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Chapter Author: Shin-ichi Fukuda, Hideki Toya

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10 Conditional Convergence in East Asian Countries: The Role of Exports in Economic Growth

Shin-ichi Fukuda and Hideki Toya

10.1 Introduction

One of the main implications of Solow-type neoclassical growth models (Solow 1956) is a notion of "convergence" according to which developing countries grow faster than developed countries given the growth rates of technology and population. In particular, if countries are similar with respect to structural parameters, 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 economies (e.g., Baumol 1986), this convergence hypothesis in neoclassical growth models seems to be inconsistent with various cross-country studies. Moreover, recent endogenous growth models, such as Romer's (1986), show that without diminishing returns to capital, the growth rate of per capita product is independent of the starting level of per capita product.

The purpose of this paper is to investigate whether there is a tendency to convergence in East Asian countries (i.e., the Asian newly industrialized economies [NIEs], the ASEAN countries, and Japan). Our interest in the subject of this paper was originally stimulated by the observation that recent growth in East Asian countries was miraculous. We first present the cross-country evidence that per capita growth rates in East Asian countries have little correlation with the starting level of per capita product even if we allow for the difference in the level of human capital. We then show that, given the export-GDP ratios, subsequent growth rates in East Asian countries are negatively related to the initial level of per capita GDP.

Shin-ichi Fukuda is associate professor at the Institute of Economic Research, Hitotsubashi University. Hideki Toya is a graduate student of economics at Hitotsubashi University.

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In the previous literature of development economics, a number of studies stressed a special role for exports in economic growth (e.g., Balassa 1978; Krueger 1980; Feder 1982; Edwards 1992). These studies highlighted various beneficial aspects of exports and international trade: 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. 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 (see Edwards 1993 for a survey).

However, in recent studies based on endogenous growth models, the results were mixed on the hypothesis that exports play a special role in economic development. In particular, several theoretical studies showed that the relation between international trade and economic growth was very ambiguous.[1] Even in empirical studies, the cross-country evidence showed that per capita growth rates had little correlation with the export-GDP ratios once the regression included other important variables (see, e.g., Kormendi and Meguire 1985; Levine and Renelt 1992).[2]

Focusing on economic development in East Asian countries, this paper reexamines the role of exports in economic growth models. We show that exports have played a special role in the economic development of East Asian countries. This explains why the role of exports in economic development was ambiguous in previous cross-sectional studies. This result is also consistent with many studies which propose that the successful promotion of exports has been primarily responsible for rapid industrialization in East Asian countries (see, e.g., Park 1988).

In the previous literature, there are several related studies which focused on a unique development pattern of Asian countries based on a recent endogenous growth framework. In particular, Grier and Tullock (1989) and Helliwell (1992) showed that there was little evidence to support the convergence hypothesis in Asian countries. Our result is in marked contrast with these studies in that we support the conditional convergence hypothesis for East Asian countries. That is, once we allow for a special role for exports, our empirical result supports the convergence hypothesis in East Asian countries.

Needless to say, the special role of exports may not be the only important factor explaining East Asian rapid economic development. For example, the increase in foreign direct investment (from, say, Japan) may be another im-

1. While Rivera-Batiz and Romer (1991) showed the positive linkage between international trade and economic growth, several theoretical studies such as Grossman and Helpman (1991) and Young (1991) showed that the relation between international trade and economic growth is very ambiguous (see Roubini and Sala-i-Martin 1991 for a survey).

2. Levine and Renelt (1992) showed that the ratio of exports to GDP is not robustly correlated with growth when investment is included as an explanatory variable.

portant factor in the rapid economic growth. Relatively stable political conditions may be another important source of East Asian growth. This paper does not rule out these possibilities. Instead, our empirical result tries to propose an independent special role for exports, which these other important factors could not play in East Asian economies.

The paper is organized as follows. Section 10.2 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 10.3 shows that, given the export-GDP ratios, subsequent growth rates in East Asian countries are negatively related to the initial level of per capita GDP. Section 10.4 investigates the role of government in East Asian economic development. Section 10.5 explores the ability of our model to predict East Asian rapid economic growth in the 1980s. Section 10.6 summarizes our main results and discusses their implications.

10.2 The Weak Convergence Tendency

This section examines whether the convergence hypothesis in neoclassical growth models has held in East Asia over the last few decades. A basic equation we estimate is the following:

$$(1) \qquad GYP_{it} = a_1 * RYO_{it} + a_2 * AD_i * RY0_{it} + b * INV_{it} + c * GN_{it},$$

where GYP is the growth rate of real per capita income, RY0 is log of the initial level of (Summers-Heston) per capita real income, INV is the log of the share of investment in GDP, and GN is the log of the rate of population growth plus 0.05.[3] AD_i is the East Asian dummy, which is one when country i is one of the nine East Asian countries and zero otherwise. The nine East Asian countries are Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Taiwan, Thailand, and Singapore.

