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Growth and Productivity in ASEAN Economies during 1960-97:

By a Growth Accounting Method and TFP

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Growth and Productivity in ASEAN Economies during 1960-97: [1]

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1. Introduction

There were many studies of the estimates of productivity growth in the ASEAN economies in recent years (see Table 1). Some previous studies, particularly by Alwyn Young, have conducted that growth rate of total factor productivity in Asian economies are not nearly as spectacular as their growth rates of output. For example, in Singapore's case, the growth rate of total factor productivity is 0.2. That is, this means that the economy grows because it uses more resources as inputs such as more factories and machines. Most studies, however, found that the growth rate of total factor productivity is more than 1.5 in Singapore. For example, Sarel (1997) estimated that the growth rate of total factor productivity was 2.46.

Table 1 Estimates for growth rates of total factor productivity (TFP)

	World Bank (1993)	Young (1995)	Sarel (1997)	UBS (1996)	Bosworth and Collins (1996)
period	1960-89	1966-90	1991-96	1970-90	1960-94
Japan	3.47				
U.S.			0.61		
Singapore	1.19	0.2	2.46	1.3~1.6	1.5
Taiwan	3.76	2.60	-	2.0~2.3	2.0
Korea	3.10	1.70	-	1.2~1.5	1.5
Thailand	2.49	-	2.25	1.5~1.8	1.8
Malaysia	1.07	-	2.00	0.3~0.9	0.9
Indonesia	1.25	-	2.20	-0.3~-0.6	0.8
Philippines	-	-	0.67	-	-0.4

Thus, the purpose of this paper is to provide the estimates of the growth rate of total factor productivity (TFP) in the ASEAN economies during the period 1960-97 including the Crisis period using the growth accounting framework. Especially we focus on the growth rate of TFP in Indonesian Economy.

The structure of the paper is as follows: Section 2 presents the growth accounting framework. In section 3 we estimate total factor productivity growth rates in the ASEAN economies using parameters of production function. Finally section 4 presents our conclusions.

2. Growth Accounting Method and TFP

The growth accounting framework, which is the traditional framework used in numerous other similar studies of growth and TFP (Young[1995], Bosworth and Collins[1996], Sarel [1997]), is that GDP growth is accounted for growth in inputs and growth of total factor productivity (TFP). In this paper we use this growth accounting framework with the aggregate production function.

We consider aggregate production function as follows:[2]

$$Y=AF(K, L). \tag{1}$$

Equation (1) relates total output Y to the economy's use of capital K and labor L and to productivity A. If the quantity of output grows, then either the quantity of inputs must grow or productivity must improve, or both.

From Equation(1), we can get Equation (2), called the growth accounting equation, written in growth rate form.

$$\frac{\Delta Y}{Y}=\frac{\Delta A}{A}+ak\frac{\Delta K}{K}+al\frac{\Delta L}{L}, \tag{2}$$

where

$\frac{\Delta Y}{Y}$ = *rate* of output growth;

$\frac{\Delta K}{K}$ = *rate* of capital growth;

$\frac{\Delta L}{L}$ = rate of labor growth;

$\frac{\Delta A}{A}$ = rate of productivity growth;

ak = elasticity of output with respect to capital;

al = elasticity of output with respect to labor.

According to Equation(2), output growth $\triangle Y/Y$ can be broken into three parts:[3]

1. that resulting from productivity growth (TFP), $\triangle A/A$,
2. that resulting from increased capital inputs, $ak\triangle K/K$, and
3. that resulting from increased labor inputs, $al\triangle L/L$.

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[2] See Abel and Bernanky (1998), *Macroeconomics*, pp. 185-190.

[3] See Abel and Bernanky (1998), *Macroeconomics*, p. 187.

In order to estimate total factor productivity growth in ASEAN economies, it is necessary to take the following four steps.

Step 1. Obtain measures of the growth rates of output, △Y/Y, capital, △K/K, and labor, △L/L, for the economy over the period 1962-1997.
Step 2. Estimate values for the elasticity of output with respect to capital, ak and for the elasticity of output with respect to labor,an, from historical data.
Step 3. Calculate the contribution of capital to economic growth as ak△K/K and the contribution of labor to economic growth as al△L/L.
Step 4. The part of economic growth assignable to neither capital growth nor labor growth is attributed to improvements in total factor productivity. The rate of productivity change △A/A is calculated from the fomula

For this TFP, we illustrate the Cobb-Douglas production function with constant returns to scale in Fig. 1. Real GDP-labor is on the vertical axis and capital -labor (real capital per worker) is on horizontal axis. This production function is shown as 0O. When capital per labor increases, for example, from k0 to k1, then output per labor increase from q0 to q1. Further, if technical change/ improves the total productivity of the factors of production, the production function shifts upward from 0O to 0O1. That is, when capital per labor increase from k0 to k1, then output per labor increases by an additional amount from q1 to q2.

