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Catch-up, Sustainable Economic Growth and Education Stock in East Asia

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Hi-Stat Discussion Paper

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Summary

This paper provides nearly 100 years of detailed estimates of education stock in Japan, Taiwan, Korea, the Philippines, and the United States. Examining this, the paper studies the role of education in terms of catch-up economic development and shows that Japan, Korea, and Taiwan achieved economic growth with a smaller education stock than the United States during their miraculously high economic growth periods. In that sense, these three countries enjoyed the latecomer advantage. Simultaneously, this paper argues that Japan's poor economic performance, since around 1990, is attributable to its insufficient investment in tertiary education. It also points out that the primary school education completed in the Philippines may be suitable for those wishing to be hired as unskilled laborers by English-speaking foreigners but unsuitable for promoting the development of domestic industries.

Acknowledgement
As a part of the PRIMCED Database Project, organized by Professor Takashi Kurosaki of Hitotsubashi University, I have engaged in constructing a more accurate, detailed, and longer-term dataset of education stock (Godo, 2011, 2012, 2014).

1 Introduction

Many intuitive arguments hint that the pursuit of, and changes in, education in East Asia have been critical for its miraculous economic success. Empirical studies on the macroeconomic role of education in East Asian countries have been so limited, however, that researchers in economics are still uncertain about even basic questions such as whether and how education has contributed to the East Asian Economic Miracle. This paucity of empirical analyses can be attributed to a lack of detailed datasets for

education.

Among the rare available datasets of education stock, many researchers use the exhaustive work by Barro and Lee (2010). However, despite its usefulness, Barro and Lee's dataset has limitations. One of the most serious problems is that their time-frame is limited—their estimates include only a couple of decades in the postwar period. This limitation makes it difficult to analyze the economic role of education from a long-term perspective. In addition to this, the accuracy of their estimates has been questioned.

This paper proceeds as follows. Section 2 discusses the theoretical link between education and economic catch-up. Section 3 outlines my methodology of estimating education stock. Section 4 briefly reviews the economic performance of five countries—Japan, Korea, Taiwan, the Philippines, and the United States. Based on my dataset on education stock, Section 5 studies the economic role of education in the catch-up process. The last section concludes the paper.

2 The theoretical link between education and economic catch-up

The world today is characterized by an extremely large income gap between low-income developing countries and high-income developed countries. In order to catch up with the developed countries, developing countries need to absorb advanced technologies and production systems from the developed countries.

There is a wide literature that attempt to connect education with economic growth. Though the evidence is mixed, it is generally argued that the relationship is positive and significant. Hanushek and Kimko (2000) and Hanushek and Wößmann (2007) for example conclude that "cognitive skills - rather than mere school attainment - are powerfully related to individual earnings, to the distribution of income, and to economic growth". The microeconomic studies show that there is a significant return of investment in education in terms of personal income; at the national level when appropritae adjustments are made similar returns to education in terms of growth can be concluded (Lindahl and Krueger, 2001). Pioneered by Romer (1986) and Lucas (1988), the new endogenous growth theory also argues for the relationship between economic growth and human capital accumulation.

Ohkawa and Rostovsky (1973), who were the first to emphasize the importance of absorptive capacity with reference to Japan's industrialization, proposed the term "social capability," which included not only the technical competence of workers, but also commercial, industrial, and financial institutions. Later, the concept of social

capability was extended to include the political and social structures that prevented vested interests from impeding innovations.

In order to improve social capability, two types of human capital are required. One is a relatively small cadre of high-level scientists and engineers who can translate foreign technology for domestic use. The other is a mass of disciplined and industrial laborers who understand the basics of the translated technology and master its use in accordance with the instructions obtained at each level of management hierarchy within a large-scale factory system.

In the early stage of economic development, people are agriculture-oriented. At this stage, traditional farmers are not familiar with scientific knowledge. In addition, they are not accustomed with the working style of the industrialized society, where the division of labor develops and people work with the inorganic rhythm of the clock. In such a situation, the modern school system provides precious opportunities for ordinary families to access scientific knowledge and involve in group activities. Thus, school education can be regarded as a social system to create human capital that is required for developing countries to catch up with developed countries.

