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TOTAL FACTOR PRODUCTIVITY SHOCK AND ECONOMIC GROWTH IN SELECTED ASEAN+3 COUNTRIES: A NEW EVIDENCE USING A PANEL VAR

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ABSTRACT

A comparison between countries shows that there is a difference in terms of economic growth achievement across nations. This difference is due to the contribution of capital growth, labor, and total factor productivity (TFP). Although the use of capital and labor plays a vital role in the production, the contribution of TFP growth is also indispensable, as it saves production costs. Nevertheless, in 1995-2000, most countries have experienced a negative growth of TFP in which can affect its contribution to economic growth. Therefore, the focal point of this study is to analyze the impact of TFP growth shock on economic growth in selected ASEAN+3 countries (i.e., Malaysia, Singapore, Thailand, Indonesia, Philippines, Cambodia, Vietnam, China, South Korea, and Japan), using the data set from 1981 to 2014. The study employed the panel vector autoregression (PVAR) method in analyzing the propagation of the shocks through impulse response function and variance decomposition. The main findings revealed that TFP growth shocks have a positive impact on economic growth. Besides, the results also showed that over the next ten years, the proportion of human capital variation would be more dominant in contributing to the economic growth for the selected ASEAN+3 countries. As the surge in TFP growth had a positive impact on economic growth, this finding indicated that each country needs to allocate more expenditure in the Research and Development (R&D) activities.

Keywords: ASEAN+3; Economic growth; Human capital, R&D, TFP growth

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1. INTRODUCTION

Total factor productivity (TFP) is one of the most important sources of economic growth, and it is a part of the contribution from capital input and labor of a country. Although capital inputs are more significant in accelerating the economic growth of a country, the role of TFP is also crucial

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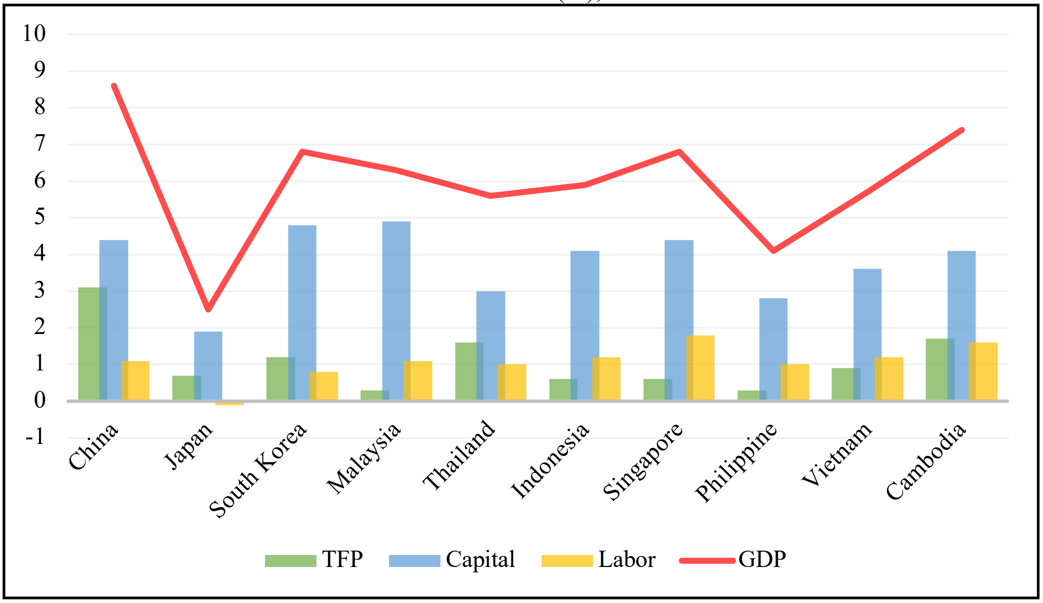
as it can increase output by using the same level of input. Generally, TFP is an increase in production, which is not caused by an increase in inputs, such as labor and capital. TFP is a measure of efficiency in the use of inputs, where quality inputs can generate higher output when used efficiently and effectively. TFP is the result of technical efficiency change and technological change. Changes in technical efficiency refer to the use of more efficient inputs to produce higher output; for example, an increase in skills through learning-by-doing. Technological change is the development of new products or new technologies that enable the improvement of production methods, and it ultimately increases output to the limit (Rahmah & Idris, 2009). Specifically, technological changes contain new production processes known as process innovations and new product discoveries known as product innovations. With process innovations, companies discover new methods of producing output whereby the output will increase at a faster rate than the inputs. This situation will eventually lead to a decrease in production costs.