Except for the use of an East Asian coefficient dummy for the initial level of per capita real income, this type of linear regression with three explanatory variables has been quite common in recent studies of endogenous economic growth (e.g., Barro 1991; Fischer 1991; Mankiw et al. 1992; and Levine and Renelt 1992). We estimated this basic equation by three alternative data sets: cross-sectional and pooled data sets based on the real national accounts constructed by Summers and Heston (1988, 1990), and a pooled data set based on the *International Financial Statistics* (*IFS*) of the International Monetary Fund. In the cross-sectional data sets, we included almost all of the world other than centrally planned economies. In pooling the data, we used five-year averaged data for G7 and East Asian countries. See the data appendix for details.

3. The number 0.05 follows Mankiw, Romer, and Weil (1991).

Table 10.1 **Tests of the Convergence Hypothesis in East Asia**

Variable	SH-A	SH-B	IFS-B
Constant	0.037	−0.012	0.029
	(1.191)	(−0.167)	(0.418)
RY0	−0.005	−0.006	−0.010
	(−2.574)	(−1.472)	(−2.825)
AD*RY0	0.003	0.002	0.002
	(5.236)	(2.993)	(1.948)
INV	0.022	0.015	0.029
	(6.802)	(1.967)	(3.319)
GN	−0.021	−0.037	−0.045
	(−1.927)	(−1.365)	(−1.899)
Adjusted R^2	0.517	0.230	0.376

Notes: SH-A is a cross-sectional regression of 99 countries based on the Summers-Heston data set. SH-B and IFS-B are pooled regressions of G7 and East Asian countries based on the Summers-Heston data set and *IFS*, respectively. Numbers in parentheses are *t*-values.

Table 10.1 summarizes our regression results. Except for the estimates of a_2, all estimates were consistent with previous studies and most were significant. In particular, regardless of the choice of data set, the estimates of a_1 were negative; that is, there was evidence of strong convergence in the world economy. However, the estimates of a_2 were significantly positive in all cases. This implies that even if we allow for the rate of investment and population growth, there is a much weaker tendency to convergence in East Asian countries.

The basic results do not change even if we allow for human capital, which plays an important role in most recent endogenous growth models. We ran a regression for the following equation:

$$\text{GYP}_{it} = a_1 * \text{RY0}_{it} + a_2 * \text{AD}_i * \text{RY0}_{it} + b * \text{INV}_{it} + c * \text{GN}_{it} + d * \text{HC}_i, \tag{2}$$

where HC is the investment rate for human capital, which is proxied by the log of the secondary school enrollment rate (see the data appendix for details about HC_i).

Except for the use of an East Asian coefficient dummy, the estimated equation is essentially the same as that estimated in Barro (1991) and Mankiw et al. (1992). A higher school enrollment rate means a higher accumulation of human capital. Thus, if higher human capital means higher economic growth, a higher school enrollment rate may lead to higher economic growth. Table 10.2 reports the regression results. Inclusion of a proxy for human capital substantially improved the fit of the model, especially the significance level of the negative coefficient of RY0. However, the estimates of a_2 were still significantly positive in all cases, implying much weaker convergence in East Asian

Table 10.2 **Tests of the Convergence Hypothesis Given the Level of Human Capital**

Variable	SH-A	SH-A	SH-B	SH-B	IFS-B	IFS-B
Constant	0.074	0.074	0.067	0.073	0.044	0.048
	(2.251)	(2.239)	(0.844)	(0.908)	(0.632)	(0.729)
RY0	−0.009	−0.009	−0.010	−0.011	−0.010	−0.015
	(−3.784)	(−3.772)	(−2.387)	(−2.435)	(−2.826)	(−3.872)
AD*RY0	0.003	0.003	0.002	0.003	0.002	0.004
	(4.054)	(1.041)	(3.032)	(2.437)	(2.297)	(3.613)
INV	0.019	0.019	0.017	0.013	0.028	0.029
	(5.797)	(5.745)	(2.291)	(1.611)	(3.182)	(3.494)
GN	−0.025	−0.025	−0.029	−0.024	−0.041	−0.053
	(−2.329)	(−2.321)	(−1.076)	(−0.882)	(−1.684)	(−2.251)
HC	0.006	0.006	0.011	0.003	0.005	−0.006
	(2.795)	(2.781)	(2.058)	(0.232)	(1.314)	(−1.022)
AD*HC		0.002		0.011		0.022
		(0.243)		(0.884)		(2.724)
Adjusted R^2	0.531	0.526	0.259	0.257	0.381	0.426