Theoretical background for the necessity of human capital accumulation for sustainable economic growth has been strengthened by development of the so-called endogenous growth model since the late 1980s.[i] The legitimacy of the endogenous growth model has been increasingly proved by various empirical studies. For example, Burja and Burjia (2013) proved that educational factors played a crucial role in the economic performance in the EU's new member states.

I agree that school education has various important uneconomic functions. For example, teaching and learning of social justice could be regarded as one of the most essential parts of school education, while it does not guarantee economic development.

Nevertheless, as Spring (2015) points out, a review of the history of the education policy in the post WWII period reveals that increasing emphasis is placed on the economic effects of school education. This trend is called "economization of education." Thus, it would be legitimate to focus on how school education in East Asia contributed to their economic catch-up.

3. Methodology for measuring education stock

To measure education stock, I use the average number of years of schooling per

person (henceforth *average schooling*). *Average schooling* can be calculated by adding the total enrollment for the corresponding years and the ages after adjusting for changes in the population due to immigration and mortality. For simplicity, it is assumed that there are no differences in education level between immigrants and domestic citizens and no correlation between school career and mortality. *Average schooling* is thus calculated using the following equation:

$$AS_{x-y,t} = \frac{\sum_{u=x}^{y}\sum_{w=0}^{u-1}\left(\frac{G_{u,t}}{G_{w,t+w-u}}\right)N_{w,t+w-u}}{\sum_{u=x}^{y}G_{u,t}}, \quad (1)$$

where,

$AS_{x-y,t}$ = *Average schooling* for persons aged x–y in year t;

$N_{w,t}$ = Total enrollment of persons aged w years in year t; and

$G_{w,t}$ = Total number of persons aged w years in year t.

Equation (1) shows that in order to estimate the current education stock for the working-age (i.e., ages 15 to 64) population, enrollment and population data must be available over many years. For example, in order to estimate education stock in the year 2000 for persons aged 60, the enrollment and population data must be available from 1940 onward. Despite the limited availability of data for such early years, I have been able to capture sufficient historical data.

Equation (1) regards all enrollment equally, regardless of education quality (such as qualification of teachers, student-teacher ratio, and the number of schooling days per year), levels, and types. Even a repeated year is counted as one.

Another assumption underlying equation (1) is that there is no depreciation in the knowledge provided in school. This may be too strong an assumption, considering the fading memory of the aged and the possible obsolescence of the knowledge acquired in earlier schooling years.

Despite these limitations, I believe that such a basic approach as expressed in equation (1) is adequate for a first attempt to construct a long-term dataset [ii].

Total educational enrollment can be decomposed into three levels: primary, secondary, and tertiary. However, classification of levels of education differs according to researchers. This paper follows the format of school statistics from the United States Department of Education, in which grades 1–8 represent primary education; grades 9-12, secondary education; and beyond grade 12, tertiary education.

Table 1 presents the summary of my estimates. Further details are given by Godo (2011, 2012, 2014).

Table 1 Average years of schooling[a] by levels of education: Philippines, Korea[b], Taiwan, Japan, and the United States

