The Role of FDI in East Asian Economic Development: A Panel Data Analysis*

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Abstract

This paper examines the extent to which foreign direct investment (FDI) has played a role in economic growth by using a model which incorporates domestic physical capital, labor, human capital, and FDI in the production function. The data used is panel data from 1977 to 1992 for five countries -- Indonesia, Korea, Malaysia, Singapore, and Thailand. The estimation results show that the contribution rate of FDI is nearly half of domestic physical capital, and much larger than that of labor. East Asian economies thus have the possibility of sustainable growth due to the role of FDI which transfers technology.

Keywords : technological progress, FDI, TFP, East Asia

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1. Introduction

This paper examines the extent to which foreign direct investment (FDI) has played a role in economic growth by using a model which incorporates domestic physical capital, labor, human capital, and FDI in the production function. The estimation results also allow an examination of the possibilities for East Asia's sustainable growth.

East Asian economies have experienced extraordinary economic growth during the last decade and have begun to occupy an important position in the world economy. These economies, Japan in particular, have become increasingly interdependent with the rest of the world. This interdependent relationship is bringing positive effects to the expansion of the world economy as the East Asian economies continue to grow. As East Asia's growth attracts the world's attention, a series of empirical works have been carried out to identify the factor of economic growth. The World Bank (1993), for instance, proves empirically that East Asia's rapid growth is led by the high growth rate of Total Factor Productivity (TFP), which is referred to as technological progress, i., e., East Asian economies have grown by the advancement in technology.

Krugman (1994), however, warned that Asia's growth would reach its limits when it attained the limit of its inputs by pointing out its similarity with the Soviet Union's growth in the 1950s. He argued that Asia's growth could be fully explained by the growth in its inputs rather than by the growth in TFP (see Young (1994)). Krugman's argument raises a debate, since it reversed a common belief that the world's center of gravity was shifting inexorably to Asia. He was attacked vehemently by economists, Asian fund managers, and politicians (for example, Rostow (1994) and Gibney (1994)).

East Asian economies were so powerful in 1995, when these discussions were held, that Krugman's (1994) argument was not taken seriously. However, at present East Asian economies are stagnant due to the currency crisis which began in Thailand. Thus, Krugman's argument seems to have gradually evolved to becoming a reality. Considering these circumstances in East Asia, it is necessary to reexamine empirically whether Krugman's argument is appropriate or not. In other

words, this paper examines whether or not East Asia's growth rate of TFP is really as high as has been estimated by the World Bank.

Krugman's argument as mentioned above is based on Young's (1994) results, but estimates of TFP vary according to both authors. Young's TFP estimates are much lower than those of the World Bank (1993), for instance. These differences come from the method by which TFP calculates as the residual. TFP includes a variety of factors such as improvement in efficiency and economies of scale, for example, other than technological progress. The literature until now has not made clear the extent to which technological progress contributes to the growth rate of TFP. In this paper, the role of technological progress for economic growth, which has been treated as part of TFP, will be examined. In what follows, the possibility of East Asia's continued growth is examined by using our estimation results, rather than using TFP which contains unidentifiable elements, as explained by Krugman.

The role of FDI must not be forgotten when estimating economic growth in East Asia. For the reason given above, it is generally considered that FDI has played an important role for economic growth. The following two literature are related to the relationship between FDI and economic growth, namely, Findlay (1978) and Hymer (1960). Findlay postulates the theoretical foundation of FDI which contributes to technological diffusion in such a way that multinational firms bring the newest technology to the affiliate factory in developing countries. Hymer (1960) points out that FDI brings technological progress in developing countries, while domestic physical capital does not, since domestic physical capital and FDI have potentially different qualities. It is thus necessary to divide the stock of physical capital into the stock of domestic physical capital and the stock of FDI.

This paper estimates a model which explicitly treats FDI as an essential input by using panel data from 1977 to 1992 for five countries -- Indonesia, Korea, Malaysia, Singapore, and Thailand. The estimation results show that FDI was an important factor for economic growth following domestic physical capital. Although these results have some relevance to Krugman's argument, as mentioned earlier, our conclusion is quite different from Krugman's. Namely, our prediction of future East Asian economic growth is a rather sustainable one, as seen in what follows.

This paper is divided into five sections. Section 2 describes the model, while sec-

tion 3 discusses the data used. The estimation results are presented and compared to this paper's results with existing literature in section 4. Section 5 provides some concluding remarks.

