MEASURING GROWTH RESIDUAL: EMPIRICAL EVIDENCE ON TOTAL FACTOR PRODUCTIVITY TEST AND SOLOW GROWTH MODEL

by

Princess Allyne Joy P. Aba, Dennis C. Maglanoc and Eleanor Garoy

ABSTRACT

This paper is an exposition of the theoretical Cobb-Douglas production function, showing how Philippine growth patterns and productivity are compared with other ASEAN countries. The derivation of the aggregates of growth and productivity highlights the development of Cobb-Douglas production function as espoused by Samuelson. Data consideration follows Cobb and Douglas theoretical limits. Extension of the derivation is the empirically tested Solow Growth model. Cobb-Douglas production used in this paper is extended with Human capital. The interest on this section is the estimates of absolute levels of TFP as residuals that are closely related to levels of output per person. GDP growth is highly affected by technical or technological growth, aside from growth drawn from physical capital, labor and human capital. Singapore has a very low relative growth drawn from its physical capital, labor and human capital, but it has coped up through the industrialization it has experienced. Philippines is a developing country but it shows a high potential in economic growth through its growth in Physical Capital (K). Philippines' physical capital growth was drawn from direct foreign and domestic capital formation; more labor was drawn from investment that may be made in the Philippines. Thailand, on the other hand, have a stabilizing economy, but it doesn't rely that much on physical capital or on labor, however, its labor have a negative amount but it can be explained by its human capital. Thailand has a small growth in labor input but it has quality drawn from their government expenditure for education. Economic growth comes from different variables, but a country's growth should be drawn from available resources it has the richest, or a combination of two or more.

Keywords: total factor productivity, cobb-douglas production function, solow growth residuals

1. Introduction

Philippines is considered to be the 39th largest economy in the world, revealed in 2014 International Monetary Fund Statistics. Unstable patterns of growth however have been recorded over the years. The period of 1980's showed a remarkable decrease in output with the country transitioning from Marcos administration to a more democratic rule but it was followed by a better growth performance around the mid 1990's. The Philippines faces a major challenge to move its economy to a higher level of growth and job creation than it has experiences during the past often turbulent decades according to the advocacy paper of Arangkada Philippines 2010.

In the working paper prepared by Michael Sarel, (1997), revealed that the period of eighteen years from 1978 to 1996 shows a very impressive growth rate of TFP in Singapore (2.2 percent), Thailand (2.0 percent), Malaysia (2.0 percent), a relatively strong rate for Indonesia (1.2 percent), and a negative rate for the Philippines (-0.8 percent). The estimated growth rate of United States over the same period is 0.3 percent. Output per person in the Philippines is the lowest among the other ASEAN countries with a 0.19 percent as compared to Indonesia (4.74 percent), Malaysia (4.54 percent), Singapore (5.09 percent) and Thailand (5.24 percent). During 1991-1996, the rates of TFP growth increased strongly in Indonesia and Philippines from 5.11 percent and 1.63 percent, respectively.

The results on national accounts data can be used to determine factor income shares of labor and capital

This paper is an exposition of the theoretical Cobb-Douglas production function, showing how Philippine growth patterns and productivity are compared with other ASEAN countries. The derivation of the aggregates of growth and productivity highlights the development of Cobb-Douglas production function as espoused by Samuelson. Data consideration follows Cobb and Douglas theoretical limits. Extension of the derivation is the empirically tested Solow Growth model. Cobb-Douglas production used in this paper is extended with Human capital. The interest of the paper basically is the estimate of absolute levels of TFP as residuals that are closely related to levels of output per person.

The general aim of the paper is to empirically show the productivity of the Philippines from the measures of the variables showed in national accounts data and to use some model such as the basic Solow growth model that explains the productivity variation and comparison of the country across two selected ASEAN countries, Singapore and Thailand. It uses internationally comparable data and delves into some methods and tests to estimate variables that contribute to productivity growth, specifically concentrated on capital, labor, and the human capital aspect as an extension variable to the model.

The paper is organized into six sections; the first section is a presentation of the general issue needed to be addressed in the paper. The Background of the Study provides a significant review of the Philippine growth patterns and considered relevant macroeconomic indicators. Presenting the argument of the paper hinges on the economic theory on Cobb-Douglas production function and relevant citation of the review of literature. The objectives of the paper are summarized conforming with the argument of the paper. The second section shows the operational definitions and measurement of the variables including capital, labor and human capital. The third section presents the methodology adopted in this paper, presenting the methods used, the data and its sources and the statistical procedures done. The fifth section presents and analyzes the empirical results and the discussion made. Lastly, the sixth section contains the conclusion and the policy implications of the paper.

1.1 Background of the Study

Users of the data, such as the government, look at statistics to determine the drivers of productivity growth for such increased is a key determinant of economic growth. Many observers have emphasized the importance of human capital, particularly as attained through education that contributes to economic progress (Lucas, 1988 and Mankiw, Romer and Weil, 1992). A well-educated people are known to enhance labor productivity to a high level, which includes more skilled workers not just of quantity but also of the quality of labor. Earlier empirical studies used school enrollment ratios or literacy rates (Romer, 1990, Barro, 1991, and Mankiw, Romer and Weil, 1992) as indicators to labor productivity. This, together with the right capital goods and mix of labor, can enhance productivity. But to measure productivity is to trace also technical change especially that productivity is not only reflected as a quantity measure but a quality measure, which is a contributed by several or many factors.

As an initial background we show for example how the different producing sectors in the country contribute to GDP and employment levels. Data generated by the Philippine Statistics Authority (PSA) in 2013, shows that 56.8% GDP share comes only from the services sector that has the highest contribution among the other sectors, agriculture and industry.

The employment rate of selected ASEAN countries in 2009 shows a high share in employment of services sector in the Philippines.

