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# A New View on the Source of East Asian Economic Growth: What Made Capital Stock Accumulation So Remarkable in East Asia?

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# A New View on the Source of East Asian Economic Growth: What Made Capital Stock Accumulation So Remarkable in East Asia? *

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**Abstract**

Replacing investment shares in GDP by growth rates of capital stock, this paper first shows that cross-country regressions can explain East Asian high rates of economic growth remarkably well. The result is observationally consistent with recent growth accounting studies which proposed that rapid expansion of the East Asian economies relied principally on rapid expansion of capital stock. However, we also find that growth rates of capital stock and shares of investment had different effects on rapid expansion of the East Asian economies. In particular, we show that high rates of investment were not unusual but that low capital-output ratios were quite unusual in the East Asian economies. This empirical finding is noteworthy because it indicates that the pattern of East Asian economic growth was not necessarily extensive. We discuss that the East Asian economies have had a unique development process because they had labor-intensive industry structure at the early stage of industrialization.

JEL Classification Codes: O11, O47, O53

Key Words: East Asia, capital accumulation, capital-output ratio

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1. Introduction

Why did East Asian economies grow faster than most other developing economies during past decades? The question has stimulated a large number of empirical studies which attempted to identify factors contributing to the East Asian economic 'miracle'.[1] In previous literature, two types of empirical studies have been done.[2] The first type of studies was cross-country regressions based on the data sets which cover a large number of countries (see, for example, World Bank (1993)). These studies frequently pointed out several factors contributing to the East Asian economic 'miracle': outward-looking development strategies, high domestic saving rates, strong inflows of foreign direct investment, technological 'catch up', relatively low income inequality, a stable macroeconomic environment, a market friendly policy environment, and so on. However, even allowing these factors, the cross-country regressions failed to explain 'miraculous' economic growth of East Asian economies, particularly high growth rates of the East Asian NIEs (see, for example, Pack and Page (1994), Page (1994), and Easterly (1995)).[3]

The second type of studies was growth accounting approaches which calculated total factor productivity (TFP) growth by using country-specific time-series data. Although some of them found significant TFP improvement, most of recent studies concluded that rapid expansion of the East Asian economies relied principally on the measurable mobilization of additional resources, especially capital accumulation (Young (1992, 1994, and 1995), Kim and Lau (1993, 1994a, b), and Collins and Bosworth (1996)). In particular, based on their findings, Krugman (1994) suggested that the East Asian economies will not be able to maintain strong growth for long because the pattern of their growth is extensive, with little growth in total factor productivity.

These results are in marked contrast with those of cross-country regressions that failed to explain rapid expansion of the East Asian economies by measurable factors. One possible reason for having these conflicting findings is that cross-country variations of parameter values are allowed in growth accounting based on country-specific time-series data but not in cross-country regressions. In fact, some previous studies reported that the growth accounting might have estimated smaller East Asian TFP growth because they set larger capital shares in the East Asian economies (see, for example, Rodrik (1997), Dowling and Summers (1998)). Since cross-country regressions generally restrict cross-country variation of capital shares, it may cause bad performance of cross-country regressions in explaining rapid expansion of the East Asian economies.

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[1] Throughout this paper, we define the East Asian economies by the Asian NIEs (Hong Kong, Korea, Taiwan, and Singapore) plus three ASEAN countries (Indonesia, Malaysia, and Thailand).

[2] Nelson and Pack (1998) classified two types of studies into "assimilation" theories and "accumulation" theories.

[3] In previous literature, Grier and Tullock (1989), Helliwell (1992), and Fukuda and Toya (1994, 1995) have shown that there was little evidence to support the convergence hypothesis in Asian countries.

However, in addition to this possibility, we need to note that a key explanatory variable is different between two types of analyses. That is, in capturing the effects of capital accumulation, the growth accounting studies usually use growth rates of capital stock, while the standard cross-country regressions use shares of investment in total output. Although the use of investment shares in cross-country regressions can be theoretically justified by Mankiw, Romer, and Weil (1992), Benhabib and Spiegel (1994) have shown an evidence that the use of capital stock data may change previous cross-country regression results drastically. The first purpose of this paper is to examine whether the use of capital stock data in cross-country regressions can improve explanatory power for East Asian high rates of economic growth. Replacing shares of investment in GDP by four alternative growth rates of capital stock, we find that cross-country regressions can explain East Asian high rates of economic growth remarkably well.

Proposing that rapid expansion of the East Asian economies relied principally on rapid expansion of capital stock, our result is observationally consistent with recent studies on growth accounting. However, it also indicates that growth rates of capital stock have had larger effects on economic growth in the East Asian economies than shares of investment have had.[4] The second purpose of this paper is to examine what made growth rates of capital stock so different from shares of investment in the East Asian economies. Compared with other developing countries, we show that high rates of investment were not unusual[5] but that low capital-output ratios, or equivalently labor-intensive industry structures, are quite unusual in the East Asian economies.

The last empirical finding is noteworthy because it indicates that the pattern of their growth was not necessarily extensive. That is, although rapid expansion of capital stock has been the primary source of economic growth in the East Asian economies, it did not need excessive investment rates in total output because of highly labor-intensive industry structures. The finding, however, raises another question why the East Asian economies have had more labor-intensive industry structure. One plausible answer to this question is that the East Asian economies have had comparative advantage in labor-intensive industries under an open trading system.[6] That is, most of the East Asian economies are small open economies that have higher population densities and are endowed with smaller natural resources. Therefore, given an open trading system where prices are mainly determined in the world markets, they could specialize in exporting labor-intensive products through importing capital-intensive products and raw materials. In addition, their outward-looking development strategies intensified this trading pattern and contributed remarkable rates of economic growth with rapid expansion of capital stock but without excessive investment rates.

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4 In their growth accounting study, Drysdale and Huang (1997) found that replacing growth rates of capital stock by shares of investment led to larger TFP growth in East Asia.

5 This observation was stated in Page (1994).

6 Sachs and Warner (1995) emphasized this view in their empirical studies.

This view is consistent with our empirical findings because "openness" amplified the effects of capital accumulation on economic growth in our regressions. It is also partly consistent with a number of studies that have stressed a special role of exports and outward orientation strategies for economic growth (for example, Balassa (1978), Krueger (1980), Feder (1982), Roubini and Sala-i-Martin (1991), and Edwards (1992)). However, while these previous studies highlighted various beneficial aspects of exports and international trade, [7] our result indicates that in the case of the East Asian economies, the contribution of "openness" was reflected mainly in remarkable growth rates of capital stock. In particular, it implies that except for technological progresses embodied in physical capital accumulation, exports and outward orientation did not lead to widespread technological spillovers and cumulative productivity benefits in the East Asian economies.[8]

As previous studies on the Dutch disease pointed out, a rich endowment of arable land and natural resources could be a mixed blessing in an open trading system (see, for example, Corden (1984) and Matsuyama (1992)). High productivity and output in the capital-intensive import substitution sector may squeeze out the labor-intensive manufacturing sector. On the other hand, economies which lack arable land and thus have the initial comparative (but necessarily absolute) advantage in labor-intensive manufacturing may successfully industrialize by relying heavily on foreign trade through importing capital-intensive products and raw materials and exporting labor-intensive manufacturing products. Noting that outward-looking development strategies intensified this labor-intensive exporting pattern, rapid expansion of the East Asian economies can be considered as a good example of such industrialization process.

The above story on the East Asian industrialization may imply that the East Asian economies have had significant technological progresses embodied in physical capital accumulation. However, unless growth rates of output are as large as growth rates of capital stock, high growth rates of capital stock cannot support low capital-output ratios for long. In fact, when we plot the time-series data of capital-output ratios in the East Asian Economies, we can see significant upward trend in their capital-output ratios except for Hong Kong. This indicates that rapid expansion of capital stock without excessive investment rates is becoming more difficult in the East Asian economies because their industry structures are changing from more labor-intensive ones to more capital-intensive ones.

The paper proceeds as follows. Section 2 presents standard cross-country evidence which failed to explain remarkable growth rates in East Asian economies. Section 3 shows that the use

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[7] Highlighted various beneficial aspects of exports and international trade are greater capacity utilization, resource allocation according to comparative advantage, exploitation of economies of scale, technological improvements and efficient management in response to competitive pressures abroad, and so on (see Edwards (1993) for the survey).

[8] This observation is consistent with Rodrik's (1994a,b) critics on the export-led growth, although he did not make distinction between capital stock growth and investment.

of growth rates of capital improve the explanatory power of cross-country regressions on economic growth in East Asian economies. Section 4 investigates the reasons why investment rates and growth rates of capital had different effects on economic growth in East Asian economies and section 5 explores why the East Asian economies have had so labor-labor intensive industry structures. Section 6 discusses the sustainability of rapid capital accumulation in the East Asian economies. Section 7 summarizes our main results and refers to their implications.