According to the Malaysia Productivity Corporation (MPC) (2016), the TFP growth that contributes to economic growth is a crucial requirement in improving the standard of living of people in a country. A high TFP growth in a country can have many benefits, such as producing more quality products or providing the best service at low cost to improve consumer satisfaction while at the same time achieves sustainable economic growth. Increases in TFP growth has influenced by human capital contribution, capital structure, demand intensity, technical advancement, and economic restructuring. Countries with high economic growth rates enable their people to gain a better standard of living and quality of life.

For this study, the country selection was made based on a partnership agreement that has established in Malaysia in December 1997 between ASEAN member countries and three countries in Northeast Asia. Due to data limitations, only a few ASEAN countries have selected and included in the study, which are Malaysia, Thailand, Indonesia, Singapore, Philippines, Vietnam, and Cambodia, as well as three East Asian countries, which are China, South Korea, and Japan. These countries have selected for the benchmark of making comparisons between selected ASEAN+3 countries. The selection of ASEAN countries has based on the geographical location of these countries as Malaysia is their nearest neighbor. According to the World Bank, countries such as Japan, South Korea, and Singapore are high-income countries. At the same time, China, Malaysia, and Thailand are high-middle income countries, followed by low-income countries such as Indonesia, Philippines, Vietnam, and Cambodia.

Figure 1: Contribution of production factor to economic growth in selected ASEAN+3 countries (%), 1970-2014



Sources: Asian Productivity Organization (2016)

Figure 1 shows the contribution of production factors on economic growth in selected ASEAN+3 countries during the period of 1970 to 2014 based on the Asian Productivity Organisation Databook (2016). The growth of TFP plays a significant role in driving fast-moving economic growth over the last few decades. China recorded an average annual growth rate of TFP by 3.1 percent. Japan recorded a TFP yearly growth rate of 0.7 percent for economic growth, while South Korea recorded a 1.2 percent annual TFP average growth rate for economic growth. Most of the ASEAN+3 countries selected recorded an average yearly growth rate of TFP between 0.3 percent and 1.7 percent. Capital growth is a dominant factor in contributing to the economic growth of the selected ASEAN+3 countries during the 1970–2014 period. Besides, during 1970–2014, the annual average rate of TFP growth in Malaysia was the lowest compared to the other selected ASEAN+3 countries. According to the Conference Board (2014), the little contribution of TFP growth in a country is due to the slowdown in demand that can affect economic growth. Additionally, and indirectly, it is due to the failure of the state in generating new technology creation.

Based on the Asian Productivity Organisation Databook (2016), the average contribution of capital growth to economic growth for the selected ASEAN+3 countries remains a dominant factor in contributing to the different economic growth rates of the selected ASEAN+3 countries compared to TFP growth contribution. Although the use of labor and capital inputs is still essential in production, a higher contribution of TFP growth is also needed in a country as it can save production costs (Idris & Rahmah, 2005). Besides, a decline in TFP growth leads to a reduction in economic growth. For example, the average annual TFP growth rates for China, South Korea, and Singapore were 4.4 percent, 2.3 percent, and 1.6 percent for the 2005–2010 period; however, the percentages went down to 2.2 percent, 0.6 percent, and 0.2 percent in the 2010-2014 period, respectively. Indirectly, the average annual economic growth rates for these countries also showed a decline from 10.7 percent, 4.2 percent, and 6.5 percent for the 2005–2010 period to 7.8 percent, 3.0 percent, and 4.4 percent in the 2010–2014 period, respectively. Similarly, data on Japan, Cambodia, and the Philippines indicated that economic growth would also increase as a result of expansion in TFP growth. However, data on Malaysia, Indonesia, Thailand, and Vietnam showed that increases in TFP growth bring about a decline in economic growth.