Figure 1. Share of Services Sector

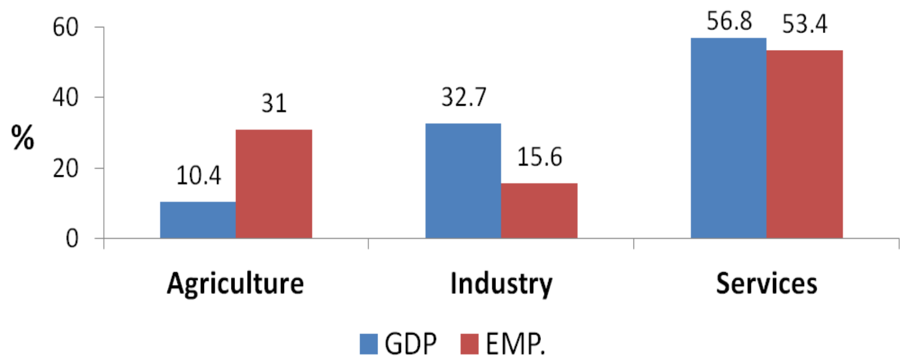
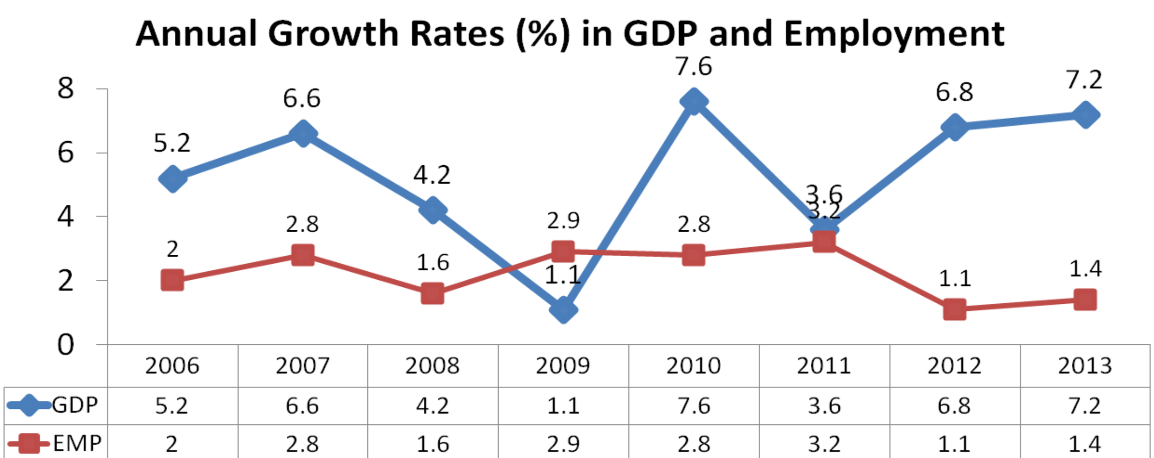


Figure 2. Annual Growth rates in GDP and Employment



Data also reveals that the Philippines show a high GDP growth but low employment creation.

Table 1. Output structure in three sectors

Country	Agriculture	Industry	Services
Indonesia	39.7	18.8	41.5
Malaysia	13.5	27.0	59.5
Thailand	41.5	19.6	38.9
Philippines	35.2	14.5	50.3

The output structure of selected ASEAN countries in 2009 still shows a high contribution of output in Services sector but has a lowest share in Industry sector in the Philippines.

Figure 3. The annual growth rate in capital formation of the Philippines (at constant prices 2000)

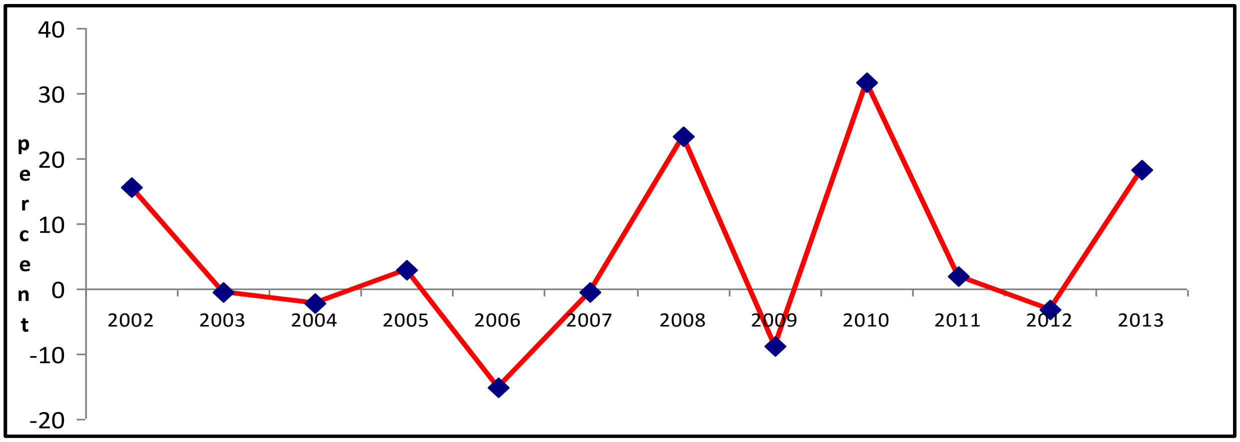


Table 2. Growth Rate Pattern in the Philippines

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
15.7	-0.4	-2.2	3.0	-15.1	-0.5	23.4	-8.7	31.6	2.0	-3.2	18.2

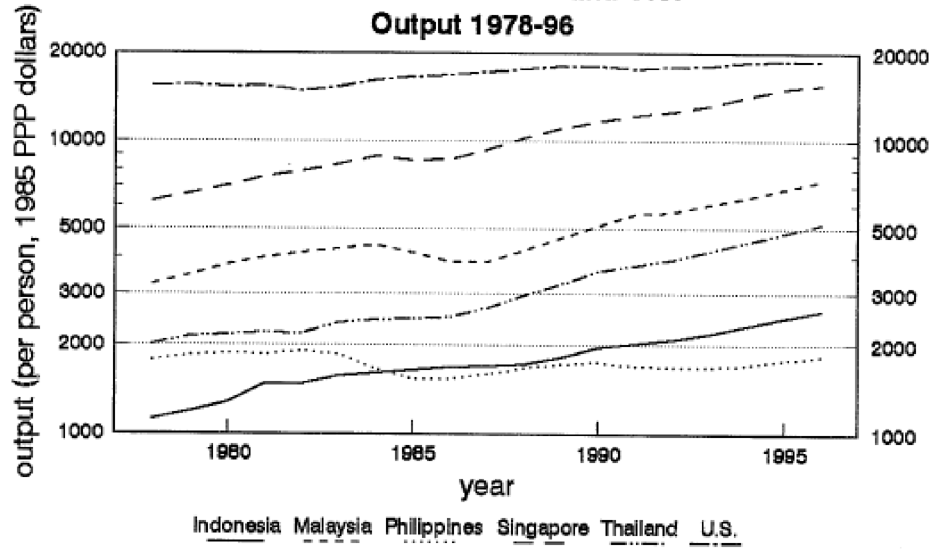
As shown in the table above, there is declining growth rate in years 2003, 2004, 2006, 2009, 2011 and 2012 that is due to lack or absence of investment and no investment. This means that fewer jobs and lower outputs can be created. Foreign direct investment in this case is lowest among original ASEAN countries.

In the data presentations above, there reveals the boom and bust movement of patterns of trend in output, employment and capital formation of the Philippines. These data shown by the can be used to estimate productivity of the Philippines from measures primarily of labor and capital.

The growth in ASEAN countries is driven either by more inputs or by greater efficiency, or the growth process is either mainly intensive or extensive. Some studies were mainly relied on national accounts data for measures of variables (labor and capital) and used these measures to determine factor income shares of these variables.

The output of selected ASEAN countries is also traced to reveal a comparison with U.S. condition.

Figure 1 (a)
Five ASEAN Countries and U.S.
Output 1978-96



Indonesia and Philippines that has the lowest output among other countries shows a contrast and cross patterns of growth between them.

The illustrations of capital and labor of five ASEAN countries and U.S. from 1978-1996 are shown respectively.

