of GDP, highest average schooling years and lowest population growth were characterised this economy (Table 4). Earlier than the story of the 1990s Asian miracle, Japan had begun its hyper-growth trend in 1950s and 1960s allowing Japan to be the only Asian country that was able to compete with other industrialised western economies. Indeed, this strong ambition to survive in the world elite league had been reflected by its ambitious education expansion after the Meiji restoration in 1868 marking the commencement period of Japanese modern economic era (Godo and Hayami 2002). As a result, before the Karachi Plan was convened by UNESCO in 1960 in order to accomplish free and compulsory seven-year primary education by 1980 in fifteen Asian countries, Japan had achieved this goal (Duke 1966).

The second cluster was formed by Hong Kong and Singapore. The strong similarity between Hong Kong and Singapore can be seen by how their impressive economic growth had been well-known since the early days of British occupation in 1800s. Having strategic geographical positions provided them benefits as trading ports. While Hong Kong had been successfully transformed its economy from a traditional agriculture society into a modern international city (Shuyong 1997), Singapore had evidently gained from directive role of the government, in addition to its advantageous geographical position leading Singapore as the centre of trade (Morris 1996; Huff 1999). The two economies had then become two of the strongest economies in East Asia.

The third cluster consisted of other East Asian countries, namely Indonesia, Korea, Malaysia, Philippines, and Thailand. This cluster can be further classified into three sub-clusters. Indonesia and Thailand joined the same sub-cluster. In the period 1960-65, these two economies were ranked as countries with the lowest incomes per capita compared to other six economies. The other sub-cluster consisted of Korea, Malaysia and Philippines. One important note should be addressed to the economic performance of Philippines. It can be seen that in this period, this country was at a similar stage of economics as Malaysia and Korea, which then became strong economies within the region. Given that current Philippines economic performance is not too impressive, it might be noteworthy to analyse why the economy cannot develop as fast as Malaysia and Korea. One possible reason is due to Philippines' political turmoil.

(ii) The period 1970-75

Due to limited data availability of China, this study performs cluster analysis covering the period 1970-75. In general, there was no significant difference between the period 1960-65 and this period. China joined the second cluster initially formed by developing countries such as Indonesia, Korea, Malaysia, Philippines and Thailand. More specifically, characterised by similar stages of economic and big population, China was in the same sub-cluster as Indonesia in the period 1970-75. China and Indonesia were among countries with the lowest income per capita, being $1283 and $872 respectively, while the average of income per capita in the region was $4576.

There were also some other economies shifted from one sub-cluster to another sub-cluster joining economies which have more similar stage of economics with them. Experiencing rapid economic growth, Korea and Malaysia were in the same sub-cluster. Philippines and Thailand joined the same sub-cluster which were characterised by middle-lower income per capita, being $2644 and $1979 respectively.

Whilst there were not many shifts in the "economic power map" of East Asia, as a region, it was noticeable that there were significant increases in economic levels of East Asian economies compared to a decade ago. The shares of investment rose of around 7%. Average schooling years increased from 3.8

years to 4.6 years. In addition, lower population growth decreasing from 2.67% in the period 1960-65 to 2.20% was characterised the region along with increases in income per capita from $2721 in the period 1960-65 to $4576.

(iii) The period 1990-95

There was not any surprise in regard to clustering East Asian countries in the period 1990-95 compared to the preceding period. The formation of cluster has already been predicted since three decades ago. The catching-up of Singapore and Korea to Japan became more evident. Still in the same sub-cluster, Indonesia and China were also catching up to Philippines which initially had higher income per capita. Nevertheless, these three economies were still at the lowest ranks of income per capita. One significant shift was made by Korea which left Malaysia and Thailand behind.

In the period 1990-95, most economies were able to increase their incomes per capita more than two times than their incomes in the period 1970-75, except Japan and Philippines. While the increase was clearly significant, the source of growth was, interestingly, an ongoing debate. Descriptive analyses in Figure 3 indicate a positive relationship between increases in GDP per capita and increases in shares of investment and schooling years, whilst the association between GDP and population growth is less evident. Nevertheless, the population growth continued to fall from 2.20% in the period 1970-75 to 1.64%.

(iv) The period 1996-2000

In the period 1996-2000, eight East Asian countries seemed to have more various characteristics than the previous period indicated by higher dissimilarities measures. There was not any significant difference between cluster formation in this period and in the 1990-95. The only difference was Hong Kong was overtaking Japan as a country with the highest income per capita over the period by increasing its income per capita about 6.5 times its income level in 1960-65 (Table 4). Following the success of Hong Kong, Singapore and Korea have successfully increased their incomes per capita over 700% their incomes levels in 1960-65.

One potential explanation of this catching-up movement is the concept of convergence. Whilst Japan was approaching its steady state and consequently has lower growth rates, Hong Kong, Korea and Singapore were at a rapid pace stage moving towards their respective steady states. However, the concept of absolute convergence did not seem to be relevant to East Asian economies. In addition to increasing dissimilarities level as indicated by cluster analyses, Figure 4 shows that there is no indication that East Asian economies move toward the same level of income per capita. If absolute convergence existed, then the countries would consequently join in the same cluster.

In order to understand why some countries develop faster than other countries, one important issue is to identify whether the *changes* or the *level* of some

economic factors affect the development speed. To identify whether the changes affect the speed, descriptive analyses are conducted. Figures 2 (ii) and (iii) show that there is little indication that increases in schooling years and population growths are significantly associated with increases in income per capita. On the other hand, surprisingly, an increase in shares of capital is negatively associated with an increase in incomes per capita (Figure 2 (i)). This somehow reflects that countries with sound economic performances such as Japan, Hong Kong and Singapore already had high shares of investment in the period 1960s.

In contrast, countries which increased their shares above 100% i.e. Indonesia, Malaysia, Korea and Thailand are some of the countries which greatly impacted by the Asian crisis. This intuitively implies that to approach the steady state income level cannot necessarily be done by increasing shares of investment. Indeed, increasing the shares of over 100% may put economies in high-risks to be affected by financial or monetary crisis.

Comparing the results to previous comparisons between 1960-65 and 1990-2000 shows that the inclusion of period 1990-2000, in which financial crisis hit East Asia does affect the results. The significance of an increase in schooling years which is previously noted becomes less apparent. As well the positive affect of increases in investment on increases in income per capita is contradicted by the descriptive results with the inclusion of the period 1997 onwards.

In addition to being sensitive to structural break as impacted by the Asian crisis, more generally, it seems that the rate of changes cannot explain the sources of growth well, especially in the long-run analysis. A study argues that to capture the long-run effect, a study needs to focus on the *level* of income and human capital rather than the *rate of changes* in each (Bloom, Canning et al. 2000). Therefore, the next relevant issue is to explore whether statistical evidences using the level of related variables support this argument.

3. The Theoretical Baseline

In this chapter, the theoretical model, labour-augmenting Solow model with inclusion of human capital variables, is derived. Labour-augmenting is one of the ways in which an effectiveness variable could be included in a production function in a Solow model.

