The Determinants of Economic Growth in ASEAN-4 Countries:

An Application of Solow-Swan and Mankiew-Romer-Weil

Models[*]

Setyo Tri Wahyudi

Brawijaya University, Malang, Indonesia

Mohd Dan Jantan

Universiti Utara Malaysia, Kedah, Malaysia

Even many studies had discussed the role of economic growth, however, it is rare for the case of ASEAN. The objective of the paper is to analyze the determinants of economic growth in ASEAN-4 countries with considered the Solow-Swan (SS) and Mankiew-Romer-Weil (MRW) models as the methods of analysis. The sample of the study is the ASEAN-4 countries: Indonesia, Malaysia, Thailand and Philippines, which covered the period 1980 to 2004. In terms of Solow-Swan model, the study found that labor and capital has significant effect on economic growth. On other hand, the Mankiew-Romer-Weil (MRW) model, which included the variable human capital into Solow-Swan, also give the significant effect on economic growth but in different results.

Keywords: economic growth, Solow-Swan (SS) model, Mankiew-Romer-Weil (MRW) model

Background

The soundness of the macroeconomic fundamentals of ASEAN countries was tested at the collapsed of the exchange rates that began in July 1997. The collapsed of the exchange rates has a big impact on financial sector of these countries not only for a short term but also for a medium term. The financial crisis had an impact on the real sector of the economy through an increase in interest rate, an increase in cost of imports, credit crunch in the banking sector, and bankruptcy of firms.

At the beginning of the crisis, the currencies of ASEAN countries began to fall rapidly against the United States dollar. These foreign exchange rate and financial crises in ASEAN countries caught many by surprise since these countries were considered having enjoyed decades of high economic growth. In 1996, just one year before the crisis, the economic growth rate was 8.0 percent for Indonesia, 8.6 percent for Malaysia, and 5.5 percent for Thailand. Nor was inflation, though somewhat higher than in the U.S., by any means out of hand,

being 7.9 percent for Indonesia, 3.5 percent for Malaysia, and 5.9 percent for Thailand (ASEAN Secretariat, 2001).

Recently, the economic situation in ASEAN has improved and stabilized. Economies in the region have registered signs of having dynamic in terms of economic growth and developments. The positive signs can be seen from the most recent macroeconomic indicators of ASEAN countries. In terms of GDP growth, with preserved economic fundamentals, the region rebounded quickly and strongly with GDP growth of 5.4 percent in 2000 and GDP per capita has increased from US$1,195.90 in 2002 to US$2,227.30 in 2007 (see Table 1). The quick recovery indicated that the region has a high degree of economic flexibility to rapidly respond to the changing of the economic environment.

Table 1

GDP per Capita of ASEAN Countries in US Dollar, 2002-2007

Country	2002	2003	2004	2005	2006	2007
Brunei Darussalam	17,157.50	18,707.70	21,863.20	25,744.10	29,922.20	31,076.10
Cambodia	308.40	347.90	390.80	450.60	512.20	598.40
Indonesia	931.50	1,100.40	1,105.20	1,301.20	1,640.00	1,919.60
Laos PDR	368.90	424.70	487.30	538.60	645.40	736.10
Malaysia	3,899.50	4,154.70	4,876.70	5,250.40	5,890.50	6,880.20
Myanmar	135.60	219.50	193.30	199.40	210.00	215.60
Philippiness	955.30	971.50	1,039.40	1,157.10	1,355.70	1,652.80
Singapore	21,098.30	22,066.40	25,355.40	26,864.30	29,499.60	35,206.10
Thailand	2,020.40	2,264.80	2,604.10	2,826.20	3,293.90	3,740.10
Vietnam	439.80	488.70	555.20	637.10	724.40	836.70
ASEAN	1,195.90	1,328.20	1,445.10	1,613.10	1,901.70	2,227.30

Note. Source: ASEAN Secretariat, retrieved from September 16, 2008.

Theoretical Framework

Economic growth refers to an increase in real GDP, the value of the annual output of final goods and services in the economy adjusted for inflation. While this measure tells us whether an overall economic performance has improved from the previous period, but it does not tell us much whether the average citizen is better or worse than in the previous period. An increase in real per capita GDP is a more accurate measure of economic growth (Ekelund & Tollison, 1996, p. 702).

