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Measuring the effects of labour productivity on ASEAN5 plus 3 economic growth

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This paper analyses the effects of labour productivity, capital deepening and total factor productivity (TFP) intensity in ASEAN5 (Malaysia, Indonesia, Philippines, Singapore and Thailand) plus 3 (China, Japan and South Korea). The results of this study show that there was slight contribution of the TFP intensity to the economic growth of these countries during the periods of the study. The results also confirm that capital intensity had a strongly significant role in achieving light labour productivity contribution that had been produced by most of these economies through using huge inputs (such as physical, capital and labour) to produce outputs. The results show that the productivity growth of most of these countries is input driven, however, the South Korean model is moving to be a productivity driven; Japan is productivity driven as the only Asian nation that joined the industrial club which is dominated by Western nations.

Keywords: ASEAN5 plus 3; Input driven; TFP intensity; Labour productivity; Capital deepening.
JEL classification: E23; C22.

INTRODUCTION

Much of the recent debate on the sources of growth in Asia has been strongly focused on the macro-level as in Young (1992, 1995) and Kim and Lau (1994), in which the authors state that other newly industrialised Asian countries' productivity was input-driven. Sarel (1996) also expressed concerns that some East Asian countries might face the same fate as the Soviet Union. His perception bears reasonable assumptions as these countries invested primarily in labour and capital rather than in technology over the past few decades and there was no real technological drive that could sustain the progress of the industrial development. According to Krugman 1994, the high growth rates in the East Asian nations were not sustainable as growth in these nations stemmed primarily from the increases in the amount of labour and capital rather than in Total Factor Productivity (TFP) (i.e., knowledge and technical change). That is to say, it will no longer be possible to continue raising levels of capital and labour. Consequently, East Asian growth

rates must eventually fall in the absence of improvements in TFP.

Furthermore, the use of TFP overcomes the problems of single productivity indicators such as labour productivity and capital deepening by measuring the relationship between output and its total inputs (a weighted sum of all inputs), thereby giving the residual output changes not accounted for by total factor input changes. Being a residual, changes in TFP are not influenced by changes in the various factors which affect technological progress such as the quality of factors of production, flexibility of resource use, capacity utilisation, quality of management, economies of scale, and so on (Rao and Preston, 1984).

TFP growth has long been identified as one of the important sources of economic growth in the western countries (Solow, 1956, 1957; Abromovitz, 1956; Denison, 1962; Kim and Lau, 1994). In a study on sources of economic growth in nine western countries, Denison

(1967) found that advanced knowledge, improved allocation of resources and economies of scale accounted for almost 60 to 90 percent of the growth in income per capita, with factor inputs (labour, capital and land) explaining a relatively small percentage of the overall economic growth. This implies that the growth of the western countries has been mainly driven by TFP growth rather than the growth in factor inputs. This finding is supported by another recent study conducted by Kim and Lau (1994), it was found that almost 45 to 70 percent of the economic growth in five of the Organization for Economic Cooperation and Development (OECD) countries was contributed by productivity growth. This growth phenomenon is somewhat different from the growth pattern observed in the Newly Industrialized East Asia Countries. Studies indicated that the growth of these countries has been mainly input-driven through massive factor accumulation rather than productivity driven (Young, 1992, 1995; Krugman, 1994; Kim and Lau, 1994). Young (1992), for example, found that over the period of 1966-1990 productivity growth in the aggregate non-agriculture economy ranges from as low as 0.2 percent in Singapore to a high as 2.3 percent in Hong Kong, whereas the manufacturing productivity ranges from a low of -1.0 percent in Singapore to a high of only 3.0 percent in South Korea.

Studies by the World Bank (1993), Sarel (1996), Thomas and Wang (1996), Klenow and Rodriguez-Clare (1997), Hsieh (2002), and others, have shown that TFP growth was an important contributor to the rapid and sustained economic growth in East Asian economies. As a result of different data sets, methodologies with different analyses, and different sample periods covered, the existing TFP literature has revealed differing views with respect to TFP growth in East Asian countries, suggesting the role of TFP growth in the East Asian economic miracle. From a policy perspective, measuring TFP growth is important as it serves as a guide for allocating resources and making investment. Besides, the report by the World Bank (1993) points out that "export-push strategies have been by far the most successful combination of fundamentals and policy interventions and hold the most promise for other developing countries", which reinforces the significance of manufacturing industries behind the East Asian economic miracle in the past several decades.