	Philippines			Korea[b]			Taiwan			Japan			United States		
	Primary[c]	Secondary[d]	Tertiary[e]	Primary[c]	Secondary[d]	Tertiary[e]	Primary[c]	Secondary[d]	Tertiary[e]	Primary[c]	Secondary[d]	Tertiary[e]	Primary[c]	Secondary[d]	Tertiary[e]
1950	4.3	0.43	0.017	2.1[f]	0.16[f]	0.028[f]	2.5	0.066	0.020	6.3	1.1	0.17	8.4	1.7	0.45
	(90.6)	(9.0)	(0.4)	(91.8)	(7.0)	(1.2)	(96.6)	(2.6)	(0.8)						
1960	5.6	0.54	0.033	2.8	0.34	0.071	3.3	0.20	0.086	6.9	1.6	0.24	8.5	2.2	0.61
	(90.6)	(8.8)	(0.5)	(87.3)	(10.5)	(2.2)	(92.0)	(5.6)	(2.4)						
1970	6.1	0.68	0.12	3.9	0.64	0.14	4.3	0.51	0.24	7.3	2.1	0.37	8.4	2.7	0.89
	(88.6)	(9.7)	(1.7)	(83.4)	(13.6)	(3.0)	(85.3)	(10.0)	(4.7)						
1980	6.9	0.96	0.23	5.4	1.2	0.20	5.6	1.1	0.56	7.6	2.6	0.58	8.3	3.1	1.4
	(85.2)	(12.0)	(2.8)	(79.6)	(17.5)	(2.9)	(77.0)	(15.3)	(7.7)						
1990	7.4	1.3	0.30	6.5	1.9	0.47	6.5	1.7	0.94	7.8	3.0	0.75	8.2	3.4	1.8
	(82.4)	(14.3)	(3.3)	(72.8)	(21.9)	(5.3)	(71.3)	(18.4)	(10.3)						
2000	7.9	1.6	0.38	7.1	2.5	0.86	7.1	2.3	1.46	8.0	3.3	1.0	8.1	3.6	2.2
	(80.2)	(16.0)	(3.8)	(67.8)	(24.0)	(8.2)	(65.7)	(20.9)	(13.4)						

	Japan			United States		
	Primary[c]	Secondary[d]	Tertiary[e]	Primary[c]	Secondary[d]	Tertiary[e]
1950	6.3	1.1	0.17	8.4	1.7	0.45
	(83.1)	(14.7)	(2.2)	(79.9)	(15.8)	(4.2)
1960	6.9	1.6	0.24	8.5	2.2	0.61
	(79.0)	(18.2)	(2.8)	(75.3)	(19.2)	(5.4)
1970	7.3	2.1	0.37	8.4	2.7	0.89
	(74.7)	(21.6)	(3.8)	(70.0)	(22.5)	(7.4)
1980	7.6	2.6	0.58	8.3	3.1	1.4
	(70.6)	(24.0)	(5.4)	(65.0)	(24.4)	(10.6)
1990	7.8	3.0	0.75	8.2	3.4	1.8
	(67.7)	(25.8)	(6.5)	(60.9)	(25.3)	(13.8)
2000	8.0	3.3	1.0	8.1	3.6	2.2
	(64.7)	(27.0)	(8.3)	(58.2)	(25.8)	(16.0)

a. Average number of years of schooling per person in the working-age population (persons aged 15-64 years).
b. Korea before 1945 means the entire Korean Peninsula. Korea thereafter means the Repiblic of Korea (South Korea).
c. Schooling of 1st to 8th grades.
d. Schooling of 9th to 12th grades.
e. Schooling of beyond 12th grade.
f. 1955 value.

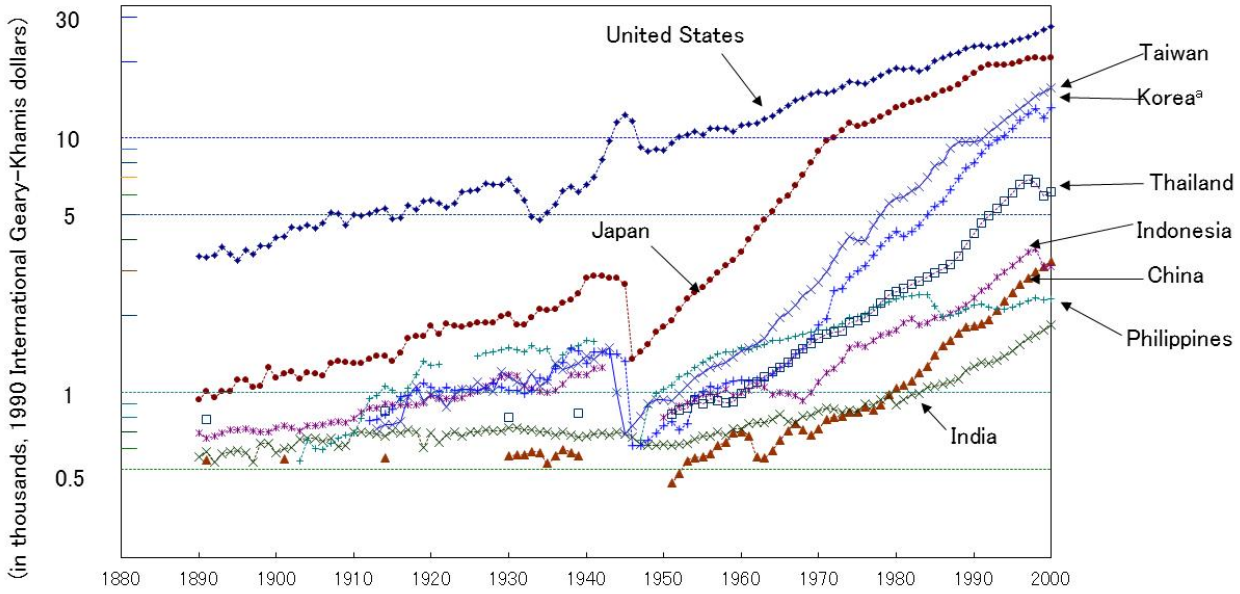
Within parenthes are percentages in the total (all the levels inclusive)