The Solow-Swan (SS) Model

The basic version of the Solow-Swan model considers a closed economy producing one single (composite) good using both labor and capital (Agenor, 2004, p. 439). It takes the rate of saving, population growth, and technological progress as exogenous. There are two inputs: capital and labor, which are paid according to their marginal products (Mankiw, Romer, & Weil, 1992). There is no government, there are a fixed number of firms in the economy, each with the same production technology. Normalizing, the number of firms to unity for simplicity, aggregate output can thus be characterized by an aggregate production function. The price of output is constant and factor prices (including wages) adjust to ensure full utilization of all available inputs. Formally, the model focuses on four variables:

- The flow of output: Y;
- The stock of capital: K;
- The number of workers: L;
- Knowledge or the effectiveness of labor: A.

On the supply side of the economy, the firm combines capital, labor, and knowledge to produce output. The aggregate production function is:
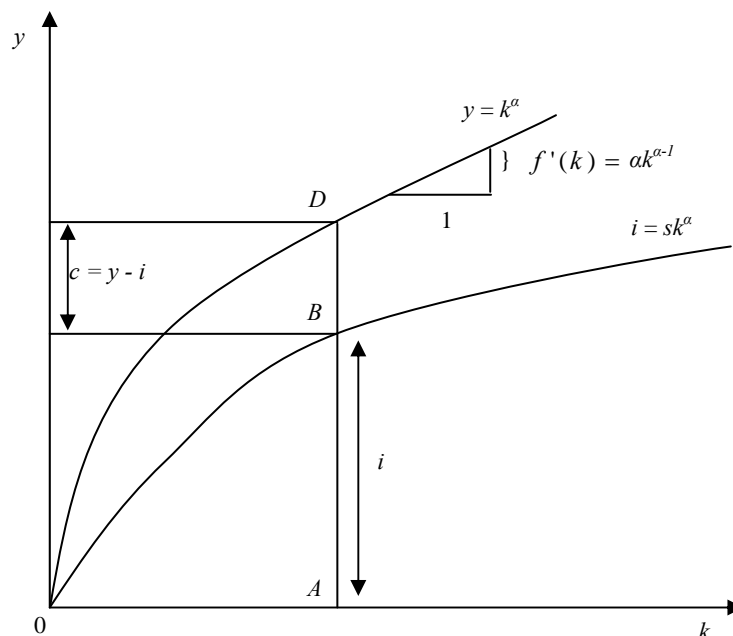
$$Y = F(K,AL); \ Y = F(AK,L); \ Y = F(K,L) \tag{1}$$

Figure 1. The production function in the Solow-Swan model. Source: Agenor, 2004, p. 443.

On the demand side, the absolute level of real demand (Y^D) is the following (Valdes, 1999, p. 23):

$$Y_t^D = C_t + I_t + G_t + X_t - M_t \tag{2}$$

Since this is a long-run model of the economy, classical full employment equilibrium must hold, therefore we have $Y = Y^D$, that is:

$$Y_t = C_t + I_t + G_t + X_t - M_t \tag{3}$$

Subtracting taxes (T) from both sides of this equation and rearranging the terms, we obtain:

$$Y_t - T_t = C_t + I_t + (G_t - T_t) + (X_t - M_t) \tag{4}$$

The link between the supply and demand sides of the economy is provided by the net investment. Which each year adds to the capital stock (Valdes, 1999, p. 25). Hence, assuming that the capital stock depreciates annually at the rate δ $(0 < \delta < 1)$, net investmet is given by:

$$\dot{K}_t = \frac{dK_t}{dt} = I_t - \delta K_t \tag{5}$$

Refer to equation (2), in which $k = K/AL$ into equation (5), we obtain:

$$\dot{\tilde{k}} = \frac{d\tilde{k}}{dt} = \frac{\frac{dK}{dt}AL - \left(\frac{dK}{dt}L + \frac{dL}{dt}A\right)K}{A^2L^2} = \frac{\frac{dK}{dt}}{AL} - \overset{\circ}{A}\tilde{k} - \overset{\circ}{L}\tilde{k}$$

$$\dot{\tilde{k}} = \frac{d\tilde{k}}{dt} = \frac{I - \delta K}{AL} - \overset{\circ}{A}\tilde{k} - \overset{\circ}{L}\tilde{k} = i - (\delta + \overset{\circ}{A} + \overset{\circ}{L})\tilde{k}$$

and since $\tilde{i} = sf(\tilde{k})$, we obtain:

$$\dot{\tilde{k}} = \frac{d\tilde{k}}{dt} = sf(\tilde{k}) - (\delta + \overset{\circ}{A} + \overset{\circ}{L})\tilde{k} \tag{6}$$

The Mankiw-Romer-Weil (MRW) Model

Aside from the inclusion of human capital, the model developed by Mankiw, Romer, and Weil (1992) is similar to the Solow-Swan model in the sense that it assumes constant return to scale (Agenor, 2004, p. 473; Valdes, 1999, p. 18). However, it differs in an important way from that model because relatively small changes in the resources devoted to physical and human capital accumulation may lead to large changes in output per worker. As a result, it is more capable to account for large differences in real incomes across countries.