Let us consider the labour-augmented Solow model with a standard Cobb-Douglas production function. At time *t* and country *j* total output is given by *Y*:

$$(3.1)\ Y_{jt} = K_{jt}^{\alpha} H_{jt}^{\beta} (A_{jt} L_{jt})^{1-\alpha-\beta}$$

where α and β are the partial elasticities of output with respect to physical and human capital. *Y*, *K*, *H, L* and *A* are output, physical and human capital, labour, and labour-augmenting technological change respectively. Assuming $\alpha+\beta<1$ and $\alpha,\beta \geq 0$ implies decreasing returns to scale. We can rewrite the above equation in terms of per capita effective units:

$$(3.2)\ y_{jt} = A_{jt} k_{jt}^{\alpha} h_{jt}^{\beta}$$

where $y=Y/L$, $k=K/AL$ and $h=H/AL$. L and A are assumed to grow exogenously at rates *n* and *g* so that $L(t) = L(0)e^{nt}$ and $A(t) = A(0)e^{gt}$. The time path of *k* is described by:

$$(3.3)\ \dot{k}_{jt} = s_{jt}^{k} \frac{y_{jt}}{A_{jt}} - (n_{jt} + g + \delta^{k}) k_{jt}$$

where δ is the constant rate of depreciation. Setting $\dot{k} = 0$ in equation (2.3) implies that the economy converges to its steady state. The steady state value of *k* is defined by:

$$(3.4)\ k_{j}^{*} = \left(\left(\frac{s_{j}^{k}}{n_{j} + g + \delta^{k}} \right)^{1-\beta} \left(\frac{s_{j}^{h}}{n_{j} + g + \delta^{h}} \right)^{\beta} \right)^{\frac{1}{1-\alpha-\beta}}$$

Repeating the same steps for human capital variable, its steady state value is:

$$(3.5)\ h_{j}^{*} = \left(\left(\frac{s_{j}^{k}}{n_{j} + g + \delta^{k}} \right)^{\alpha} \left(\frac{s_{j}^{h}}{n_{j} + g + \delta^{h}} \right)^{1-\alpha} \right)^{\frac{1}{1-\alpha-\beta}}$$

Substituting equations (3.4) and (3.5) back to equation (3.2) then taking natural logarithms form and setting $\delta^{h}=\delta^{k}$, the following is the restricted equation:

$$(3.6)\ \ln y_{j}^{*} = \ln A_{j} + gt + \frac{\alpha}{1-\alpha-\beta}\left(\ln s_{j}^{k} - \ln(n_{j} + g + \delta)\right) + \frac{\beta}{1-\alpha-\beta}\left(\ln s_{j}^{h} - \ln(n_{j} + g + \delta)\right)$$

As the rate of convergence is not strictly constant, the above model can be approximated by a partial adjustment model. Let $\hat{y}^{*}$ be the steady state level of income per *effective* worker and $\hat{y}_{t}$ be its actual value at any time *t*. Approximating around the steady state, the speed of convergence is given by: $\frac{\partial \ln \hat{y}(t)}{\partial t} = \lambda[\ln(\hat{y}^{*}) - \ln \hat{y}(t)]$. The parameter λ is the rate at which an economy goes approximately half-way from the actual to the steady state value and equal

to $(n_j+g+\delta)(1-\alpha-\beta)$[4]. To simplify the notation, we denote $e^{-\lambda\tau}=\gamma$, where τ is the time interval. The restricted theoretical model can be therefore simplified into:

(3.7)

$$\ln y_t = \gamma \ln y_{t-1} + (1-\gamma)\frac{\alpha}{1-\alpha-\beta}\left(\ln s_j^k - \ln(n_j + g + \delta)\right) + (1-\gamma)\frac{\beta}{1-\alpha-\beta}\left(\ln s_j^h - \ln(n_j + g + \delta)\right) + (1-\gamma)\ln A_j + g(t-\gamma(t-1))$$

The theoretical model above shows that the actual income per worker is influenced by income in previous period, population growth, share of human capital and (physical) capital, technology, and time effect.

The discussion in the next section concentrates on the issues related to a human capital variable and a coefficient γ that is needed to test the hypothesis about convergence. If γ is less than one (in addition to it must be a positive value), we have enough evidences of convergence. It should be pointed out that the convergence derived from the above theoretical model is conditional convergence, also known as beta convergence.

In contrast, to test the absolute convergence or sigma convergence, one only needs to see whether the standard deviation of the log of income decrease over time. These two concepts of convergence were initially investigated by (Barro and Sala-i-Martin 1992). They define sigma convergence exists when the dispersion of real per capita income across groups of economies decreases over time, while beta convergence means that there is a negative relationship between the growth rate of income per capita and the initial level of income.

4. Empirical Evidences on Education

4.1. Data and Methodology

To implement the panel data analysis, the theoretical Solow growth model in (3.7) is transformed into the following econometric model:

$$y_{jt} = \gamma y_{j\,t-1} + \sum_{i=1}^{3} \theta_i x_{jt}^i + \mu_j + \eta_t + u_{jt} \qquad (4.1)$$

for country j =1,…, N, over t=1,…, T period.

Here y_{jt} is the logarithm of real GDP per capita; $x_{jt}^1 = \ln(n_j + g + \delta) \equiv \ln(n_{jt}+0.05)$ where n_{jt} is the population growth; $x_{jt}^2 = \ln s_{jt}^k$ is natural logarithm of share of investment (including government) of real GDP (%); $x_{jt}^3 = \ln s_{jt}^h$ is natural logarithm of average schooling years in

[4] This equation is obtained by using Taylor approximation of actual income per effective worker around its steady state values.

the total population over age 25; $\mu_j = (1-\gamma)\ln A_j$ is time-invariant country effect; $\eta_t = g(t-\gamma(t-1))$ is the unobservable time effect; and u_{jt} is white noise.

The model contains 3 exogenous variables: the share of investment (including government) of real GDP, the population growth, and the real GDP per capita. Data are taken from (Heston, Summers et al. October 2002).[5] Average schooling years in the total population over age 25 data are taken from (Barro and Lee 2000).

Data are averaged over 5-year periods term from 1965-2000. This study covers longer period then the previous study by Islam (1995), which covers the period 1965-1980. Hence, we have eight five-year data (time) points for each country (balanced panel). So when t =1970, for example, then $t-1$ =1965. This method can be used to overcome problems from limited source of data, to reduce serial correlation, to reduce business cycle fluctuations influence and to accommodate convergence analyses given that yearly time spans are too short (Islam 1995).

There are nine East Asian countries included in analyses: Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and China. But, as schooling data in 1960-70 for China are not available, analyses which include China only cover the period 1975-95.

By definition the individual effect $(1-\gamma)\ln A_j$ reflects not only technology but also resource endowments, climate and institutions (Mankiw, Romer et al. 1992). Hence, it is reasonable to assume that this term is correlated with the exogenous variables included in the model, investment, population growth and schooling years. There are at least two alternative estimators can be applied: fixed effects and first differencing. A similar study to this paper by Islam (1995) applies fixed effects panel analysis or LSDV (least square dummy variables).

However, fixed effects and first differencing are inconsistent if an explanatory variable in some time period is correlated with the error term. This problem might appear in the econometric model in equation (4.1) because it has a lagged dependant variable as one of the exogenous variables. Furthermore, there is a tendency that investment shares are correlated with schooling years. For example, high investment might probably be found in an economy whose labour force has good educational background. One way to consistently estimate the model specification is by using instrumental variable methods in

[5] This dataset uses 1996 as the base year. Variables *y* and *n* refer to variables *rgdpl* (real GDP per capita (constant price= laspeyres)) and *grpop* respectively. Variable *sk* refers to the sum of *ki* (investment share of *rgdp*l) and *kg* (government share of *rgdpl*). Both variables are in percentages.

both first differencing and fixed effects. This study therefore uses instrumental variable method in fixed effect.[6] Table 6 reports the results of this analysis.

