

# **The Role of Human Capital Accumulation for Economic Growth in East Asian countries**

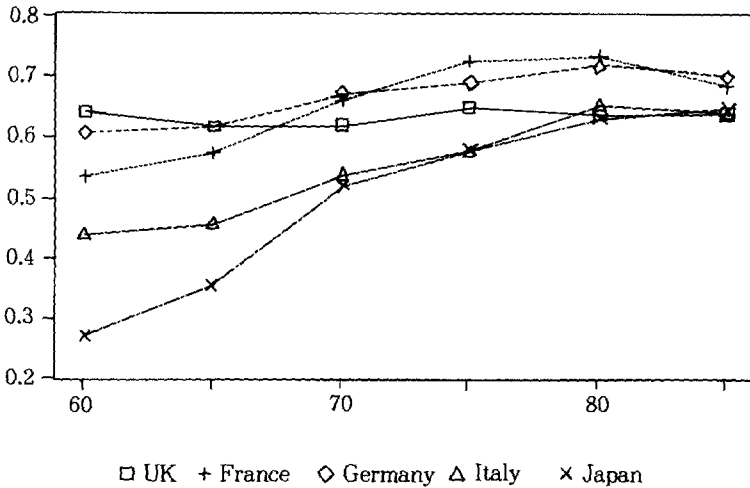
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The purpose of this paper is to investigate whether the difference in human capital accumulation can explain the non-convergent feature in East Asian countries. The paper first presents the cross-country evidence that growth rates in East Asian countries had little correlation with the starting level of income for the last few decades. In addition, the paper shows that this non-convergent result does not change even if the regressions allow the difference in school-enrollment rates. Noting that government expenditure on education can improve the quality of education, the paper then demonstrates that government expenditure on education played a special role for East Asian miraculous economic growth for the last few decades. The paper also shows that exports played a special role in explaining the convergence hypothesis in East Asian countries. (*JEL* Classifications: E62, J24, O40)

## **I. Introduction**

One important feature of neoclassical growth models (say, Solow 1956) is the "convergence" that developing countries grow faster than developed countries given the growth rates of technology and population. To the extent that countries are similar with respect to structural parameters, the neoclassical growth models predict that a country's per capita growth rate tends to be negatively related to its starting level of income per person. However, except for the evidence in OECD

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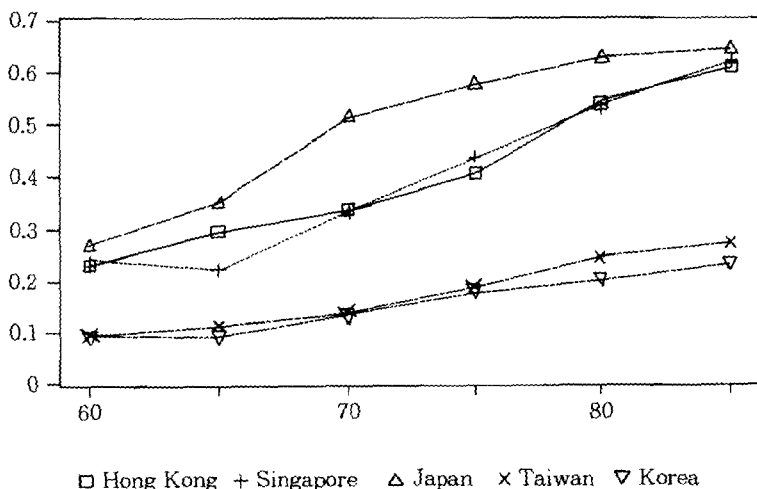


- Notes: 1) Vertical line shows each country's per capita GDP in terms of per capita GDP in the United States.  
 2) Horizontal line shows calendar years.  
 3) Data is based on Summers and Heston (1988).

**FIGURE 1**  
 CONVERGENCE IN OECD COUNTRIES

economies (see, for example, Baumol 1986; Dowrick and Nguyen 1989; and Figure 1), the convergence of growth rates seems to be inconsistent with various cross-country studies. The inconsistency is particularly true in East Asian countries where the per capita income levels have diverged rather than converged for the last few decades (see Figure 2 and Figure 3).

Recent studies on endogenous growth have tried to construct a neo-classical theory of growth that is consistent with these features. These studies have shown that without diminishing returns to capital, the growth rate of per capita product is independent of the starting level of per capita product (e.g., Romer 1986; Rebelo 1991). Moreover, not a few studies have emphasized the role of human capital accumulation in explaining the main features of economic development (e.g., Lucas 1988, 1993; Romer 1990; Becker, Murphy, and Tamura 1990). In these models, human capital is the key input which generates the new products or ideas that underlie technological progress. Thus, countries with greater initial stocks of human capital can experience higher rates of investment in physical capital and tend to grow faster.