3. Estimates of Total Factor Productivity

Before estimating the production function, we classify six east countries, Japan and U.S. according to development stages by per capita GDP (base year is 1987).[4] This result is presented in Table 2. In belonging to development stage of middle income (low), Japan was the 1951-60 period, Taiwan was the 1952-75 period, Korea was the 1954-77 period, Thailand was the 1967-97 period, Malaysia was the 1962-81 period, and Indonesia and Philippines were the 1962-97 period before the economic crisis. As to period of middle income (Upper), Korea was for the 1978-97 period and Malaysia was for the 1982-97 period.

3.1 Estimates of Production Function and TFP

[4] see World Bank, *World Bank Report*, in every year.

We estimated the production function of Equation (1) for the above every development stages of six East Asia countries, Japan and U.S. The GDP (Y) is real GDP in 1983 prices (currency in every country) for every country, the capital input (K) is real capital stock in 1983 prices (currency in every country) for every country, and

Table. 2 Development Stages of Six East Asia Countries, Japan and U.S.

Per capita GDP(1987 dollars)	Low Income	Middle Income (Low)	Middle Income (Upper)	High Income	(1998,Dec.) Income
	~480	481 ~ 1,939	1,940 ~ 5,999	6,000~	
Japan		1951~60	1961~71	1972~97	
U.S.				1951~90	
Taiwan		1952~75	1976~87	1988~97	9,000$
Korea		1954~77	1978~97		6,000$
Thailand	1960~66	1967~97			1,800$
Malaysia		1962~81	1982~97		3,000$
Indonesia		1962~97			500$
Philippines		1962~97			500$

labor inputs (L) is the number of employment for every country.

For the GDP data we used, we obtain from ADB database and adjust in 1983 prices. The Capital stock was estimated using the capital stock database of World Bank, at constant 1983 prices. The labor force estimates were derived from ADB Yearbook.

First, we estimate the case of no constant returns to scale as follows:

$$\log(Y)=\text{constant}+\alpha*\log(K\text{-}1)+\beta*\log(L), \qquad (3)$$

The estimated results of the production function without constant returns to scale are summarized in Table 3 (a) - (c).

Broadly speaking the estimated results were reasonable judging from t-values and adjusted R^2. GDP was positively related to both inputs. Thus, for each country and for every year, using this estimated parameters of a Cobb-Douglas production function without constant returns to scale, we now estimate the growth rates of total factor productivity with the above steps. Table 4 summarizes these results of the average

growth rates of total factor productivity. The results of estimates for growth rates of total factor productivity are depicted, for each country, in Figure 2. The results suggests that:

Table 3 the estimated results of the production function in every Development Stage: (without constant returns to scale)

(a) the period of Middle Income (Low):

log(Y)=constant + α *log(K-1)+ β *log(L), estimation method: OLS

	Japan	Taiwan	Korea	Thailand	Malaysia	Indone-sia	Philipp-ines
Period	51-60	52-75	54-77	67-97	62-81	62-97	62-97
Constant	4.347 <5.90>	2.292 <23.0>	3.234 <12.7>	0.624 <1.74>	0.744 <11.9>	3.409 <8.52>	1.937 <5.10>
Capital stock logK(-1)	0.7092 <7.76>	0.545 <7.19>	0.647 <12.2>	0.572 <10.0>	0.668 <14.6>	0.625 <9.85>	0.612 <7.28>
Lobar log(L)	-0.324 <-0.72>	0.466 <1.35>	0.156 <1.13>	0.623 <3.46>	0.11 <1.11>	0.147 <0.86>	0.021 <0.15>
R^2	0.993	0.998	0.997	0.998	0.997	0.998	0.991
D.W.	1.59	1.07	1.86	1.16	1.84	1.18	0.91

where GDP (logY), capital stock (logK-1) and labor (logL) are in logarithms and the t-statistics are expressed in parentheses below the coefficients.