## 2. Results from Standard Cross-Country Regressions

Recent empirical studies on economic growth have paid special attention to cross-country regressions using the data set of a large number of countries (e.g., Barro (1991)). In particular, Mankiw, Romer, and Weil (1992) have shown that once we allowed the difference in human capital, the cross-country regressions strongly support Solow's (1956) type neoclassical growth models. Although the results were somewhat sensitive in other empirical studies (e.g., Levine and Renelt (1992)), it is surprising that the data set which may have large measurement errors can generally explain world-wide economic growth well.

However, even if we allow various factors, many of previous cross-country regressions could not explain 'miraculous' economic growth of East Asian economies, particularly high growth rates of the Asian NIEs. The purpose of this section is to reconfirm these results.

A basic equation we estimate in this section is as follows[9]

$$(1) \quad \Delta y/y = constant + a * y_0 + b * (I/Y) + c *(\Delta L/L) + d*X + e*Dummies,$$

where $\Delta y/y$ is the growth rate of real per capita income, $y_0$ is log of per capita real income in 1960, $I/Y$ is average shares of investment in GDP between 1960 and 1990, $\Delta L/L$ is rates of population growth from 1960 to 1990, and $X$ denotes the other factors which may have affected the rate of economic growth.

In the regressions, we included two East Asian dummy variables as well as a Latin American dummy (*LAAM*) and a Sub-Saharan African dummy (*SAF*). One East Asian dummy is the East Asian *NIEs* dummy which takes one when country i is a member of the NIEs (that is, Hong Kong, Korea, Taiwan, and Singapore) and is zero otherwise. The other East Asian dummy is the *ASEAN* dummy which takes one when country i is either of Indonesia, Malaysia, and Thailand but takes zero otherwise. Since economic growth in the Philippines was less rapid than other East Asian economies, we did not include the Philippines in our *ASEAN* dummy. If these East Asian dummy

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9 The following estimations are based on the White's heteroskedastic-consistent estimates of the standard errors.

variables are significantly positive, we can see that the estimated equation cannot explain high growth rates of the East Asian economies.

Except for the use of the East Asian dummies, this type of linear regression is a standard one in recent literature of economic growth. Except for the other factors $X$, we estimated this basic equation by using the cross-sectional data sets which augmented the Real National Accounts constructed by Summers and Heston (1988, 1991). The data sets include almost all of the world other than centrally planned economies. We used the internet version of Summers-Heston data set which is now updated until 1992 in the web site.

As for the other factors $X$ in equation (1), we used measures of human capital in Barro and Lee's (1996) educational attainment data set and several measures in Sachs and Warner's data set.[10] Among various measures of human capital in Barro and Lee's data set, we used log of average schooling years in the total population in 1960 ($Lh$) and its growth rate over the period 1960-1990 ($\Delta h/h$). From measures in Sachs and Warner's data set, we used the following six variables: openness (*OPEN*),[11] share of exports of primary products in GNP in 1970 (*SXP*), physical access to international waters (*ACCESS*), tropical climate (*TROP*), log of life expectancy at birth, circa 1965-1970 (*LIFE*), and the difference between the growth rate of the economically active population and growth of total population (*GPOP*).

Table 1 summarizes our regression results.[12] All estimates were consistent with previous studies and most of them were statistically significant. In particular, regardless of the choice of data sets and the East Asian dummies, the coefficient of initial real income level, $y_0$, was significantly negative, implying that there was evidence of strong convergence in the world economy. However, both the *NIEs* and *ASEAN* dummies were significantly positive for all cases, implying that the estimated regressions cannot explain high growth rates in the East Asian economies, particularly the East Asian NIEs, that is, Hong Kong, Korea, Taiwan, and Singapore.

For example, when we estimated (1) based on three basic explanatory variables ($y_0$, $I/Y$, and

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10 See Sachs and Warner (1997a) and (1997b) for a description of the data. The data set of Sachs and Warner provides other variables such as central government savings, a general institutional quality index, a measure of ethno-linguistic fractionalization, average national saving 1970-89, and average inflation 1965-90. However, because these variables are available only for limited number of countries, we did not include them in our explanatory variables.

11 The *OPEN* variable is a slightly revised version of the variable used in Sachs and Warner (1995). It is defined as the fraction of years during the period 1965-1990 in which the country is rated as an open economy according to the criteria in Sachs and Warner (1995). An economy is deemed to be
open to trade if it satisfies four tests: (1) average tariff rates below 40 percent; (2) average quota and licensing coverage of imports of less than 40 percent; (3) a black market exchange rate premium that averaged less than 20 percent during the decade of the 1970s and 1980s; and (4) no extreme controls (taxes, quotas, state monopolies) on exports.

12 Because the Barro and Lee's human capital measures are available for 83 countries, most of our cross-country regressions are based on the sample size of 83 countries.

$\Delta L/L$), the estimated coefficients of the *NIEs* and *ASEAN* dummies respectively took 0.036 and 0.017. This implies that the basic cross-country model underestimates growth rates of the NIEs by 3.6% and growth rates of ASEAN by 1.7%. Even when we include human capital variables ($Lh$ and $\Delta h/h$) in the regression, the estimated coefficients of the *NIEs* and *ASEAN* dummies respectively took 0.031 and 0.014, implying that the model underestimated growth rates of the NIEs by 3.1% and growth rates of ASEAN by 1.4%.

When we included some measures in Sachs and Warner's data set, the coefficients of the East Asian dummies became smaller. In particular, the inclusion of "Openness" (*OPEN*) and share of exports of primary products (*SXP*) made the *ASEAN* dummy less significant and reduced the significance level of the *NIEs* dummy to some extent. This indicates that outward-looking development strategies without exporting primary products were one important factor contributing to the East Asian economic 'miracle'.[13]

However, even if we used these explanatory variables, the East Asian *NIEs* dummy remained significantly positive in all regressions. Therefore, in identifying factors contributing to the East Asian economic 'miracle', particularly high growth rates of the East Asian NIEs, the standard cross-country regressions were not successful enough.

## 3. Cross-Country Regression Based on the Capital Stock Data

In the last section, we reconfirmed that standard cross-country regressions could not explain 'miraculous' economic growth of East Asian economies, particularly high growth rates of the East Asian NIEs. These results are in marked contrast with those of growth accounting studies which showed that rapid expansion of the East Asian economies relied principally on the measurable mobilization of additional resources, especially capital accumulation.

One possible reason for the conflicting findings is that cross-country variations of parameter values are allowed in time-series analyses but not in cross-country regressions. However, in addition to this possibility, we need to note that a key explanatory variable is not common between two types of regressions. That is, in capturing the effects of capital accumulation, growth accounting studies usually use growth rates of capital stock, while standard cross-country regressions usually use shares of investment in total output.

The purpose of this section is to examine whether the use of capital stock data in cross-country regressions can improve explanatory power for East Asian high rates of economic growth. Specifically, using growth rates of capital stock, we estimated the following cross-country version of growth accounting equation:

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[13] This view has been emphasized in a large number of previous studies (e.g, World Bank (1993), Pack and Page (1994), Page (1994), Fukuda and Toya (1995), and Sachs and Warner (1995)).

(2) $\Delta y/y = constant + a^* y_0 + b^*(\Delta k/k) + c^*(\Delta h/h) + d^*Lh + e^*Z + f^*Dummies,$

where $\Delta k/k$ is growth rates of per capita physical capital stock and $\Delta h/h$ is growth rates of per capita human capital stock.

The standard growth accounting methodology with human capital specifies an aggregate production function in which per capita income, $Y_t$, is dependent upon three input factors –physical capital, $K_t$, labor, $L_t$, and human capital, $H_t$. Assuming a Cobb-Douglass production function, $Y_t = A_t K_t^{\alpha} L_t^{\beta} H_t^{1-\alpha-\beta}$, the relationship for long-term growth can be expressed as $\Delta Y/Y = constant + \alpha^*(\Delta k/k) + \beta^*(\Delta L/L) + (1-\alpha-\beta)^*(\Delta H/H)$. Defining that $y \equiv Y/L$, $k \equiv K/L$, and $h \equiv H/L$, equation (2) specifies this relationship with other explanatory variables: log of the initial level of per capita real income $y_0$, log of the initial level of human capital stock $Lh$, a number of 'ancillary variables' $Z$, and dummy variables. Except for ancillary variables and dummy variables, the equation is similar to the equations estimated by Benhabib and Spiegel (1994) and Pritchett (1995). Except for growth rates of capital stock, it is also similar to equation (1).