Figure 2 (a)
Five ASEAN Countries and U.S.
Capital 1978-96

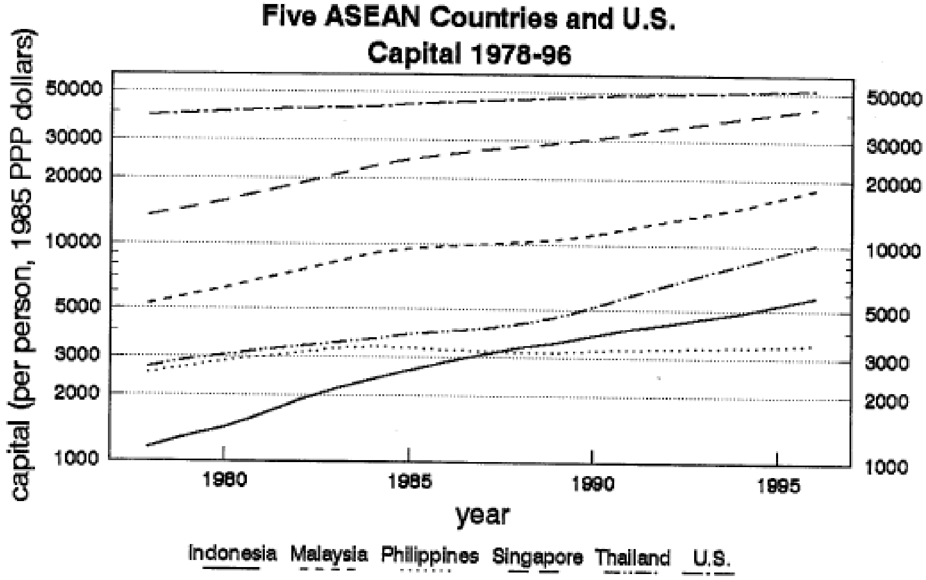
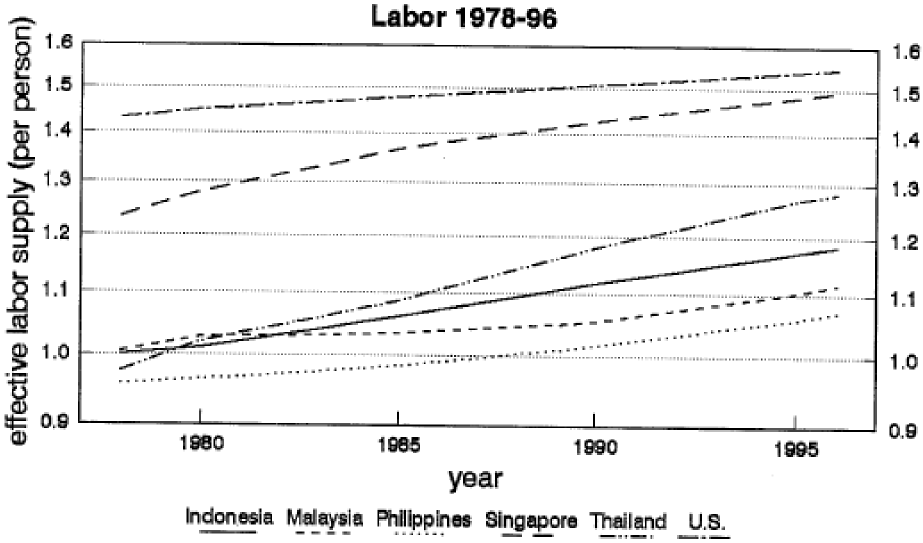


Figure 3 (a)
Five ASEAN Countries and U.S.
Labor 1978-96



Capital is highest on Singapore next to U.S. and Philippines have the lowest between the year 1985 to 1990 until 1995, the same is true in the effective labor supply of Singapore and Philippines but this time from 1978 to 1996.

Still, the illustrations above can be used to measure productivity not only of the Philippines but also of other ASEAN countries particularly in Singapore and Thailand to show comparison of the three countries, being the concern of this paper.

This is some of the review of the status of Singapore and Malaysia. The economic success of Singapore after being separated from Malaysia in 1965 causes a new challenge in the global market that countries whether large or small have struggles to follow the industry and productivity of East Asian economies including Singapore. This achievement becomes phenomenal for a small nation that can take part to other competitive nations in the world. In 2005, Asian policy makers Jee-Peng Tan, Tommy Koh and Birger Fredriksen, Yaw Ansu and Dzingai Mubuka at the World Bank published a book entitled “Some Small Countries Do It Better” includes Singapore, Finland and Ireland as examples of underdeveloped, poor in natural resources and with few population which is now have a high growth rates over a decade and used economic models to help countries that has low and middle income to aim accelerate growth.

The economic growth of Malaysia turns them into 2nd row of newly industrialized countries, largely because of expanding industrial sector. Part of their success is being the biggest supplier of their primary products to industrialized countries like rubber, palm oil, etc. In 2013, they reported in their productivity performance that one of the factor that driven their economy is labor productivity. This is divided into different sectors such as manufacturing, services, agriculture, mining and construction. The individual performance of each sector has a huge impact on the country’s total productivity growth. And the increased in quality of labor is cause by an impact of technical progress, which is referred to as total factor productivity. Any changes in TFP are called Solow Residual (Cobb and Douglas, 1928).

1.2 Theoretical Framework

This section provides and discusses the basic foundation of the Cobb-Douglas Production Theory and how the solow growth residual is derived. The methodology is the same as that presented by Islam (1995), and restated in Lee, Pesaran, and Smith (1997) and Barossi-Filho, Silva and Diniz (2003). This paper, however, adds to it another factor of productivity as contributor to growth, which is the Human Capital.

Let us assume a Cobb-Douglas production function is extended to include the following:

$$Y = A(K^{\alpha}, L^{\beta}, H^{\theta}) \qquad (1)$$

where *Y*, *K*, *L*, *H* and *A* denote total output, physical capital stock, labor force, human capital, and technology respectively.

Increasing inputs means increasing outputs. In other words, the marginal productivity of capital *(MPK),* marginal productivity of labor *(MPL),* and the marginal productivity of human capital *(MPH)*, are all positive contributors to the total output produced. And the measures of the preceding marginal productivity variables are as follows:

$$MPK = \alpha AK^{\alpha}L^{\beta}H^{\theta} = \alpha Y/K \qquad (2)$$

$$MPL = \beta AK^{\alpha}L^{\beta}H^{\theta} = \beta Y/K \qquad (3)$$

$$MPH = \theta AK^{\alpha}L^{\beta}H^{\theta} = \theta Y/H \qquad (4)$$

where α, β, and θ are the factor productivity rate of capital, labor and human capital respectively. The represented *K*, *L*, *A*, variables are denoted by time and only labor is denoted by the technical change;

$$Y = K^{\propto}_{(t)}H_{(t)}A_{(t)}L^{\beta}_{(t)} \qquad (5)$$

Equation (5) shows that only labor productivity is affected by technical or technological change, thus, technical change is measured as:

$$\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - \left(\alpha * \frac{\Delta K}{K}\right) - \left(\beta * \frac{\Delta L}{L}\right) - (\theta * \frac{\Delta H}{H}) \qquad (6)$$

Capital stock change over time is given by the following equation:

$$\frac{\partial k/\partial t}{k} = (\frac{sf(k)}{k}) - (n + g + \delta) \qquad (7)$$

where *k* ≡ *K*/ΔL and *y* ≡ *Y*/ΔL, and *s* is the constant savings rate s ≥ (0,1). After taking logs on both sides of equation (1), the income per capita steady-state is:

$$\ln\frac{(Y(t))}{(L(t))} = \ln(A0) + (gt) + \frac{a}{(1-a)}\ln(s) - \frac{a}{(1-a)}\ln(n + g + \delta) \qquad (8)$$

which is the equation obtained by Mankiw, Romer, and Weil (1992). These authors implicitly assume that the countries are already in their current steady state.