There is only production sector, with output given by:

$$Y_t = K_t^\alpha H_t^\beta (A_t L_t)^{1-\alpha-\beta}, \ \alpha, \beta > 0, \ \alpha + \beta < 1 \tag{7}$$

where H is the stock of human capital, and L is the number of workers. Temple (1998) introduced the distinction between equipment and structures (buildings) as two components of capital in the Mankiw-Romer-Weil framework. His production function generalized (7) to give $Y = K_S^{\alpha_S} K_E^{\alpha_E} H^\beta (AL)^{1-\alpha_S-\alpha_E-\beta}$, where K_S is the stock of structures, K_E is the stock of equipment goods, $0 < \alpha_S, \alpha_E, \beta < 1$, and H and L are defined as before. There are now constants return to K_S, K_E, L, and H.

The long-run equilibrium values (*steady state*) of physical ($\tilde{k}$) and human capital ($\tilde{h}$) can be solved:

$$\tilde{k} = \left\{ \frac{s_K^{1-\beta} s_H^\beta}{\varphi} \right\}^{\frac{1}{1-\alpha-\beta}} \text{ and, } \ \tilde{h} = \left\{ \frac{s_K^\alpha s_H^{1-\beta}}{\varphi} \right\}^{\frac{1}{1-\alpha-\beta}} \tag{8}$$

which yields:

$$\frac{\tilde{k}}{\tilde{h}} = \frac{S_K}{S_H} \tag{9}$$

Total physical capital, human capital, and output (K, H, and Y) are growing at rate $n + \gamma$; and physical capital per worker, human capital per worker, and output per worker (K/L, H/L, and Y/L) are growing at rate γ. Thus, as in the Solow-Swan model, the long-run growth rate of output per worker is determined by the exogenous rate of technological progress.

Methodology and Data

This study attempts to look at the determinants of economic growth in ASEAN-4 countries, namely Indonesia, Malaysia, Thailand, and Philippines for the period 1980 to 2004. Interesting of those periods because

it was accounts a remarkable macroeconomic phenomenon in ASEAN-4 countries, ranging from the economic situation several years after financial liberalization, the emergence of financial markets, lead to bank failures, and 1997-1998s economic crisis. A panel data regression model will be chosen as appropriate model to develop in this study.

Scope

The specific objective of this study is to investigate the sources of economic growth. The model estimation in the study is mainly based on the Solow-Swan and Mankiw-Romer-Weil model. All of variables employed in this study are: real Gross Domestic Product that represents the real output every year, labor (L), real capital stock (K), and human capital (HK).

Types and Sources of Data

The types of data use in this study are annual cross-section and time series data, which is panel data. The annual data was chosen because this data can show the higher variation than the quarterly or monthly data. All of data used in this study is a secondary data, means that the data have already processed by certain legitimate institution that will provide and publish their findings for public. The sources of the data were obtained from: (1) International Financial Statistics (IFS); (2) IMF Collection Data for ASEAN countries; (3) World Bank; (4) Asian Development Bank (ADB); (5) Global Market Information Database (GMID); (6) Bank Indonesia; (7) Bank Negara Malaysia; (8) Bank of Thailand; (9) Bank of Philippiness; and (10) Other sources related with this study in various publication periods and editions.

Model Specifications

As described earlier, this study employs two models as follows.

The Solow-Swan (SS) model. This study use Cobb-Douglas production function to look capital and labor contribution, given by:

$$Y = AK^{\alpha}L^{1-\alpha} \tag{10}$$

into logarithm model, we get:

$$\log Y = \log \left\{ A_t K^{\alpha} L^{1-\alpha} \right\}$$
$$\log Y = \log A_t + \alpha \, \log K + (1-\alpha) \, \log L \tag{10'}$$

where, Y = real GDP; A = total factor productivity; K = real capital stock; L = labor; α = capital share.