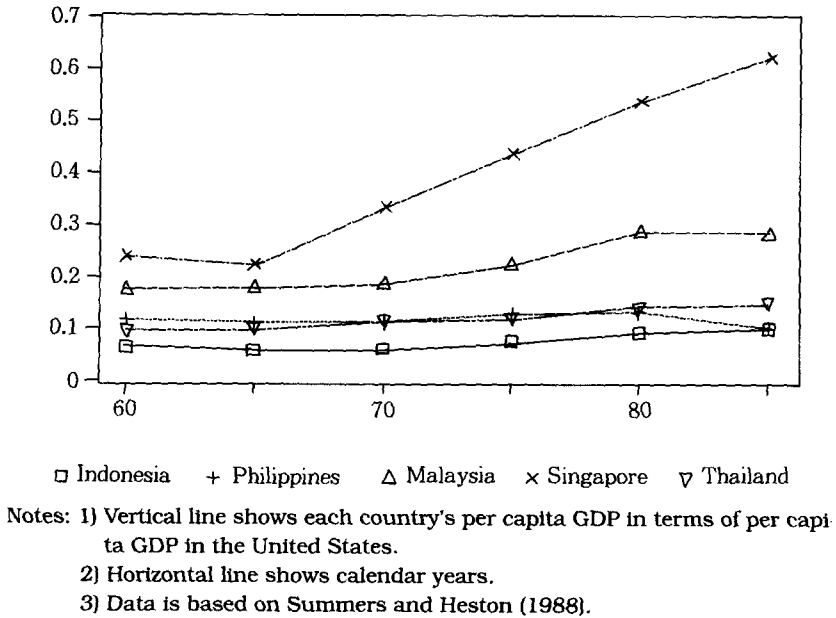


- Notes: 1) Vertical line shows each country's per capita GDP in terms of per capita GDP in the United States.  
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 3) Data is based on Summers and Heston (1988).

**FIGURE 2**  
NON CONVERGENCE IN NIEs COUNTRIES

Recent empirical studies have also paid special attention to the role of human capital accumulation for a successful economic growth. In particular, Barro (1991) and Mankiw, Romer, and Weil (1992) have shown that once we allowed the difference in human capital, the cross-country evidence strongly supports the convergence hypothesis in neo-classical growth models. These studies mainly focused on human capital accumulation through schooling and used school-enrollment rates (say, the enrollment rate in secondary school) as proxies for human capital. The results were, however, somewhat sensitive in other empirical studies (e.g., Murphy, Shleifer, and Vishny 1991; Levine and Renelt 1992).<sup>1</sup> Moreover, more adequate proxies for human capital have been explored in recent empirical studies (e.g., Barro and Lee 1993a, 1993b).

<sup>1</sup>Murphy, Shleifer, and Vishny (1991) showed that countries with a higher proportion of engineering college majors grow faster, whereas countries with a higher proportion of law concentrators grow more slowly. Levine and Renelt (1992) reported that school-enrollment rates were not robustly correlated with growth when we changed the conditioning information set.



**FIGURE 3**  
NON CONVERGENCE IN ASEAN COUNTRIES

The purpose of this paper is to investigate whether the allowance for the difference in human capital accumulation can explain the non-convergent feature in East Asian countries (that is, Asian NIEs countries, ASEAN countries, and Japan). Our interest in the paper was originally stimulated by the observation that recent growth in East Asian countries was miraculous. The paper first presents the cross-country evidence that per capita growth rates in East Asian countries had little correlation with the starting level of per capita product for the last few decades. In addition, the paper shows that the non-convergent result in East Asian countries does not change even if the regressions allow the difference in school-enrollment rates. The paper then stresses the role of government expenditure on education in accumulating human capital. Noting that government expenditure on education can improve the quality of education, we demonstrate that in East Asian countries, government expenditure on education played a special role in accumulating human capital, leading to miraculous (and non-convergent) economic growth for the last few decades.

In some recent studies on endogenous growth, the effects of govern-

ment consumption on the rate of economic growth were extensively discussed (for example, Barro 1990). These studies have shown that an increase in the share of government consumption in GDP has a negative effect on the rate of economic growth. The argument was that government consumption had no direct effect on private productivity, but lowered saving and growth through the distorting effects from taxation. However, since government expenditure on education can improve the quality of education, it is hard to say that a similar argument may be applied to government expenditure on education.

In the following empirical investigation, we show that government expenditure on education had a significantly negative effect on the rate of economic growth if we exclude East Asian countries from the sample. This result implies that in most of countries, the role of government expenditure on education is negligible (and rather harmful) in accumulating the high quality of human capital. However, we also demonstrate that in East Asian countries, government expenditure on education had a significantly positive effect on economic development.

In the previous literature, there are several studies which have focused on a unique development pattern of Asian countries based on a recent endogenous growth framework. In particular, Grier and Tullock (1989), Helliwell (1992), and Fukuda and Toya (1993) have shown that there was little evidence to support the convergence hypothesis in Asian countries. Our empirical results show that the puzzling result in these studies can be explained partly by the high quality of human capital accumulation through government expenditure on education.

However, our empirical results also show that the role of government expenditure on education is not big enough to support the whole of the conditional convergence in East Asian countries. The final section of this paper thus examines the role of exports in East Asian countries. It is shown that in addition to government expenditure on education, exports played a special role for economic development in East Asian countries. As emphasized by Fukuda and Toya (1993), the result explains the convergence hypothesis in East Asian countries very well. It is also consistent with a lot of studies which propose that the successful promotion of exports has been primarily responsible for rapid industrialization in East Asian countries.

In the previous literature of development economics, a number of studies stressed a special role of exports for economic growth (for example, Balassa 1978; Krueger 1980). These studies highlighted various beneficial aspects of exports and international trade: greater capa-

city 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. These studies also proposed that since there are substantial differences in productivities between export-oriented and non-export-oriented industries, countries which have adopted export-oriented policies benefit from closer-to-optimal resource allocation and higher growth. Our empirical result in the final section supports these view at least in East Asian countries, showing that exports as well as government expenditure on education played a special role for economic development in these countries.