Apart from differences in the specific parameter values for each country, there is an additional term, $\ln(A(0)) + gt$ in equation (8), which deserves attention. Mankiw, Romer, and Weil (1992) assume g is the same for all countries, so gt is the deterministic trend and $\ln(A(0)) = a + \varepsilon$, where a is a constant and ε is the country-specific shock. However, the same cannot be said about $A(0)$ since this term reflects the initial technological endowments of an individual economy. This point is reinforced by Islam (1995) and Lee, Pesaran, and Smith (1997), who argue that this specification form generates loss of information on the technological parameter dynamics. The reason for this is that the panel data approach is the natural way to specify all shifts in the specific shock terms for a given country, ε.

In order to proceed, we assume a law of motion for the behavior of the per capita incomes near the steady state. Let y* be the equilibrium level for the output per effective worker, and y(t), its actual value at time t. An approximation of y in the neighborhood of the steady state produces a differential equation that generates the convergence path. After some algebraic work on equation (5), we derive the same equation as Mankiw, Romer, and Weil (1992) by which to analyze the path of convergence across countries:

$$(\ln(y_t) - \ln(y_{t-1})) = (1 - e^{-(\lambda\Delta t)})\frac{a}{(1-a)}\ln(s) - (1 - e^{(\lambda\Delta t)})\frac{a}{(1-a)}\ln(n + g + \delta) - (1 - e^{(\lambda\Delta t)})\frac{a}{(1-a)}\ln(y_{(t-1)}) \quad (9)$$

Most research on this topic admits time spans in estimating the panels as opposed to use of an entire time series (a recent exception is Ferreira, Issler, and Pessôa (2000)). In fact, this could conceal important problems such as unit roots and structural breaks. Moreover, as long as a first-order-integrated stochastic process is detected for a set of time series, the possibility of a panel data error-correction representation cannot be discarded (Barossi, Filho and Diniz (2003)).

This kind of methodology leads to a more puzzled equation as stressed by Islam (1995). Processes on estimating the total productivity requires a lot of estimation of stochastic data to guarantee the absence of bias in estimated parameters, which is the most efficient in economic papers.

1.3. Review of Literature

Several studies have attempted to measure productivity and what factors constitutes to it. An increase in productivity produce a greater output as the same level in input, thus result in higher GDP, one of the primary indicators used to measure the health of a country's economy. It determines the economic performance and standard of living of a whole country.

Alwyn Young (1992, 1995) and Paul Krugman (1994) contend that economic growth in Asia is driven by accumulation of the inputs in the production process and not by increase in productivity. They conclude that is not by quality of factors of production but by quantity of it like labor, capital and other inputs that contributes to it like human capital and natural resources.
Human capital became popular especially when Human Capital Theory advocated by Becker (1964) and Schultz (1961). Since then, human capital proxies were used to measure variables that cannot be measure or difficult to measure.

Newland and San Segundo (1996) used several measures as indicators of human capital in Peru and La Plata in eighteenth century as physical strength and skills. They see human capital as ability and education of an individual, as the costs of physically raising a child or its health. Ljungberg (2002) uses enrolment and education expenditure on education to look at the causality between education and growth in Sweden between 1867 and 1995; Nunes (2003) considers the behavior of government expenditure on education in Portugal between 1852 and 1995

Edward C. Prescott (1998) adds human capital in the Cobb-Douglas production function and defined it as investment in training. A proxy variable can be used in place of a variable that cannot be measured or is difficult to measure. The proxy variable may not be the center of the interest itself, but has a close correlation with the variable of interest. Theory of Lucas (1988) indicate that average years of education can be used as proxy for the share of resources devoted to human capital formation.

A recent paper by Castello and Domenech (2002) further examines the influence of human capital distribution on economic growth. The authors provided new human inequality measures to analyze inequality and economic growth for a broad number of countries. This paper suggests that "human capital inequality negatively influences economic growth rates not only through the efficiency of resource allocation but also through reduction in investment rates".

The Solow Growth model (Robert Solow, 1956) gives the determinants of economic growth and proves that it is not only the capital and labor that contributes to it but shows that there is unaccounted portion that not accounted for by increases in capital and labor. This unaccounted portion of economic growth is called the Solow residual – accredited to technological change. The Solow model was elaborated by Robert Solow and Trevor Swan in 1956 and is considered to be one of the most important contributions to the theory of economic growth. This model presents a simplified picture of the economy as a whole and helps to get an insight into the causes of the economic growth and the reasons for the income differences between countries (Acemoglu, 2008, ch.2).

Robert Solow (1956) explained that the growth in output as a function of capital accumulation and exogenously by labor growth and technological progress. The factor of technology is the most important in factor in the Solow model.

Factors other than Capital and Labor are Natural Resources and Human Capital. Mankiw, Romer and Weil (1992) findings allow us to conclude that human capital performs an important role in the production function. Islam (1995) has an opposite conclusion, once a technological progress is introduced in the model.

Technological progress that cause a larger portion to output, Lim (1998) estimated the Total Factor Productivity (TFP) or the technological progress in the Philippines using Cobb-Douglas production function indicating that TFP is negative for some sectors like manufacturing and services although these sectors have a higher endowment in GDP. Yet, Cororaton and Abdula (1998) arrived that TFP is little positive in manufacturing sector.

Cororaton (2002) in his findings that TFP growth improved to +0.93 percentage points in 1998-2000 from -4.26 percentage points in the middle of 1980s to its contribution to economic growth. It is said that capital has not changed as much over the years but it has the largest contributor to economic growth. Just like in other researches, expenditure on research and development is recognized as one of the important factor, positive and statistically significant for TFP growth. Other factors affecting TFP growth are the exports and imports which resulted as positive determinants. Another is foreign direct investments which resulted to as highly statistically significant affecting TFP growth.

One that contributes to the growth of total factor productivity is what Kuznets (1966) calls seable knowledge, this is what used by United States to increase their total factor productivity. Factors like capital, labor, human capital and technological progress has many indicators constitutes to it that can affect the economic growth. A good and reliable indicator to each factor relies on what data you gathered and where it came from.