Variables are expressed in natural logarithm so that the estimated coefficients can be interpreted as measures of the percentage of change in GDP per capita associated with a unit change in each explanatory variable. Given that all explanatory variables are also expressed in natural logarithm, a unit change also implies one percent change in each explanatory variable. The logarithm transformation is also an alternative way to standardise data given that all variables have different unit of measurement.

4.2. Results and Discussions

4.2.1 What are significant growth factors in East Asia?

Column (1) in Table 6 reports the importance of investment shares and schooling years in predicting East Asian economic growth. One percent increase in average schooling years is associated with 27.1% increase in GDP per capita. The implied elasticity of output with respect to human capital is 0.201. Its significance shows that economic growth is associated with the level of education expansion, instead of its increases or changes. This is as predicted descriptively in the previous section. The significance of education outperforms the importance of (physical) capital, as measured by investment shares of GDP. The implied elasticity of output with respect to physical capital is only 0.058. One percent increase in investment shares of GDP is associated with 7.8% increases in GDP per capita.

To see how East Asian's position at the international level, this study compares its results to empirical results derived by Islam (1995) who covers the period 1960-1985 and divides the data into three sub-groups, namely INTER (international) with all countries includes, NON-OIL and OECD countries. Table 7 presents the comparison. Human capital coefficients in Islam's model from all sub-groups appear with unexpected signs (negative) and are statistically insignificant. The consequence is the implied elasticities of output with respect to human capital are negative. The results violate an assumption in theory that both elasticities are non-negative numbers, $\alpha, \beta \geq 0$.

First concern is then addressed to the results sensitivity to sample or period selection. This paper then limits the period to 1965-85. The results are relatively similar to Islam's. The output elasticity to human capital is negative. This obviously contradicts the results when data from 1980s to 2000 are included, in which education provides higher contribution to the economic growth than investment.

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[6] The t-test to evaluate ρ in $\hat{u}_{j,t} = \rho \hat{u}_{j,t-1} + \varepsilon_t$ concludes that there is not enough evidence to reject the null hypothesis at 1% level of significance i.e. there is no autocorrelation among the disturbances.

In addition, looking at the contribution of investment shares suggests that between 1960s and 1980s investment played a more significant role in boosting economic growth than in recent years. This is probably due to the Asian crisis in which the excessive investment inflow to East Asian economies could indeed severely attack their economic stability.

Furthermore, Table 7 also shows investment is somewhat more important for East Asian countries than OECD countries during the period 1960s-90s, but it is less important than investment for NON-OIL countries and the world average (INTER) . While variables presented in this study cannot capture the quality of institutional policy, such as governance, law enforcement, ease at doing business, etc, the results contradict a current study which reports that the productivity of any given level of investment is greater in countries with better institutions (Gwartney, Holcombe et al. 2006). However, looking at results from recent years suggests that the significance of investment in that period might only be due to "temporary euphoria" which is least related to the building of institutional capacity of East Asian economies. Therefore, there is not enough evidence to conclude that investment can indeed be important factor of *sustainable* growth. On the other hand, education seems to show a promising trend as a significant growth factor.

The results also suggest that the inclusion of human capital lowers the magnitude of investment in predicting economic growth. Table 8 shows the comparison. Without human capital variable, the elasticity of output with respect to capital greatly increases from 0.058 to 0.625. This accentuates the necessity of including human capital variable in order to avoid misspecification biases.

4.2.2 Does convergence exist?

The results show that there is convergence in East Asian economies. The implied rate of convergence based on 1965-2000 data is 3.9%. Comparing the result to OECD countries, the rate of convergence of OECD countries (λ_{OECD}=9.1%) is over two times faster than the rate of Asian countries with the inclusion of human capital variable. This suggests that the difference between the steady state level of GDP per capita for each East Asian economy and its actual income per capita is going to be halved in about 18 years (t = - ln 2 / ln λ_{ASIAN}) and about 8 years for OECD countries.

In a study about OECD countries, Islam (1995) omits human capital as one of the exogenous variable. Then, the difference is going to be halved in about 20 years. It is almost three times longer than the periods to half-way converge implied by model with human capital. Without the inclusion of human capital as the explanatory variable, the OECD countries rate of convergence is within

the interval that was specified by (Lee, Longmire et al. 1998), 2% - 4%, for OECD countries. Similar results are found by this study.[7]

By omitting human capital variable, the evidence shows that the difference between the steady state level of GDP per capita for each economy and its current income per capita is going to be halved in about 64 years, or over three times longer than the periods to half-way converge implied by model with human capital (Table 8). The model derives the rate of convergence is 1.1%. This emphasises the importance of human capital.

However, the results are sensitively impacted by period selection. Table 9 presents the comparison. Compared to the period 1960s-1990s, the rate of convergence derived from more recent data is indeed lower. It is predicted by 1965-1985 data that the rate of convergence is 5.3%, while recent data using instrumental fixed effects method yields 3.9% rate. The same finding is derived by using different panel methods. This supports the argument that the rate of convergence is not strictly constant (Lee, Longmire et al. 1998). The rate is related to what the economies achieve in the process of reaching their respective steady state levels. As the economies can fluctuate any time, the rate can too.

To see whether the results are sensitively impacted by country selection, Table 6 shows the comparison when an economy is excluded. In general, there is not much variation. Focusing on the rate of convergence, the average rate is 3.8% or about the same as all-sample results, with the standard error 0.004. The conditional or beta convergence as shown in Figure 5 also does not show any indication that the convergence is either related to the economic-level of an economy being excluded from the samples, or increases in GDP achieved by the excluded economy.

As predicted by previous cluster analyses, Figure 6 shows that there is no indication that the absolute or sigma convergence in East Asia exists. It is not evident that the variation of income per capita as measured by standard deviation of (logarithm) GDP per capita decreases over time.

4.2.3 Further discussion

While useful, empirical works may suffer from some limitation. Hence, finding significant statistical coefficients on human capital should be followed up by careful interpretation. One critical issue is that schooling years as proxies for human capital ignore the quality aspect of schooling. Schooling years also

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[7] Without human capital variable, the theoretical model in (3.7) becomes:

$$\ln y_t = \gamma \ln y_{t-1} - (1-\gamma)\frac{\alpha}{1-\alpha}\ln(\mathrm{n_j} + \mathrm{g} + \delta) + (1-\gamma)\frac{\alpha}{1-\alpha}\ln \mathrm{s_j^k} + (1-\gamma)\ln A_j + g(t-\gamma(t-1))$$

Imposing restrictions on coefficient that $ln(n_j+g+\delta)$ is equal to coefficient of $ln\, s_j^k$ allows a unique estimated value of λ as well as the output elasticity parameter, α.

overstate growth in human capital with low initial levels of education (Collins, Bosworth et al. 1996). This argument can be seen by comparing between this paper results and researches on OECD countries. While studies on OECD countries – countries with high initial levels of education – which finds no evidence for relationship between initial schooling level and economic growth (Islam 1995; Krueger and Lindahl 2000), this paper argues the significance of human capital in East Asian region. Unfortunately, due to limited data availability, many researches including this study still use the schooling years data which are relatively more complete than other human capital data.

One critical issue should also be addressed to how education can stimulate productivity. As this study has shown its direct significance of human capital on economic growth, another possible channel of how education might affect productivity is when education can stimulate an increase in innovation and technological progress. This is related to the concept of TFP and often causes vagueness on how human capital is being modelled in the growth model. It is suggested that a simple illustration to distinguish between human capital and technological progress is while human capital can be measured by the cumulative effect of formal education, technological progress is the number of new designs as a result of knowledge from the education (Romer 1990).