Notes: SH-A is a cross-sectional regression of 98 countries based on the Summers-Heston data set. SH-B and IFS-B are based on the same data sets as in table 10.1. Numbers in parentheses are *t*-values.

countries. Furthermore, the essential result did not change even if we added an East Asian coefficient dummy on the human capital variable.[4]

In previous studies such as Barro (1991) and Mankiw et al. (1992), it was shown that, once we allowed for differences in human capital, the cross-country evidence supported the convergence hypothesis in neoclassical growth models. Our result is in marked contrast with these previous studies because the data still showed little supporting evidence for the convergence hypothesis given the level of human capital. The following sections explore why the data do not support the convergence hypothesis in East Asian countries.

10.3 Exports and Conditional Convergence

In Asian NIES, it is widely believed that the successful promotion of exports has been primarily responsible for 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 the other Asian NIES, i.e., Taiwan, Hong Kong, and Singapore. Even in the ASEAN countries, similar evidence is found, conspicuously for Thailand and

4. In the cross-sectional studies based on Summers and Heston's data, Taiwan was excluded from the sample because data on human capital are not available in the data set of Mankiw et al. (1992).

Malaysia in the late 1980s. In these two countries, the growth rate of exports was more than twice as large as the rate of GNP growth between 1987 and 1990. The contribution of exports was less conspicuous in the Philippines and Indonesia. However, even in these countries, the export-GNP ratios were high compared to other developing countries (say, Latin American countries) and they went up steadily in the late 1980s (see table 10.3).

This section examines whether the results indicating weaker convergence in East Asian countries are due to the exclusion of export variable in the regression. We estimated the following equation:

$$\text{GYP}_{it} = a_1 * \text{RY0}_{it} + a_2 * \text{AD}_i * \text{RY0}_{it} + b * \text{INV}_{it} + c * \text{GN}_{it} + e * \text{X}_{it}, \tag{3}$$

where X_{it} is the share of exports in GDP (see the data appendix for details).

We estimated this equation with and without an East Asian coefficient dummy on the share of exports in GDP.[5] Table 10.4 summarizes our regression results. Except for the estimates of a_2, the inclusion of the export variable did not change the basic properties. However, it led to two noteworthy results on the estimates of a_2 and e.

First, the inclusion of the export variable made the estimates of a_2 less significant in all regressions. In particular, when we included an East Asian dummy in the coefficient of the export variable, the estimates of a_2 became far from significant in all cases and were negative in two regressions. This result implies that, given the export-GDP ratios, there is a strong tendency for poor countries to grow faster on average than rich countries, even in East Asia. In other words, given the export-GDP ratios, East Asian countries show conditional convergence, under which their subsequent growth rates are negatively related to their initial level of per capita GDP.

Second, when we included an East Asian dummy in the coefficient of the export variable, the coefficient of the export variable without an East Asian dummy became significantly negative. This result may partly reflect the fact that many Latin American countries experienced a decline of growth rates in spite of export increases in the 1980s. This may also be caused by the data problem that our export variable includes nonmanufactured products. However, since we can significantly reject the hypothesis that the sum of the coefficients of X and AD*X is zero, the total effects of exports on East Asian economic growth were still significantly positive (see T-STAT in table 10.4). Thus, we can see how special a role exports have played in East Asian economic development during the last few decades. We can also make a conjec-

5. In the cross-sectional studies of 98 countries, we also added the coefficient dummy, PD, for exporters of nonfuel primary products and fuels (mainly oil) based on the classification of the World Bank, *World Development Report 1992*. The coefficient of this dummy variable was significantly negative, implying that the exports of nonmanufactured products do not help accelerate the rate of economic growth.

Table 10.3 **Growth Rates of Output and Export**

	Malaysia			Thailand			Indonesia			Philippines		
Year	dY	dEX	EX/Y	dY	dEX	EX/Y	dY	dEX	EX/Y	dY	dEX	EX/Y
1986	1.0	−5.4	51.4	4.8	16.8	26.5	5.7	−7.3	19.5	3.4	15.6	26.3
1987	5.3	23.2	61.6	9.0	25.8	30.0	4.8	40.1	23.9	4.7	12.9	26.6
1988	8.6	18.6	68.1	12.4	31.5	34.2	0.5	14.9	24.4	6.1	21.7	28.2
1989	8.4	20.3	76.7	11.4	23.1	36.5	12.3	20.4	25.4	5.8	15.3	28.5
1990	9.3	17.5	77.3	9.5	15.3	36.8	6.9	20.1	26.4	2.7	12.6	27.9
1991	8.3	17.0	81.8	–	–	–	6.4	18.2	27.4	−1.0	19.7	29.4

Source: IFS.