Sources see the maintext

4 Review of economic growth in East Asia and the United States and the process of economic catch-up

Before examining the estimation results of *average schooling,* it is useful to review economic growth in East Asia and the United States (Figure 1). The United States has been the leader in the world economy since the late 19th century. Thus, it would be reasonable to assume that the United States has been the world leader that East Asian countries have attempted to catch.

Figure 1. Comparison of per-capita GDP among Asian economies and the United States



a Korea before 1945 means the entire Korean Peninsula. Korea thereafter means the Republic of Korea (South Korea).

Source: Maddison2010)

Japan can be considered part of the first wave of East Asia catch-up industrialization. Japan is the first non-Western country that ascended from a less-developed stage to "the club of wealthy nations." In contrast with its economic rise through the 1980s, Japan plunged into a prolonged economic stagnation at the beginning of the 1990s. Thus, the Japanese economy has experienced both successful and unsuccessful economic periods after World War II.

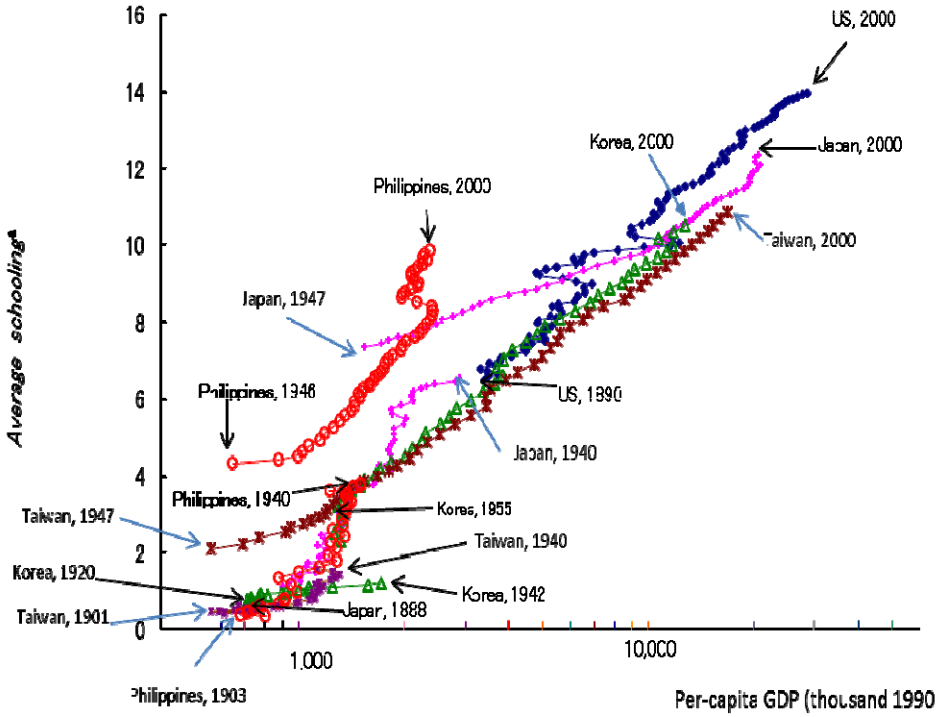
Korea and Taiwan, which also achieved miraculous economic success just 15–20 years after Japan, can be considered part of the second wave of the East Asia catch-up industrialization. Currently, Thailand, India, China, and Indonesia are entering the third wave of the East Asia catch-up industrialization.