The paper is organized as follows. Section II presents the cross-country evidence that per capita growth rates in East Asian countries have little correlation with the starting level of per capita product. Section III shows that this non-convergent result in East Asian countries does not change even if we allow the difference in school-enrollment rates. Section IV investigates the role of government expenditure on education for East Asian economic development. Section V discusses the effects of other components of government expenditures, including public investment, on economic growth. Section VI shows that given the export-GDP ratios, growth rates in east Asian countries are negatively related to the initial level of per capita GDP. Section VII summarizes our main results and refers to their implications.

## II. Weak Convergence Tendency in East Asian Countries

The purpose of this section is to reconfirm the previous result that a simple convergence hypothesis in neoclassical growth models did not hold in East Asian countries for the last few decades. A basic equation we estimate is as follows

$$GYP_t = a_1 \times RY_{0t} + a_2 \times AD_t \times RY_{0t} + b \times INV_t + c \times GN_t \quad (1)$$

where  $GYP$  is the growth rate of real per capita income,  $RY_0$  is log of the initial level of (Summers-Heston) per capita real income,  $INV$  is log of the share of investment in GDP, and  $GN$  is log of the rate of population growth plus 0.05.<sup>2</sup>  $AD_t$  is the East Asian dummy which is one when country  $t$  is one of nine East Asian countries and is zero otherwise. Nine East Asian countries are Hong Kong, Indonesia, Japan, Korea,

<sup>2</sup>The number of 0.05 follows Mankiw, Romer, and Weil (1991).

**TABLE 1**  
THE TESTS OF CONVERGENCE HYPOTHESIS IN EAST ASIAN COUNTRIES

	<i>BW</i>	<i>BW</i>	<i>MRW</i>	<i>MRW</i>
constant	0.0482 (3.1797)	0.0391 (2.6242)	0.0812 (2.3797)	0.0394 (1.2636)
$RY_0$	-0.0078 (-2.6036)	-0.0083 (-2.8881)	-0.0058 (-2.7182)	-0.0046 (-2.4205)
$AD \times RY_0$		0.0229 (2.9154)		0.0033 (5.2584)
<i>INV</i>	0.0296 (5.3560)	0.0268 (4.9619)	0.0266 (7.5154)	0.0220 (6.7810)
<i>GN</i>	-0.0056 (-1.9619)	-0.0064 (-2.3291)	-0.0113 (-0.9089)	-0.0197 (-1.7676)
<i>T-STAT</i>		1.7811		-0.6413
adj. $R^2$	0.2450	0.3038	0.3814	0.5169
sample size	101	101	99	99

Notes: 1) The columns of *BW* show cross-sectional regressions of 101 countries based on the data set of Barro and Wolf (1989). The columns of *MRW* show cross-sectional regressions of 99 countries based on the data set of Mankiw, Romer, and Weil (1992).

2) *t*-values in the parentheses.

3) *T-STAT* in the table denotes *t*-values for the hypothesis that growth rate was not correlated with the initial level of per capita real income in East Asian countries.

Malaysia, Philippines, Taiwan, Thailand, and Singapore. These nine countries were particularly chosen by the observation that recent growth in East Asian countries was miraculous.

Except for the use of the East Asian coefficient dummy on the initial level of per capita real income, this type of linear regression with three explanatory variables is a standard one in recent studies of endogenous economic growth (for example, Barro 1991; Fischer 1991; Mankiw, Romer, and Weil 1992; Levine and Renelt 1992). We estimated this basic equation by using the data sets supplied by Barro and Wolf (1989) and Mankiw, Romer, and Weil (1992); Cross-sectional data sets which augmented the Real National Accounts constructed by Summers and Heston (1988). Sample periods of the estimations are 1960-85 in the data set of Mankiw, Romer, and Weil and 1970-85 in that of Barro and Wolf.<sup>3</sup> The data sets include almost all of the world other than centrally planned economies. See Data Appendix for their details.

<sup>3</sup>In Barro's data base, the data set from 1960 to 1985 is also available. We do not use this data set partly because it is similar to the data set of Mankiw,

Table 1 summarizes our regression results. Except for the estimate of " $a_2$ ", all estimates were consistent with previous studies and most of them were significant. In particular, regardless of the choice of data sets or the East Asian dummy, the estimate of " $a_1$ " was significantly negative, implying that there was evidence of strong convergence in the world economy. However, the estimate of " $a_2$ " was significantly positive in all cases. Moreover, when we used the Barro-Wolf's data set from 1970 to 1985, the absolute value of " $a_2$ " is significantly greater than that of " $a_1$ ". This implies that per capita income levels have diverged rather than converged in East Asian countries. In other words, East Asian countries had little tendency of the convergence for the last few decades and that this non-convergent tendency became more conspicuous after 1970. In the following section, we explore what caused such non-convergent in East Asian countries.

### III. The Role of School-Enrollment Rates

As explained in the introduction, most of recent empirical studies on endogenous growth models mainly focused on human capital accumulation through schooling. These studies proposed that once we allow the difference in school-enrollment rates (say, the enrollment rate in secondary school), the cross-country evidence strongly supports the convergence hypothesis in neoclassical growth models. A basic idea of these studies is that higher enrollment rate in school means higher accumulation of human capital. Thus, as long as higher human capital means higher economic growth, higher enrollment rate in school may lead to higher economic growth.

In order to check the validity of this conjecture in East Asian countries, this section examines the basic equation allowing the difference in school-enrollment rates. We ran a regression for the following equation:

$$\begin{aligned} GYP_t = & a_1 \times RY_{0t} + a_2 \times AD_t \times RY_{0t} + b \times INV_t + c \times GN_t \\ & + d_1 \times HC_t + d_2 \times AD_t \times HC_t, \end{aligned} \quad (2)$$

where  $HC_t$  is the human capital proxy in country  $i$ . For the human capital proxy, we used the percentage of working-age population in the secondary school for the data set of Mankiw, Romer, and Weil<sup>4</sup> and the

Romer, and Weil and partly because the data from 1970 to 1985 is more consistent with our analysis.