On world-wide estimates of physical capital stocks, limited studies provide alternative data sets. In the following analyses, we use the following four data sets of physical capital stocks: Nehru and Dhareshwar (1993), Benhabib and Spiegel (1994), King and Levine (1994), and the data for World Development Report 1991.[14] These data sets estimated a variety of measures of physical capital stocks of nations by using the perpetual inventory method based on alternative assumptions to generate initial capital stock estimates.[15] Needless to say, world-wide estimates of capital stock are susceptible to measurement errors because of differences in measures of capital, depreciation rates applied, and a number of other factors. However, substantial measurement errors only tend to degrade the strength of estimated statistical relationships. In addition, checking the sensitivity of the results by alternative data sets, we may mitigate the possible estimation biases caused by measurement errors in capital stock.

Table 2 summarizes our estimation results of equation (2) with and without three ancillary variables: $OPEN^*(\Delta k/k)$, $TROP$, and $GPOP$.[16] Except for the East Asian dummies, the estimated

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[14] Except for the data of Benhabib and Spiegel (1994), we downloaded the capital stock data from the World Bank's homepage. As for the data in the East Asian economies, the data of Hong Kong is missing in Nehru and Dhareshwar (1993) and the data of Indonesia is missing in the data for World Development Report 1991.

[15] The estimates by Benhabib and Spiegel (1994) and King and Levine (1994) are based on investment data in the Summers and Heston data set, while Nehru and Dhareshwar (1993) and World Development Report are based on investment data in the World Bank set.

[16] $OPEN^*(\Delta k/k) \equiv$ an $OPEN$ variable multiplied by growth rates of per capita capital stock. After estimating equation (2) with several ancillary variables in Sachs-Warner data set, we found that these three ancillary variables were statistically significant and stable.

coefficients were quite similar to those in previous studies. However, regardless of the choice of capital stock data, the table shows that growth rates of capital stock had more significantly positive effect on economic growth than shares of investment had. In addition, even without three ancillary variables, the inclusion of growth rates of capital stock in the regression greatly reduced the significance level of the East Asian dummies.

For example, when we estimated equation (2) based on four basic explanatory variables ($y_0$, $\Delta k/k$, $Lh$, and $\Delta h/h$), the estimated coefficients of the *NIEs* and *ASEAN* dummies lied between 0.015 and 0.021 and between 0.002 and 0.009 respectively. Recalling the corresponding estimates in Table 1 were 0.031 and 0.014, this indicates that when we simply replace $I/Y$ by $\Delta k/k$ in the regression, the coefficient of the *NIEs* dummy declined from 1% to 1.9% and that of *ASEAN* declined from 0.5% to 1.2%. In particular, when we included three ancillary variables, especially a variable of $OPEN*(\Delta k/k)$, the East Asian dummies turned out to be statistically insignificant in most cases. This indicates that high rates of economic growth in the East Asian economies are no more unusual given their high growth rates of capital stock and high degrees of openness.

One noteworthy result in the above findings is that growth rates of capital stock and shares of investment had different effects on rapid expansion of the East Asian economies. In fact, when we plot both shares of investment and growth rates of capital stock, we can find that the East Asian economies are remarkable outliers in the figure. For example, using four alternative data sets, Figure 1 shows cross-country evidence on how average shares of physical investment in GDP are correlated with growth rates of physical capital stock.[17] At the world-wide level, we can easily see that there exists strong positive correlation between investment rates and growth rates of capital stock in all cases. However, except for the Philippines (PHL), East Asian economies and Japan (JPN) are outliers for this world-wide positive correlation.

Among seven East Asian economies, Korea (KOR) and Taiwan (TWN) are remakable outliers in all figures, and so is Singapore (SGP) in three of four figures. In case of Hong Kong (HKG), Indonesia (IDN), Malaysia (MYS), and Thailand (THA), the deviations from world-wide positive correlation are relatively moderate. But, even in these economies, actual growth rates of capital stock were more than 2% higher than what was predicted by the world-wide positive correlation. Therefore, we can conclude that compared with other countries, these East Asian economies have had enormously high growth rates of physical capital stock for their relatively moderate investment rates.[18]

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[17] Average shares of investment in GDP are based on the Summers-Heston data set from 1960 to 1990.

[18] In Figure 1, some African countries are also outliers in terms of this world-wide positive correlation. However, capital stock data of these countries might have serious measurement errors.

4. Investment Rates and Growth Rates of Capital Stock

In the last section, we presented cross-country evidence that growth rates of physical capital stock and shares of physical investment had different effects on rapid expansion of the East Asian economies. The purpose of this section is to investigate what made growth rates of physical capital stock so much different from shares of physical investment in the East Asian economies.

Define physical capital stock at time t by $K_t$, output at time t by $Y_t$, and physical investment at time t by $I_t$. Then, we can derive the following identity:

$$(3) \quad I_t / K_t = (I_t / Y_t) / (K_t / Y_t)$$

Because $I_t / K_t$ is approximately equal to $\Delta K_t / K_t \equiv (K_{t+1} - K_t) / K_t$, this identity indicates that growth rates of capital stock can be high either when shares of investment in GDP ( $I_t / Y_t$) are high, or when capital-output ratios ($K_t / Y_t$) are low.

When we look at world-wide data, the cross-country evidence shows that growth rates of physical capital stock have no significant negative correlation with capital-output ratios. For example, using King-Levine and Nehru-Dhareshwar data sets, Figure 2 presents cross-country evidence on how average growth rates of per capita capital stock are correlated with capital-output ratios in 1960.[19] In the figure, we can see no world-wide evidence that growth rates of capital stock have significantly negative correlation with initial capital-output ratios. Recalling that growth rates of capital have had strongly positive correlation with shares of investment in GDP in Figure 1, this indicates that physical investment rates have been the dominant source of physical capital stock growth in most of the world economies.

However, except for the Philippines (PHL), the East Asian economies and Japan (JPN) are remarkable outliers for this world-wide evidence. That is, as we have already seen, Figure 1 shows that the East Asian economies have had enormously high growth rates of capital stock for relatively moderate investment rates. On the other hand, Figure 2 demonstrates that the East Asian economies, especially Korea (KOR), Taiwan (TWN), and Singapore (SGP), are unique in having low capital-output ratios in the initial period and high growth rates of capital stock in the following periods.

This result indicates that the East Asian development process has had a unique feature such that low capital-output ratios at the early stage of industrialization were responsible for remarkably high growth rates of capital stock in the following periods. Needless to say, this unique feature does not deny the importance of high investment rates and other factors in explaining high growth rates of

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19 In the figures, we excluded the data of countries whose capital-output ratios exceeds four because measurement errors may be serious for them.

capital stock in the East Asian economies. However, the evidence clearly suggests that high investment rates were not enough to explain remarkable high growth rates of capital stock in the East Asian economies.

Table 3 reconfirms this evidence by cross-country regressions based on two alternative data sets of physical capital stocks: Nehru and Dhareshwar (1993) and King and Levine (1994). It reports the estimation results of the following equation:

$$(4)\quad log(\Delta k/k) = constant + a^* log\,(I/Y) + b^* log\,(K_0/Y_0) + c^* X + d^*(NIEs\ Dummy) + e^*(ASEAN\ Dummy),$$

where $K_0/Y_0$ is capital-output ratios in 1960.

When initial capital-output ratios, $log\ (K_0/Y_0)$, is not included in the regression, both the *NIEs Dummy* and the *ASEAN Dummy* are significantly positive in all cases. This wa true even if we included several ancillary variables in the regression. Thus, unless low initial capital-output ratios are taken into account, high investment rates are not enough to explain remarkable high growth rates of capital stock in the East Asian economies. However, the inclusion of initial capital-output ratios in the regression greatly reduced the significance level of the East Asian dummies. In particular, when we included six ancillary variables, the East Asian dummies turned out to be statistically insignificant in all cases.[20] This indicates that low capital-output ratios at the early stage of industrialization can explain remarkably high growth rates of capital stock in the East Asian economies very well.

## 5. Why Were the East Asian Economies So Labor-Intensive?

As far as we know, almost all of previous studies interpreted that rapid expansion of capital stock in the East Asian economies should be attributed to their high investment rates. In particular, several studies such as Young (1995) and Krugman (1994) concluded that rapid expansion of the East Asian economies relied principally on extensive use of output for investment because rapid expansion of capital stock has been the primary source of their rapid economic growth. However, our result implies that this conclusion is not necessarily correct in explaining remarkable rapid expansion of the East Asian economies during past decades because it neglects the fact that capital-output ratios were exceptionally low in the East Asian economies.