Mankiw-Romer-Weil (MRW) model. A key implication of the growth model with physical and human capital accumulation was developed by Mankiw, Romer, and Weil (1992). As indicated in the previous chapter, the differences in population growth and capital accumulation can potentially account for the observed large variations in incomes across countries. Then, the contribution of labor in economic growth, divides into two as labor and human capital. This model called MRW model, given by:

$$Y = A_t K^{1-\alpha} (hL)^{\alpha} \tag{11}$$

Translate into logarithm, yields:

$$\log Y = \log \left\{ A_t K^{\alpha} (hL)^{1-\alpha} \right\}$$
$$\log Y = \log \left\{ A_t K^{\alpha} (h)^{1-\alpha} (L)^{1-\alpha} \right\}$$
$$\log Y = \log A + \alpha \log K + (1-\alpha) \log h + (1-\alpha) \log L \tag{11'}$$

where, Y = real GDP; A = total factor productivity; K = real capital stock; L = labor; h = human capital; α = capital share.

Methods of Analyzing

Based on the specific objectives of study, the appropriate tool that can be used for an analysis is a panel data regression models framework. A panel data offers various advantages over traditional time series data in addition to the larger number of observations. The use of panel data allows, not only an increase in degrees of freedom and better estimators' large sample properties, but also the reduction of endogeneity[1], due to the consideration of specific country affects that can be correlated with regressors (fixed effects) or not (random effects) (Sequira & Campos, 2005). The steps of the methodology may be summed up in terms of the following.

Fixed effects estimation. Under panel data assumptions[2], to eliminate the fixed effect, a_i, fixed effects transformation was a better method applied to estimate the panel data model (Wooldridge, 2006, p. 485). To see what this method involves, consider a model with a single explanatory variable for each i:

$$y_{it} = \beta_1 x_{it} + a_i + u_{it}; \ t = 1, \ 2, ..., \ T \tag{12}$$

Now, for each i, average this equation over time, we get:

$$\overline{y}_i = \beta_i \overline{x}_i + a_i + \overline{u}_i \tag{13}$$

where $\overline{y}_i = T^{-1} \sum_{t-1}^{T} y_{it}$, and so on. Because a_i is fixed over time, it appears in both equations (12) and (13). If we substract equations (12) and (13) for each t, we wind up with:

$$y_{it} - \overline{y}_i = \beta_1 (x_{it} - \overline{x}_i) + u_{it} - \overline{u}_i; \ t = 1, \ 2, ..., \ T$$

or:

$$\ddot{y}_{it} = \beta_1 \ddot{x}_{it} + \ddot{u}_{it}; \ t = 1, \ 2, ..., \ T \tag{14}$$

where $\ddot{y}_{it} = y_{it} - \overline{y}_i$ is the time-demeaned data on y, and similar for $\ddot{x}_{it}$ and $\ddot{u}_{it}$. The fixed effect transformation

also called the within transformation. The important thing about equation (14) is that the unobserved effect, a_i, has disappeared. This suggest that we should estimate equation (14) by pooled OLS. A pooled OLS estimator is based on the time-demeaned variables is called fixed effects estimator or the within estimator. The latter name comes from the fact that OLS on equation (14) use the time variation in y and x within each cross-sectional observation.

Under straight exogeneity assumption on the explanatory variables, the fixed effects estimator is unbiased; roughly the idiosyncratic error, u_{it}, should be uncorrelated with each explanatory variable across all time periods. In this context, the fixed effects estimator permits for arbitrary correlation between the unobserved effects, a_i, and the independent variables in any time period, just as with first differencing. Because of this, any explanatory variable that is constant over time for all i gets swept away by the fixed effects transformation: $\ddot{x}_{it} = 0$ for all i and t, if x_{it} constant across t (Wooldridge, 2000, p. 442, 2006, p. 486). The other assumptions needed for a straight OLS analysis to be valid are the error u_{it} are homoskedastic and serially uncorrelated (across t)[3] (Wooldridge,

---

[1] A term used to describe the presence of an endogenous explanatory variable.
[2] For completed, see Wooldridge (2006). *Introductory econometrics: A modern approach* (3rd ed.). United States of America: South-Western College Publishing.
[3] Described in the latter of this section.

2006, p. 486).

Random effects estimation. Begin with the unobserved effects model as before:

$$y_{it} = \beta_0 + \beta_1 x_{it1} + ... + \beta_k x_{itk} + a_i + u_{it} \qquad (15)$$

where equation (15) explicitly include an intercept so that we can make the assumption that the unobserved effects, a_i, has a zero mean (without loss of generality). We would usually allow for dummies among the explanatory variables as well. In using fixed effect, the goal is to eliminate a_i because it is tought to be correlated with one or more of the x_{itj}. But suppose we think a_i is uncorreated with each explanatory variable in all time periods. Then, using a transformation to eliminate a_i results in inefficient estimators (Wooldridge, 2006, p. 494).