1.4. Objectives of the paper (Statement of the Problem)

The specific aim of the paper is to measure the total factor productivity (TFP) of the Philippines and in comparison with Singapore and Thailand. Specifically, the paper intended to achieve the objective by the following:

A. To construct the model of the Cobb-Douglas production function with the inclusion of the human capital.
B. To determine the marginal rate of contribution and marginal rate of return of the different variables, capital, labor and human capital, to the National Income or GDP of the three states, Philippines, Singapore, and Thailand.
C. To determine the measure the marginal rate of change of the technology between the three ASEAN Nations in the span of 30 years.
D. To identify the differences in the implemented policies between states that help them achieve economic growth.
E. To demonstrate the patterns of growth of the three states being affected by the different policies implemented by their respective states.

1.5. Significance of the study

This paper aims to distinguish the variables affecting the economic growth of the state. It aims to provide the information on identifying the hindrances of economic growth of the Philippines by a comparison of the data analysis of the factors of production from two other different ASEAN nations, Thailand and Singapore. This would help on identifying the patterns of growth of the Philippines and the two other identified states. This paper would help on identifying policies that would increase the income of the Philippines through identifying the factors of production that help the other two states on increasing their economic growth. This paper would provide different projects and policies implemented by the two other states, which helped them on their growth and can be applied in Philippines System. This would also provide the contributions of the different variables used in the paper, such as capital (K), labor (L) and human capital (H) being affected by technical progress (A), to the income (GDP) of each identified states.

2. Methodology

This paper is a descriptive and quantitative research that demonstrates the Cobb-Douglas production function that leads to the derivation of the labor productivity of three ASEAN countries, the Philippines, Singapore and Thailand.

2.1 Data Gathering and Instrumentation

This paper will empirically estimate the productivity in the Philippines compared to productivity of two other members of ASEAN countries Singapore and Thailand.

Let us assume a Cobb-Douglas production function is extended to include the following:

$$Y = A(K^{\alpha}, L^{\beta}, H^{\theta}) \qquad (1)$$

where Y, K, L, H and A denote output, physical capital stock, labor force, human capital and technology, respectively.

Real national accounts are used to gather data through websites of World Bank, Philippine Statistics Authority (PSA) Asian Development Bank (ADB), and National Economic and Development Authority (NEDA) for the period of 1983-2014. This includes time series based on GDP to account output. Regarding labor inputs, employment rate, percentage of employment devoted to wage and salaried workers and the product of average remuneration per employee and number of employees which is the total remuneration can be used for representation. As to capital inputs, these consists of foreign and domestic direct investments which the sum of these two is called the gross capital formation. The indicators are based on the paper presented by Kao (2013). Finally, the human capital input would be the percentage of government expenditure devoted to gross capital expenditure on education (Stroombergen, Rose, Nana, 2002). In order to get rid of fluctuations, only annual average values will be used.

2.2 Econometric Model

The econometric model for this particular Cobb-Douglas production function

$$lnY = \beta_0 + \beta_1 lnA(t) + \beta_2 \alpha lnK(t) + \beta_3 \beta lnL(t) + \beta_4 \theta lnH(t) + ln\beta_5 + \mu_i \qquad (2)$$

where:
Y = Total Production Output
μ = Error Term
β_0 = Autonomous Output Rate when all Variable contribution rates are zero
β_1= Factor Contribution Rate of Technical Growth
β_2 = Factor Contribution Rate of Capital to Total Productivity
β_3 = Factor Contribution Rate of Human Capital to Total Productivity
β_4 = Factor Contribution Rate of Labor to Total Productivity
β_5 = Factor Contribution of the Error Term

From the above equation the relationship between output and the three inputs (labor, capital and human capital) is nonlinear, and linear to its parameters β's and θ and that represents as the factor shares of each input, respectively.

The study considers the error term as the other variables that contribute a change in the Total Productivity, that are unobservable.

The data set contains information on the input of production data (in logarithms) and on the output (in logarithms) for three hypothetical countries. With this data, the parameters of a Cobb Douglas Production Function can be estimated.

ln*A*	logarithmic employment of technical growth
ln*K*	logarithmic employment of capital
ln*L*	logarithmic employment of labor
ln*H*	Logarithmic employment of human capital
ln*Y*	Logarithmic output

The Growth Accounting Framework split the growth of output into growth of factors of production: one that explained the growth of amount of inputs used in production and the other is explained by the variable that is not part of the growth of inputs but part of growth in output which is known as the Total Factor Productivity. Total factor productivity is a measure of technological progress and changes that may occur in it are called Solow Residual. Economists measure $\Delta A/A$ by

$$\Delta A/A = \Delta Y/Y - [(\beta \times \Delta L/L) - (\alpha \times \Delta K/K) - (\theta \times \Delta H/H)] \quad (3)$$

where:

$\Delta A/A$=technological progress
$\Delta Y/Y$=output growth
$\Delta L/L$=labor growth
$\Delta K/K$ =capital growth
$\alpha + \beta + \theta = 1$

α = capital share (technological factor shares are derived from production functions and are defined as the elasticity of output with respect to each factor of production)

Factor contribution of each variable, such as α, β and θ, will be measured through the valuation of its productivity contribution to GDP, as used in the paper of Kao (2013) will be shown as;

$$\alpha = \frac{Gross\ Domestic\ Product}{Labor\ force\ participation\ rate} \quad (4)$$

$$\beta = \frac{Gross\ Domestic\ Product}{Gross\ Capital\ Formation} \quad (5)$$

$$\theta = \frac{Gross\ Domestic\ Product}{Gross\ Expenditure\ on\ Education} \quad (6)$$

where α is a measure of labor productivity, β is a measure of capital productivity and θ is the measure of productivity on human capital.

Gross Capital Formation from the equation (5), is composed by the Foreign Direct Investment and Domestic Direct Investment

Gross Expenditure on Education from equation (6), is a proxy variable to measure the influence of Human Capital on the Gross Domestic Product or the total output.

Thus, from the three above equation we used as variables of national productivity, we supposed that $National\ Productivity = \alpha + \beta + \theta + \mu$, where μ denotes the productivity measured that was considered as noise in the equation.

The paper is also designed in determining the marginal contribution of each variable, through the measurement of marginal productivity of capital (*MPK*), marginal productivity of labor (*MPL*) and marginal productivity of human capital (*MPH*), to the *GDP*. The determination of the latter will provide a brief evaluation of annual contribution of the identified variable to total productivity. With respect to the autonomous output ($\bar{Y}$) and the disturbance term (μ) at a certain time period, we can determine the GDP or total output with equation 4.

$$Y_t = \bar{Y} + MPK(K_t) + MPL(L_t) + MPH(H_t) + \mu_t \quad (7)$$

2.3 Statement of Hypotheses

This study is to empirically prove that the factor productivity of GDP of the three ASEAN Nations is highly contributed by Capital, Labor and Human Capital.