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[20] Six ancillary variables are log of human capital stock (*Lh*), growth rates of human capital stock ($\Delta h/h$), tropical climate (*TROP*), the difference between the growth rate of the economically active population and growth of total population (*GPOP*), openness (*OPEN*), and shares of exports of primary products (*SXP*).

When capital-output ratios are low, relatively moderate rates of investment can achieve remarkably unusual capital accumulation. In this case, even if rapid expansion of capital stock is the primary source of economic growth, the economy can achieve it without excessive investment rates. Our result suggests that rapid expansion of the East Asian economies should be interpreted as such a development process. In particular, because economies with low capital-output ratios are labor-intensive, a source of remarkably unusual capital accumulation in the East Asian economies should be attributed to highly labor-intensive industry structures at the early stage of their industrialization.

The finding, however, raises another question why the East Asian economies have had more labor-intensive industry structures. One plausible answer to this question is that the East Asian economies have had comparative advantage in labor-intensive industries under an open trading system. In fact, most of the East Asian economies are small open economies which have higher population densities and are endowed with smaller natural resources. Therefore, given an open trading system where prices are mainly determined in the world markets, they could specialize in exporting labor-intensive products through importing capital-intensive products and raw materials.

The view is consistent with our empirical findings because "openness" amplified the effects of capital accumulation on economic growth in our regressions. It is also consistent with the view that the East Asian economies which lack natural resources and thus have the initial comparative advantage in labor-intensive manufacturing may successfully industrialize by relying heavily on foreign trade through importing capital-intensive products and raw materials and exporting labor-intensive manufacturing products.

However, we should recall that unless remarkably high growth rates of capital stock were taken into account, the East Asian dummies remained significantly positive even if we included "openness" variables (that is, *OPEN* and *SXP*) in standard cross-country regressions.[21] This indicates that "openness" was not enough to explain the East Asian economic 'miracle' when we ignore the role of capital accumulation without extensive investment, or equivalently the role of labor-intensive industry structures at the early stage of industrialization. It also implies that except for technological progresses embodied in physical capital accumulation, exports and outward orientation did not lead to widespread technological spillovers and cumulative productivity benefits in the East Asian economies.

Moreover, we should note that outward-looking development strategies can contribute to remarkable rates of economic growth only under labor-intensive industry structures. Recalling that labor-intensive industry structures were guided by targeted industrial policies in many East Asian economies, this implies that outward-looking development strategies in the East Asian

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[21] Picking up examples of Turkey and Chile in the early 1980s, Rodrik (1994b) showed that export orientation policy did not necessarily lead to an investment boom.

economies were successful not only because they established an open trading system but also because they targeted appropriate industries following the pattern of industrial sequencing.

In fact, under typical outward-looking development strategies, many of the East Asian economies started exporting highly labor-intensive industrial products such as textiles, apparel, and toys at the early stage of industrialization. Only after a success of these labor-intensive light industries, they moved to the next stage where they exported more sophisticated and less labor-intensive goods such as machinery, steel, chemicals, and shipbuilding.[22] During this industrialization process, capital accumulation might have been observationally a primary source of economic growth in terms of growth accounting, and technological progresses could exist only when they were embodied in physical capital accumulation. However, for these economies, it was vital to promote less labor-intensive industry only after a success of more labor-intensive industry. If they did not follow this appropriate pattern of industrial sequencing, the East Asian economies could not have achieved rapid capital growth of capital stock without extensive investment.

## 6. Sustainability of Capital Accumulation without Extensive Investment

In general, output level can grow as large as capital stock when there exists increasing-returns to scale in capital, when growth rates of human capital are large, or when rates of technological progress are large. Thus, if the East Asian economies satisfied these conditions, they could have supported low capital-output ratios for long. However, when we plot time-series movement of capital-output ratios during past decades, we can see significant upward trends in the capital-output ratios in the East Asian Economies except for Hong Kong.

For example, using King-Levine data set, Figure 3 presents time-series evidence on how capital-output ratios in the East Asian NIEs and Japan have changed during past decades. The evidence shows that in all of the East Asian NIEs, capital-output ratios were relatively stable until the mid-1960s. Even after late the 1960s, capital-output ratios in Hong Kong (HKG) have been stable around 1.5. However, since the early 1970s, capital-output ratios have had drastic upward trends in the other Asian NIEs. In particular, capital-output ratios in Singapore (SGP) rose up from 1.5 to nearly 3, and those in Korea (KOR) and Tawian (TWN) rose up from 1 to 2.

These upward trends in capital-output ratios probably reflect the fact that the East Asian industry structures changed from highly labor-intensive ones to less labor-intensive ones. Therefore, to the extent that technological progresses were embodied in physical capital accumulation, the East Asian economies have enjoyed a sort of widespread technological spillovers and cumulative productivity benefits. However, the upward trends in capital-output ratios imply that rapid expansion of capital

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[22] See Teranishi (1992) and Ito (1994, 1996) for Japanese experience.

stock without excessive investment rates is becoming more difficult in the East Asian economies.

In fact, most of the East Asian economies have experienced significant decline in growth rates of capital stock in the 1980s, although their investment rates never declined in the 1980s. For example, Table 4 shows how growth rates of capital stock and investment rates changed from the mid-1960s to the 1980s in the East Asian economies. It shows that growth rates of capital stock in Korea and Taiwan declined drastically in the first half of the 1980s and so did those in Indonesia and Malaysia in the latter half of the 1980s. However, it also shows that investment rates in these economies had upward trends from the mid-1960s to the 1980s.

In general, promoting particular industries at the early stage of industrialization tends to be successful because it is relatively easy for the government to find targeted industries. However, it becomes more and more difficult as the economy develops and becomes more mature. The above empirical finding may indicate that the East Asian economies have come to have this type of difficulty that is commonly observed in most of matured economies.

## 7. Concluding Remarks

This paper tried to answer the question as to what contributed to the faster growth in East Asian economies. In previous literature, cross-country regressions failed to explain 'miraculous' economic growth of East Asian economies by measurable factors, while growth accounting studies based on country-specific time-series data found that rapid expansion of the East Asian economies relied principally on the measurable mobilization of additional resources, especially capital accumulation. This paper first reconciled these two conflicting findings by showing that replacing investment shares by growth rates of capital stock, cross-country regressions can explain East Asian high rates of economic growth remarkably well.

The result is observationally consistent with recent studies on growth accounting in concluding that rapid expansion of the East Asian economies have relied principally on rapid expansion of capital stock. However, it also indicates that growth rates of capital stock and shares of investment had different effects on economic growth in the East Asian economies. In fact, we found that high rates of investment were not unusual but that low capital-output ratios, or highly labor-intensive industry structures, were quite unusual in the East Asian economies. The above empirical findings are noteworthy because they indicate that the pattern of economic growth with high growth rates of capital stock was not necessarily extensive and that there existed technological progresses embodied in capital accumulation in the East Asian economies.

We conjectured that the East Asian economies have had more labor-intensive industry structure because the East Asian economies have had comparative advantage in labor-intensive industries under an open trading system. We also stressed the role of targeted industrial policies in

establishing labor-intensive industry structures at the early stage of industrialization. However, unless growth rates of output are as large as growth rates of capital stock, high growth rates of capital stock cannot support low capital-output ratios for long. In fact, by showing significant upward trends in their capital-output ratios, we discussed that rapid expansion of capital stock without excessive investment rates is becoming more difficult in recent East Asian economies.