Notes: dY = rate of real output growth, dEX = rate of export growth, and EX/Y = export as a percentage of output. For real output, we used real GDP for Malaysia and Indonesia, and real GNP for Thailand and the Philippines.

Table 10.3 (continued)

	Korea			Taiwan			Singapore			Hong Kong		
Year	dY	dEX	EX/Y	dY	dEX	EX/Y	dY	dEX	EX/Y	dY	dEX	EX/Y
1986	11.7	25.5	38.6	11.8	27.7	56.7	1.9	−2.4	126.7	10.5	17.1	112.0
1987	11.4	22.3	41.5	11.2	17.8	60.3	9.0	20.7	141.4	13.6	33.9	127.6
1988	10.9	12.6	39.9	7.5	6.6	59.1	10.6	27.1	158.1	8.0	30.3	146.4
1989	6.0	−4.6	34.1	7.1	8.5	58.1	9.0	9.9	153.5	2.8	20.2	155.7
1990	8.8	9.1	37.7	4.9	5.0	56.0	7.8	8.8	149.6	3.2	16.8	164.3
1991	8.1	12.9	29.3	7.0	13.9	57.8	6.5	7.1	148.1	4.1	24.4	182.3

Table 10.4 **Tests of the Convergence Hypothesis Given the Export-GDP Ratios**

Variable	SH-A	SH-A	SH-B	SH-B	IFS-B	IFS-B
Constant	0.087	0.054	−0.005	−0.045	0.040	0.016
	(2.739)	(1.720)	(−0.064)	(−0.638)	(0.599)	(0.240)
RY0	−0.006	−0.005	−0.008	−0.010	−0.013	−0.014
	(−3.502)	(−2.716)	(−2.052)	(−2.423)	(−3.413)	(−3.656)
AD*RY0	0.002	0.001	0.001	−0.001	0.001	−0.001
	(3.076)	(1.101)	(1.740)	(−0.599)	(0.816)	(−0.859)
INV	0.024	0.024	0.015	0.016	0.029	0.030
	(7.567)	(7.403)	(2.032)	(2.294)	(3.442)	(3.622)
GN	−0.008	−0.019	−0.043	−0.069	−0.051	−0.067
	(−0.753)	(−1.754)	(−1.587)	(−2.389)	(−2.160)	(−2.745)
X	0.015	−0.027	0.012	−0.081	0.013	−0.062
	(1.560)	(−2.375)	(1.648)	(−1.946)	(1.898)	(−1.682)
AD*X		0.050		0.098		0.077
		(3.012)		(2.279)		(2.057)
PD*X	−0.044					
	(−4.162)					
T-STAT		1.871		2.244		2.382
Adjusted R^2	0.586	0.552	0.246	0.283	0.395	0.418

Notes: SH-A, SH-B, and IFS-B are based on the same data sets as in table 10.1. Numbers in parentheses are *t*-values. T-STAT denotes *t*-statistics for the hypothesis that the sum of the coefficients of X and AD*X is zero.

ture about why some previous cross-country studies showed mixed evidence on the correlation between growth rates and export-GDP ratios.

10.4 The Role of Government

In recent studies on endogenous growth, the effects of government consumption on the rate of economic growth have been extensively discussed (e.g., Barro 1990). In these studies, it has been 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 distortionary effects from taxation.

This section investigates whether including a government consumption variable will change our basic results from the previous sections. We first estimated our basic equation with a government consumption variable but without an export variable. We ran a regression as follows:

$$\text{GYP}_{it} = a * \text{RY0}_{it} + b * \text{INV}_{it} + c * \text{GN}_{it} + f * \text{GC}_{it}, \tag{4}$$

where GC_{it} is the share of government consumption in GDP.