Equation (15) becomes a random effects model when we assume that the unobserved effects, a_i, is uncorrelated with each explanatory variable:

$$Cov(x_{itj}, a_i) = 0; t = 1, 2, 3, ..., T; j = 1, 2, 3, ..., k \qquad (16)$$

The assumptions in random affects include all of the fixed effects assumptions plus additional requirement that a_i is independent of all explanatory variables in all time periods. If we think the unobserved effects, a_i, is correlated with any explanatory variables, we should use first differencing or fixed effects.

Finding and Discussion

As mentioned before, all of variables used in this study such as real GDP, real capital stock, labor, and human capital for all countries are estimated using the Solow-Swan and Mankiw-Romer-Weil in the logarithm form. The results as follows.

The Solow-Swan Model

Solow-Swan model developed from Cobb-Douglas production function. Based on the empirical test using panel data method with cross-section for four countries and time series for period 1980-2004, given the results presented as follows:

In the fixed effect results, as presented in Table 2, coefficient of each independent variable gives the share of value are 0.3 and 0.7 for capital and labor, respectively. These coefficients imply that increase one percent in capital will increase GDP by 0.3 percent, while increase one percent in labor will increase GDP by 0.7 percent. Labor share give higher effect on growth than capital stock. The R^2 of the model is 0.99, which indicates that 99 percent of the real GDP variation is explained by the involved variables in the model. Meanwhile, on the random effect results, as presented in Table 3, coefficient of each variables show 0.52 and 0.28 for capital and labor, respectively. Also, all of coefficients in this model show statistically significant.

Based on the results in Table 2 and Table 3, the fixed effect method was given the reasonably coefficient for real capital stock and labor than random effect. Fixed effect method give higher coefficient and significant statistically than random effect. Therefore, without applying Husman test to choose one of both methods, we can conclude that fixed effect method is chosen as appropriate model since this result given a higher and rational value. Then, the results given the model as follows:

$$\log (RGDP) = 0.3 \log RK + 0.7 \log L + \varepsilon$$
$$t - statistic \qquad (5.7996) \qquad (4.9457)$$
$$R^2 = \qquad 0.9941$$

Table 2

Fixed Effect Panel Data Test Result for the Solow-Swan Model

Variable	Fixed-effect			
	Coefficient	Std. error	*t*-statistic	Prob.
Ln (Real Capital Stock)	0.3205	0.0552	5.7996	0.0000
Ln (Labor)	0.7481	0.1512	4.9457	0.0000
R-square	0.9941			

Note. Number of observations: 100.

Table 3

Random Effect Panel Data Test Result for Solow-Swan Model

Variable	Random-effect			
	Coefficient	Std. error	*t*-statistic	Prob.
Constant	1.7804	1.1618	1.5324	0.1287
Ln (Real Capital Stock)	0.5220	0.0514	10.1540	0.0000
Ln (Labor)	0.2878	0.1418	2.0285	0.0452
R-square	0.9914			

Note. Number of observations: 100.

Based on these result, we can say that labor in ASEAN-4 countries has a dominant factor than capital in order to support economic growth in this area. Increase in labor will give beneficial to enhance growth rate in this region.

Total factor productivity. Total Factor Productivity (TFP) is the portion of output not explained by the amount of inputs used in the production. As such, its level is determined by how efficiently and intensely the inputs are utilized in production. To calculate TFP, we use formula (Greene, 2005, in Endy & Donni, 2006):

$$(d \log A)/A = (d \log Y)/Y - \alpha(d \log K)/K - (1-\alpha)(d \log L)/L$$

with the capital and labor shares are 0.3 and 0.7 respectively, calculation for TFP ASEAN-4 given as:

$$(d \log A)/A = (d \log RGDP)/RGDP - 0.3(d \log RK)/RK - 0.7(d \log L)/L$$

Based on the calculation, we get the results -0.015, which means that TFP growth in ASEAN-4 has declined by 1.5 percent during periods 1980 to 2004. If we look for each ASEAN-4 countries, TFP in each ASEAN countries as presented in Figure 2, show that Malaysia, Thailand, and Indonesia have positive TFP. Meanwhile, only the Philippine show negative TFP. TFP was the highest (1.29 percent) for Malaysia, followed by Thailand (1.28 percent). The TFP was only 0.18 percent for Indonesia (1980-2004), while Philippines shown a negative TFP of -0.80 percent.