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Table 1 Estimation Results from Standard Cross-country Regressions

| | | | | | |
|---|---|---|---|---|---|
| *y0* | −0.005 | −0.008 | −0.012 | −0.012 | −0.011 |
| | (−1.82) | (−2.97) | (−4.11) | (−4.52) | (−4.74) |
| *I/Y* | 0.071 | 0.004 | 0.024 | 0.015 | 0.023 |
| | (2.37) | (1.24) | (0.90) | (0.62) | (1.19) |
| *Δ L/L* | −0.267 | −0.267 | −0.171 | 0.168 | 0.224 |
| | (−1.16) | (−1.27) | (−0.68) | (0.64) | (1.11) |
| *Lh* | | 0.012 | −0.005 | 0.003 | 0.004 |
| | | (3.41) | (1.12) | (0.64) | (1.08) |
| *Δ h/h* | | 0.012 | 0.005 | 0.004 | 0.005 |
| | | (2.70) | (0.99) | (0.82) | (1.06) |
| *TROP* | | | −0.012 | −0.014 | −0.009 |
| | | | (−3.26) | (−3.73) | (−2.64) |
| *LIFE* | | | 0.027 | 0.017 | 0.019 |
| | | | (1.51) | (1.09) | (1.32) |
| *ACCESS* | | | −0.001 | −0.005 | −0.006 |
| | | | (−0.47) | (−1.71) | (−2.42) |
| *GPOP* | | | 0.011 | 0.010 | 0.011 |
| | | | (1.55) | (1.79) | (2.89) |
| *OPEN* | | | | 0.018 | 0.017 |
| | | | | (3.57) | (4.65) |
| *SXP* | | | | | −0.050 |
| | | | | | (−2.96) |
| *SAF* | −0.011 | −0.009 | −0.002 | −0.001 | 0.004 |
| *Dummy* | (−2.49) | (−1.80) | (−0.39) | (−0.23) | (0.96) |
| *LAAM* | −0.008 | −0.009 | −0.005 | −0.001 | −0.001 |
| *Dummy* | (−1.90) | (−2.19) | (−1.35) | (−0.43) | (−0.21) |
| *NIES* | 0.036 | 0.031 | 0.024 | 0.018 | 0.013 |
| *Dummy* | (10.36) | (9.40) | (3.86) | (3.36) | (3.11) |
| *ASEAN* | 0.017 | 0.014 | 0.018 | 0.008 | 0.010 |
| *Dummy* | (4.37) | (3.34) | (3.92) | (2.16) | (1.58) |
| Adj. R-sq. | 0.611 | 0.644 | 0.713 | 0.771 | 0.831 |
| # of coun. | 83 | 83 | 83 | 83 | 79 |

Notes 1. T-values are in parentheses.
2. Estimated constant terms are not shown in the table.

Table 2-(1) Cross-country Regression Results by Using Capital Stock Data

| | King-Levine Data Set | King-Levine Data Set | Nehru Data Set | Nehru Data Set |
|---|---|---|---|---|
| y0 | -0.004 | -0.006 | -0.003 | -0.006 |
| | (-1.99) | (-3.13) | (-1.33) | (-2.79) |
| $\Delta k/k$ | 0.341 | 0.190 | 0.364 | 0.195 |
| | (5.00) | (2.73) | (4.77) | (2.30) |
| *Lh* | 0.010 | 0.007 | 0.008 | 0.006 |
| | (4.03) | (2.58) | (2.09) | (1.49) |
| $\Delta h/h$ | 0.009 | 0.005 | 0.007 | 0.006 |
| | (2.46) | (1.66) | (1.22) | (1.13) |
| *TROP* | | -0.010 | | -0.008 |
| | | (-3.68) | | (-3.04) |
| *GPOP* | | 0.013 | | 0.011 |
| | | (2.57) | | (2.02) |
| *OPEN* | | 0.204 | | 0.289 |
| $*(\Delta k/k)$ | | (2.05) | | (3.43) |
| *SAF* | -0.004 | 0.000 | -0.006 | -0.002 |
| | (-0.92) | (-0.00) | (-1.07) | (-0.06) |
| *LAAM* | -0.008 | -0.004 | -0.008 | -0.002 |
| | (-2.90) | (-1.37) | (-2.90) | (-0.81) |
| *NIES Dummy* | 0.020 | 0.008 | 0.012 | 0.005 |
| | (4.35) | (1.17) | (2.37) | (0.82) |
| *ASEAN Dummy* | 0.002 | -0.001 | 0.005 | -0.002 |
| | (0.21) | (-0.13) | (1.44) | (-0.43) |
| Adj. R-sq. | 0.755 | 0.806 | 0.755 | 0.815 |
| # of coun. | 83 | 83 | 73 | 73 |

Notes 1. T-values are in parentheses.
2. Estimated constant terms are not shown in the table.

Table 2-(2) Cross-country Regression Results by Using Capital Stock Data

| | Benhabib Data Set | Benhabib Data Set | WDR Data Set | WDR Data Set |
|---|---|---|---|---|
| y0 | -0.004 | -0.007 | -0.004 | -0.006 |
| | (-1.90) | (-3.54) | (-1.68) | (-2.80) |
| $\Delta k/k$ | 0.277 | 0.128 | 0.206 | 0.112 |
| | (3.86) | (1.88) | (3.19) | (1.41) |
| *Lh* | 0.007 | 0.005 | 0.009 | 0.007 |
| | (1.84) | (1.43) | (2.71) | (2.04) |
| $\Delta h/h$ | 0.007 | 0.005 | 0.008 | 0.005 |
| | (1.53) | (1.18) | (2.01) | (1.16) |
| *TROP* | | -0.011 | | -0.010 |
| | | (-4.32) | | (-3.00) |
| *GPOP* | | 0.011 | | 0.013 |
| | | (2.27) | | (2.25) |
| *OPEN* | | 0.295 | | 0.113 |
| $*(\Delta k/k)$ | | (3.06) | | (1.09) |
| *SAF* | -0.005 | 0.000 | -0.007 | -0.003 |
| | (-1.15) | (-0.11) | (-167) | (-0.76) |
| *LAAM* | -0.010 | -0.002 | -0.008 | -0.005 |
| | (-3.37) | (-0.97) | (-2.93) | (-1.91) |
| *NIES Dummy* | 0.021 | 0.005 | 0.015 | 0.005 |
| | (4.05) | (0.59) | (1.72) | (0.47) |
| *ASEAN Dummy* | 0.008 | 0.005 | 0.009 | 0.007 |
| | (2.07) | (1.17) | (2.00) | (1.24) |
| Adj. R-sq. | 0.732 | 0.809 | 0.755 | 0.745 |
| # of coun. | 83 | 83 | 82 | 82 |

Notes 1. T-values are in parentheses.
2. Estimated constant terms are not shown in the table.

Table 3. Determinants of Capital Stock Growth: King-Levine Data Set

| | King Data Set | King Data Set | King Data Set | King Data Set | Nehru Data Set | Nehru Data Set | Nehru Data Set | Nehru Data Set |
|---|---|---|---|---|---|---|---|---|
| *log(I/Y)* | 0.688 | 0.693 | 1.739 | 1.626 | 0.448 | 0.409 | 0.693 | 0.639 |
| | (3.41) | (2.14) | (6.35) | (4.63) | (3.62) | (1.40) | (4.49) | (1.93) |
| *log(Ko/Yo)* | | | -1.260 | -1.237 | | | -1.088 | -1.151 |
| | | | (-5.71) | (-5.45) | | | (-6.16) | (-5.73) |
| *Lh* | | 0.534 | | 0.442 | | 0.108 | | -0.192 |
| | | (2.22) | | (2.13) | | (0.44) | | (-1.02) |
| *Δh/h* | | 25.986 | | 18.147 | | 11.147 | | -6.228 |
| | | (2.78) | | (2.21) | | (1.02) | | (-0.73) |
| *TROP* | | 0.371 | | 0.238 | | 0.035 | | -0.167 |
| | | (1.11) | | (0.85) | | (0.11) | | (-0.72) |
| *GPOP* | | -0.167 | | 0.049 | | -0.043 | | 0.469 |
| | | (-0.41) | | (0.15) | | (-0.12) | | (1.75) |
| *OPEN* | | -0.074 | | -0.015 | | 0.082 | | 0.237 |
| | | (-0.30) | | (-0.07) | | (0.41) | | (1.45) |
| *SXP* | | -2.215 | | -0.840 | | -2.893 | | -1.548 |
| | | (-1.87) | | (-0.72) | | (-3.73) | | (-2.54) |
| *NIES Dummy* | 0.908 | 0.659 | 0.419 | 0.198 | 1.230 | 0.928 | 0.051 | -0.470 |
| | (6.37) | (1.90) | (2.57) | (0.58) | (13.11) | (2.90) | (0.25) | (-1.48) |
| *ASEAN Dummy* | 1.043 | 1.070 | 0.164 | 0.114 | 0.934 | 1.099 | 0.259 | 0.229 |
| | (3.54) | (3.54) | (0.67) | (0.31) | (9.54) | (3.52) | (2.27) | (0.91) |
| Adj. R-sq. | 0.335 | 0.400 | 0.553 | 0.595 | 0.296 | 0.360 | 0.610 | 0.657 |
| # of coun. | 76 | 73 | 76 | 73 | 68 | 67 | 68 | 67 |

Notes 1. T-values are in parentheses.

2. Estimated constant terms are not shown in the table.

3. *log(Ko/Yo)* = log of initial capital-output ratios.