(b) the period of Middle Income (Upper)

log(Y)=constant + α *log(K-1)+ β *log(L), estimation method: OLS

	Japan	Taiwan	Korea	Malaysia
Period	61-71	77-90	78-97	82-97
Constant	-2.93 <-0.81>	1.628 <5.96>	2.938 <9.81>	0.511 <2.52>
Capital stock logK(-1)	0.462 <3.32>	0.201 <1.92>	0.298 <2.71>	0.092 <0.67>

Lobar (logL)	2.33 <1.72>	2.281 <6.06>	1.781 <3.82>	1.927 <4.97>
R^2	0.995	0.997	0.995	0.967
D.W.	1.52	1.08	1.53	1.64

where GDP (logY), capital stock (logK-1) and labor (logL) are in logarithms and the t-statistics are expressed in parentheses below the coefficients.

(c) the period of High Income:

log(Y)=constant + α *log(K-1)+ β *log(L), estimation method: OLS

	Japan	Taiwan	U.S.
Period	72-97	86-97	51-90
Constant	1.219 <1.73>	0.759 <2.75>	0.331 <0.68>
Capital stock logK(-1)	0.223 <3.77>	0.405 <5.59>	0.21 <1.93>
Lobar (logL)	2.062 <5.88>	1.847 <4.77>	1.295 <7.56>
R^2	0.997	0.997	0.998
D.W.	1.51	1.38	1.56

where GDP (logY), capital stock (logK-1) and labor (logL) are in logarithms and the t-statistics are expressed in parentheses below the coefficients.

(1)During the period 1987-96, the growth rates of TFP were strong and stable in three of the five ASEAN economies (Malaysia, Thailand, and Indonesia). However, the growth rate of TFP was not strong and unstable in Philippines, especially it was negative in 1991 and 1992.

(2)During the more recent period 1990-96, the growth rates of TFP increased and stable in two of the five ASEAN economies (Malaysia and Indonesia) compared with the 1987-96 period.

(3) In Indonesia, during the period 1987-96, growth rate of TFP was increased after deregulation began in 1985. Other recent studies suggested that in Indonesia the

growth rate of TFP was smaller than elsewhere in Asia (see Table1). However, the results of our estimated growth rates of TFP in Indonesia is not smaller than in Malaysia and Thailand.

(4)In 1997, when crisis began, the growth rate of TFP as well as capital stock decreased rapidly in Indonesia, Thailand, and Korea. On the other hand, the growth rate of TFP as well as capital stock did not decrease rapidly in Taiwan, Malaysia, and Philippines.

Table 4 Estimates for growth rates of total factor productivity (TFP)

	Middle Income (Low)		Middle Income (Upper)		High Income	
	period	TFP	period	TFP	period	TFP
Japan	1951-60	0.21	1961-71	0.18	1972-97	0.14
U.S.	-	-	-	-	1951-90	0.09
Taiwan	1952-75	0.11	1977-90	-0.09	1986-97	0.32
Korea	1954-77	0.13	1978-97	0.33	-	-
Thailand	1967-97	0.21	-	-	-	-
Malaysia	1962-81	0.23	1982-97	0.22	-	-
Indonesia	1962-97	0.11	-	-	-	-
Philippines	1962-97	0.97	-	-	-	-

4. Conclusion

The growth accounting study that was conducted in this paper covered four ASEAN economies, Korea, Taiwan, Japan and the United States during the period 1960-97

including the Crisis. Especially we focused on the growth rate of TFP in Indonesian Economy.

The results of the growth rate of total factor productivity (TFP) show very impressive. The results suggests that:

(1)For developing stage of low middle income (per capita GDP is from 481US$ to 1,939US$), during the period 1962-97, the average growth rates of TFP were for Thailand (0.21 percent), Indonesia (0.11 percent), Malaysia (0.23 percent for period 1962-81), Japan (0.21 percent for period 1951-60), Taiwan (0.11 percent for period 1952-75), and Korea (-0.13 percent for period 1954-77).

(2)However, during the period 1987-96 the growth rates of TFP were for Thailand (1.3 percent), Indonesia (1.2 percent), Malaysia (1.1 percent), Taiwan (0.3 percent), and Korea (0.5 percent). In other words, during the period 1987-96, the growth rates of TFP were strong and stable in three of the five ASEAN economies (Malaysia, Thailand, and Indonesia). However, the growth rate of TFP was not strong and unstable in Philippines, especially it was negative in 1991 and 1992.

(3)During the more recent period 1990-96, the growth rates of TFP increased and stable in two of the five ASEAN economies (Malaysia and Indonesia) compared with the 1987-96 period.

(4) In Indonesia, during the period 1987-96, growth rate of TFP was increased after deregulation began in 1985. Other recent studies suggested that in Indonesia the growth rate of TFP was smaller than elsewhere in Asia (see Table1). However, the results of our estimated growth rates of TFP in Indonesia is not smaller than in Malaysia and Thailand.