Figure 3 presents movement of the total employment in ASEAN-4 countries. Most of the countries have experienced positive growth in employment during the study. Across all the country employment has grown over the longer term, although individual rates of growth show some variability. For example, employment trend for Indonesia during 1980-2004 show that, development of total employment in Indonesia increase gradually. This condition is not surprising since population in Indonesia was the largest among these countries. While Thailand and Philippines increase slightly. Meanwhile, the growth of labor in Malaysia is lower than among countries.
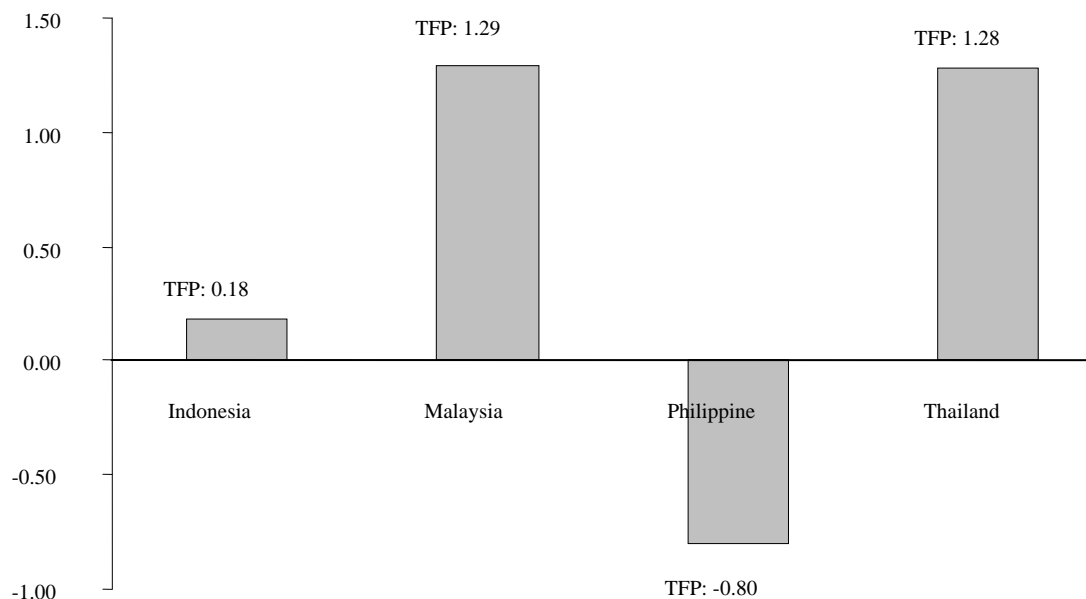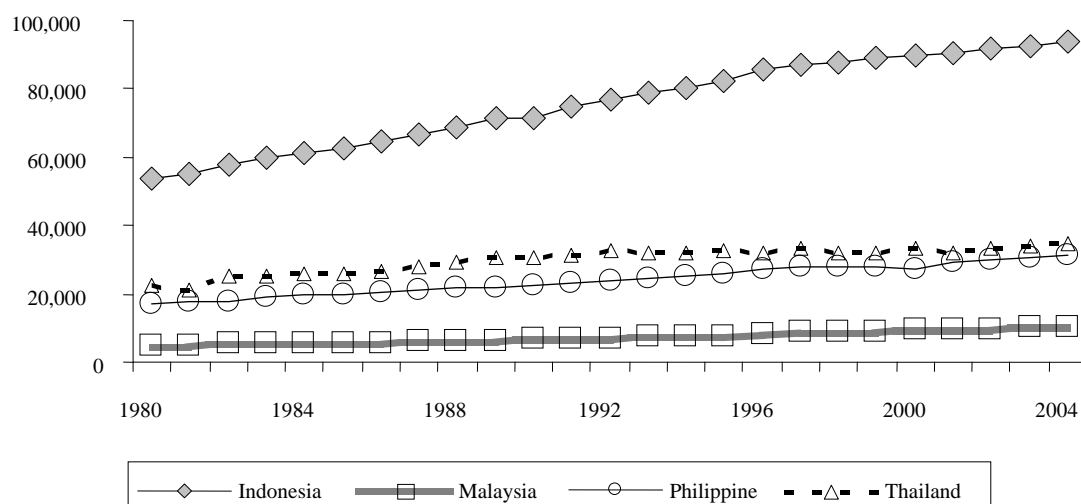
Figure 2. TFP in ASEAN-4 countries.

Figure 3. Total employment in ASEAN-4 countries (in thousands).