Additionally, from 1995 to 2000, there was a surge in TFP growth to economic growth in most of the selected ASEAN+3 countries. The shock that occurred due to the Asian financial crisis that struck in 1997/1998 had started in Thailand. Most of the selected ASEAN countries had experienced a sharp decline in TFP growth over the previous period, as evidenced by negative TFP growth rates. The 1997/1998 crisis had indirectly affected the quality of human capital, unemployment, inflation, and income distribution. TFP growth had once again declined sharply during the 2005-2010 period due to the global financial crisis in 2008. In the period 2010 to 2014, policies and incentives by the respective governments have a positive impact on TFP growth in ASEAN+3 nations.

Therefore, given this background, this paper contributes to the existing literature, and it is relevant to policymakers in several ways. First, this study improves previous studies in terms of the effect of TFP shock on economic growth whereby the topic was not much explored by previous researchers when the TFP shock that occurs in the economy could affect the economic growth. Fauzi and Nooraini (2012), in their study, used pooled, fixed, and random effects to analyze the contribution of economic growth in selected ASEAN countries. Meanwhile, Atif, Noreha, and Ishak (2013) focused on the impact of human capital on economic growth in Saudi Arabia. Other than that, Lai and Ishak (2014) used an autoregressive distributed lag (ARDL) approach to investigate the relationship between human capital and economic growth in their study. Rahmah, Noorasiah, and Siti Rohayu (2017) focused more on the contribution of TFP on Malaysian economic growth in the oil palm sector. Therefore, further studies are crucial in analyzing the effects of TFP on economic growth using different dimensions. Second, this study could also help policymakers to boost economic growth by increasing the contribution of TFP growth compared to capital and labor factors. The reason is that the increase in TFP growth can save production costs in a country. Therefore, this study is the first to embark on the investigation of the effect of TFP shock on economic growth using the PVAR approach.

This paper has been organized into five sections. The second section reviews past studies, followed by methodology and model specification in the third section. The fourth section deals with study results, and finally, the last part will conclude.

2. LITERATURE REVIEW

There are various research findings on the relationship between TFP growth and output growth. According to a study conducted by Kim and Lau (1994), technology was a crucial factor in influencing the development and economic growth of developed countries, while capital played an important role in East Asian countries. They estimated that 48 percent to 72 percent of output growth in East Asian countries was due to capital raising. They also measured the influence of TFP growth on economic growth post-World War II. Similar results were also obtained by Lee (1998), whose study showed that the TFP growth of South Korea economy was in relation to output growth and other factors. The results showed that TFP growth contribution to output growth was 3.24 percent, revealing that there were also other influences such as capital and labor on output growth.

Using the residual Solow method on United States data to study the relationship between TFP growth and output growth, Growth, Domenech, and Srinivasan (2003) found that output growth has positively correlated with TFP growth. Similar studies conducted in the United Kingdom also found a positive correlation between output growth and TFP growth. Furthermore, Han (2003) investigated the predictive capacity of TFP growth over many countries during the 1966-1990 period. They used TFP growth as a free variable, while the rate of Gross Domestic Product (GDP) growth per capita and investment were treated as dependent variables in two different models. The findings showed that overall, TFP growth was positively and significantly associated with economic growth for each Organisation for Economic Co-operation and Development (OECD) country.