**TABLE 2**  
THE TESTS OF CONVERGENCE HYPOTHESIS GIVEN THE LEVELS OF SCHOOL  
ENROLLMENT RATES

	<i>BW</i>	<i>BW</i>	<i>MRW</i>	<i>MRW</i>
constant	0.0602 (3.5542)	0.0433 (2.6201)	0.0584 (1.8611)	0.0605 (1.9294)
$RY_0$	-0.0146 (-3.9295)	-0.0110 (-3.0483)	-0.0083 (-3.4015)	-0.0088 (-3.5609)
$AD \times RY_0$	0.0207 (2.6707)	0.0147 (1.9731)	0.0026 (3.8704)	0.0050 (2.3132)
<i>INV</i>	0.0272 (5.1186)	0.0235 (4.6150)	0.0195 (5.8687)	0.0194 (5.8348)
<i>GN</i>	-0.0055 (-1.9175)	-0.0061 (-2.2803)	-0.0184 (-1.6887)	-0.0185 (-1.7045)
<i>HC</i>	0.0061 (2.5819)	0.0041 (1.8172)	0.0016 (2.4088)	0.0018 (2.6399)
$AD \times HC$		-0.0150 (-3.7346)		-0.0023 (-1.1750)
adj. $R^2$	0.3427	0.4222	0.5211	0.5231
sample size	100	100	98	98

Notes: 1) The columns of *BW* show cross-sectional regressions of 101 countries based on the data set of Barro and Wolf (1989). The columns of *MRW* show cross-sectional regressions of 99 countries based on the data set of Mankiw, Romer, and Weil (1992).

2) *t*-values in the parentheses.

log of the enrollment rate in secondary school for the Barro's data set. See Data Appendix for the details.

Table 2 reports the regression results. In all cases, the inclusion of a school-enrollment rate variable (i.e., *HC*) substantially improved the fitness of the model, especially the significance level of " $a_1$ " (i.e., negative effect of the initial level of real income). Thus, the allowance for the difference of school-enrollment rates made the convergence hypothesis more relevant in most of countries. However, the allowance for the difference of school-enrollment rates caused no significant change in the estimate of " $a_2$ "; the estimate of " $a_2$ " was still significantly positive in any cases. Furthermore, the estimated coefficient of the East Asian dummy on the school-enrollment rate variable (i.e., " $d_2$ ") was negative in any cases and its absolute value was greater than that of " $d_1$ ". In

<sup>4</sup>In the cross-sectional studies based on the data set of Mankiw, Romer, and Weil (1991), Taiwan was excluded from the sample because the data of human capital is not available in the data set.

particular, the estimate of " $d_2$ " was significant in the case of Barro-Wolf's data set from 1970 to 1985.

The above result implies that the level of school-enrollment rates played no special role for miraculous East Asian economic development and that allowing its difference does not change the non-convergence tendency in East Asian countries. In particular, it suggests that school-enrollment rates only had negligible effects on East Asian economic development, especially after 1970.

#### IV. The Role of Government Expenditure on Education

If the quality of education is important in accumulating human capital, variables such as school-enrollment rates are no longer good proxies for human capital. Although the adjustments of the quality of education are very difficult tasks, the adjustments are partly possible if we use government expenditure on education as proxies for human capital. From this point of view, this section investigates whether the allowance of government expenditure on education will change our basic results in the previous sections. We ran a regression as follows:

$$\begin{aligned} GYP_i = & a \times RY_{0i} + b \times INV_i + c \times GN_i \\ & + e_1 \times GE_i + e_2 \times AD_i \times GE_i \end{aligned} \quad (3)$$

where  $GE_i$  is the share of government expenditure on education in GDP.

Since the data of government expenditure on education for most of countries is available only after 1970, we only used the Barro-Wolf's data set from 1970 to 1985. We estimated this equation with and without the East Asian coefficient dummy on  $RY_0$ . Table 3 summarizes the regression results. Except for East Asian countries, government expenditure on education had a significantly negative effect on the rate of economic growth. (That is, the estimate of " $e_1$ " was significantly negative in any cases.) This result implies that in accumulating the high quality of human capital, the rate of government expenditure on education was negligible (and rather harmful) in most of countries. However, when we included an East Asian dummy in the coefficient of government expenditure on education, the coefficient of this dummy variable (i.e., " $e_2$ ") was significantly positive and its absolute value was much larger than that of non East Asian countries (i.e., " $e_1$ "). In addition, the estimate of " $a_2$ " (i.e., the coefficient of the East Asian dummy on the initial level of real income) became much less significant in this case,

**TABLE 3**  
THE ROLE OF GOVERNMENT EXPENDITURE ON EDUCATION

	<i>BW</i>	<i>BW</i>	<i>BW</i>
constant	0.0504 (3.0537)	0.0502 (3.0047)	0.0119 (2.0497)
$RY_0$	-0.0058 (-2.1936)	-0.0058 (-2.1670)	
$AD \times RY_0$		0.0009 (0.0985)	
<i>INV</i>	0.0271 (4.9534)	0.0270 (4.9138)	
<i>GN</i>	-0.0064 (-2.5756)	-0.0064 (-2.5615)	
<i>GE</i>	-0.3271 (-2.5161)	-0.3253 (-2.4654)	0.0244 (0.1871)
$AD \times GE$	0.7792 (4.6749)	0.7686 (3.8632)	1.0340 (5.6848)
<i>T-STAT</i> (1)		-0.5742	
<i>T-STAT</i> (2)	1.9876	1.8065	4.6507
adj. $R^2$	0.4311	0.4251	0.2326
sample size	101	101	101

Notes: 1) Cross-sectional regressions are based on the data set of Barro and Wolf (1989).