2. The Model

Economic growth can be explained as the long-term trend in the potential output of an economy, and it is also broken down into two parts: the part which can be explained by the growth in inputs used in production, and that which cannot be explained by the growth in inputs. The former is called partial productivity and the latter total factor productivity, or TFP (see Solow (1957)). These two notions are defined as follows. Let us assume the following linear homogeneity of production function as follows;

$$Y_{it}=Af(K_{it},L_{it},H_{it}), \tag{1}$$

where i, t, Y, A, K, L, and H denote country, time, output of economy, the level of technology (i. e., TFP), the stock of physical capital, labor, and human capital, respectively. Take logarithms of equation (1) and differentiate it, and we obtain the following;

$$\frac{dY}{Y}=\frac{dA}{A}+\alpha\frac{dK}{K}+\beta\frac{dL}{L}+\gamma\frac{dH}{H} \tag{2}$$

where α, β, and γ denote the elasticity of physical capital, labor, and human capital, respectively. These are the partial productivity of the above inputs. Then the definition of TFP is given as follows;

$$\frac{dA}{A}=\frac{dY}{Y}-(\alpha\frac{dK}{K}+\beta\frac{dL}{L}+\gamma\frac{dH}{H}) \tag{3}$$

In this paper, the stock of physical capital, K, is divided into two parts, domestic physical capital and FDI. Production function can thus be expressed as follows;

$$Y_{it}=Af(D_{it},F_{it},L_{it},H_{it}), \tag{4}$$

where D, and F denote the stock of domestic physical capital and the stock of FDI, respectively. The production function to be estimated in this paper is assumed to be of the following Cobb-Douglas-type;

$$Y_{it}=AD^{\alpha_{D}}{}_{it}DF^{\alpha_{F}}{}_{it}L^{\beta}{}_{it}H^{\gamma}{}_{it}\exp u_{it}, \tag{5}$$

where α_D, α_F, and u_i denote the elasticity of domestic physical capital, FDI, and disturbance of the model, respectively. Under the assumption of constant return to scale, α_D, α_F, β, and γ satisfy the following restriction;

$$\alpha_D+\alpha_F+\beta+\gamma=1. \tag{6}$$

Take logarithms of equation (5) and differentiate it totally with respect to t, then by the same calculation deriving the definition of TFP expressed in equation (3), TFP of equation (5) is expressed as follows;

$$\frac{dA}{A}=(\frac{dY}{Y}-\frac{dH}{H})-\left\{\alpha_D(\frac{dD}{D}-\frac{dH}{H})+\alpha_F(\frac{dF}{F}-\frac{dH}{H})+\beta(\frac{dL}{L}-\frac{dH}{H})\right\}+u_{it}. \tag{7}$$

Equation (7) will be employed for estimation later in this paper. It should be noted that γ is erased by equation (6).

3. The Data

As previously mentioned, this paper utilizes the panel data from 1977 to 1992 for five countries -- Indonesia, Korea, Malaysia, Singapore, and Thailand. The sample period was chosen to begin in 1977 for the following three reasons. Firstly, the effect of the oil crisis is to be excluded. Secondly, this reason is related to the method of construction of particular stock variables for which only flow data are available. The stock data are constructed from flow data. In so doing, we have to decide the year when the particular stock is assumed to be zero. Those years differ according to the stocks. Human capital has the latest year among the beginning years of the stocks thus constructed, and that is 1971. Since the growth rate of this variable from 1971 to 1976 is excessively high, data for these periods are

excluded. All data begin in 1977. Thirdly, there are many missing values of data which make it difficult to estimate correctly the data related to Hong Kong, Taiwan, and the Philippines, so these countries are excluded from the model.

There are three sources of data, namely, *Key Indicators of Developing Asia and Pacific Countries*, Nehru-Dhareshwar (1994), and *World Data 95*. Those data other than Nehru-Dhareshwar are flow data, but we are interested in the stock data of domestic physical capital, human capital, and FDI. As mentioned above, the data are required to be constructed from flow. There are several ways to do so. The perpetual inventory method is adopted here. We use the same rate of depreciation as defined in Nehru-Dhareshwar, namely, Indonesia 0.027, Korea 0.026, Malaysia 0.027, Singapore 0.018, and Thailand 0.043. The following are the sources of data:

(a) The aggregate real output of the economy

The real GDP in 1987 prices in terms of local currency derived from World Data 95 are used.

(b) The stock of domestic physical capital

The data constructed by Nehru-Dhareshwar available up to 1990 was used for the stock of physical capital. The data starts from 1950 when physical capital stock is assumed to be zero. We extend those data to 1992 by the perpetual inventory method. By using these data, the stock of domestic physical capital was constructed by subtracting the stock of FDI from the stock of physical capital.

(c) Labor

The data for labor is constructed by multiplying the 15-64 year-old population by (1-unemployment rate), since population itself does not explain economic growth, but the number of employed does. The unemployment rate and the 15-64 year-old population were quoted from *Key Indicators of Developing Asia and Pacific Countries.*

(d) Human capital stock

Accumulated expenditure on education cited from *World Data 95* is used as the proxy of human capital. Since these expenditures are expressed in nominal terms, it is necessary to change them to real terms by using the GDP deflator. As men-

tioned previously, 1971 is adopted as the stock of human capital was zero.