(5)In 1997, when crisis began, the growth rate of TFP as well as capital stock decreased rapidly in Indonesia, Thailand, and Korea. On the other hand, the growth rate of TFP as well as capital stock did not decrease rapidly in Taiwan, Malaysia, and Philippines.

Appendix A: Estimation of the case of constant return to scale

we estimate the case of constant returns to scale as follows:

$$\log(Y/L)=\text{constant} + \alpha * \log(K\text{-}1/L), \quad (4)$$

The estimated results of the production function with constant returns to scale are summarized in Table 5 (a) - (c).

Table 5 the estimated results of the production function in every Development Stage: (the case of constant returns to scale)

(a) the period of Middle Income (Low):
log(Y/L)=constant + α *log(K-1/L), estimation method: OLS

	Japan	Taiwan	Korea	Thailand	Malaysia	Indone-sia	Philipp-ines
period	51-60	52-75	54-77	67-97	62-81	62-97	62-97
constant	3.121 <17.5>	2.294 <27.2>	3.576 <13.1>	1.051 <4.77>	0.882 <9.86>	3.142 <8.94>	0.648 <1.30>
Capital stock per labor log[K-1 /L]	0.558 <21.9>	0.548 <28.9>	0.548 <15.27>	0.614 <12.7>	0.510 <15.09>	0.542 <12.1>	0.672 <5.81>
R^2	0.982	0.996	0.987	0.995	0.976	0.992	0.890
D.W.	1.09	1.07	1.86	0.97	1.43	1.34	0.91

where GDP per labor (logY/L), capital stock per labor[log(K-1/L)] are in logarithms and the t-statistics are expressed in parentheses below the coefficients.

(b) the period of Middle Income (Upper)
log(Y/L)=constant + α *log(K-1/L), estimation method: OLS

	Japan	Taiwan	Korea	Malaysia

period	61-71	77-90	78-97	82-97
constant	2.275 <13.4>	1.296 <2.86>	3.305 <6.75>	0.675 <2.11>
Capital stock per labor log[K-1 /L]	0.678 <32.5>	0.718 <9.95>	0.580 <11.2>	0.566 <6.62>
R^2	0.991	0.980	0.987	0.981
D.W.	1.21	1.17	1.25	0.83

where GDP per labor (logY/L), capital stock per labor[log(K-1/L)] are in logarithms and the t-statistics are expressed in parentheses below the coefficients.

(c) the period of High Income:

log(Y/L)=constant + α *log(K-1/L), estimation method: OLS

	Japan	Taiwan	U.S.
period	72-97	86-97	51-90
constant	4.414 <10.4>	1.667 <7.78>	2.322 <3.51>
Capital stock per labor log[K-1 /L]	0.432 <9.58>	0.666 <21.1>	0.261 <1.78>
R^2	0.985	0.988	0.943
D.W.	1.37	1.84	1.29

where GDP per labor (logY/L), capital stock per labor [log(K-1/L)] are in logarithms and the t-statistics are expressed in parentheses below the coefficients.

Broadly speaking the estimated results were reasonable judging from t-values and

adjusted R^2. GDP was positively related to both inputs. However, judging from adjusted R^2 this case is not good fitting than the case of no constant returns to scale. For each country and for every year, using this estimated parameters of a Cobb-Douglas production function with constant returns to scale, we now estimate the growth rates of total factor productivity with the same method. Table 6 summarizes these results of the average growth rates of total factor productivity. Let us compare to the case of no constant returns to scale. In this case, the growth rate of TFP is negative in Indonesia and Philippines because both capital elasticity and labor elasticity are bigger than without constant returns to scale. On the other hand, the growth rate of TFP is bigger than without constant returns to scale in Thailand because sum of capital elasticity and labor elasticity is smaller than without constant returns to scale.

Table 6 Estimates for growth rates of total factor productivity (TFP)
(the case of constant returns to scale)

	Middle Income (Low)		Middle Income (Upper)		High Income	
	period	TFP	period	TFP	period	TFP
Japan	1951-60	1.96	1961-71	-0.11	1972-97	0.14
U.S.	-	-	-	-	1951-90	0.90
Taiwan	1952-75	0.11	1977-90	0.16	1986-97	0.79
Korea	1954-77	-0.2	1978-97	0.58	-	-
Thailand	1967-97	0.38	-	-	-	-
Malaysia	1962-81	0.42	1982-97	0.56	-	-
Indonesia	1962-97	-0.1	-	-	-	-
Philippines	1962-97	-0.3	-	-	-	-

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