These findings have been supported by Hafiz, Ilyas, and Afzal (2010) in their study on TFP growth in four East Asian countries. They used output growth and investment growth as dependent variables to test the predictability of TFP growth values. The results showed that TFP growth was positively and significantly associated with output growth and, by extension, investment growth. Their study also found that an increase in TFP growth could lead to a significant increase in GDP growth. Using the accounting growth method, Banerjee and Roy (2014) proved that TFP growth contributed significantly to the economic growth of India in the long run, which consistent with the endogenous growth theory. The evidence above is in line with the findings obtained by Bosworth and Collins (2008), which used accounting growth methods to study the sources of economic growth in 84 countries from the period of 1960 to 2000. The results of their studies showed that the rapid economic growth of countries in the East Asian region (excluding China) was not due to high increases in productivity and technological uses; instead, it was due to increases in both human and physical capital. For China, the TFP contribution was a dominant factor in accelerating economic growth. A study by Park (2012) on the importance of TFP to economic growth in 12 Asian countries found that the capital accumulation factor was essential for Asian countries in the pre-2000 period. However, TFP's contribution to economic growth had increased only after that period. Other than that, Kim and Park (2017) found that the TFP growth rate can explain a significant part of the growth slowdowns in middle-income countries, whereas labor and capital growth played a relatively smaller role in the downturn. TFP growth contributed significantly to the upward transition of income level, especially in the transition to the middle-income countries.

Results obtained by Van der Eng (2009) on TFP and economic growth in Indonesia for the period 1970–2007 showed that growth in capital stock and education accounted for 70 percent and 34 percent respectively on economic growth, while TFP growth contributed -4 percent against economic growth. He found that TFP growth was only positive for the period 2007-2007 at 1.7 percent, with a 33 percent contribution to economic growth. These findings clearly showed that the Indonesian economy has yet to experience the impact of the technological change that has taken place. This was further supported by Leonardo and Luis (2015), who found that TFP growth contributed negatively to the economic growth of Mexico for the period of 1990 to 2011. However, a similar study was conducted by Van der Eng (2010) in the Indonesian country from 1880 until 2008, which showed that TFP contribution to economic growth was generally low, from 7 percent to 13 percent. The main contributor to economic growth during that period was capital stock with contributions ranging from 44 percent to 61 percent, while human capital contributed to economic growth at a range of 31 percent to 41 percent. A recent study by Yalcinkaya, Huseyni, and Celik (2017) has examined the impact of gross fixed capital formation, employed labor, and the TFP on real GDP per capita using second-generation panel data analyses over the period 1992–2014. They found that TFP has a more significant impact on economic growth than fixed capital formation and employed labor for all country groups. Besides, the effect of TFP on economic growth was found to be higher for developed countries than for emerging countries. Moreover, a study by Saleem, Shahzad, Bilal Khan, and Khilji (2019) tries to observe causal relationships between innovation, total factor productivity, and economic growth in Pakistan simultaneously. The results reveal that variables are co-integrated. They also found that innovation significantly contributes to economic growth and production level in Pakistan.

Although the TFP growth contribution to economic growth in Malaysia was very significant, its contribution was still lower than the input factors of capital and labor. This showed that capital contribution remained high in contributing to economic growth (Rahmah, Noorasiah, & Idris, 2014). According to Elsadig and Krishnasamy (2013), TFP growth can explain the increase in knowledge-based economies as it takes into account technological changes and other features, including knowledge. A study by Lee and Hong (2012) on the economic growth of Asian countries for the period of 1981 to 2007 using the Cobb-Douglas production function found that TFP overall growth was a contributor to economic growth. However, some countries, such as the Philippines and Malaysia, had shown low TFP growth contribution to economic growth during the period. Their findings also showed that educational variables were essential contributors to economic growth in most Asian countries. Besides, the study by Rahmah et al., (2017) by using the static panel analysis (pooled ordinary least square, fixed and random effects) found that TFP growth has a positive and significant impact on output growth. They found high TFP growth contribution to output growth in non-food-based industries compared to food-based industries in Malaysia.