This study was able to identify that earlier studies were based on the econometric method of estimation which has the gap of inability to calculate the contributions of productivity indicators used in these studies. It was also noticed that the growth accounting approach was not based on statistical theory and, hence statistical models cannot be applied to evaluate its reliability, thus casting doubts on its results. The present study suggests closing these gaps by providing a statistical analysis in the first step of the estimation to get the coefficients of the explanatory variables that are used by econometric approach. In addition to a second step plugging the parameters of the variables into the model of the above mentioned divisia translog index approach to calculate the growth rates of productivity indicators including the calculation of the residual of the model (TFP growth) and output growth that is used by growth accounting approach.

This paper aims to investigate the role of capital deepening and TFP intensity in achieving higher labour productivity contribution in ASEAN5 plus 3. Section 2 contains descriptions on the estimation methods employed in this paper and Section 3 demonstrates details of the data. Results of the empirical analysis are explained in Section 4. Finally, Section 5 presents the conclusion.

METHODOLOGY AND ESTIMATION PROCEDURES

An attempt was made to apply the conventional growth accounting framework developed by Solow (1956, 1957), finally brought to fruition by Kendrick (1961) and further refined by Denison (1962), Denison and Edward (1979), Griliches and Jorgenson (1962), Jorgenson et al., (1987), Dollar and Sokoloff, (1990) and Elsadig (2006), to this study. The production function for economies is represented as follows:

$$\mathrm{GDP}t, i = F\left(\mathrm{K}t, i,\ \mathrm{L}t, i,\ \mathrm{T}t, i\right) \qquad (1)$$

Where for Country i = 1, 2, …, 8 in Year t =1965-2006, the output is annual GDP, and the inputs are: fixed physical capital K, number of persons employed L, and time T, that proxies for total factor productivity (TFP) as a technological progress of the countries.

The Divisia Index basically decomposes the aggregate output growth into the contribution of changes in inputs (such as aggregate capital, labour), and TFP growth. This approach calculates the productivity indicators without considering statistical analysis to show the reliability of the results generated.

This study attempts to fill this gap by developing this model into a parametric model and providing statistical analysis for it in the first step as follows: -

$$\ln\mathrm{GDP}t, i\ = a + \alpha.\ln\mathrm{K}t, i + \beta.\ln\mathrm{L}t, i + \ \varepsilon t, i \qquad (2)$$

Where:
α = output elasticity with respect to aggregate capital
β = output elasticity with respect to aggregate labour
a = intercept or constant of the model[*]
ε = is the residual term[†]
t = is 1965-2006
ln = logarithm to transform the variables.

Following Dollar and Sokoloff, (1990), Wong (1993), Felipe (2000) and Elsadig (2006); when constant returns $\beta = (1 - \alpha)$ to scale is imposed, equation (2) becomes:

$$\ln GDP\,t, i = a + \alpha \,.\ln Kt,\; i + \;(1 - \alpha\,)\,.\ln Lt,\; i + \;\varepsilon t, i \quad (3)$$

$$t = 1965 \;\; - 2006$$

For the purposes of this study, equation (3) was transformed by dividing each term by L (labour input) and then the output elasticity was calculated with respect to capital deepening, i.e. $\alpha = \alpha 1 + \alpha 2$. According to Dollar and Sokoloff, (1990) and Elsadig (2006), the production function can be in the form:

$$\Delta\ln(GDP/L)t, i = a + \alpha_1 \Delta\ln (K/L)t, i + \alpha_2 \left[\Delta\ln (K/L)t, i\right]^2 + \varepsilon t, i \quad (4)$$

$$t = 1965 - 2006$$

Then, it follows that

$\Delta\ln(GDP/L)t, i$ is the contribution of labour productivity (output per worker)

$\overline{\alpha\,\Delta\ln(K/L)}t, i = \alpha_1 \Delta\ln (K/L)t, i + \alpha_2 \left[\Delta\ln (K/L)t, i\right]^2$

is the contribution of the capital deepening

$\varepsilon t, i_{_\tau}$ is the residual term that proxies for TFP intensity growth $(\Delta\ln(TFP/L)t, i)$

Δ is the difference operator denoting e proportionate change rate.

Since the intercept (a) has no position in the calculation of the productivity growth rate indicators it becomes:

$$\Delta\ln(GDP/L)t,\;\; i \;\;= \overline{\alpha}\,.\Delta\ln \overline{(K/L)}\,t, i + \;\Delta\ln(TFP/L)t,\;\; i \quad (5)$$

Where $\overline{\alpha}$ denotes the share of capital deepening, and (TFP/L)

$t, i_{_\text{T}}$, is the translog index of TFP intensity growth.