Mankiw-Romer-Weil Model

   The second model used to test the exogenous growth model is Mankiw-Romer-Weil (MRW) model. As described before, this model developed from Solow-Swan model with include human capital in the model. In this study, we use adult literacy rate as a proxy of human capital. Panel regression model for MRW model, as presented in Table 4 found that all of explanatory variable statistically significant at 5 percent level of significance.

   Then, the Mankiw-Romer-Weil model can be written as:

$$\log(RGDP) = 0.29 \log(RK) - 0.64 \log(L) + 0.068 HK + \varepsilon$$
$$t - statistic \quad\quad (5.9216) \quad\quad\quad (-1.9766) \quad\quad (4.7039)$$
$$R^2 = 0.9952$$

Table 4

Fixed Effect Panel Data Test Result for MRW Model

Variable	Fixed-effect			
	Coefficient	Std. error	*t*-statistic	Prob.
Ln (Real Capital Stock)	0.2971	0.0501	5.9216	0.0000
Ln (Labor)	-0.6446	0.3261	-1.9766	0.0510
Human Capital	0.0683	0.0145	4.7039	0.0000
R-square	0.9952			

Note. Number of observations: 100.

In this model, it looks that the explanatory variables in the model can explain model as 99.52 percent, shown from R^2. While the coefficient of each variable in the model give the value that reasonably with theory. The coefficient of real capital, labor, and human capital are 0.29, -0.64 and 0.068, respectively. This result is at odd to what is expected. As mentioned in literature review, it is expected that capital, labor and human capital plays an important role give effect in generating output. Include human capital in the MRW model given result different effect for labor. This particular result may due to the different proxy used to capture the influence of labor on the MRW model.

United Nations Development Programme (UNDP) using three dimensions in order to measure human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and enrolment at the primary, secondary and tertiary level) and having a decent standard of living (measured by purchasing power parity, PPP, income). As presented in Table 5, there shows life expectancy, adult literacy, and human development index for ASEAN. Base on the Human Development Index (HDI) reported by UNDP, among ASEAN-4 countries, Malaysia has upper position in HDI rank followed by Thailand, The Philippines and Indonesia with 63rd, 78th, 90th, and 107th out of 177 countries in the world, respectively.

Table 5

Human Development in ASEAN Countries

Country	Life expectancy (years)		Adult literacy rate (% ages 15 and older)		HDI	
	2005	2006	2005	2006	2005	2006
Indonesia	69.7 (100)	67.2	90.4 (56)	90.4	0.73 (107)	0.71 (108)
Malaysia	73.7 (57)	73.4	88.7 (62)	88.7	0.81 (63)	0.81 (61)
The Philippines	71 (90)	70.7	92.6 (46)	92.6	0.77 (90)	0.76 (84)
Thailand	69.6 (102)	70.3	92.6 (45)	92.6	0.78 (78)	0.78 (74)
Singapore	79.4 (14)	78.9	92.5 (47)	92.5	0.92 (25)	0.92 (25)
Brunei Darussalam	76.7 (36)	76.6	92.7 (44)	92.7	0.89 (30)	0.87 (34)
Vietnam	73.7 (56)	70.8	90.3 (57)	90.3	0.73 (105)	0.71 (109)
Cambodia	58 (140)	56.5	73.6 (99)	73.6	0.60 (131)	0.58 (129)
Myanmar	60.8 (134)	60.5	89.9 (58)	89.9	0.58 (132)	0.58 (130)
Laos	63.2 (127)	55.1	68.7 (106)	68.7	0.60 (130)	0.55 (133)

Notes. Number in the parentheses shown country's rank out of 177 countries. Source: Human Development Reports, UNDP, (several editions), 2008.

Table 5 presents the adult literacy rates among the ASEAN countries. Thailand was 45th rank out of 177 countries in 2005. This position then followed by Philippines, Indonesia, and Malaysia in 46th, 56th, and 62nd, respectively. In addition, Vietnam has a better position compare with Malaysia, in 57th. These positions, for all countries shown remain unchanged in the 2006. According these ranks, in general, we can conclude that education in ASEAN-4 countries during 2005-2006 still shows a better improvement.

Concluding Remarks

In this paper we analyze the determination of economic growth for four ASEAN countries using panel data regression models focusing on the application of Solow-Swan and Mankiew-Romer-Weil model during 1980 to 2004. Through this analysis we particularly hope to contribute to the literature by allowing the possibility that different growth effects may apply depending on the sign and magnitude of the explanatory variable. Specifically, the estimated results for each model used in this study given conclusion and results as given below.

The Solow-Swan Model

The estimation of The Solow-Swan model using Cobb-Douglas production function in which capital stock and labor are independent variables and real GDP is dependent variable. Based on the estimated results, the fixed effect model is more superior model compared to random effect to predict the effect of real capital stock and labor on GDP.