While the concept is important, it is not easy to measure technological progress. One common method used by economists is by measuring the error term. However, this can overestimate the magnitude of TFP as the error term not only contains TFP but also white noises. Fortunately, one advantage of applying panel analysis as used in this study is a possibility of measuring country-specific effects as formulated by the econometric model in equation (4.1).

Table 10 presents the estimated country effects. The pattern is obvious. Countries with high income per capita tend to have high level of TFP, such as Japan, Hong Kong, Singapore and Korea. Comparing the results from periods 1965-2000 and 1975-95 suggests that there is no significant change in ranking. This is probably related to why the relative economic position of each East Asian economy is relatively stable over the periods.

To see whether the level of *A(0)* is correlated with the average schooling years, a pooled regression analysis is applied. The regression has the following results:[8]

Ln A(0)	=	26.83736***	+	7.369 lns^h ***
		(1.151)		(0.679)
N=69	F(1,67) = 117.71		(Adj)R^2=0.6319	

The significance of education on *A(0)* supports the possibility of second channel of how education can affect growths i.e. by stimulating technological

[8] *** denotes significant at 1%.

progress. Hence, the results from this study not only point out that education has an important direct role in production function but also indirect role by boosting technological progress. This is different from results derived by Islam (1995) who only validates the role of education to fuel the technological progress.

However, regardless whether or not education is significant on economic growth, interestingly, none of the researches concluding insignificant effects of education on the economic growth concludes education is not an important factor in economic at the end. Only few studies provide extreme view on how education can indeed become an obstacle in development (Hanf, Ammann et al. 1975). Most scholars maintain the traditional belief which is more like a doctrine that education is one important factor behind economic growth. As they are not supported by robust empirical evidences, they propose some conditions of the key success of education as a significant source of growth.

In summary, education can only be significant on the economic growth if it can: (1)Stimulate innovation to differ between innovators and imitators (Nelson and Phelps 1966); (2) Develop profit-maximising incentives of the workers (Romer 1990); (3) Be accessible for all population, especially primary and secondary education to achieve income equality and hence social cohesion (World Bank 1993); (4) Be accompanied by complementary capital investments as when investment occurs in only one input, the production function might be zero and even create loss (Hanf, Ammann et al. 1975). Combining these all prerequisites together yields an extremely difficult challenge for any economy, especially low-income economies. The government must conduct universal education with a high quality. Then, it is questioned whether the government should prioritise quantity over quality aspects to reach social cohesion, or quality over quantity aspects to specialise in producing innovative qualified graduates.[9]

5. Concluding Remarks

Based on data from 1965 to 2000, while the region successfully increases its average income per capita of about 500%, this paper finds that there has been very small variation in the distribution of economic power in the East Asian region. What is noticeable is only the catching up of some economies such as Singapore, Hong Kong and Korea to Japan. The rest remain the same. While the role of education becomes more evident in recent years than in the earlier periods and at the same time the role of investment becomes less important, education-driven economic development seems to be an incomplete and insufficient development policy without enforcing what types of education can

[9] The author is currently engaged in a research which provides individual country analyses on how East Asian economies deal with this dilemma in addition to discussions on decentralisation in education and its impacts on the role of education in economic growth. The paper is currently under revision for publication and expected to published by the end of 2008.

really boost economic performances. But in general, education seems to have a good opportunity as a sustainable solution to poverty as it is not only able to increase productivity but also stimulate technological innovation.

This study finds statistical evidences on the existence of conditional convergence. No evidence is found to support the absolute convergence. Nevertheless, the rate should be interpreted carefully as it is sensitively impacted by the period selection. For policy makers, this indication recommends them to neither overestimate nor underestimate their current economic performances as the rate can be altered.

Referring to the concept of steady state level, it seems that the concept should not be termed as "the final goal" of an economy. Given that in these days most countries are inter related due to globalisation, fluctuation, in contrast to steady state level, in investment, education level, labour force is unlikely to be avoided. If this is the case, an attempt to reach convergence can actually be interpreted as an attempt to reach economic stability. Given the current nature of international economy, this can only be achieved by international cooperation which also includes security, food and other basic needs supply stability. Once these requisites are met, economies can then set a steady state economy as their sustainable development policy.

There have been growing interests among economists especially ecological economists on interpreting the implication of and what steady state economies mean. One important implication is such economies allow usage of natural resources exactly at the amount of human being need. This is motivated by the economics concept of the steady state value which defines the condition when income per capita grows at the rate to compensate combined rates of population growth, technological progress and depreciation. As a result, concerns on development could be then focused on how to develop human capital which can stimulate technological innovation without relatively exploiting the resources.

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Table 1. School Enrollment (% Gross)[1]

Country	Primary			Secondary			Tertiary		
	1985-1996	1997-2000	2001-2006	1985-1996	1997-2000	2001-2006	1985-1996	1997-2000	2001-2006
Brunei Darussalam	113.8	112.7	108.1	76.5	84.1	91.6	---	11.4	14.4
Cambodia	86.7	99.5	131.1	29.0	16.9	23.8	0.7	2.2	2.8
China	125.2	---	116.6	48.7	62.3	68.8	3.0	7.0	14.2
Hong Kong	102.4	103.9	108.4	79.6	---	83.5	---	---	30.7
Indonesia	114.2	110.9	115.4	45.5	54.9	60.4	9.2	---	15.6
Japan	99.7	101.3	100.6	97.1	101.9	102.2	29.6	45.4	51.4
Lao PDR	104.9	95.8	103.2	89.8	99.9	91.9	38.6	69.0	85.4
Malaysia	98.6	101.3	104.7	65.1	77.3	91.0	25.4	27.0	63.9
Myanmar	95.4	98.3	94.0	57.1	69.3	71.9	8.2	24.0	29.1
Philippines	107.2	88.6	93.2	22.3	36.0	38.9	4.3	8.4	11.3
Singapore	109.5	112.7	112.4	70.7	75.8	82.2	27.1	28.0	29.8
Thailand	103.4	---	---	67.1	---	---	20.5	---	---
Vietnam	98.1	93.1	97.9	30.7	---	79.4	---	33.4	40.2
Average	104.55	101.65	107.13	59.94	67.84	73.80	16.66	25.58	32.40
Standard deviation	9.77	7.93	10.78	23.63	26.70	23.10	13.21	20.38	24.31

Source: World Development Indicator Online (2007); averaged by author.

[1] Enrolments may be over 100% of the age group because of students repeating years study plus other over age students.

Table 2. GDP, GDP Growth and Public Spending on Education

Country	GDP (Constant 2000 US$; '000 000)			GDP Growth per Capita (%)			Public Spending on Education (% GDP)		
	1985-1996	1997-2000	2001-2006	1985-1996	1997-2000	2001-2006	1985-1996	1997-2000	2001-2006
Brunei Darussalam	3817	4217	4650	-1.9	-1.2	0.5	3.5	4.4	---
Cambodia	2469	3219	4661	4.1	5.5	7.0	---	1.3	1.8
China	528460	1071195	1575324	8.9	7.3	8.8	2.2	1.9	---
Hong Kong	114178	156470	184605	4.2	2.5	3.5	2.8	---	4.2
Indonesia	117316	164494	188384	5.4	-2.0	3.3	1.0	1.4	1.1
Japan	3997790	4575273	4791428	2.9	0.4	1.3	---	3.5	3.6
Korea, Rep.	300337	469133	587422	7.4	3.1	4.0	3.8	3.8	4.4
Lao PDR	997	1593	2076	2.8	3.5	3.8	---	1.2	2.3
Malaysia	50383	83961	100822	4.8	1.3	2.5	5.1	5.9	8.0
Myanmar	---	---	---	0.6	6.6	7.8	---	0.6	1.3
Philippines	54545	71145	84792	0.4	1.4	2.6	3.0	3.9	3.2
Singapore	48035	83835	99918	5.1	3.7	2.4	3.1	---	3.7
Thailand	83954	119350	141120	7.3	-1.7	4.1	3.1	5.0	4.6
Vietnam	16520	28642	38653	4.3	4.9	6.3	1.8	---	---

Source: World Development Indicator Online (2007), averaged by author.