We estimated this equation with and without an East Asian coefficient dummy on the share of government consumption in GDP. Table 10.5 summa-

Table 10.5 **Role of Government Consumption in East Asia**

Variable	SH-A	SH-A	SH-B	SH-B	IFS-B	IFS-B
Constant	0.120	0.082	0.116	0.008	0.120	−0.014
	(3.588)	(2.477)	(2.098)	(0.107)	(2.465)	(−0.192)
RY0	−0.010	−0.008	−0.010	−0.006	−0.013	−0.007
	(−4.476)	(−3.772)	(−2.729)	(−1.353)	(−3.702)	(−1.821)
INV	0.029	0.026	0.018	0.013	0.038	0.025
	(8.712)	(7.803)	(2.447)	(1.733)	(5.157)	(2.811)
GN	−0.016	−0.021	−0.015	−0.038	−0.029	−0.054
	(−1.371)	(−1.881)	(−0.581)	(−1.341)	(−1.287)	(−2.205)
GC	−0.084	−0.064	−0.103	−0.137	−0.028	−0.077
	(−3.923)	(−3.090)	(−1.994)	(−2.563)	(−0.537)	(−1.411)
AD*GC		0.124		0.092		0.119
		(3.579)		(1.983)		(2.337)
Adjusted R^2	0.464	0.524	0.185	0.213	0.349	0.383

Notes: SH-A, SH-B, and IFS-B are based on the same data sets as in table 10.1. Numbers in parentheses are *t*-values.

rizes the regression results. As in previous studies, the government consumption variable without an East Asian coefficient dummy had a significantly negative effect on the rate of economic growth in many cases. However, when we included an East Asian dummy in the coefficient of the government consumption variable, the estimated coefficients of this dummy variable were significantly positive and their absolute values were greater than those of non–East Asian countries in most cases. This result is consistent with the result of Grier and Tullock (1989), implying that an increase in government service was special in East Asian countries and had some positive effects on the rate of economic growth.

The result, however, no longer carried through when we included both export and government consumption variables in the regression. That is, when we estimated the following regression:

$$(5) \qquad \mathrm{GYP}_{it} = a * \mathrm{RY0}_{it} + b * \mathrm{INV}_{it} + c * \mathrm{GN}_{it} + e * \mathrm{X}_{it} + f_1 * \mathrm{GC}_{it} + f_2 * \mathrm{AD}_i * \mathrm{GC}_{it},$$

the estimated coefficient of AD*GC was significant in no case (see table 10.6). Moreover, the effects of other variables, especially the positive effects of exports on East Asian economies, were essentially the same as what had been obtained without government consumption variables.

This suggests that, in East Asian countries, an increase in government service has some positive effects on the rate of economic growth through increasing export-GDP ratios. This interpretation is consistent with the view that most East Asian countries have achieved rapid economic development by export

Table 10.6 **Role of Government Consumption and Exports in East Asia**

Variable	SH-A	SH-A	SH-B	SH-B	IFS-B	IFS-B
Constant	0.129	0.082	0.001	−0.042	−0.001	0.002
	(3.950)	(2.492)	(0.007)	(−0.551)	(−0.007)	(0.025)
RY0	−0.010	−0.007	−0.008	−0.010	−0.011	−0.014
	(−4.909)	(−3.593)	(−1.866)	(−2.225)	(−2.439)	(−2.961)
INV	0.027	0.027	0.014	0.016	0.026	0.030
	(8.509)	(8.020)	(1.891)	(2.117)	(2.920)	(3.302)
GN	−0.008	−0.020	−0.045	−0.065	−0.059	−0.069
	(−0.758)	(−1.868)	(−1.589)	(−2.271)	(−2.394)	(−2.770)
GC	−0.062	−0.048	−0.076	0.011	−0.042	0.075
	(−3.335)	(−2.388)	(−1.185)	(0.150)	(−0.734)	(0.848)
AD*GC	0.066	0.038	0.068	−0.023	0.079	−0.030
	(1.968)	(0.925)	(1.425)	(−0.374)	(1.433)	(−0.358)
X	0.020	−0.024	0.013	−0.072	0.011	−0.064
	(2.372)	(−2.230)	(1.695)	(−1.926)	(1.741)	(−1.454)
AD*X		0.048		0.087		0.079
		(3.571)		(2.337)		(1.729)
PD*X	−0.048					
	(−4.978)					
T-STAT		2.401		1.966		2.2131
Adjusted R^2	0.618	0.573	0.231	0.272	0.398	0.412

Notes: SH-A, SH-B, and IFS-B are based on the same data sets as in table 10.1. Numbers in parentheses are *t*-values. T-STAT denotes *t*-statistics for the hypothesis that the sum of the coefficients of X and AD*X is zero.

promotion policies rather than import substitution policies (see, e.g., Teranishi 1992). It may also indicate that government policies did not function well to promote exports and economic growth outside East Asia.