To calculate the average annual contribution growth rate of the TFP intensity and labour productivity as well as the contribution of the capital deepening, equation (5) becomes

$$\Delta\ln(TFP/L)t,\;\; i \;=\; \Delta\ln(GDP/L)t,\;\; i \;-\; [\overline{\alpha}\,.\Delta\ln \overline{(K/L)}\,t, i \quad (6)$$

Thus, equation (6) expresses the decomposition of labour productivity contribution growth into the contribution of capital deepening, and the contribution of the quality of these factors. This is expressed as the TFP intensity growth.

Sources of Data

The data for this paper was collected from various sources. Real Gross Domestic Product (GDP), real fixed physical capital and number of employment were collected from Asian Development Bank: Key indicators of developing Asia and Pacific countries, Statistical and Data Systems Division, and international financial statistics of International Monetary Fund yearbook, as well as from the individual countries databases and the International Labour Organization. Due to lack of data on man-hours of work, the labour input index is constructed based on the number of persons employed.

RESULTS AND DISCUSSION

Autoregressive estimator has been applied to Equation 4 of the model being generated from Cobb-Douglas

production function to measure the shift in the production functions of ASEAN-5 plus 3. An annual time series data over the period of 1965-2006 for GDP, aggregate physical capital and number of employment have been employed for the individual countries. Analysis of the data using Equation 4 has shown that the estimated coefficients of the explanatory variables of the model are mainly significant at 5% and 10% levels. According to Durbin-H values the model has no problem of autocorrelation (Table 1). In addition, the adjusted R^2 and t-values do not indicate multicollinearity in the model (Table 1). Since the model used in our study is specified in first differences and the calculated growth rates are used in the discussions of results and findings of the study, the model is found to be stationary. Engle and Granger (2003), state that if economic relationships are specified in first differences instead of levels, the statistical difficulties due to non-stationary variables can be avoided because the differenced variables are usually stationary even if the original variables are not.

Empirical Analysis

Analysis was carried out to compare the productivity indicators between the ASEAN5 plus 3 economies for the entire period of 1965-2006. In order to study the effect of governments' policies in improving the productivity growth, the study period was divided into two phases. These phases, which corresponded to the major policy changes, were 1965-1987; 1988-2006. The period of the 1960s; and 1970s witnessed the labour driven policies in these countries. The decades of 1980s, 1990s and 2000s saw a further diversification of the economy into more advanced industries through investment driven policies. As a result of these polices the range of economic activities and sources of growth had become more diversified. In addition, these decades witnessed further diversification of the economies of these countries into more advanced industries. During these decades, the economic structural transformation took place in most economies of these countries; with the exception of Japan whose structural transformation took place in early 1970s. The manufacturing sector became the engine of growth in these countries. Finally, this includes the period of 1988-2006, i.e. was the period during and after the Asian financial crisis of 1997 and its negative impact continued until 2000 with significant damage to the Asian economies.

However, the contribution of TFP intensity growth to the economies of these countries in terms of average annual productivity growth was low (Table 2). The highest

Table 1. Estimated Coefficients of ASEAN 5 + 3, 1965-2006

Country	Intercept	Capital Intensity		Adjusted R^2	D-H
1. China	-0.06 (-1.20)	α_1 0.68 (2.19)**	α_2 0.32 (1.73)*	0.99	-0.63
2. Japan	-0.13 (-1.63)	α_1 0.54 (2.03)**	α_2 0.46 (1.87)*	0.99	-0.62
3. Indonesia	-0.18 (1.87)*	α_1 0.61 (2.03)**	α_2 0.39 (1.99)**	0.93	-0.65
4. Korea	0.25 (6.66)**	α_1 0.53 (3.11)**	α_2 0.47 (2.68)**	0.99	-0.61
5. Malaysia	-0.14 (-4.34)**	α_1 0.64 (4.37)**	α_2 0.36 (2.16)**	0.98	-0.66
6. Philippines	-0.22 (-1.30)	α_1 0.54 (2.44)**	α_2 0.46 (2.04)**	0.92	-0.59
7. Singapore	-0.17 (-1.38)	α_1 0.63 (2.22)**	α_2 0.37 (1.84)*	0.91	-0.57
8. Thailand	-0.15 (-1.54)	α_1 0.69 (2.59)**	α_2 0.31 (1.85)*	0.92	-0.56

Note: Figures in parentheses are t-values, ** Indicate significant at 5% level, * Indicates Significant at 10% level
Figures in Table 1 were estimated using equation (4)

contribution of labour productivity by considering only capital intensity in the model to the productivity growth of the ASEAN5 plus 3 was the contribution of the sub period of 1988-2006 in most countries under study (Table 2). In addition, the contribution of labour productivity to the productivity growth of the economies of these countries was high also during the sub-period of 1965-1987 (Table 2). This was found to be the period of labour driven. And the sub period of 1988-2006 was the perceived period of investment driven. As a result the performance of the economies of these countries was rapid compared with the period before the transformation of these economies into investment driven that supported by foreign direct investment (FDI). The TFP intensity growth contributed very low and the labour productivity was not the highest to contribute to the economy's productivity growth. The reasons were the economic recession of 1973, 1985 and

the financial crisis of 1997 and the quality of human capital and the technology involved in the production of most of these economies.