Table 3. Unemployment with Education (% Total Employment)

Country	Primary			Secondary			Tertiary		
	1985-1996	1997-2000	2001-2006	1985-1996	1997-2000	2001-2006	1985-1996	1997-2000	2001-2006
Brunei Darussalam	---	---	85.1	---	---	3.6	---	---	6.7
Hong Kong	50.8	47.2	47.6	36.9	41.0	40.1	9.7	9.9	10.6
Indonesia	37.6	39.0	46.0	48.2	47.7	36.6	9.3	8.6	6.7
Japan	29.7	23.3	54.4	50.9	51.6	53.4	19.3	24.8	27.7
Macao, China	24.5	25.7	16.3	51.9	52.8	53.2	23.6	21.5	30.4
Myanmar	64.6	64.9	65.3	9.1	12.2	14.4	4.1	7.2	6.7
Philippines	47.3	41.4	34.2	43.5	46.1	48.7	4.5	9.0	13.6
Vietnam	35.8	26.9	24.4	25.3	26.8	26.0	19.7	29.8	35.1

Source: World Development Indicator Online (2007), averaged by author.

Table 4. Country Characteristics (Comparison between 1960-65 and 1996-2000 periods)

Country	Share of investment (incl. government) of real GDP (%)			Average schooling years in the total population over age 25			Real GDP per capita (Constant US$)			Population growth (%)		
	1960-1965	1996-2000	Increase[1]	1960-1965	1996-2000	Increase[2]	1960-1965	1996-2000	Increase[3]	1960-1965	1996-2000	Increase[4]
Hong Kong	37.22	32.72	0.88	4.90	9.47	1.93	3955.51	25645.50	6.48	3.73	1.98	0.53
Indonesia	20.76	32.67	1.57	1.36	4.71	3.46	940.02	3713.53	3.95	2.14	1.63	0.76
Japan	43.44	37.49	0.86	7.22	9.72	1.35	6066.10	24268.57	4.00	0.99	0.21	0.22
Korea	25.11	38.26	1.52	4.43	10.46	2.36	1725.99	14647.25	8.49	2.64	0.95	0.36
Malaysia	29.41	45.31	1.54	2.67	7.88	2.95	2367.39	9489.49	4.01	3.09	2.43	0.78
Philippines	28.18	31.82	1.13	4.08	7.62	1.87	2143.82	3291.52	1.54	3.01	1.46	0.49
Singapore	34.41	10.27	0.30	3.29	8.12	2.47	3320.83	24938.85	7.51	2.73	2.61	0.96
Thailand	36.21	40.66	1.12	3.15	6.10	1.94	1255.74	6751.74	5.38	2.99	0.44	0.15
Average	31.84	33.65	1.12	3.89	8.01	2.29	2721.93	14093.31	5.17	2.67	1.46	0.53
Std. Error	7.33	10.51	0.44	1.74	1.92	0.67	1683.56	9669.05	2.26	0.81	0.88	0.29

Sources: Heston, Summers et.al (2002) and Barro and Lee (2000); averaged and calculated by authors.

[1] Shares of investment in 1960-65 – 1995-2000 ratio.
[2] Average schooling years in the total population over age 25 in 1960-65 – 1995-2000 ratio.
[3] Real GDP per capita (constant US$) in 1960-65 – 1995-2000 ratio.
[4] Population growth in 1960-65 – 1995-2000 ratio.

Table 5. Country Characteristics (Comparisons between 1970-75 and 1990-95 periods)

Country	Share of investment (incl. government) of real GDP (%)			Average schooling years in the total population over age 25			Real GDP per capita (Constant US$)			Population growth (%)		
	1970-75	1990-95	Increase[1]	1970-75	1990-95	Increase[2]	1970-75	1990-95	Increase[3]	1970-75	1990-95	Increase[4]
Hong Kong	29.08	31.11	1.07	5.66	9.33	1.65	7882.14	24087.80	3.06	0.02	0.02	0.76
Indonesia	25.84	40.32	1.56	2.47	4.03	1.63	1283.35	3342.83	2.60	0.02	0.02	0.70
Japan	47.04	38.28	0.81	7.36	9.44	1.28	12769.16	22988.87	1.80	0.01	0.00	0.22
Korea	31.96	46.49	1.45	5.77	10.09	1.75	3326.16	11981.60	3.60	0.02	0.01	0.56
Malaysia	35.56	46.76	1.31	3.70	7.65	2.07	3388.88	7714.09	2.28	0.02	0.02	1.02
Philippines	32.32	31.55	0.98	5.46	7.33	1.34	2644.22	2940.54	1.11	0.03	0.02	0.84
Singapore	58.97	49.09	0.83	4.34	7.82	1.80	7043.22	20360.61	2.89	0.02	0.03	1.68
Thailand	45.18	53.97	1.19	3.55	5.73	1.61	1979.15	5906.57	2.98	0.03	0.01	0.45
China	38.91	46.62	1.20	3.40	5.48	1.61	872.41	2419.85	2.77	0.02	0.01	0.52
Average	38.32	42.69	1.16	4.63	7.43	1.64	4576.52	11304.75	2.57	0.02	0.02	0.75
Std. Error	10.46	7.89	0.26	1.53	2.04	0.23	3907.53	8921.31	0.74	0.00	0.01	0.42

Sources: Heston, Summers et.al (2002) and Barro and Lee (2000); averaged and calculated by authors.

[1] Shares of investment in 1970-75 – 1990-95 ratio.
[2] Average schooling years in the total population over age 25 in 1970-75 – 1990-95 ratio.
[3] Real GDP per capita (constant US$) in 1970-75 – 1990-95 ratio.
[4] Population growth in 1970-75 – 1990-95 ratio.

Table 6. Panel estimation[1]