4. Countries whose growth rates of capital stock were negative are excluded.

**Table 4: Growth Rates of Capital Stock Growth and Investment Rates in East Asia**

(i) Growth Rates of Capital Stock

| | Korea | Taiwan | Singapore | Hong Kong | Indonesia | Malaysia | Thailand | Philippines | Japan |
|---|---|---|---|---|---|---|---|---|---|
| 1965-69 | 12% | 10% | 7% | 4% | 9% | 4% | 9% | 4% | 11% |
| 1970-74 | 12% | 13% | 15% | 5% | 14% | 7% | 6% | 3% | 10% |
| 1975-79 | 11% | 10% | 8% | 6% | 12% | 7% | 5% | 6% | 5% |
| 1980-84 | 5% | 6% | 10% | 7% | 12% | 9% | 4% | 3% | 3% |
| 1985-88 | 6% | 4% | n.a. | 5% | 5% | 2% | 3% | -3% | 3% |

(ii) Shares of Investment in GDP

| | Korea | Taiwan | Singapore | Hong Kong | Indonesia | Malaysia | Thailand | Philippines | Japan |
|---|---|---|---|---|---|---|---|---|---|
| 1965-69 | 18% | 19% | 24% | 19% | 7% | 17% | 19% | 14% | 34% |
| 1970-74 | 22% | 25% | 39% | 18% | 14% | 23% | 18% | 14% | 39% |
| 1975-79 | 28% | 27% | 33% | 21% | 18% | 24% | 18% | 20% | 35% |
| 1980-84 | 28% | 26% | 40% | 21% | 24% | 31% | 17% | 19% | 32% |
| 1985-89 | 31% | 22% | 33% | 18% | 26% | 25% | 18% | 13% | 34% |
| 1990-92 | n.a. | n.a. | 35% | 18% | 27% | 32% | 29% | 16% | 38% |

Notes) 1. All figures are averaged values during the specified periods.
2. Growth rates of capital stock are based on the King-Levine data set.
3. Shares of investment in GDP are based on the Summers-Heston Data Set.

Figure 1-(1) Physical Investment and Capital Stock Growth: King-Levine Data Set

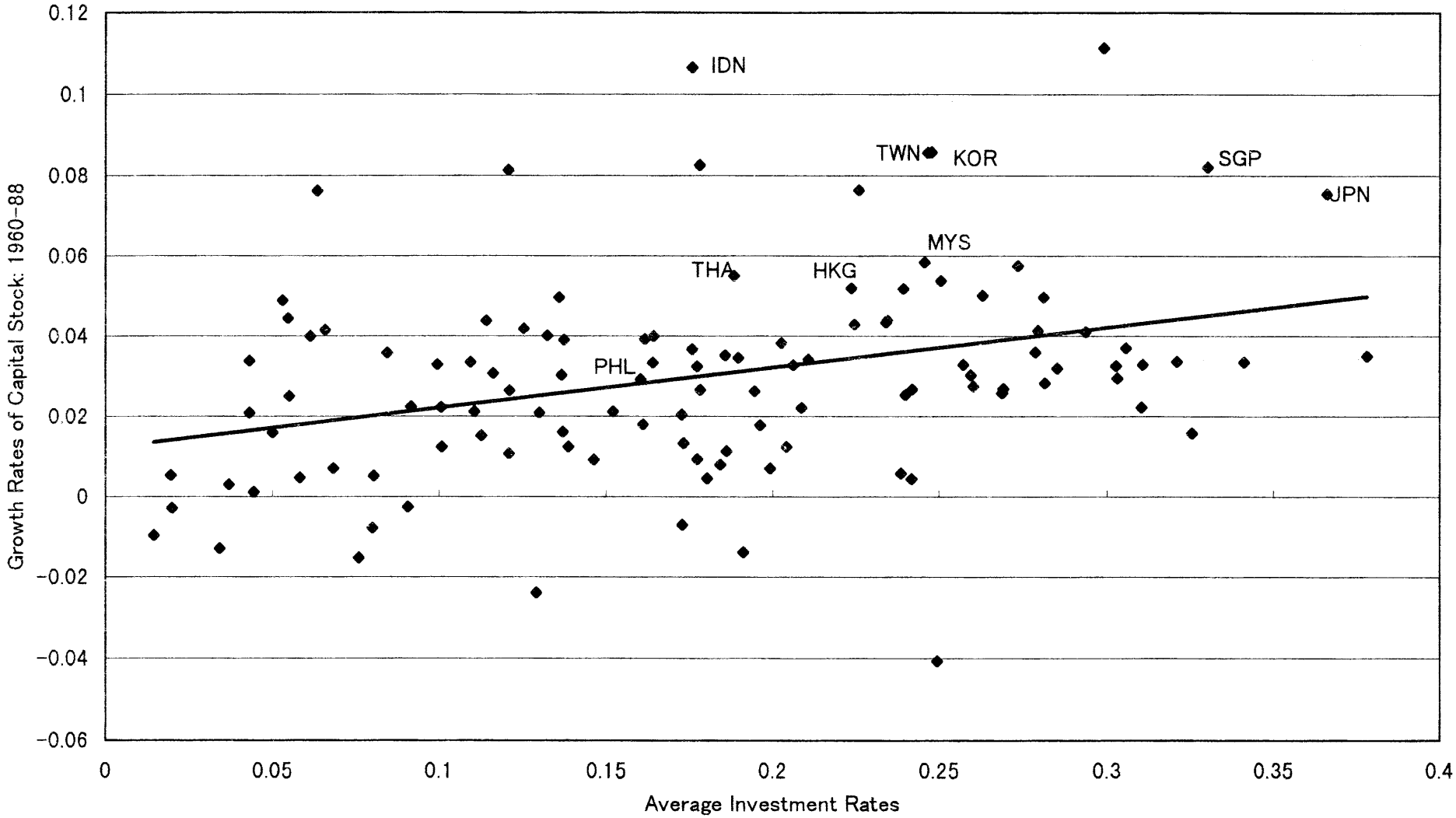

Figure 1-(2) Physical Investment and Capital Stock Growth: Nehru-Dhareshwar Data Set