The highest contribution of capital deepening to labour productivity in terms of average annual productivity growth of the ASEAN5 plus 3 was during the sub-period of 1988-2006 study (Table 2). This reflects the fact the comparative advantage in unskilled labour intensive that eventually helped to attract FDI in the latter half of the 1980s. These countries accelerated trade liberalisation policies and drastically eased restrictions with respect to capital ownership of foreign companies, which fostered the significant increase of global capital. By examining the role of capital intensity to achieve productivity driven economy through the contribution of TFP intensity growth, it was found from the results that there was a significant contribution of capital intensity to TFP intensity

Table 2. ASEAN 5 + 3 Productivity Indicators (in percentage)

Country	Labour Productivity	Capital Deepening	TFP Intensity
China			
1965-2006	4.97	6.44	1.47
1965-1987	8.14	11.3	1.77
1988-2006	8.68	13.7	1.73
Japan			
1965-2006	5.42	10.1	2.7
1965-1987	8..66	11.6	3.39
1988-2006	12.2	15.3	4.92
Indonesia			
1965-2006	3.34	4.52	1.23
1965-1987	5.04	4.24	1.64
1988-2006	4.14	4.77	1.25
Korea			
1965-2006	4.16	8.20	1.71
1965-1987	8.23	10.8	1.87
1988-2006	8.79	11.8	2.13
Malaysia			
1965-2006	5.34	5.69	1.24
1965-1987	7.81	11.7	1.51
1988-2006	6.16	7.27	1.68
Philippines			
1965-2006	3.31	3.53	0.92
1965-1987	5.01	7.30	1.0
1988-2006	5.11	4.00	1.28
Singapore			
1965-2006	3.26	5.73	1.91
1965-1987	4.92	8.55	1.93
1988-2006	5.61	11.0	1.95
Thailand			
1965-2006	3.34	3.76	1.35
1965-1987	5.09	3.81	1.42
1988-2006	4.81	7.18	1.69

Note: Figures in Table 2 were calculated using equation (6).

growth of the economies of these countries during all the periods of study (Table 2). It should be recalled FDI is the source of technology transfer to these countries through Transnational Corporations (TNCs) invested in them. As a result the capital deepening had a very significant role in achieving light labour productivity contribution.

Conclusion

This study justifiably claims to fill the gaps in the previous studies by developing applications of intensive growth theory and introducing the TFP intensity (TFP per unit of labour) as well as providing a statistical analysis. The statistical estimation was successfully employed to attain the coefficients of the explanatory variables that had been used by econometric approach. In addition, a second step that plugs the parameters of the variables into the model in order to compute the contribution rates of productivity indicators, such as the calculation of the residual of the model (TFP intensity), capital deepening and labour productivity contributions which have been used by growth accounting approach.

The results confirm that capital intensity had a significant role in achieving light labour productivity contribution that is produced by most of these economies through using huge inputs to produce output (that is call input driven) with not showing technological progress (which is call productivity driven). As soon as economic structural transformation took place at most of these economies in 1980s, FDI escalated and significantly helped the manufacturing sector to become the driving engine of economic growth instead of agricultural sector that was the engine of growth of these countries.

The results show that the productivity growth of most of these countries is input driven, however, South Korean Model is moving to be a productivity driven that has shown by the constructed companies such as Daewoo, Samsung and LG competed globally. Japan was the only exception which led economic structural transformation in 1970s and joined the industrial club of mainly western nations. The japan economy is the only Asian economy considered to be productivity-driven based on high quality of technology and highly skilled human capital that eventually expedited and fostered an outstanding technological progress. This helped Japan through its TNCs to enter the club of industrial countries which is led and dominated by the Western countries.

In this regard, Japan has contributed significantly to the economic development of most of the East Asian nations through trade, foreign direct investment, bank financing and assistance, the degree of its contribution is now declining following the long stagnation of the Japanese economy in the 1990s. Driving frontward, Japan should pursue to boost the economic growth of Japan and East Asia through contributing to the building of a wide-ranging East Asian free trade agreement which is called ASEAN Plus Three.

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[*] The intercept term, as usual, gives the mean or average effect on dependent variable of all the variables excluded from the model.

[†] The residual term proxies for the total factor productivity growth that accounts for the technological progress of the economy through the quality of input terms.