10.5 East Asian Economic Growth in the Second Half of 1980s

Throughout the 1980s, the rates of economic growth in the NIEs were miraculous. Even in the ASEAN countries, most economies conquered the slowdown of growth in the early 1980s and achieved rapid economic growth in the second half of the 1980s. For most countries, this was not the first time they accomplished such a high level of economic growth. In fact, most East Asian countries achieved a comparably high growth rate in the 1970s. However, from the viewpoint of economic development, the rapid economic growth in the late 1980s had special meaning. This is because, for most East Asian countries, the export-oriented manufacturing industry became dominant in the late 1980s. That is, before the mid-1980s, the main exports of many East Asian countries were primary products and agricultural products. However, in the late 1980s and the early 1990s, manufactured products came to account for more than half of exports in these countries.

Table 10.7 **Mean-Square Errors of the Forecasts by Three Equations**

Case	Equation without East Asian Dummy	Equation with East Asian Dummy	Equation with Export Dummy
Case 1	3.938	3.340	2.858
Case 2	3.089	2.582	2.230
Case 3	4.427	3.547	3.210
Case 4	3.651	3.042	2.612

Notes: Case 1 = mean-square errors of the forecasts for nine East Asian countries. Case 2 = mean-square errors of the forecasts for East Asian countries except the Philippines. Case 3 = mean-square errors of the forecasts for East Asian countries except Japan. Case 4 = mean-square errors of the forecasts for five ASEAN countries.

The purpose of this section is to explore the ability of our estimated equations in previous sections to predict the economic development of East Asian countries after the mid-1980s. To make the forecasts, we used three types of equations: a basic equation without an East Asian coefficient dummy, a basic equation with an East Asian coefficient dummy, and an equation with an export variable. We made forecasts of the growth rates from 1985 to 1991 in East Asian countries, based on their per capita real GDP in 1985 and the seven-year averaged data of explanatory variables (i.e., investment ratios, population growth rates, and export ratios). The parameter set we used for the forecasts was estimated by the pooled data of G7 and East Asian countries from 1960 to 1991 in the *IFS*.

Table 10.7 summarizes the mean-square errors of the forecasts by the three types of equations. Figure 10.1 also plots the relation between the actual and predicted growth rates for the nine East Asian countries for equations with and without the export variable. Two interesting results were derived from the table and figure. The first was that the mean-square errors in the forecasts with an East Asian coefficient dummy were smaller than those without such a dummy. This result implies that the weaker convergence tendency in East Asian countries still carries through after the mid-1980s. The second was that the mean-square errors were smallest in the forecasts of equation (3) with the export variable. This result is quite consistent with our proposition that exports are the main source of weak convergence in East Asian countries.

During the 1980s, the export structure in most East Asian countries drastically changed. One reason was the "big push" in the demand side. That is, after the Plaza Accord (in September 1985), the Japanese yen appreciated substantially. This appreciation first increased the demand for manufactured products from the Asian NIEs. The appreciation then increased the demand for export-oriented manufactured products from the ASEAN countries, because the

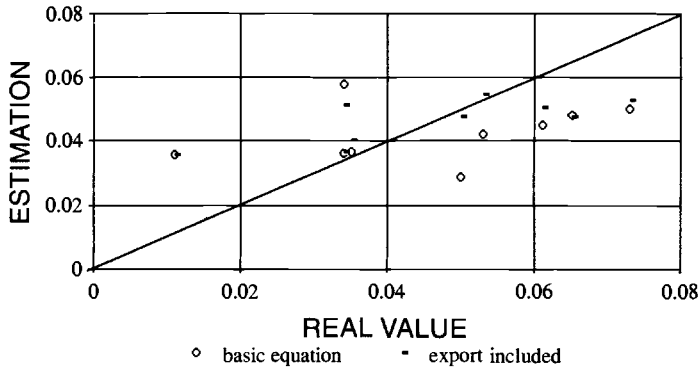

Fig. 10.1 Convergence versus conditional convergence
Note: Estimated values are based on the estimates of equations (1) and (3).

NIEs' currencies also substantially appreciated in the late 1980s. Since this "big push" in the demand side had spillover effects, most East Asian countries achieved rapid economic growth without following the standard steps of endogenous growth models. The above result implies that our basic equation with the export variable clearly tracks such a development process of the East Asian countries in the late 1980s.

10.6 Concluding Remarks

This paper investigated whether there was a tendency to convergence in the East Asian countries (i.e., the Asian NIEs, the ASEAN countries, and Japan) over the last few decades. The paper first presented the cross-country evidence which rejects the strong convergence hypothesis in East Asian countries. Stressing the role of exports in economic growth, the paper then showed that given the export-GDP ratios the cross-country evidence supports the strong conditional convergence hypothesis in East Asian countries.