Ln y_t	Full sample	Excluding Hong Kong	Excluding Indonesia	Excluding Japan	Excluding Korea	Excluding Malaysia	Excluding Philippines	Excluding Singapore	Excluding Thailand	Excluding China	Excluding HongKong,Japan, Singapore
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$ln\ y_{t-1}$	0.781***	0.798***	0.790***	0.807***	0.764***	0.804***	0.787***	0.739***	0.769***	0.777***	0.616***
	(0.073)	(0.084)	(0.071)	(0.071)	(0.067)	(0.081)	(0.076)	(0.076)	(0.073)	(0.074)	(0.102)
$ln\ s^k - ln(n+g+\delta)$	0.078**	0.083**	0.062	0.075**	0.068*	0.078*	0.071*	0.397**	0.069*	0.075*	0.406***
	(0.039)	(0.041)	(0.042)	(0.038)	(0.041)	(0.041)	(0.039)	(0.080)	(0.040)	(0.040)	(0.092)
$ln\ s^h - ln(n+g+\delta)$	0.271**	0.250*	0.254**	0.252**	0.291**	0.229	0.274**	0.191	0.291**	0.277**	0.366**
	(0.126)	(0.140)	(0.124)	(0.121)	(0.115)	(0.148)	(0.131)	(0.139)	(0.131)	(0.128)	(0.157)
Constant	0.372	0.273	0.490	0.258	0.500	0.369	0.390	-0.973**	0.455	0.413	-0.882*
	(0.302)	(0.337)	(0.329)	(0.291)	(0.338)	(0.314)	(0.295	(0.431)	(0.309)	(0.308)	(0.459)
Implied coefficients											
β	0.201	0.188	0.193	0.190	0.214	0.175	0.204	0.120	0.214	0.205	0.206
α	0.058	0.062	0.047	0.057	0.050	0.059	0.053	0.250	0.051	0.056	0.229
λ	0.039	0.035	0.037	0.034	0.042	0.034	0.037	0.047	0.041	0.037	0.078
Cor (u_i, Xb)	0.558	0.502	0.558	0.586	0.590	0.588	0.585	0.607	0.553	0.517	0.268
R^2											
R^2 Within	0.750	0.980	0.982	0.985	0.978	0.980	0.984	0.988	0.981	0.982	0.986
R^2 Between	0.641	0.980	0.981	0.982	0.979	0.985	0.990	0.979	0.979	0.975	0.902
R^2 Overall	0.714	0.976	0.972	0.976	0.974	0.979	0.984	0.975	0.973	0.973	0.945
No.countries	9	8	8	8	8	8	8	8	8	8	6

* significant at 10%; ** significant at 5%; *** significant at 1%

[1] Method: (restricted) instrumental variable in fixed effect. Variable ln y_{t-1} is instrumented by using variables ln s^k_{t-1} , ln $s^h_{t-1}$and ln y_{t-2}

Table 7. Comparison between Estimation of East Asian and other sub-groups

Dependent Var : ln y_t	Nine East Asian countries		Comparative study*		
			International (countries)	Non-Oil countries (countries)	OECD countries
Data Span	1965-1985	1965-2000	1960-1985	1960-1985	1960-1985
Estimation Method	IV-fixed effects	IV-fixed effects	LSDV	LSDV	LSDV
Elasticity of output with respect to human capital (β)	-0.067	0.201	-0.0069	-0.1990	- 0.045
Elasticity of output with respect to capital (α)	0.342	0.058	0.4947	0.5224	0.2074
Rate of convergence (λ)	0.053	0.039	0.0440	0.0375	0.0913

*Islam (1995)

Table 8. Comparison between Model With and Without Human Capital[1]

Dependent Var: ln y_t	Human Capital	
	With	Without
$ln\ y_{t-1}$	0.781***	0.933***
	(0.073)	(0.022)
$ln\ s^k - ln(n+g+\delta)$	0.078**	0.111**
	(0.039)	(0.039)
$ln\ s^h - ln(n+g+\delta)$	0.271**	---
	(0.126)	
Constant	0.372	0.085
	(0.302)	(0.299)
Implied coefficients		
β	0.201	---
α	0.058	0.625
λ	0.039	0.011
Cor (u_i, Xb)	0.558	0.581
R^2		
R^2 Within	0.750	0.978
R^2 Between	0.641	0.993
R^2 Overall	0.714	0.987
Time to converge (years)	18	64

* significant at 10%; ** significant at 5%; *** significant at 1%

] Method: (restricted) instrumental variable in fixed effect. Variable ln y_{t-1} is instrumented by using variables ln s^k_{t-1} , ln $s^h_{t-1}$and ln y_{t-2}

Table 9. Comparison of Panel estimation

Ln y_t	Pooled regression		Fixed effects		Instrumental fixed effects[1]	
	1965-2000	1965-1985	1965-2000	1965-1985	1965-2000	1965-1985
	(1)	(2)	(3)	(4)	(5)	(6)
ln y_{t-1}	0.637***	0.471***	0.230***	0.191***	0.781***	0.826***
	(0.066)	(0.086)	(0.052)	(0.064)	(0.073)	(0.082)
ln s^k - *ln*($n+g+\delta$)	0.227	0.587**	0.047	0.566*	0.078**	0.473***
	(0.158)	(0.250)	(0.108)	(0.326)	(0.039)	(0.128)
ln s^h - *ln*($n+g+\delta$)	0.672***	0.743***	1.260***	0.914**	0.271**	-0.093
	(0.134)	(0.185)	(0.103)	(0.258)	(0.126)	(0.180)
Constant	-1.181	-2.373	0.806	-0.681	0.372	-0.931
	(0.978)	(1.413)	(0.717)	(1.509)	(0.302)	(0.611)
Implied coefficients						
β	0.354	0.319	0.546	0.368	0.201	-0.067
α	0.120	0.252	0.020	0.228	0.058	0.342
λ	0.056	0.188	0.193	0.352	0.039	0.053
R^2						
R^2 Within	---	---	0.880	0.750	0.982	0.975
R^2 Between	---	---	0.668	0.641	0.981	0.978
R^2 Overall	0.834	0.752	0.747	0.714	0.976	0.972

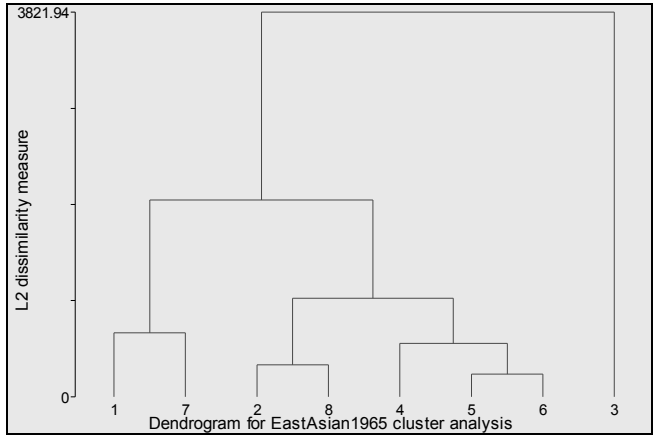
* significant at 10%; ** significant at 5%; *** significant at 1%

[1] Imposed restriction: ln s^k = - ln ($n+g+\delta$); Variable ln y_{t-1} is instrumented by using variables ln s^k_{t-1} and ln y_{t-2}

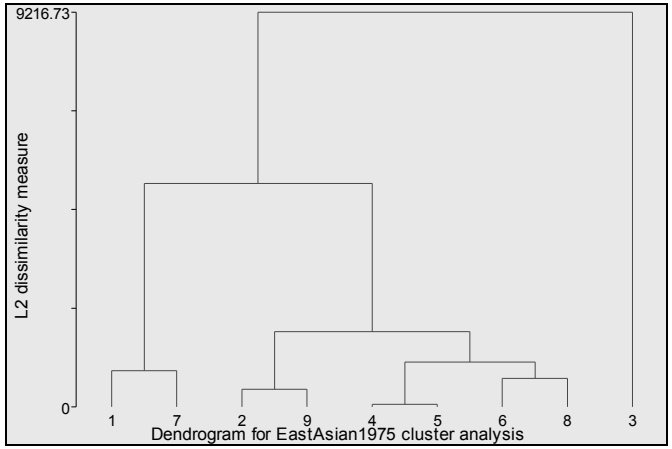
Table 10. Estimated Country Effects

Country	Full period 1965-2000 (1)		The period 1975-95 (2)	
	Ln A(0)	Rank	Ln A(0)	Rank
Hong Kong	41.734	2	42.774	2
Indonesia	35.116	7	35.082	8
Japan	43.554	1	44.356	1
Korea	40.527	4	39.967	4
Malaysia	39.339	5	38.909	5
Philippines	37.182	8	37.699	6
Singapore	41.139	3	41.833	3
Thailand	37.238	6	37.151	7
China	---	---	34.539	9