2) *t*-values in the parentheses.

3) *T-STAT* (1) denotes *t*-values for the hypothesis that growth rate was not correlated with the initial level of per capita real income in East Asian countries.

4) *T-STAT* (2) denotes *t*-values for the hypothesis that the share of government expenditure on education in GDP has no effect on the growth rate in East Asian countries.

showing that once we allow the different level of government expenditure on education, the cross-country evidence almost supports the convergence hypothesis even in East Asian countries.

These results imply that human capital accumulation through government expenditure on education contributed largely to non-convergent economic growth in East Asian countries. The results also indicate that the high quality of human capital in East Asian countries can be measured well by government expenditure on education rather than by school enrollment rates.

The importance of government expenditure on education in East Asian countries may be more directly seen in Table 4. For four groups of countries (that is, OECD countries, East Asian countries, Latin

**TABLE 4**  
GROWTH RATES AND THE LEVEL OF HUMAN CAPITAL IN FOUR GROUPS OF COUNTRIES

	Periods	OECD	East Asia	Latin America	Africa
Growth rates	60-85	0.028	0.051	0.014	0.013
	70-85	0.023	0.051	0.006	0.006
Enrollment rates for primary school	1960	1.105	0.924	0.850	0.492
	1970	1.070	0.991	0.920	0.673
	1985	1.010	1.040	1.029	0.836
Enrollment rates for secondary school	1960	0.524	0.275	0.191	0.046
	1970	0.725	0.428	0.306	0.105
	1985	0.894	0.659	0.501	0.256
Literacy rates	1960	0.962	0.639	0.661	0.208
Shares of G.E. on education	70-85	0.357	0.325	0.235	0.212

Notes: 1) Japan was included in the sample of East Asia and was excluded from the sample of OECD.

2) Based on the data set of Barro and Wolf (1989), data was calculated by authors.

3) Shares of G.E. on education denote the shares of average government expenditure on education in the total government expenditures.

American countries, and African countries), Table 4 shows the averages of growth rates, school-enrollment rates, literacy rates, and the shares of expenditure on education in the total government expenditures. In the table, we can see that East Asian countries had relatively high shares of government expenditure on education as well as high growth rates. We can also see that school enrollment rates and literacy rates in East Asian countries were higher than those in African countries. However, compared with Latin American countries (and OECD countries), East Asian countries had neither high school enrollment rates in primary school nor literacy rates. These results suggest that in explaining miraculous (and non-convergent) economic growth in East Asian countries, the high quality of human capital through a significant size of government expenditure on education is more important than school enrollment rates or literacy rates.<sup>5</sup>

<sup>5</sup>The recent report by World Bank (World Bank, 1993) showed a similar view with ours (see Chapter 5 in the report). The report also demonstrated that the weight of government expenditure on primary education was large in East Asian

## V. The Role of Other Government Expenditures

As explained in the introduction, some recent studies on endogenous growth have shown that an increase in the share of government consumption in GDP has a negative effect on the rate of economic growth (for example, Barro 1990). The empirical result in the last section, on the other hand, indicated that this result no longer carried through in East Asian countries if we confine our attention to government expenditure on education. Besides government expenditure on education, it is now curious to see whether the effects of government consumption in East Asian countries are different from those of other countries. We estimated the following regression:

$$GYP_t = a \times RY_{0t} + b \times INV_t + c \times GN_t + e_1 \times GE_t + e_2 \times AD_t \times GE_t + f_1 \times GC_t + f_2 \times AD_t \times GC_t, \quad (4)$$

where  $GC_t$  is the share of government consumption exclusive of education and defense service in GDP.

Since the data of government consumption exclusive of education and defense service is available only after 1970 for most of countries, we only used the Barro-Wolf's data set from 1970 to 1985. We estimated this equation with and without the East Asian coefficient dummies. As is apparent in Table 5, the estimated coefficient of  $GC_t$  (i.e., " $f_1$ ") was significantly negative in any cases. However, the estimated coefficient of the East Asian dummy (i.e., " $f_2$ ") was significant in no case. This suggests that besides government expenditure on education, an increase in government service has a negative effect on the rate of economic growth in East Asian countries as well as in other countries.<sup>6</sup>

For the effect of public investment on economic growth, a slightly different result has been discussed in previous literature. For example, Barro (1990) has shown that an increase in the share of public investment has no significant effect on the rate of economic growth. The argument was that when governments optimize the size of productive public services, positive effects of productive public services is canceled

countries.

<sup>6</sup>We also examined whether the share of government expenditure on defense in GDP has some significant effect on economic growth. However, no estimated coefficient of government expenditure on defense in GDP was significantly different from zero.