For the last few decades, the rates of economic growth in East Asia have been miraculous. The result of this paper implies that such miraculous "big push" economic growth is largely attributable to export-oriented economic growth. However, there still remains the question of why East Asian countries achieved export-oriented economic growth but other countries did not. A hint at an answer is the special role of government policy. In section 10.4, we showed that an increase in government service was special in East Asian countries and had some positive effects on the rate of economic growth. As is well known, governments in most East Asian countries have pursued export promo-

tion policies rather than import substitution policies for the last few decades. Investigating the role of such a government policy in detail is an interesting topic for future research.

Appendix

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

The data on real GDP (if not, GNP) and investment ratios are based on three alternative data sets. The first data set is from the 99 non–oil-exporting country data set in Mankiw et al. (1992), which augmented and implemented the Mark IV data sample described in Summers and Heston (1988). The second data set is from the Mark V data sample described in Summers and Heston (1991). It is composed of five-year averaged data of G7 (i.e., the United States, the United Kingdom, France, Germany, Italy, Canada, and Japan) and East Asian countries from 1960 to 1984 and four-year averaged data of G7 and East Asian countries from 1985 to 1988. The third data set is from the IMF, *International Financial Statistics* (Yearbook) (Washington, D.C., various years) except for Hong Kong and Taiwan. (The data of Hong Kong and Taiwan are taken from the statistical yearbook of each country.) It is composed of five-year averaged data of G7 and East Asian countries from 1960 to 1984 and seven-year averaged data of G7 and East Asian countries from 1985 to 1991.

For the data on human capital, we used two alternative data sets. When we ran a regression based on the data set in Mankiw et al., we used the human capital data in Mankiw et al., which is the percentage of the working-age population that is in secondary school. Data for Taiwan are not available in this set. In other cases, we used the secondary school enrollment rate in 1960, which is available in the World Bank, *World Development Report* (Washington, D.C., various years).

For the data on export-GDP ratios, we used two alternative data sets. In the 99-country cross-sectional regression, the data was taken from Georg P. Muller, *Comparative World Data* (Baltimore: John Hopkins University Press, 1988) (and if not, IMF, *International Financial Statistics* [Yearbook] [Washington, D.C., various years]). In other cases, we calculated the export-GDP ratios based on the IMF, *International Financial Statistics* (Yearbook) (Washington, D.C., various years) by taking the five-year average from 1960 to 1984 and the four- or seven-year average after 1985 of the G7 and East Asian country data.

The data on share of government consumption in GDP are based on three alternative data sets. The first data set is from the 99-country data set in Summers and Heston's Mark V data sample, which is averaged from 1960 to 1985.

The second data set is from Summers and Heston's Mark V data sample, which is composed of the five-year averaged data of G7 and East Asian countries from 1960 to 1984 and the four-year averaged data from 1985 to 1988. The third data set is from the IMF, *International Financial Statistics* (Yearbook) (Washington, D.C., various years), which is composed of the five-year averaged data of G7 and East Asian countries from 1960 to 1984 and the seven-year averaged data from 1985 to 1991.

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Comment

Koichi Hamada

This is a neat paper. It is concisely written—I would even say too concisely written to be sufficiently reader-friendly. It requires careful reading.

The Meaning of the Experiment

First, let us consider the meaning of convergence or conditional convergence, and the meaning of the experiments in this paper. I would like to appeal to a modified version of the Swan diagram indicating the relationship between the natural rate of growth and actual economic growth. Rigorously, there is a problem because the natural rate of growth below is defined as a specific type of technical progress—labor-augmenting technical progress. However, as long as most current empirical analysis is conducted by the extensive use of the Cobb-Douglas production function, I think the simplification is justified because in such a world every kind of technical progress can be reduced to labor-augmenting technical progress.

In figure 10C.1, the capital/output ratio is measured on the horizontal axis. This can be regarded as positively related to the income level under a given technology. On the vertical axis, the growth rates of capital and income are measured. The growth rate of labor is given the natural rate of growth, which may be exogenous or endogenous. The growth rate of capital is given in a Solow growth model by

$$\dot{K}/K = (S^Y)/K = S(K/Y)^{-1},$$

Koichi Hamada is professor of economics at the Economic Growth Center, Yale University.