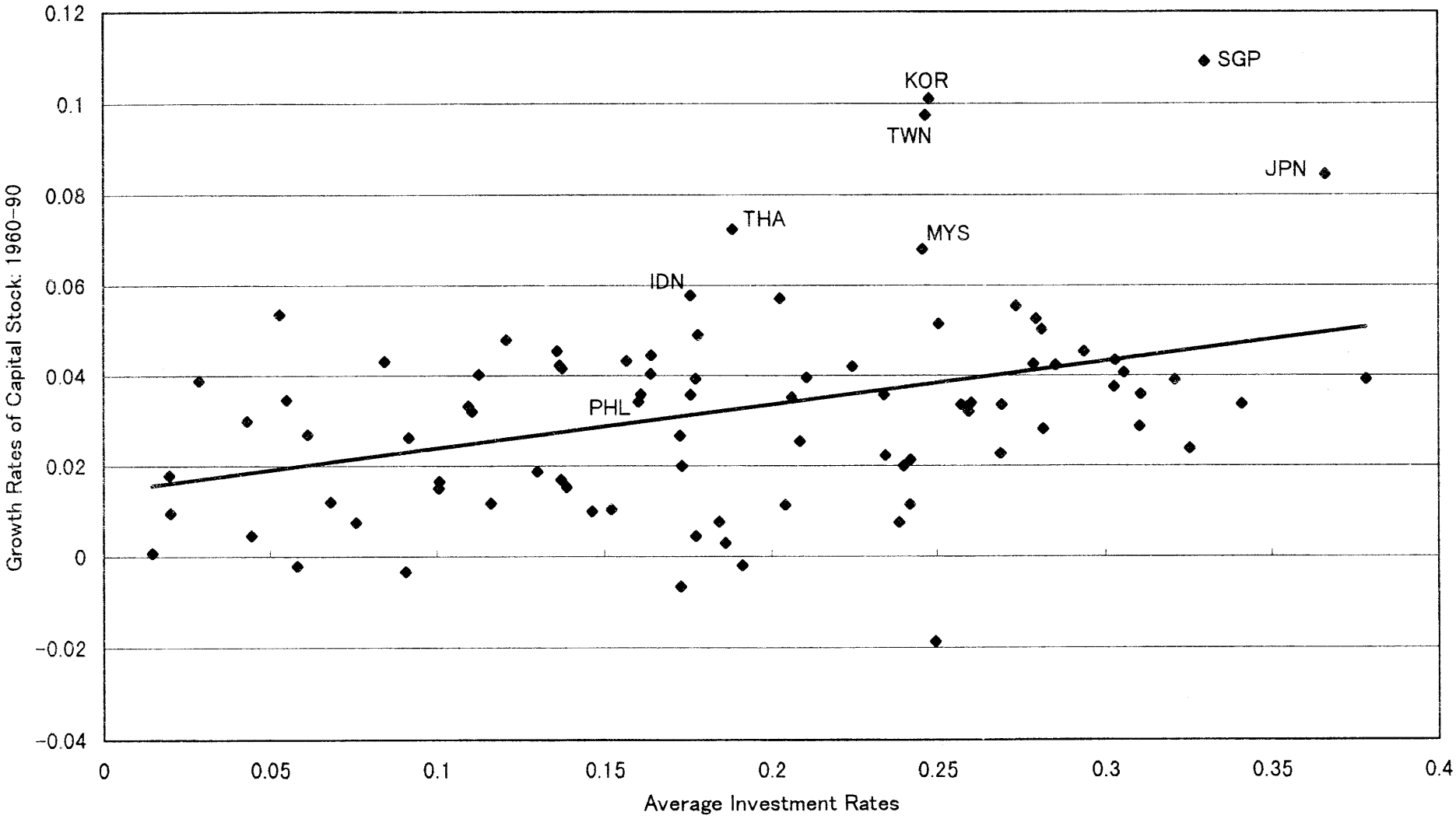

Figure 1-(3) Physical Investment and Capital Stock Growth: Benhabib-Spiegel Data Set

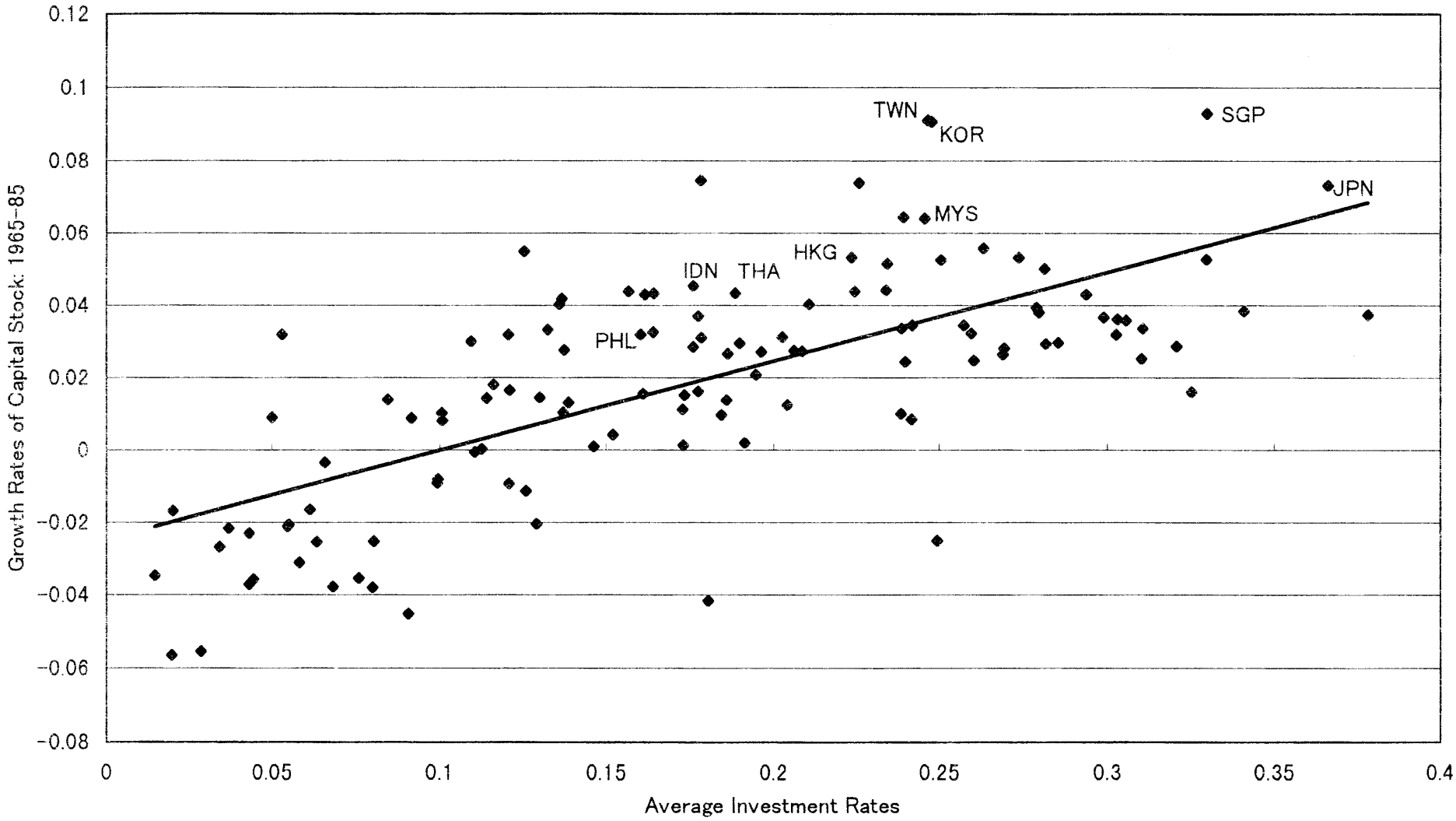

Figure 1-(4) Physical Investment and Capital Growth: World Development Reprot Data Set

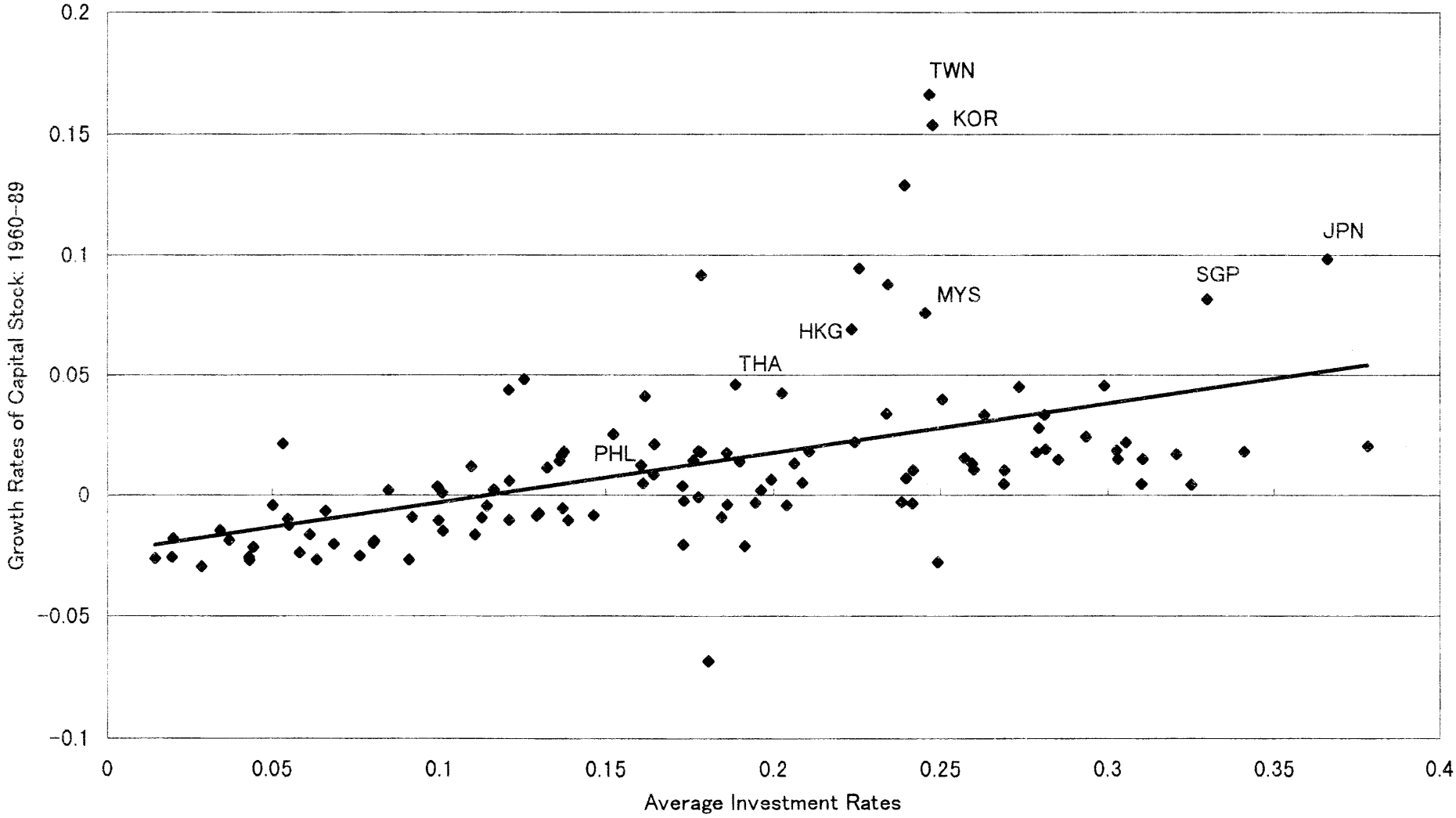

Figure 2-a. Initial Capital-Output Ratios and Capital Stock Growth: King-Levine Data Set