The hypotheses for the study are stated as:

Null Hypotheses; Ho: $\frac{\Delta A}{A} \neq 0$, $\alpha > 0$, $\beta > 0$ and $\theta > 0$

and $\beta_2 > 0$, $\beta_3 > 0$ and $\beta_4 \neq 0$

Alternative Hypotheses; Ha: $\frac{\Delta A}{A} = 0$, $\alpha \leq 0$, $\beta \leq 0$,$\theta \leq 0$

and $\beta_2 \leq 0$, $\beta_3 \leq 0$ and $\beta_4 = 0$

The first set of null hypotheses is stated in a manner that α, β and θ will positively reflect on the Total Productivity, and that technical growth ($\frac{\Delta A}{A}$) from residuals, affects the GDP in either positive or negative form.

The next set of null hypotheses is stated with an expectation that two of the stated factors of production, capital (*K*), labor (*L*), are high contributors to the Total Productivity. On the other hand, *H* as human capital, whether the result is positive or negative, still affects the Total Productivity and should be included in the equation.

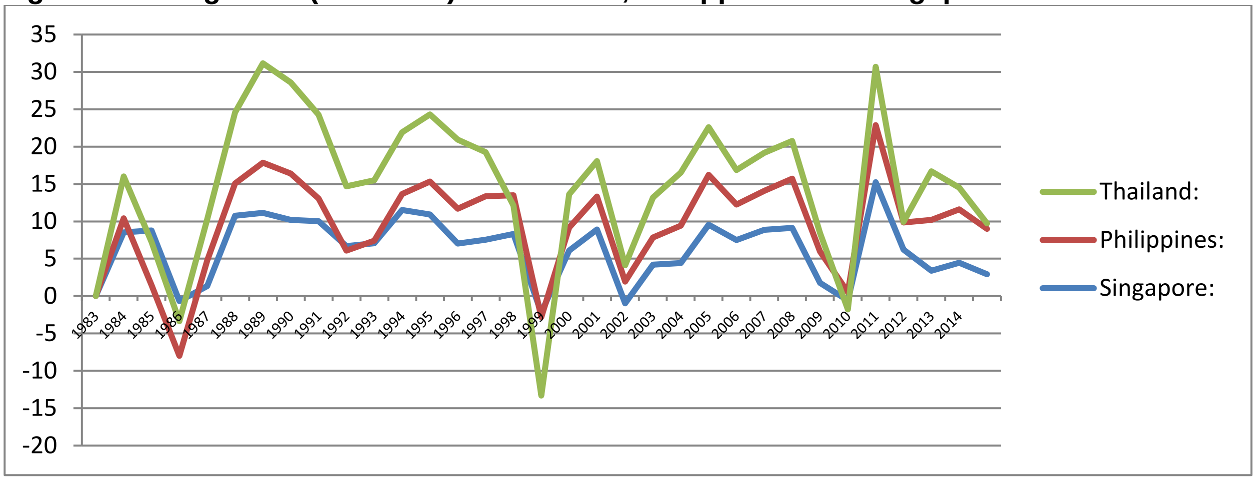
3. Results and Discussion:

GDP Growth Rate is broadly explained as the rate at which a nation's gross domestic product or the nation's total output changes/varies from one year to another. It is used to measure the economic growth of a nation for a certain period of time.

3.1 Descriptive Statistics

Figure 1 shows the Annual GDP Growth of Thailand, Philippines and Singapore for 31 consecutive years from 1983-2014. It shows the rise and fall of GDP growth in the economy for each country. The highest peak shown in the above figure for the year 1989 was only recovered after 22 years, one that causes its fall was the Asian Financial crisis that world's financial markets were stuck in a loop.

Figure 1. GDP growth (annual %) of Thailand, Philippines and Singapore



Growth in the economy is either intensive or extensive. And intensiveness of the growth of the economy relies on its factor contributors. This paper utilizes three different factor contributors of GDP Growth to measure the Country's Total Productivity.

Regression analysis is used as a tool to measure the marginal contribution/productivity of the given factor of the Cobb-Douglas Production Function, such as capital, labor and human capital. It is a statistical technique used for analyzing large amounts of data in order to estimate by how much and in what direction a dependent variable will change as a result of a change in the explanatory variables. (Studenmund, 2011)

The outputs of the models will be examined by looking whether the signs of the coefficients obtained are consistent with the hypotheses established in this paper based on economic theory and whether the coefficients are statistically significant, i.e. statistically different from zero.

The Total Productivity Theory states that the total output is contributed by its independent variables, which are labor, capital and human capital in this paper. The variance of study shows that the chosen variables, both dependent and independent, are highly significant to each other. Whereas, we assume that the residual of the study is the contribution of technology or technical change in the total productivity, as the Solow Residual state so.

3.2 Empirical Results:

3.2.1 Philippines

$$lnY = 11.54 + 1.03lnK(t) + -2.53lnL(t) + -0.25lnH(t)$$

If all the coefficients (capital, labor and human capital) are 0, GDP would be 11.54. The Slope Coefficient states that for every 1 percent increase in Gross Capital Formation in its natural logarithmic form, GDP would relatively increase by 1.03 and every 1 percent increase in labor force participation rate in its natural logarithmic form, GDP would relatively decrease by 2.53. For every 1 percent increase in Government Expenditure on Education in its natural logarithmic form, GDP would relatively decrease by 0.25.

3.2.2 For Singapore,

$$lnY = 5.98 + 1.22lnK(t) + -2.41lnL(t) + -0.15lnH(t)$$

If all the coefficients (capital, labor and human capital) are 0, GDP would be 5.98. Slope coefficients state that every 1 percent increase in Gross Capital Formation in its natural logarithmic form, GDP would relatively increase by 1.22 and for every 1 percent increase in Labor Force Participation Rate in its natural logarithmic form, GDP relatively would decrease by 2.41. For every 1 percent increase in Government Expenditure on Education in its natural logarithmic form, GDP would relatively decrease by 0.15.

3.2.3 Thailand

$$lnY = 25.68 + 0.70lnK(t) + -3.89lnL(t) + 0.45lnH(t)$$

If all the coefficients (capital, labor and human capital) are 0, GDP would be 25.68. Beta coefficients state that for every 1 percent increase in Gross Capital Formation in its natural logarithmic form, GDP would relatively increase by 0.70 and for every 1 percent increase in Labor Force Participation Rate in its natural logarithmic form, GDP would relatively decrease by 3.89. For every 1 percent increase in Government Expenditure on Education in its natural logarithmic form, GDP would relatively increase by 0.45.

The results in human capital for Philippines and Singapore shown in this paper justify the paper done by Castello and Domenech (2002) which suggests that “human capital inequality negatively influences economic growth rates not only through the efficiency of resource allocation but also through reduction in investment rates”.