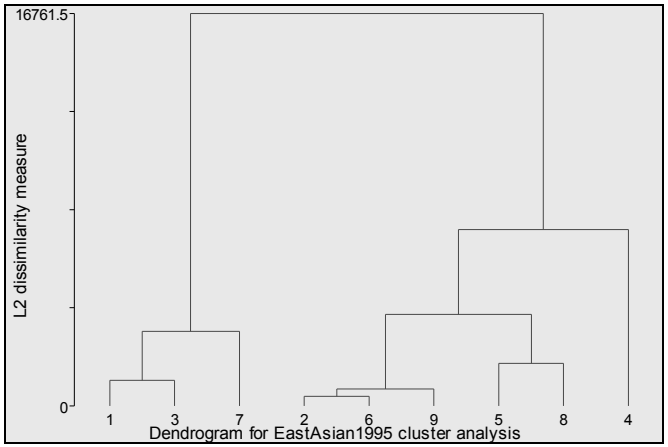
Figure 1. Dissimilarities of East Asian Countries[1]



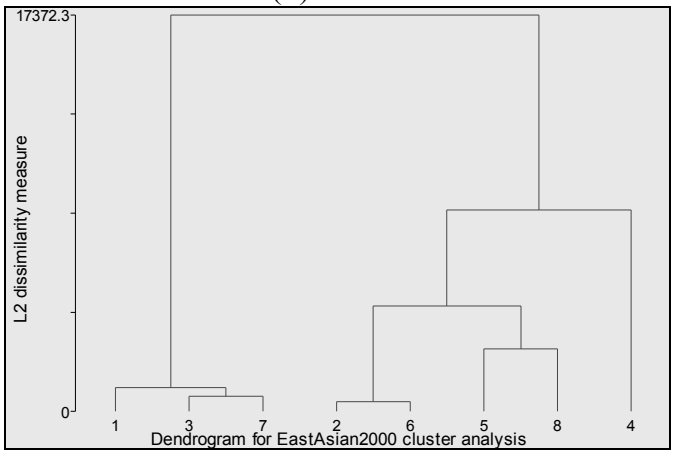
(i) 1965



(ii) 1975



(iii) 1995

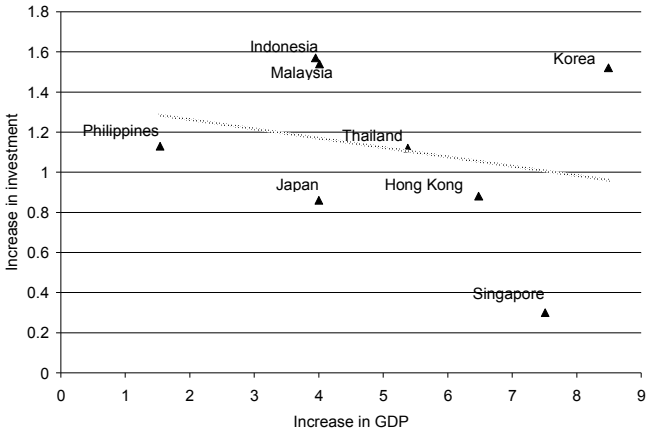


(iv) 2000

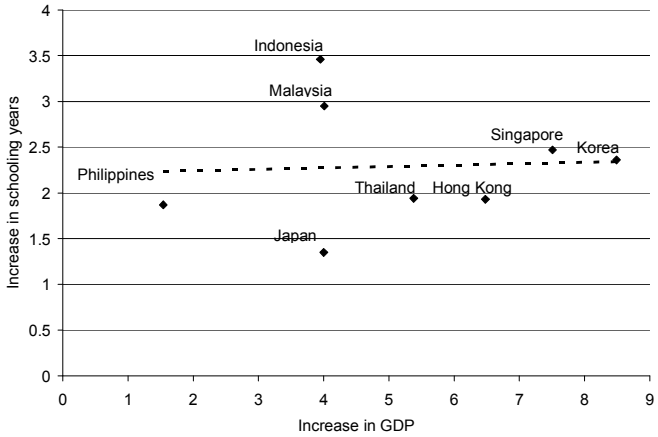
Data sources: Heston, Summers et.al (2002) and Barro and Lee (2000); derived by authors. Country's codes: (1) Hong Kong; (2) Indonesia; (3) Japan; (4) Korea; (5) Malaysia; (6) Philippines; (7) Singapore; (8) Thailand; (9) China.

Figure 2. Factor of increase in GDP per capita 1965-2000

(i) Increase in shares of investment



(ii) Increase in schooling years



(iii) Increase in population growths

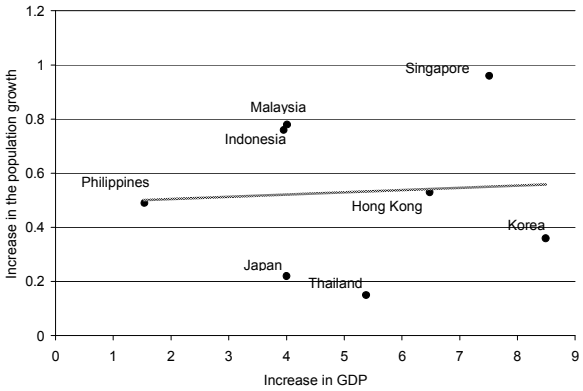
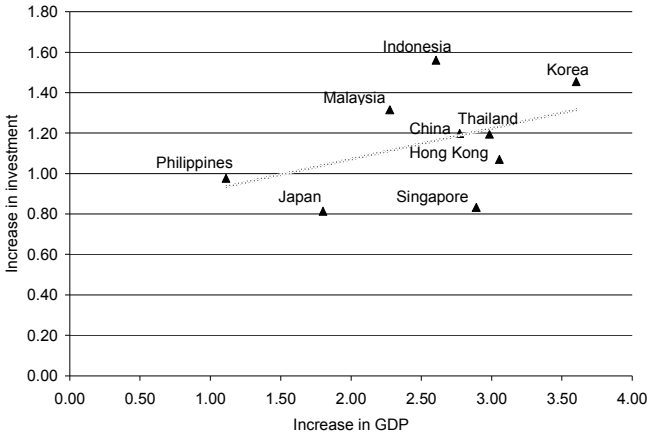
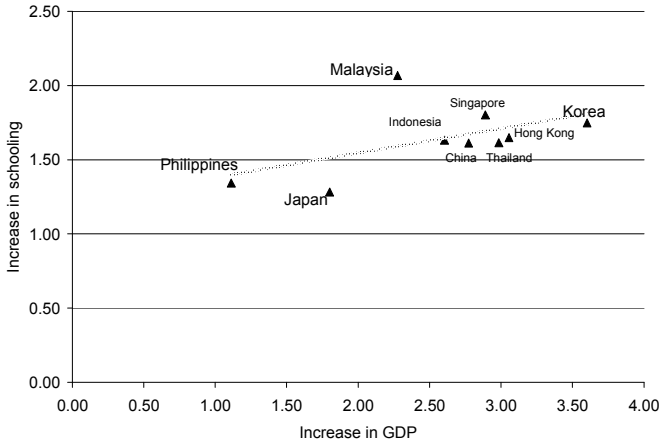