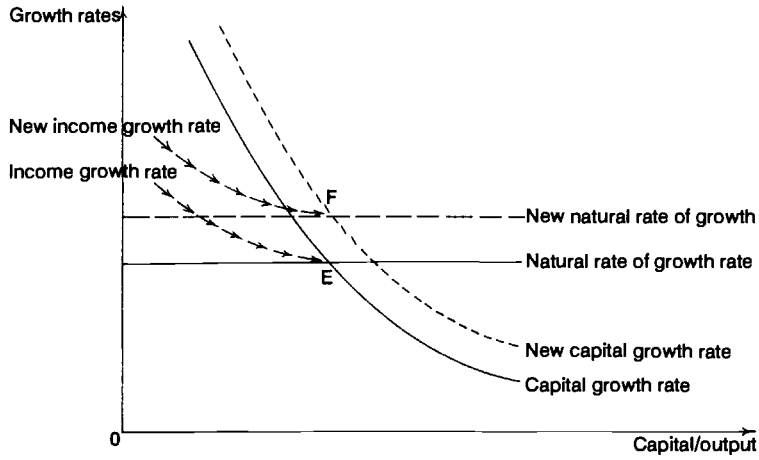

Fig. 10C.1 Conditional and unconditional convergence

where K, L, Y, and S are, respectively, capital, labor, income, and the propensity to save.

Or, in a Cass-Koopmans optimizing growth model, as well as in the modern endogenous growth model, the growth rate of capital is implicitly given by the Euler equation:

$$\dot{\lambda}/\lambda = -(r - \delta),$$

where λ, r, and δ are the marginal utility of consumption, the rate of interest, and the rate of time preference, respectively. The growth rate of income is given by the convex combination of the growth rate of capital and the natural rate of growth.

In a simple growth model, E is the equilibrium. As the arrows indicate, the growth rate is correlated negatively with the initial level of income. Suppose the natural rate of growth is exogenously given and, in some circumstances, common to all the countries. Then, *the higher* the initial capital-output ratio, *the lower* the income growth rate. This is the case of *unconditional* convergence.

In an endogenous growth model—or some version of the neoclassical growth model with learning by doing and embodied technical progress—the natural rate of growth is affected by investment in physical and human capital. Suppose investment or export rises, then the natural rate of growth will move upward. Government consumption spending may move the natural rate of growth downward. The capital accumulation path depicted by the Euler equation can also be affected in turn by the shift of the natural rate of growth. The growth path will shift from the lower set of arrows to the upper and to a new equilibrium F.

Thus, triggering factors such as equipment investment, government consumption, and investment in human capital have two effects: the effect on the equilibrium rate of growth and the effect on the adjustment path (see fig. 10C.1). If one adjusts the effects of the triggering factors, one can still see the negative correlation between initial income level and rate of growth during the adjustment. This is the case of conditional convergence.

Since the effect of these factors is a combination of the long-run effect on the level of the growth rate and the short-run effect on the adjustment process, the statistical results should be interpreted very carefully. The cross-country comparison of average growth rates over a substantial time span can be interpreted as the long-run effect, but the results of time-series regression contain both kinds of effects. Therefore the result of Fukuda's analysis by pooling time-series and cross-country data needs careful evaluation, because the pooled data trace segments of the convergence process. The only case in which the paper avoids this identification problem completely is the case of the effect of human capital. There, since Fukuda uses only the initial level of human capital—he should be more explicit about it—its effect should be viewed as the effect in the long run.

The Interpretation of the Empirical Results

We shall briefly examine the meaning of the empirical results.

Equations (1) and (2) seem to indicate that convergence is weaker in Asian countries. Dependence on the initial level of income is weak there. Does this mean that the Asian economy is more dynamic than other regions of the world, and that the enduring effects of triggering factors are stronger in East Asia?

In interpreting equation (3), the author claims that it "explains why the role of exports in economic development was ambiguous in previous cross-sectional studies." The explanation is given in section 10.3, but it is just an explanation of statistical reasons and falls short of the clarification of the underlying economic mechanism.

The author states that the estimation results of equations (4) and (5) "suggests that, in East Asian countries, an increase in government service has some positive effects on the rate of economic growth through increasing export-GDP ratios." This is an interesting interpretation but does not seem to be a definite implication derived from the results.

I will not repeat my characterization of the whole exercise as producing black boxes that I mentioned in my comments on Krueger's paper (chap. 1 in this volume): The results are informative, but the clarification of the economic mechanism is missing. Rather I will conclude with two questions:

Is the in-sample comparison of the accuracy in forecasts between equations that have different degrees of freedom a fair comparison? Does an equation with an additional dummy not have an advantage in such a comparison?

Figure 10C.1 is easier to grasp if the actual values are on the vertical axis so that the vertical deviation is the forecasting error. Each point should be identified by a country name. Does this figure suggest that Asian countries have been moving toward more nonconvergence?