3.2.4 Country Comparisons

Table 1. Philippines

Year	MPK	MPL	MPH	TFP	Returns to Scale	Elasticity Coefficient: Physical Capital	Elasticity Coefficient: Labor	Elasticity Coefficient: Human Capital
1983								
1984	-0.02	0.00	0.01	-4.96	-0.01	-0.07	-0.01	0.03
1985	-0.30	0.00	0.01	1.27	127.52	-3.02	-0.04	0.07
1986	0.12	0.01	0.01	-0.11	0.04	1.96	0.22	0.09
1987	0.22	0.01	0.05	-0.66	1.36	2.20	0.12	0.41
1988	0.20	0.00	0.04	-0.93	0.66	1.41	-0.03	0.28
1989	0.25	-0.01	0.08	1.89	-3.64	1.98	-0.08	0.57
1990	0.23	0.00	0.14	0.50	-0.35	1.73	-0.01	0.98
1991	-0.03	0.00	0.03	13.61	0.00	-0.21	0.00	0.23
1992	0.13	0.01	0.03	1.83	0.06	1.67	0.10	0.41
1993	0.18	0.00	0.06	0.88	0.29	2.34	-0.05	0.72
1994	0.13	0.00	0.06	0.03	0.36	1.02	-0.03	0.43
1995	0.05	0.02	0.05	-11.08	1.93	0.42	0.16	0.47
1996	0.18	0.00	0.10	0.78	1.39	1.51	0.02	0.77
1997	0.13	0.00	0.06	0.38	-1.45	1.28	-0.04	0.52

1998	0.13	0.01	0.07	17.37	0.02	0.71	0.04	0.35
1999	-0.12	0.00	-0.08	0.97	-0.17	-1.23	-0.03	-0.79
2000	0.06	-0.02	-0.08	-0.34	-0.14	0.68	-0.23	-0.81
2001	0.24	0.05	-0.08	-1.79	-0.39	3.25	0.59	-0.93
2002	0.16	-0.02	-0.01	1.48	0.64	2.30	-0.25	-0.13
2003	0.02	0.01	0.02	-17.83	0.17	0.22	0.17	0.20
2004	0.06	-0.01	-0.19	0.53	-0.54	0.48	-0.08	-1.43
2005	0.10	-0.03	-0.06	0.87	-0.03	0.97	-0.25	-0.55
2006	-0.08	-0.02	0.04	2.50	-0.64	-0.81	-0.16	0.44
2007	0.05	-0.01	0.02	0.23	0.33	0.60	-0.10	0.25
2008	0.20	0.01	0.04	18.95	-0.41	1.93	0.07	0.33
2009	-0.12	0.00	-0.02	1.03	0.05	-2.88	0.12	-0.39
2010	0.28	0.00	-0.02	3.39	0.31	2.84	0.01	-0.13
2011	0.07	0.01	0.06	-1.33	-0.13	0.95	0.10	0.87
2012	-0.04	-0.01	0.02	1.33	-0.05	-0.45	-0.07	0.26
2013	0.16	0.00	-0.01	5.77	2.63	1.93	-0.05	-0.16
2014	0.09	0.01	0.02	2.83	-0.68	1.03	0.12	0.24

Table 2. Singapore

YEAR	TFP	MPK	MPL	MPH	RETURNS TO SCALE	ELASTICITY COEFFICIENT (LABOR)	ELASTICITY COEFFICIENT (CAPITAL)	ELASTICITY COEFFICIENT (HUMAN CAPITAL)
1983								
1984	0.1990	0.0973	-0.0063	-0.0189	-0.0716	-0.0716	-0.2133	22.7699
1985	-0.8469	-0.1661	-0.0193	-0.0193	0.8884	0.8884	0.8877	-355.9115
1986	21.8760	-0.1234	0.0016	-0.0097	2.1588	2.1588	-13.0163	-395.8745
1987	4.3082	0.1013	0.0064	-0.0098	0.0627	0.0627	-0.0957	-198.6133
1988	1.0265	0.0681	0.0032	-0.0201	0.0216	0.0216	-0.1348	-2.6577
1989	-1.5845	0.1452	0.0032	-0.0009	0.0247	0.0247	-0.0069	5.6240
1990	-1.4592	0.1691	0.0277	-0.0009	0.2136	0.2136	-0.0067	1.1589
1991	-7.2148	0.0583	-0.0188	-0.0018	-0.1821	-0.1821	-0.0173	-9.5117
1992	1.0234	0.1151	0.0031	-0.0009	0.0416	0.0416	-0.0118	8.6873
1993	0.6331	0.1721	-0.0079	-0.0009	-0.0591	-0.0591	-0.0067	2.9864
1994	-3.8892	0.0165	0.0063	-0.0009	0.0482	0.0482	-0.0068	-12.6468
1995	0.7910	0.1215	-0.0307	-0.0009	-0.3168	-0.3168	-0.0093	15.9415
1996	-0.1362	0.1144	0.0343	-0.0217	0.4181	0.4181	-0.2572	-0.7168
1997	0.4979	0.1622	-0.0063	-0.0222	-0.0728	-0.0728	-0.2552	4.0117
1998	-2.9406	-0.2547	-0.0095	-0.0112	0.2569	0.2569	0.3030	-244.5228
1999	0.1317	0.0532	0.0156	-0.0114	0.8185	0.8185	-0.5876	-159.1034
2000	0.6291	0.1705	-0.0142	-0.0232	-0.1232	-0.1232	-0.2000	9.1314
2001	3.0173	-0.2983	0.0186	0.0648	-0.5738	-0.5738	-2.0421	-223.7402
2002	0.4204	-0.0587	-0.0126	0.0895	-0.4420	-0.4420	3.3144	-47.4568
2003	0.6884	-0.4070	-0.0063	0.0267	-0.2442	-0.2442	1.0489	57.8921
2004	-1.4170	0.3315	0.0016	-0.0900	0.0127	0.0127	-0.6921	-157.1670
2005	0.1435	0.0159	-0.0048	-0.1420	-0.0528	-0.0528	-1.4748	-20.2033
2006	-0.0384	0.1356	0.0308	-0.0734	0.3224	0.3224	-0.7304	16.3052
2007	-0.3554	0.1641	0.0015	-0.0381	0.0115	0.0115	-0.2785	1.4147
2008	2.9872	0.2425	0.0076	-0.0396	2.8483	2.8483	-14.4573	143.5334
2009	15.4512	-0.0692	-0.0031	0.0833	-0.1085	-0.1085	3.0870	-127.8490

YEAR	TFP	MPK	MPL	MPH	RETURNS TO SCALE	ELASTICITY COEFFICIENT (LABOR)	ELASTICITY COEFFICIENT (CAPITAL)	ELASTICITY COEFFICIENT (HUMAN CAPITAL)
2010	-25.1635	0.1382	0.0121	0.0246	0.0922	0.0922	0.1890	45.6218
2011	0.9550	0.0483	-0.0015	-0.0111	-0.0218	-0.0218	-0.1596	-13.9223
2012	1.0640	0.1313	0.0075	0.0179	0.1709	0.1709	0.4090	20.9647
2013	-0.3504	0.0091	0.0015	-0.0662	0.0358	0.0358	-1.5275	-41.5109
2014	-7.7915	-0.0171	0.0045	0.0187	0.1472	0.1472	0.6195	212.9323