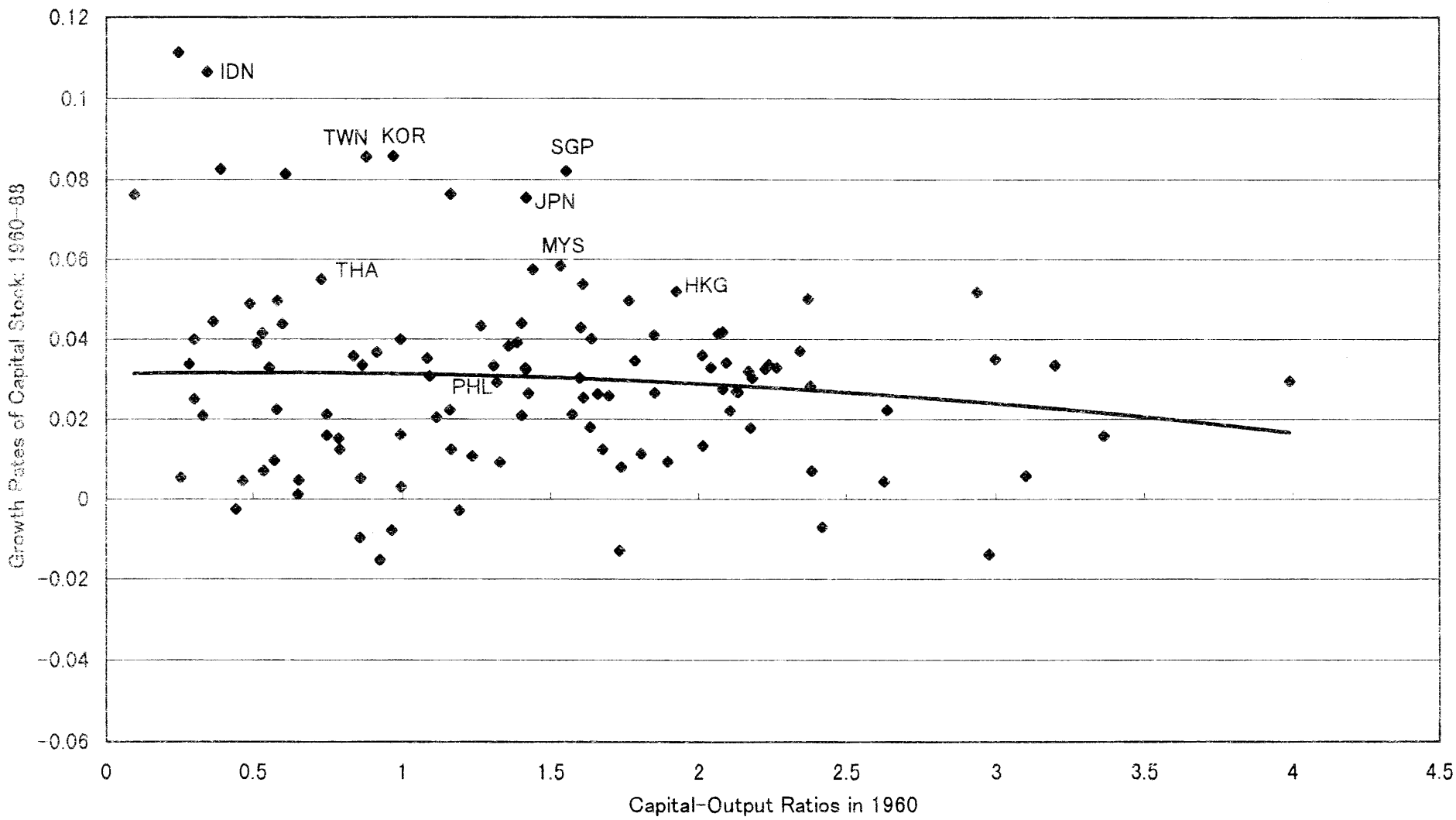

Figure 2-b. Initial Capital-Output Ratio and Capital Stock Growth: Nehru-Dhareshwar Data Set

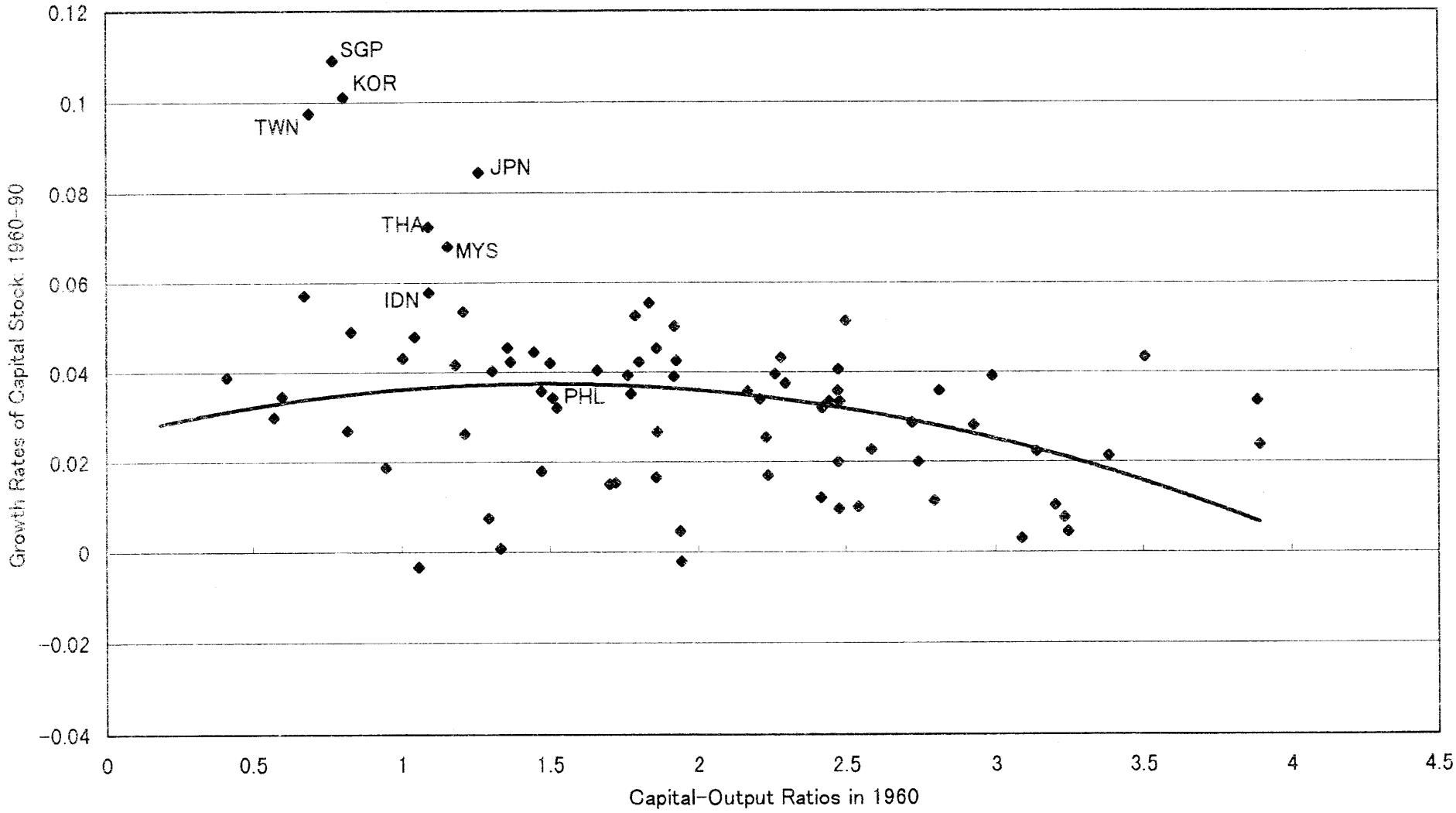

Figure 3. Time-series Evidence om Capital-Output Ratios in the East Asian Economies