The Philippines is seen as an example of economic failure and thus was unable to become one of "the East Asian Tigers." Until the beginning of the 1960s, per-capita GDP in the Philippines was higher than that in Taiwan and Korea, making it a relatively wealthy country in East Asia. Indeed, in the early post-war period, the Philippines was often described internationally as the hope of East Asia. However, later in the 1960s, there was a slowdown in its economic growth. Currently, the per-capita GDP in the Philippines is lower than that of not only Taiwan and Korea but also Thailand and Indonesia.

5 The results: Education, catch-up and sustainable economic growth

It is important to recognize that the school education system is a rather significant institution for underdeveloped economies as they catch-up with advanced economies. Specifically, a supply of the following two types of human capital is needed for the effective imitation of advanced industrial technologies (Hayami and Godo, 2010): (1) high-level scientists and engineers who can decode the scientific principles underpinning machines and equipment that are part of advanced industrial technologies; and, who can identify appropriate designs and manuals for the use of foreign technologies in local conditions, meaning, human capital completing tertiary educations; (2) laborers with the aptitude for working under the factory system in terms of conformity with the disciplines of collective work as well as compliance with instructions from employers conveyed through a hierarchy of management, meaning, human capital completing primary and secondary education.

Figure 2 Per-capita GDP versus *average schooling* [a]



Philippines (1903-40, 1946-2000), Korea [b] (1920-42, 1955-2000), Taiwan (1901-40, 1947-2000) Japan (1888-1940, 1947-2000), United States (1890-2000)

a Average number of years of schooling per person in the working-age population (persons aged 15–64 years).
b Korea before 1945 means the entire Korean Peninsula. Korea thereafter means the Republic of Korea (South Korea).

Sources: see the maintext

The scatter diagram in Figure 2 shows the change in the per-capita GDP and *average schooling* (inclusive of all levels of education) for the six countries. Except for the years of the Great Depression and the postwar high-growth era, the United States traces a clear locus along a straight line. The result of the OLS regression between per-capita GDP (Y) and *average schooling* (AS) for the United States can be expressed in the following manner:

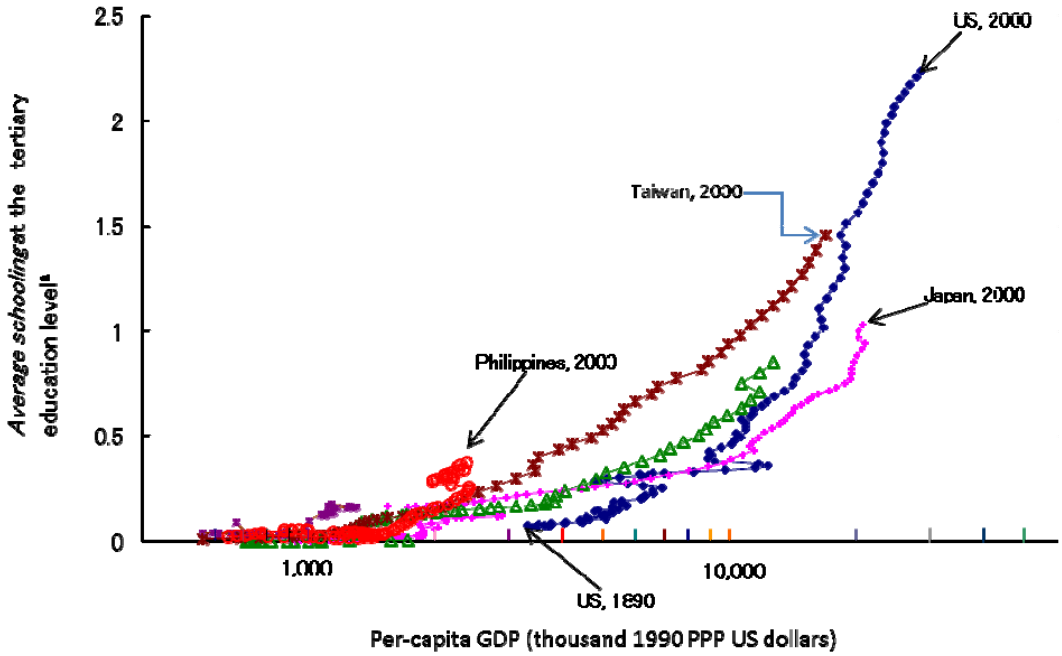
$$\ln Y = \underset{(59.1)}{6.31+0.275AS} \qquad R^2 = 0.970$$