**TABLE 5**  
THE EFFECTS OF GOVERNMENT CONSUMPTION ON ECONOMIC GROWTH

	BW	BW	BW
constant	0.0580 (3.5515)	0.0583 (3.5256)	0.0582 (3.5719)
$RY_0$	-0.0093 (-3.1985)	-0.0093 (-3.1020)	-0.0094 (-3.2445)
$AD \times RY_0$		-0.0014 (-0.1567)	
INV	0.0278 (5.2099)	0.0278 (5.1837)	0.0279 (5.2460)
GN	-0.0072 (-2.9549)	-0.0072 (-2.9117)	-0.0072 (-2.9727)
GE	-0.2566 (-1.9559)	-0.2606 (-1.9398)	-0.2471 (-1.9035)
$AD \times GE$	0.7670 (2.9490)	0.7976 (2.4446)	0.6484 (3.8322)
GC	-0.0972 (-2.4763)	-0.0968 (-2.4479)	-0.1013 (-2.6279)
$AD \times GC$	-0.0750 (-0.6018)	-0.0832 (-0.6130)	
adj. $R^2$	0.4607	0.4550	0.4644
sample size	101	101	101

Notes: 1) Cross-sectional regressions are based on the data set of Barro and Wolf (1989).

2)  $t$ -values in the parentheses.

out by distorting effects from taxation. To see the validity of his result in our framework, we estimated the following regression:

$$\begin{aligned} GYP_i = & a \times RY_{0i} + b \times INV_i + c \times GN_i + e_1 \times GE_i + e_2 \\ & \times AD_i \times GE_i + g_1 \times GI_i + g_2 \times AD_i \times GI_i \end{aligned} \quad (5)$$

where  $GI_i$  is the share of government investment in GDP.

Since the data of government investment is available only after 1970 for most of countries, we only used the Barro-Wolf's data set from 1970 to 1985. We estimated this equation with and without the East Asian coefficient dummies. Table 6 reports the estimation results. The estimated coefficient of  $GI_i$  (i.e., " $g_1$ ") was not significant in any cases. The estimated coefficient of the East Asian coefficient dummy (i.e., " $g_2$ ") was not significantly different from zero either, although it always took negative sign. This suggests that as in other countries, an increase in government investment only has a negligible effect on the rate of economic

**TABLE 6**  
THE ROLE OF GOVERNMENT INVESTMENT IN EAST ASIAN COUNTRIES

	<i>BW</i>	<i>BW</i>	<i>BW</i>
constant	-0.0463 (-0.9013)	-0.0519 (-1.0111)	-0.0454 (-0.8844)
$RY_0$	-0.0085 (-2.3366)	-0.0084 (-2.3193)	-0.0090 (-2.5228)
$AD \times RY_0$		0.0358 (1.2662)	
<i>INV</i>	0.0298 (3.6739)	0.0280 (3.4262)	0.0301 (3.7256)
<i>GN</i>	-0.0475 (-2.6868)	-0.0479 (-2.7198)	-0.0475 (-2.6893)
<i>GE</i>	-0.2217 (-1.4138)	-0.2023 (-1.2897)	-0.1916 (-1.2478)
$AD \times GE$	0.9325 (2.2913)	1.4469 (2.5218)	0.5870 (3.0439)
<i>GI</i>	-0.0126 (-0.0778)	0.0092 (0.0567)	-0.0496 (-0.3161)
$AD \times GI$	-0.5016 (-0.9643)	-1.9507 (-1.5530)	
adj. $R^2$	0.4120	0.4172	0.4126
sample size	76	76	76

Notes: 1) Cross-sectional regressions of 76 countries are based on the data set of Barro and Wolf (1989).

2) *t*-values in the parentheses.

growth in East Asian countries.

## VI. Exports and the Conditional Convergence in East Asian Countries

Until previous sections, we have discussed the role of human capital accumulation for economic growth and found that government expenditure on education played an important role in East Asian countries. We have also shown that once we allow the difference in the level of government expenditure on education, the cross-country evidence almost supports the convergence hypothesis even in East Asian countries. However, even if we allow the difference in the level of government expenditure on education, the significance level of the convergence in East Asian countries was not high enough in our cross-country studies (see *T-STAT* (1) in Table 3).

**TABLE 7**  
THE TESTS OF CONVERGENCE HYPOTHESIS GIVEN THE EXPORT-GDP RATIOS

	<i>BW</i>	<i>BW</i>
constant	0.0498 (3.0493)	0.0512 (3.1353)
$RY_0$	-0.0062 (-2.4035)	-0.0058 (-2.2415)
$AD \times RY_0$		-0.0111 (-1.1435)
<i>INV</i>	0.0273 (5.0980)	0.0276 (5.1601)
<i>GN</i>	-0.0068 (-2.7675)	-0.0066 (-2.7171)
<i>GE</i>	-0.2491 (-1.8925)	-0.2612 (-1.9818)
$AD \times GE$	0.3822 (1.6788)	0.4199 (1.8281)
<i>X</i>	-0.0159 (-1.4756)	-0.0162 (-1.5051)
$AD \times X$	0.0540 (2.5494)	0.0666 (2.7929)
<i>T-STAT</i>		-1.7406
adj. $R^2$	0.4573	0.4590
sample size	101	101

Notes: 1) Cross-sectional regressions are based on the data set of Barro and Wolf (1989).

2) *t*-values in the parentheses.

3) *T-STAT* denotes *t*-value for the hypothesis that growth rate was not correlated with the initial level of per capita real income in East Asian countries.

The purpose of this section is to investigate whether the result of weaker convergence in East Asian countries was due to the exclusion of export variable in the regression. The investigation was motivated by the fact that the successful promotion of exports has been primarily responsible for East Asian rapid industrialization. For example, in Korea, the phenomenal increase in export earnings accounted for about one-third of the increase in output growth between 1955 and 1975. Although the period of rapid economic growth may be different, similar evidence can be found for other Asian NIEs countries and most of ASEAN countries.