Figure 3. Factor of increase in GDP per capita 1975-95

(i) Increase in shares of investment



(ii) Increase in schooling years



(iii) Increase in population growths

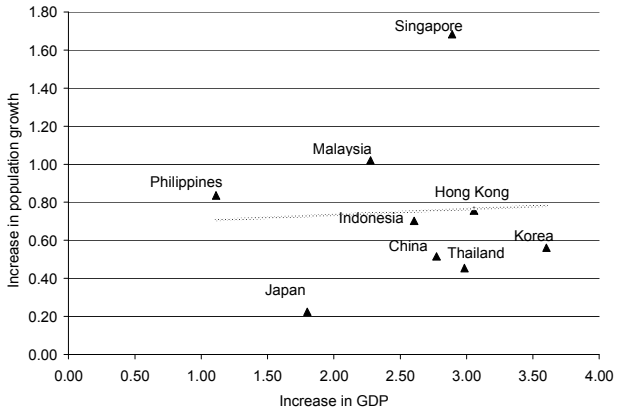
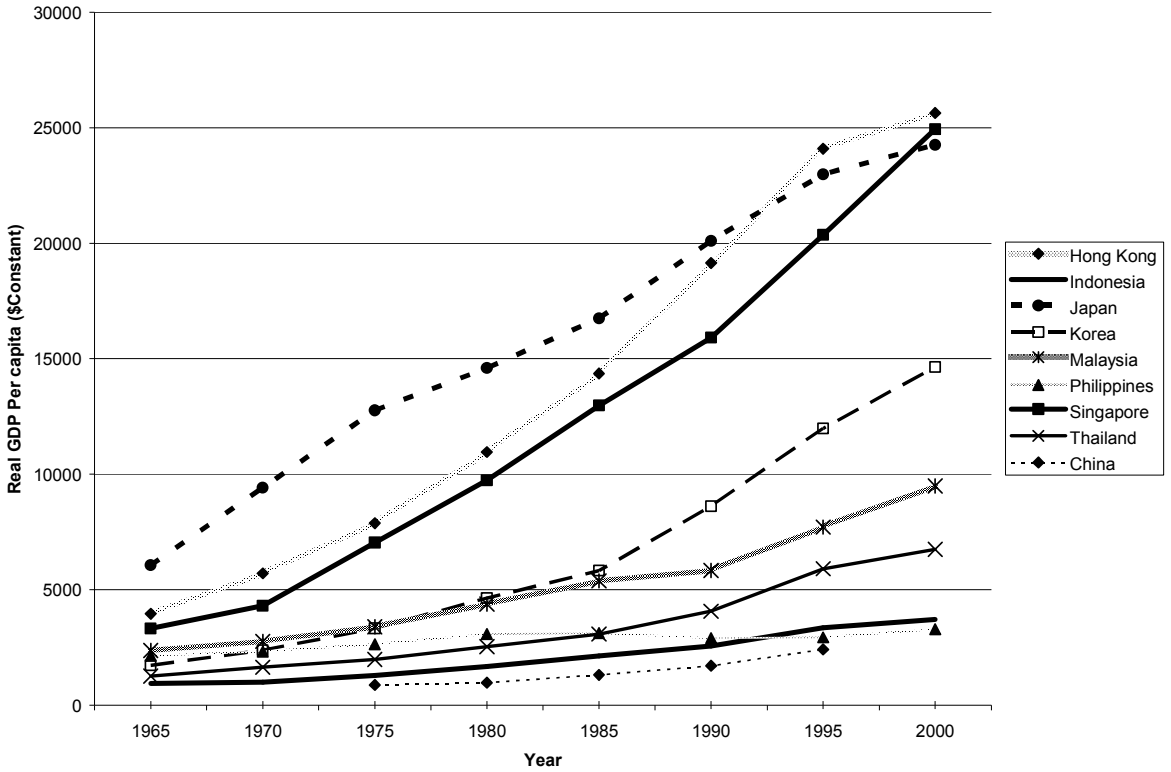


Figure 4. East Asian GDP per capita



Source: Heston, Summers et.al (2002)

Figure 5. Beta Convergence

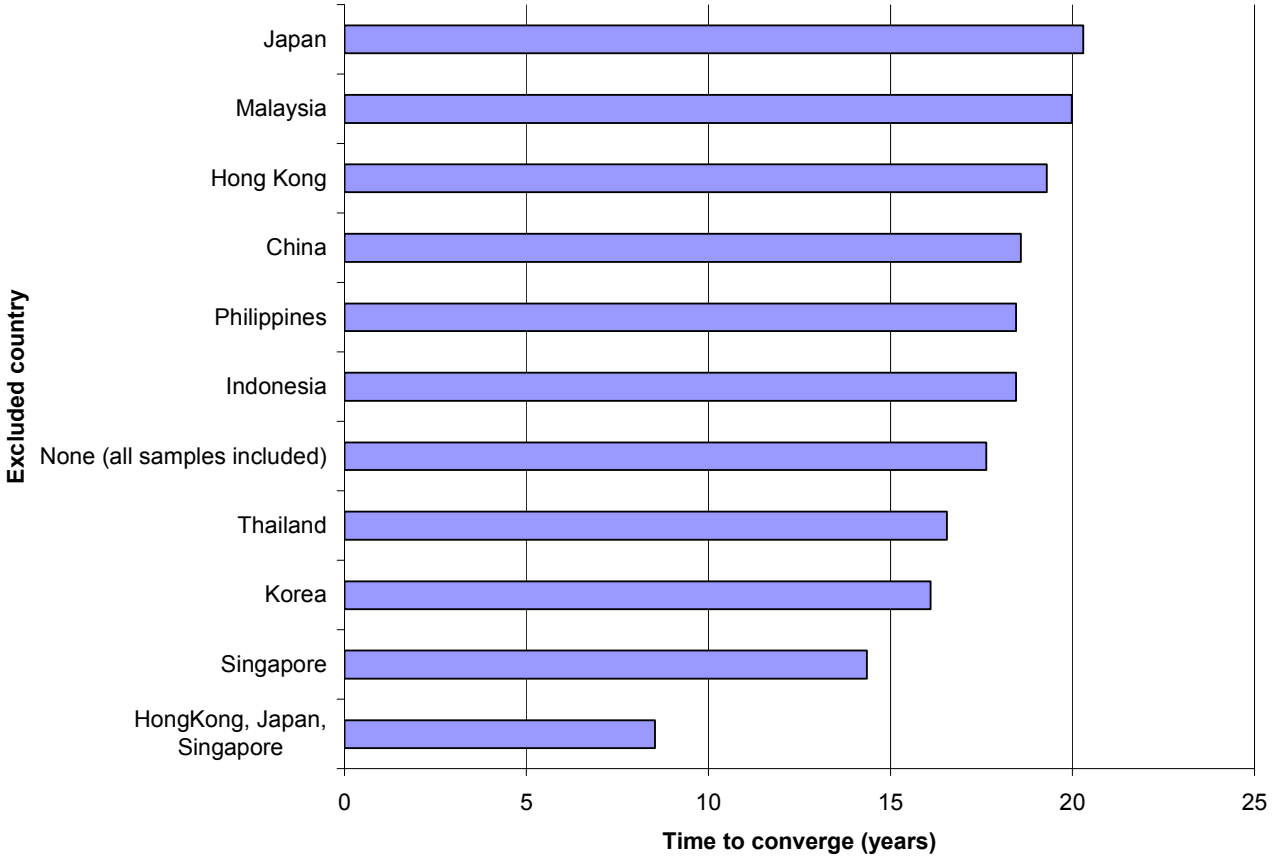


Figure 6. Sigma Convergence