In the fixed effect models, estimation results given capital share and labor share 0.3 and 0.7, respectively. It implies that labor share given higher effect on economic growth in ASEAN-4 during the study. These results also imply that the quantity of labor supply in ASEAN-4 countries is still a dominant factor to support growth in this region. These conclusions are not surprising since total employment in ASEAN-4 countries shows increase gradually during period 1980 to 2004. Increase in population also means that increase in quantity of labor supply.

Total factor productivity in these regions shows a -1.5 percent during period 1980-2004. Malaysia was a higher followed by Thailand with 1.29 and 1.28 percent, respectively. Indonesia, during 1980-2004 was TFP recorded by 0.18 percent, only The Philippines show -0.80 percent.

Mankiw-Romer-Weil Model

The Mankiw-Romer-Weil model is developed from Solow-Swan model which included Human Capital in the model.   In this study, adult literacy rate (measured as % ages 15 and older) used as a proxy of human capital that indicates the result of a country's efforts to provide basic education for its citizens.

Based on the fixed effects estimation results, explanatory variables can explain model as 99.5 percent. The coefficient of real capital, labor, and human capital are show significant statistically 0.29, -0.64, and 0.06, respectively. These results are different from Solow-Swan model, particularly for labor effect. This result does not add to the literature. There is exist diminishing marginal productivity of labor in the model.

There are two reasons about the diminishing marginal productivity of labor on growth (OECD, 2007). First, because skilled workers are more likely to be employed than unskilled workers, an increase in the employment rate is likely to increase the proportion of unskilled workers in the workforce. This will reduce the average quality of labor input and reduce measured productivity, which does not control for labor quality. Second, if employment and hours increase because of a labor supply surge, labor intensive industries are likely to expand.

Human capital in the MRW model shows a positive effect. It means that development in adult literacy rate as a proxy of human capital in ASEAN-4 during 1980 to 2004 only give lower effect in order to increase GDP growth in the region. And that is precisely positive effect on growth. However, these results give empirical fact that economy in ASEAN and ASEAN-4 particularly, during period of study has shown significantly changes. Several empirical results shown that effect of human capital on growth also has different results, positively, negatively and also insignificantly then we can conclude that, differences in use proxy for human capital will also give effect different results on growth.

References

Agenor, P. R. (2004). *The economics of adjustment and growth* (2nd ed.). Cambridge, Mass.: Harvard University Press.

ASEAN Secretariat. (2008a). *Table 10: Interest rate, 3-month time deposit, end of period (in percentages).* Retrieved September 16, from http://www.aseanseg.org

ASEAN Secretariat. (2008b). *Table 12: Exchange rate, US$1 in national currency, average (in national currency).* Retrieved September 16, from http://www.aseanseg.org

ASEAN Secretariat. (2008c). *Table 7: Gross domestic product per capita in ASEAN, at current prices (nominal), in US dollars.* Retrieved September 16, 2008, from http://www.aseanseg.org

Ekelund, R. B., & Tollison, R. D. (1996). *Economics: Private markets and public choice* (5th ed.). New York: Addison-Wesley, Longman.

Endy D. T., & Donni, F. A. (2006). Faktor-faktor determinan pertumbuhan ekonomi Indonesia. Working paper, WP/08/2006. Jakarta: Bank Indonesia.

Greene, W. H. (2000). *Econometric analysis* (4th ed.). New York: Prentice Hall.

International Financial Statistics (IFS). (1970-2005). *Statistical yearly IMF database.* Washington. Retrieved from http://www.imf.org

International Financial Statistics (IFS). (2008). *World economic and financial surveys: World economic outlook database.* Washington. Retrieved from http://www.imf.org

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics, 107*(2), 407-437.

OECD. (2007). *More jobs but less productive? The impact of labour market policies on productivity.* Retrieved from http://www.oecd.org/els/employmentoutlook

Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics, 70,* 65-94.

UNDP. (2008). *Human development reports.* Retrieved from http://www.undp.org

Valdes, B. (1999). *Economic growth: Theory, empirics and policy.* Northampton, M.A.: Edward Elgar.

Verbeek, M. (2004). *A guide to modern econometrics* (2nd ed.). New York: John Wiley & Sons.

Wooldridge, J. M. (2006). *Introductory econometrics: A modern approach* (3rd ed.). United States of America: South-Western College Publishing.

World Bank. (2008). *Data and statistics.* Retrieved from http://www.worldbank.org