We estimated the following equation:



$$\begin{aligned}
 GYP_i = & a_1 \times RY_{0i} + a_2 \times AD_i \times RY_{0i} + b \times INV_i + c \times GN_i + e_1 \\
 & \times GE_i + e_2 \times AD_i \times GE_i + h_1 \times X_i + h_2 \times AD_i \times X_i
 \end{aligned}
 \quad (6)$$

where  $X_i$  is the share of exports in GDP (see Data Appendix for the details).

By using the data set of Barro-Wolf from 1970 to 1985, we estimated this equation with the East Asian coefficient dummy on the share of exports in GDP. Table 7 summarizes our regression results. Except for the estimate of " $a_2$ ", the inclusion of export variable did not change the basic properties. In particular, the effects of government expenditure on education (i.e., " $e_1$ " and " $e_2$ ") did not change even if we allow the role of exports. However, the inclusion of export variable in the regression led to two noteworthy results. The first was that the inclusion of export variable made the estimate of " $a_2$ " negative. In particular,  $t$ -value for the hypothesis that the sum of " $a_1$ " and " $a_2$ " is zero (i.e.,  $T$ -STAT in Table 7) took some negative value, although its significance level was not so high. This result implies that given the export-GDP ratios, there is more strong tendency of convergence even in East Asian countries. The second was that the coefficient of export variable without East Asian dummy (i.e., " $h_1$ ") was negative. This suggests that exports might have played a special role for economic development in East Asian countries.

## VII. Concluding remarks

This paper investigated the role of human capital accumulation in East Asian countries (that is, Asian NIEs countries, ASEAN countries, and Japan). The paper first found that even if we allowed the difference in school-enrollment rates, there was no strong tendency of convergence in East Asian countries. The paper then showed that government expenditure on education had a significantly positive effect on economic development and partly explained the non-convergent economic growth in East Asian countries. The paper also showed that exports played a special role in explaining the convergence hypothesis in East Asian countries.

If the quality of education is important in accumulating human capital, variables such as school-enrollment rates are no longer good proxies for human capital. Although the adjustments of the quality of education are very difficult tasks, the adjustments are partly possible if we use government expenditure on education as proxies for human ca-

pital. Our empirical results indicated that at least in East Asian countries, human capital accumulation through government expenditure on education was particularly important for economic development. Thus, in future research, the quality of human capital deserves to be allowed in investigating the sources of miraculous economic growth.

### **Appendix: Data**

In the text, we ran regressions based on various data sets. The details of the data sets are as follows.

The data of real GDP (if not, GNP), investment ratios, and population are based on Barro and Wolf (1989) and Mankiw, Romer, and Weil (1992). These cross-sectional data sets implemented the Mark IV data sample described in Summers and Heston (1988). Sample periods of the estimations are 1960-85 in the data set of Mankiw, Romer, and Weil and 1970-85 in that of Barro and Wolf.

For the data of school enrollment rate variable, we used two alternative data sets. When we ran a regression based on the data set in Mankiw, Romer, and Weil (1992), we used the human capital data in Mankiw, Romer, and Weil (1992), which is the percentage of the working-age population that is in secondary school. The data of Taiwan was not available in this data set. When we ran a regression based on the data set in Barro and Wolf (1989), we used the enrollment rate of secondary school in 1960, which was originally taken from *UNESCO Statistical Yearbooks*, various issues. The data of Oman was not available in this data set.

The data of government consumption (that is, government expenditure on education, government consumption net of education and defense service, and government investment) are based on Barro and Wolf (1989). The data was originally taken from *UNESCO Statistical Yearbooks* (various issues), *IMF Government Financial Statistics* (various issues), *IMF International Financial Statistics* (various issues), and Summers and Heston (1988).

For the data of the export-to-GDP ratios, the data was taken from Georg P. Muller, *Comparative World Data* (The John Hopkins University Press, 1988) (and if not, *International Financial Statistics Yearbook*, various issues).

## References

- Balassa, B. "Exports and Economic Growth: Further Evidence." *Journal of Development Economics* (1978): 181-9.
- Barro, R.J. "Government Spending in a Simple Model of Endogenous Growth." *Journal of Political Economy* 98 (1990): S103-S25.
- \_\_\_\_\_. "Economic Growth in a Cross Section of Countries." *Quarterly Journal of Economics* 106 (1991): 407-43.
- Barro, R.J., and Lee J.-W. "International Comparisons of Educational Attainment." NBER Working Paper 4349 (1993). (a)
- \_\_\_\_\_. "Losers and Winners in Economic Growth." NBER Working Paper 4341 (1993). (b)
- Barro, R.J., and Wolf, H.C. "Data Appendix for Economic Growth in a Cross Section of Countries." mimeo (1989).
- Baumol, W.J. "Productivity Growth, Convergence and Welfare: What the Long Run Data Show." *American Economic Review* 76 (1986): 1072-85.
- Becker, G.S., Murphy, K.M., and Tamura, R. "Human Capital, Fertility, and Economic Growth." *Journal of Political Economy* 98 (1990): S12-S37.
- Dowrick, S., and Nguyen, D.-T. "OECD Comparative Economic Growth 1950-85: Catch-Up and Convergence." *American Economic Review* 79 (1989): 1010-30.
- Fischer, S. "Growth, Macroeconomics, and Development." In O. Blanchard and S. Fischer (eds.), *NBER Macroeconomics Annual 1991*. Cambridge: MA, M.I.T. Press.
- Fukuda, S., and Toya, H. "The Conditional Convergence in East Asian Countries: The Role of Exports for Economic Growth." Paper presented at the NBER Fourth Annual East Asian Seminar on Economics, (June 1993), San Francisco.
- Grier, K.B., and Tullock, G. "An Empirical Analysis of Cross-national Economic Growth, 1951-1980." *Journal of Monetary Economics* 24 (1989): 259-76.
- Helliwell, J. "International Growth Linkages: Evidence From Asian and the OECD." NBER Working Paper 4245 (1992).
- Krueger, A. "Trade Policy as an Input to Development." *American Economic Review* 70 (1980): 288-92.
- Levine, R., and Renelt, D. "A Sensitivity Analysis of Cross-country Growth Regressions." *American Economic Review* 82 (1992): 942-63.
- Lucas, R.E. "On the Mechanics of Economic Development." *Journal of Monetary Economics* 22 (1988): 3-42.
- \_\_\_\_\_. "Making a Miracle." *Econometrica* 61 (1993): 251-72.
- Mankiw, N.G., Romer, D., and Weil, D.N. "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics* 108 (1993): 407-37.
- Murphy, K.M., Shleifer, A., and Vishny, R.W. "The Allocation of Talent: Implication For Growth." *Quarterly Journal of Economics* 106 (1991): 503-30.