(e) The stock of FDI

The data of FDI in each country is cited from World Data 95. The original data is expressed in terms of nominal and U.S. dollars. First, the data are transformed in terms of local currency. Second, FDI in each country at local currency are changed into real terms by the GDP deflator. Finally, the stock of FDI is obtained by the perpetual inventory method, starting in 1968 with zero FDI stocks.

4. Empirical Results

Estimation Results by Panel Data

This section presents the results of the author's estimation.[1] The results are summarized in Tables 1 and 2.

Table 1
Panel Data Regressions, Economic Growth

	D	L	F
coefficient	0.5101	0.3025	0.1812
t-statistics	(7.912)	(8.110)	(3.737)
contribution rate	75%	15%	33%

$R^2=0.96$

Note: The period of observation is 1977−92 (annual data). Variables are defined in section 2.

Table 2
Growth Rate of TFP

Indonesia	−0.0370
Korea	−0.0231
Malaysia	−0.0535
Singapore	−0.0248
Thailand	−0.0291

1) Estimation is calculated using econometric software, Limdep.

In panel data analysis, there are the following two frameworks. One is the single equation model and the other is the sets of equation model. This paper employs the former, as did Nehru-Dhareshwar (1994) and the World Bank (1993). In the single equation model, there are the following two basic methods: namely, (a) the fixed effect (FE) model; and (b) the random effect (RE) model. In the former, A_i, which expresses the country specific effect, is assumed to be fixed and correlated with the regressors. In the latter, A_i is considered to be a group specific disturbance, which is similar to u_{it}, and is assumed to be random and uncorrelated with the regressors. The RE model is not consistent if group specific disturbance A_i's are correlated with explanatory variables, while the FE model is consistent whether A_i's are correlated with explanatory variables or not. The Hausman test, which examines whether or not A_i's correlate with explanatory variables or not, fails to reject the RE model at the 5% level of significance. The RE model is accepted by the Hausman test, but we employ rather the FE model because our aim is to make a comparison of empirical results with Nehru-Dhareshwar and the World Bank. The FE model is expressed as follows;

$$y_{it}=A_i+\alpha_D D_{it}+\alpha_F F_{it}+\beta L_{it}+u_{it} \tag{8}$$

1) $E(u_{it}^2)=\sigma^2$
2) $E(u_{it},u_{is})=0, \quad t \neq s$
3) $E(u_{it},u_{js})=0, \quad i \neq j.$

From the construction of data, it is noted that the numbers of the data is far smaller than 100. It is said that tests of unit root and co-integration require more than 100 samples to attain the desired results. Thus, we did not examine these tests.

It is expected that all estimated coefficients of production factors are positive. As is shown in Tables 1 and 2, all estimated coefficients of production factors are positive and significant at 1% critical value, while only the growth rate of TFP is negative. The proprieties of each estimated coefficient are discussed one by one in more detail as follows:

(a) The growth rate of TFP

TFP tends to include a variety of elements other than technological progress because of the ways stocks are constructed. The more the capital stock is measured to contain improvement in productivity, the less is the growth rate of TFP. Indeed, Nadiri (1970) suggests that the growth rate of TFP should be zero, if inputs are measured properly and the production function is correctly specified. If an economy shows its technological level, TFP growth will be positive. If inefficiency in production surpasses the advancement of technology level, TFP growth will be negative. Latin America and Africa, for example, show negative TFP growth in almost all the literature, while the growth rate of TFP of the United States is always positive. The results obtained by our empirical analysis show negative TFP growth, although in other literature TFP growth is positive in East Asian economies. This will be discussed later in more detail.

(b) The elasticity of domestic physical capital

Increases in domestic physical capital are expected to be positive and significant to economic growth. The estimation results obtained here are consistent with what we expected. However, the elasticity of domestic physical capital seems to be rather large in comparison with other papers in which the stock of FDI is contained. This point will be examined later.

(c) The elasticity of FDI

It is generally recognized that FDI pulls economic growth. Without FDI, domestic savings is the only source of investment. If one economy faces a shortage of savings, FDI will be a powerful source for providing production equipment instead of domestic capital. In addition, FDI transfers the newest technology to the host country, as discussed earlier. FDI is expected to be positive and significant to economic growth. The coefficient of FDI is interpreted as the rate of technological progress realized by technology transfer via FDI. The rate of technological progress therefore can be observed by two factors, namely, the growth rate of TFP and the coefficient of FDI. The estimated coefficient of FDI is positive and significant as is expected. This indicates East Asian economies have experienced technological progress through technology transfer via FDI.