Broadly, Japan, Korea, and Taiwan followed the path of the United States. More precisely, the paths of these four countries are slightly lower than the United States: the later the economic catching-up begins, the lower the path in Figure 2. This

implies that these four countries achieved economic growth with a smaller education stock than the United States. In this sense, these four East Asian countries "saved" on educational investments. This situation can be compared to *keirin*, a bicycle racing sport where followers easily trace the path of the top runners by using their windbreak.

How do followers "save" on educational investments? To provide a clear answer to this question, comprehensive analyses are necessary beyond the scope of this paper. However, it may be plausible to assume that followers have two advantages. First, instead of creating new technologies independently, followers can simply imitate the advanced technologies of foreign countries that are the outcomes of the heavy educational investments made by the frontrunner countries. Second, a country that began to catch-up later can imitate advanced foreign technologies more effectively by studying the experience of other countries that began their catch-up earlier.

Figure 3 Per-capita GDP and *average schooling* at the tertiary education level[a]



Philippines (1903-40, 1946-2000), Korea[b] (1920-42, 1955-2000), Taiwan (1901-40, 1947-2000) Japan (1888-1940, 1947-2000), United States (1890-2000)

a Average number of years of schooling in tertiary education per person in the working-age population (persons aged 15-64 years).
b Korea before 1945 means the entire Korean Peninsula. Korea thereafter means the Republic of Korea (South Korea).

Sources: see the maintext.

Another question is at what educational level did these four East Asian countries save on investments? To answer to this, I prepared another scatter diagram

presented in Figure 3 that traces the movement of the combination of per-capita GDP and *average schooling* at the education level.

Interestingly, in Figure 3, the paths of Taiwan and Korea are clearly higher than that of the United States. This implies that Taiwan and Korea "saved" on investments in primary and secondary education (recall that Taiwan and Korea traced lower paths than the United States in Figure 2). In contrast to Taiwan and Korea, Japan's path in Figure 3 is clearly lower than that of the United States. This implies that Japan "saved" on investments in tertiary education.

It is known that in the miraculous economic growth period, Japanese leaders did not focus on strengthening tertiary education. Instead, they vociferously demanded an increase in the number of middle schools orientated toward vocational education. The allocation of a large budget for middle-level education at the expense of higher-level education was probably efficient for maximizing the economic growth of Japan in the postwar catch-up process. However, the high-growth performance of the Japanese economy at that time depended on the availability of advanced technology from abroad that could be readily imitated by a relatively small cadre of high-level scientists and engineers. This backlog was certain to be exhausted as advanced foreign technology was successfully imitated. When Japan closed its technology gap vis-à-vis advanced industrial economies at the end of its successful economic catch-up in the 1980s, it required new and original technologies to compete with other industrial economies in the world market. In contrast to imitating ideas from abroad, a larger amount of higher-quality human capital is necessary to produce innovative ideas and designs domestically. However, Japan failed to prepare such a human capital base during the miraculous economic growth period. The very success of the miracle growth caused Japanese entrepreneurs and policymakers to become blind to the need for high-quality human capital at the end of the catch-up process.