- Rebelo, S. "Long-Run Policy Analysis and Long-Run Growth." *Journal of Political Economy* 99 (1991): 500-21.
- Romer, P.M. "Increasing Returns and Long-Run Growth." *Journal of Political Economy* 94 (1986): 1002-37.
- \_\_\_\_\_. "Human Capital and Growth: Theory and Evidence." *Carnegie-Rochester Conference Series on Public Policy* 32 (1990): 251-86.
- Solow, R. "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics* 70 (1956): 65-94.
- Summers, R., and Heston, A. "A New Set of International Comparisons of Real Product and Price Levels: Estimations for 130 Countries." *Review of Income and Wealth* 34 (1988): 1-25.
- World Bank. *The East Asian Miracle*, New York, NY: Oxford University Press. 1993.

**Comment**

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It is my pleasure and honor to have the opportunity to make comments on this very interesting paper. Firstly, I would like to point out that we should be careful when interpreting these empirical results because econometric models cannot be justified as representing causal relationships w/o paper theoretical models. For example, the economic growth rate and the human capital accumulation can move in the same direction endogenously by a certain set of exogenous government policies and political variables. In this case, the level of human capital and economic growth rate correlate positively with each other, but human capital itself does not cause the economy grow faster. In this context, I would like to make comments on the empirical findings of this paper.

Even though we have the negative sign on the variable, GNP per capita, in the growth regression with additional variables plugged in, it is hard to believe the "convergence", unless we have a *good theoretical model* behind those additional variables in the regression.

This paper has two major empirical findings; one is the positive sign, in the growth regression, on the variable, government subsidy on education for East Asian countries, whereas *it is not for the other countries*, and the other is that the export variable has been shown to have positive effect on the economic growth rate of East Asian countries, whereas *it has not of the other countries*. At this point, the important questions are what causes the process of development of East Asian countries differ from that of other countries, and what we can learn from these empirical findings for the development strategy.

For the first empirical finding, it is essential to understand what kind of role the education has played in the development process of East Asian countries. In Romer's paper (1992), it is said that ideas are most important factor for the economic development and that human capital, just a connection of neurons, and ideas are closely related as inputs and outputs. The value of human capital can be increased by

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new ideas and ideas are critical input in the production of more valuable human capital. Depending on the stage of development of a certain country, the role of human capital of this country can be different from that of other countries. For example, the newly developing countries may use human capital to learn ideas from developed countries following quality ladder theory, whereas developed countries may use human capital relatively more for the creation of new ideas. Some less developed countries probably do not have any opportunity to learn nor create any idea such that their value of human capital is very small. Therefore, the effect of human capital on a certain country's economic growth depends on the role of human capital, which is also determined by this country's development stage and strategy. With this setup, we can infer, from the first empirical finding, that East Asian countries effectively use human capital to learn ideas from developed countries and that government subsidy on education payoff for this purpose, whereas it may not for the other purpose. This hypothesis would be tested by setting up a proper econometric model.

For the second empirical finding, we should also ask what kind of role export has played in the development process of East Asian countries. If we would like to focus on technology transfer effect through trade, then share of trade in GDP,  $(\text{export} + \text{import})/\text{GDP}$ , might be a better proxy than  $\text{export}/\text{GDP}$ . Additionally, the variable, the ratio of manufactures exports plus machinery imports to value added of manufacturing sector, will be more appropriate, considering that technology transfer occurs mainly through these channels. Moreover, we are able to construct a better proxy which can capture that technology transfer will be greater if trading partner's technology level is higher. Now, I am curious to know whether we can get the same result with the second empirical finding with these variables. According to the above story, the second empirical finding may imply that East Asian countries make trades mainly with technologically more advanced countries and in the technology intensive sector, maximizing technology transfer through trade.

My point, here, is that even though this paper's empirical findings are very interesting, still we should try to understand the economic stories behind them more accurately and that we had better pursue more exact empirical studies to test whether these stories are more consistent with the data than others. Thank you.

**Reference**

- Helliwell, John F. "Trade and Technology Progress." NBER Working Paper 4226 (December 1992).
- Romer, Paul M. "Two Strategies for Economic Development: Using Ideas and Producing Ideas." Proceedings of the World Bank Annual Conference on Development Economics (1992).