Table 2. Thailand

YEAR	TOTAL FACTOR PRODUCTIVITY	MPK	MPL	MPH	RETURNS TO SCALE	ELASTICITY COEFFICIENT (LABOR)	ELASTICITY COEFFICIENT (CAPITAL)	ELASTICITY COEFFICIENT (HUMAN CAPITAL)
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	1.000	-0.008	1.000	1.000	0.580	-0.072	-0.114	29.459
1985	0.929	-0.004	-1.159	-0.995	0.268	-0.038	-0.066	-11.328
1986	5.178	-0.004	2.367	-0.998	-0.341	-0.018	-0.063	-190.136
1987	-3.569	-0.094	1.092	0.001	0.747	-0.010	-0.699	18.792
1988	-1.016	-0.132	0.336	1.335	0.956	0.022	-0.741	2.423
1989	0.680	-0.100	-0.310	0.396	0.782	0.038	-0.597	-1.675
1990	1.071	0.105	0.213	1.827	2.517	-0.049	0.740	1.598
1991	5.137	0.095	-0.752	0.687	1.789	-0.180	0.773	-4.241
1992	-112.088	-0.014	-2.133	0.023	0.110	-0.207	-0.123	-9.011
1993	0.977	0.064	0.524	0.024	1.382	-0.230	0.625	6.717
1994	-0.537	0.060	0.199	0.025	1.314	-0.195	0.484	1.729
1995	2.201	-0.092	0.221	13.525	0.606	0.015	-0.664	1.868
1996	11.194	0.100	-0.985	-0.002	2.041	0.022	1.142	-7.165
1997	1.088	0.227	1.409	-0.502	0.712	0.052	9.979	185.821
1998	1.110	0.031	0.693	1.082	29.179	0.705	-1.367	-46.177
1999	0.878	0.058	141.405	0.159	19.098	-8.376	26.194	-884.799
2000	-22.842	0.077	0.968	3.819	4.112	0.119	1.387	32.358
2001	1.996	-0.079	-0.691	-0.007	0.476	0.167	-1.841	-12.513

YEAR	TOTAL FACTOR PRODUCTIVITY	MPK	MPL	MPH	RETURNS TO SCALE	ELASTICITY COEFFICIENT (LABOR)	ELASTICITY COEFFICIENT (CAPITAL)	ELASTICITY COEFFICIENT (HUMAN CAPITAL)
2002	1.206	-0.226	-0.966	1.378	-3.400	-0.308	-3.492	-11.193
2003	-4.328	-0.029	0.619	2.200	1.375	0.192	-0.357	11.369
2004	1.788	0.079	0.188	-1.765	2.664	0.062	0.936	2.356
2005	1.468	-0.022	0.319	-0.339	2.385	0.048	-0.251	4.455
2006	-0.106	0.025	48.687	1.371	0.100	-0.114	0.266	-21.757
2007	-1.405	-0.131	1.310	2.154	-1.331	0.120	-1.537	47.555
2008	3.405	-0.023	0.899	4.491	2.001	-0.044	-0.369	26.710
2009	1.705	0.091	1.392	0.669	68.398	1.907	-22.123	-1064.376
2010	2.072	-0.099	2.411	-0.192	1.529	-0.065	-0.900	-111.457
2011	0.896	0.272	-3.036	-1.493	8.123	-0.067	7.624	-29.194
2012	-0.819	-0.046	0.612	2.003	1.732	0.038	-0.613	12.000
2013	2.086	0.014	-5.172	1.300	0.744	-0.208	0.328	-32.790
2014	-1.877	0.088	1.232	0.607	-2.753	-1.160	4.588	160.655

The coefficient estimates shown above are positive average marginal factor contribution for the last 32 years, it explains that growth in income (Y) are highly contributed by physical capital (*K*), rather and labor (L) and human capital (H) for the Philippines. Singapore's marginal factor productivity are quite lower than the first stated country, it only has 7.26%, 0.168% and -0.795% average marginal factor productivity values, which only states that their growth is not highly affected by human capital for the last 32 years but is contributed by physical capital, labor and other variable not added to the equation. On the other hand, Thailand showed another different result, its physical capital has a marginal factor contribution of 5.903%, which is the least among the three countries, a -0.538% for marginal factor contribution for labor have shown another different perspective in production, which do not highly rely to labor inputs, and a marginal factor contribution for human capital of 0.9173%. All marginal productivity measures for three countries are measured through the average of all the Marginal Factor Productivity in a thirty (30) year basis being computed as

$$:\frac{(Current\ variable - Previous\ variable)}{Previous\ variable}.$$

Total Factor Productivity (TFP) is the portion of output not explained by the amount of input used in production which is a measure of technological progress and changes or technological change ($\frac{\Delta A}{A}$) that may occur. TFP growth is usually measured by the Solow residual and it varies over time. Solow Residual explains the growth being experienced by a country that doesn't being reflected on its factor productivity. Singapore, being a developed country, may have very low factor productivity contributions from the measured variables in the regression; however, its sudden GDP growth is explained by the technical change or technological progress it has experienced in the span of 30 years, as measured through its residuals.

The hypotheses for the study are stated as:

Null Hypotheses; Ho: $\frac{\Delta A}{A} \neq 0$, $\alpha > 0$, $\beta > 0$ and $\theta > 0$

and $\beta_2 > 0$, $\beta_3 > 0$ and $\beta_3 \neq 0$

Alternative Hypotheses; Ha: $\frac{\Delta A}{A} = 0$, $\alpha \leq 0$, $\beta \leq 0$,$\theta \leq 0$

and $\beta_2 \leq 0$, $\beta_3 \leq 0$ and $\beta_3 = 0$

For the stated hypothesis, technical change $\frac{\Delta A}{A}$ or residuals is equal to 0 and factor contributions (α, β, θ) are less than and equal to 0 as shown in table 3, thus, reject the null hypothesis for the first set.

Singapore's variation of its low growth in labor is explained by the technical progress or industrialization that it has experience, as compared from the other two (2) countries, Philippine and Thailand. Singapore has an average technical change of 8.56% compared to 1.23% and 0.73% of Philippines and Thailand, respectively. Technical growths of Singapore have affected the industrialization of labor.

The "goodness of fit" of data used in this paper is being reflected by R square of its regression results. Philippines, Singapore, and Thailand has the R square of 0.9825, 0.9325, and 0.9739, respectively, which reflects that more than 90% of the regression results are coming from the data gathered for the study, for all three countries, rather from its residuals.

4. Conclusion and Policy Implications

As discussed in the previous section of this paper, we conclude that the GDP growth is highly affected by technical or technological growth, aside from growth drawn from physical capital, labor and human capital. Singapore has a very low relative growth drawn from its physical capital, labor and human capital, but it has coped up through the industrialization it has experienced.

Philippines is a developing country but it shows a high potential in economic growth through its growth in Physical Capital (K). Philippines' physical capital growth was drawn from direct foreign and domestic capital formation; more labor was drawn from investment that may be made in the Philippines. Thailand, on the other hand, have a stabilizing economy, but it doesn't rely that much on physical capital or on labor, however, its labor have a negative amount but it can be explained by its human capital. Thailand has a small growth in labor input but it has quality drawn from their government expenditure for education.

Economic growth comes from different variables, but a country's growth should be drawn from available resources it has the richest, or a combination of two or more.

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