(d) The elasticity of labor

It is considered that the growth of labor is also an essential factor for economic growth. Therefore, the elasticity of labor is expected to be positive and significant. The estimation result obtained here is consistent with the above.

It should be noted here that the data of FDI used in this paper is derived from the balance of payments. Therefore, the part of FDI is cancelled out by debt in the balance of payment. Thus, the amount of FDI in this paper tends to be underestimated. This measurement error in FDI is uniform across economies and over time, and the estimation results may not be affected by this.

Comparison with Existing Literature

Let us compare the estimation results with the following two literature, which have practically the same frameworks; one is Nehru-Dhareshwar, and the other the World Bank. It may not be appropriate to compare our result regarding elasticity with Nehru-Dhareshwar and the World Bank, since their model covers 87 countries around the world, while our model only those of East Asia. Their sample period is from 1960 to 1990, while ours is from 1977 to 1992. However, both have a similar framework of the model, that is, single equation model and the Cobb-Douglas-type production function. In addition, Nehru-Dhareshwar and the World Bank use human capital as a variable explicitly, and TFP growth is estimated as a residual.

(a) Comparison of TFP contribution

Our estimation obtains negative TFP growth in East Asian economies, on the contrary to that of the other two (see Table 3). As pointed out in section 3, these differences come from the method by which the stock data are constructed. Our model treats FDI explicitly as a variable which brings technology transfer, and contributes to the technological progress in the host countries, while Nehru-Dhareshwar and the World Bank do not use FDI as a variable. The role of technological progress in this paper can be observed by TFP and a coefficient of FDI. Negative TFP growth in our result implies that East Asian economies contain some kind of inefficiency in their market. On the other hand, according to our re-

sult, FDI contributes positively to economic growth. It is generally admitted that FDI brings a higher level of technology. To sum up, East Asian economies have not only experienced inefficiency, but have also advanced its technological level due to FDI.

Table 3
Growth Rate of TFP

	Uchida	Nehru-Dhareshwar	World Bank
Indonesia	−0.0370	0.55	1.2543
Korea	−0.0231	2.21	3.1021
Malaysia	−0.0535	0.96	1.0755
Singapore	−0.0248	0.61	1.1911
Thailand	−0.0291	2.21	2.496

Sources: Nehru-Dhareshwar (1994) and the World Bank (1993).

(b) Comparison of elasticity

As for the comparison of elasticity of domestic physical capital, our estimation result is much larger than that of the two literature. This difference could be explained in the following way: Firstly, it can be explained by the high saving rate in East Asian economies. This high domestic saving rate has led to high domestic capital investment, and savings are allocated to the growing sector of the economy. Therefore, it can be said that domestic physical capital plays a more important role. Secondly, as for the labor share in Table 4, our result is lower in comparison with the two literature. This is reflected by the fact that East Asian economies have rather smaller shares of labor to capital. This comes from the characteristics of their economic systems which promote economic growth by distributing more income to capital than labor. The economic growth of Korea, for instance, has been led by nurturing "Zaibatsu," which implies large industrial groups.

Table 4
Panel Data Regressions, Economic Growth

	K	D	L	H	F
Uchida	−	0.5158	0.2992	−	0.1807
Nehru-Dhareshwar	0.32	−	0.20	0.48	−
WorldBank	0.178	−	0.669	0.154	−

Sources: Nehru-Dhareshwar (1994) and the World Bank (1993).
Note: Variables are defined in section 2.

5. Concluding Remarks

This paper estimated factors that affect East Asian economic growth by the panel data analysis. The estimated coefficient of domestic physical capital is larger than that of FDI. This indicates that although FDI is an important factor for economic growth, domestic physical capital is essential. This conclusion seems to support Krugman's argument such that East Asian economic growth is led by increases in the amount of physical capital. However, the contribution rate of FDI is nearly half of domestic physical capital, and much larger than that of labor (see Table 1). From this, it can be said that FDI is still substantial in the growth process. In this sense, East Asian economies have more poteutial for sustainable growth, than Krugman predicted. Appropriate policies and economic circumstances to secure the consecutive flow of FDI in those economies can guarantee their sustainable growth.

There still remain some problems to overcome for future research. First of all, FDI does not necessarily transfer technology, and the host countries do not always absorb transferred technology. It is thus necessary to generalize our model by examining the extent to which FDI transfers technology and the host country absorbs transferred technology.

Second, the single equation model is employed in order to carry out a comparison with other literature, while sets of equation model are used in many studies (Young (1994) and Kim-Lau (1994)). The latter admits differences in differing economies. Even if differing economies have similar economic conditions, it cannot be said that they all have exactly the same elasticity. The sets of equation model, therefore, is more suitable for analysis in this context.

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