For Japan's business society in the early postwar period, primary and secondary education was probably more important than tertiary education in creating demand for the domestic products, by affecting consumption behavior of Japanese youths. School education at the primary and secondary levels is a highly effective means for embedding a Japan-specific preference among youths belonging to middle-class families. School-wide activities such as morning assemblies, school lunches, school excursions, school festivals, extracurricular activities, and sports days provide opportunities for Japanese youths to become inculcated into Japanese society and culture. Foreign companies often complain that the tastes of Japanese consumers are so singular that foreign companies find themselves at a disadvantage against domestic

companies when selling their products to Japanese consumers. This singularity may have helped the rapid business expansion of domestic companies in the early postwar period. However, once the Japanese market became saturated after the end of its high-growth era, such effects ceased to be successful. This may be one of the reasons why Japan has suffered through such a prolonged recession beginning in the 1990s[iii].

In contrast to Japan, Taiwan and Korea made relatively heavy investments in tertiary education and saved on investments in primary and secondary education. While there are many possible reasons for this contrast, it should be noted that the populations of Taiwan and Korea are much smaller than Japan. This means that even if a Taiwan-specific or Korea-specific consumption preference is created, the demand for domestic products is not as large as in Japan's case. In addition, apart from primary and secondary education, Taiwan and Korea require compulsory military training of their youths, which also contributes to their development. Thus, it is reasonable to assume that the business societies in Korea and Taiwan did not demand an increase in the number of schools providing middle-level education as strongly as the Japanese business society did. In addition, Taiwanese and Korean youths are more motivated to seek education abroad than Japanese youths. Tertiary education leads to the seeking of job opportunities in foreign countries. This may be among the major reasons for heavy investments in tertiary education in Taiwan and Korea.

The history of the Philippines in this context is unique; compared with its education stock the per-capita GDP in the Philippines is low. Why did the Philippines veer from the path of the United States and the other four East Asian countries? There are various possible reasons for this. However, it may be important to acknowledge that primary school education in the Philippines has been mostly completed in English. Thus, it may be reasonable to argue that education in the Philippines has been suitable for those wishing to be hired as unskilled laborers by English-speaking foreigners.

Hayami and Godo (2011) assert that the economic successes of Japan, Korea, and Taiwan can be characterized by "military-style heavy industrialization." These countries had a large number of laborers who were middle-level educated, homogeneous laborers during the miraculous economic growth period. Since school education was usually not completed in English in these countries, those who received a middle-level education were not at a clear advantage to work abroad. Thus, domestic factories were more favorable workplaces. This situation is in sharp contrast to the case of the Philippines.

6. Conclusion

The miraculous economic growth in East Asia is often described as the catch-up through industrialization, that is, underdeveloped countries achieved high economic growth by imitating advanced technologies in Western countries. In Section 4, I find that among Japan, Taiwan, and Korea, the countries that began catch-up industrialization later "saved" more on educational investment compared with their precursors. I call this "the *keirin* hypothesis."

Japan's savings on educational investment differed from Korea's and Taiwan's. While Japan saved on investment in tertiary level of education, Korea and Taiwan saved on primary and secondary levels of education. Japan's strategy worked very efficiently in supporting the catch-up growth in the miracle era but turned out to be a major constraint on sustaining economic growth when this process was completed in the 1980s.

School education in the Philippines was suitable for those wishing to be hired as unskilled laborers by English-speaking foreigners. This is in sharp contrast with Japan, Korea, and Taiwan, where school education created a mass of homogeneous laborers suitable for heavy domestic industries. This may be one of the reasons for the Philippines failure to join "the East Asian Tigers" in the postwar period.

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[i] Lucas (1988) is the pioneer of development of the endogenous growth model. For more details, see Hayami and Godo (2005).

[ii] In future analyses, equation (1) can be revised by putting weight on enrollments according to quality, levels, and types of education. Further, the possibility of depreciating knowledge can be considered by multiplying (1 - δ)u-w- with Nw,t+w-u in equation (1), where δ denotes the rate of depreciation. This could be a subject for future research.

[iii] Hayami and Godo (2010) provide more discussion on this.