According to Ishak, Rahmah, and Zulkifly (2011), the education sector has grown rapidly following the policy of liberalization along with the government efforts to make Malaysia a center of excellence in education in the Asian region. This causes the country to require more competitively-skilled labor to contribute to economic growth. Their findings showed that human capital and employee traits had a significant influence on the abilities, performance, and competitiveness of workers. Lai and Ishak (2014) study on the accumulation of human capital and economic growths in Malaysia from 1981 to 2010 using an ARDL method, and their findings showed that there is a long-run relationship between the two variables, whereby highly educated labor contributed positively to economic growth. Besides, according to Lai and Ishak (2015), human capital is a crucial driver of economic growth in a country, as first posited through the endogenous growth theory introduced by Uzawa (1965), Lucas (1988), and Romer (1990). Oguchi, Amdzah, and Shafii (2002) argued that FDI is also one of the key factors contributing to economic growth in a country because the inclusion of FDI will indirectly lead to technology transfer and an abundance of knowledge that will ultimately increase the economic growth. This opinion has supported by Elsadig (2010), who found that foreign direct investment (FDI) contributed more to economic growth than TFP growth. Another study conducted by Fauzi and Nooraini (2012) found that from 1981 to 2008, shows that FDI variables, together with economic and capital openness, have positive relationships with economic growth for the ASEAN-4 countries. Besides, Ozturk (2016) proposed the middle class, innovation, and productivity as essential growth factors, with foreign direct investment (FDI) as the source for diminishing marginal effect on economic growth.

Overall, some previous studies have found that TFP growth could harm the economic growth of a country, as opposed to capital factors that have a positive impact on economic growth. Most previous studies also found that other factors, such as capital stock and human capital, were more dominant in contributing to economic growth. However, the increase in TFP growth contribution to a country is also significant and necessary as it can help to save production costs. The innovation of this study is by proposing a PVAR approach in analyzing the effects of TFP shock on economic growth in selected ASEAN+3 countries. Commonly, most previous studies used ordinary least squares (OLS) and static panel to investigate the relationship between TFP and economic growth. However, the new approach can directly examine the propagation (the magnitude and the sign) of the shock of TFP growth upon the variables of interest, and also can forecast the variation of a variable as a result of self-shock or shock over other variables using the variance-decomposition technique. Thus, given this background, this study contributes to the new empirical findings of the impact of TFP growth shock on economic growth in selected ASEAN+3 countries.

3. METHODOLOGY

This study used the panel vector autoregressive (PVAR) approach in analyzing the impact of TFP growth shock on economic growth in selected ASEAN+3 countries (i.e., Malaysia, Indonesia, Thailand, Philippines, Vietnam, Cambodia, Singapore, China, South Korea, and Japan) for 1981 till 2014. All variables are chosen based on economic growth theory (Solow Model). The dependent variable of this study is economic growth, whereas the independent variables are capital stock, total workforce, average schooling year, growth of TFP, and FDI. The variables selected in this study were based on the endogenous theory and also past reviews. The growth of TFP has constructed using Malmquist's productivity index as follows.

3.1. Index Productivity Malmquist

According to Fare, Grosskopf, Norris, and Zhang (1994), the formula for obtaining a more accurate Malmquist Productivity Index should be output-oriented, as it increases the output by using the same amount of input. In other words, the Malmquist Productivity Index is an aggregate ratio of output to input. The data of output and input was collected from The Conference Board Economy Database (2015).

$$m_o\ (y_s, x_s, y_t, x_t) = \left[m_0^s\ (y_s, x_s, y_t, x_t)\ x\ m_0^t\ (y_s, x_s, y_t, x_t)\right]^{1/2} \quad (1)$$

However, Fare et al., (1994) developed the equation of Malmquist's productivity index change as:

$$m_o\ (y_s, x_s, y_t, x_t) = \left[\frac{d_0^s\ (y_{t,} x_t)}{d_0^s\ (y_{s,} x_s)}\ x\ \frac{d_0^t (y_t x_t)}{d_0^t (y_{s,} x_s)}\right]^{1/2} \quad (2)$$

Where, m_o represents the technical efficiency index, x is the input, and y is the output. Besides, $d_0^s\ (y_{t,} x_t)$ shows the distance between time, t versus technology of time or productivity of production points $(y_{t,} x_t)$ versus production points $(y_{s,} x_s)$. A value of m_o which exceeds one indicates positive TFP changes for both periods, while m_o values of less than one reflect the negative value of the TFP change over the previous period.

$$m_o(y_s, x_s, y_t, x_t) = \underset{\text{(TEC)}}{\frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)}} \underset{\text{(TC)}}{\left[\frac{d_0^s(y_t, x_t)}{d_0^t(y_t, x_t)} \, x \, \frac{d_0^s(y_s, x_s)}{d_0^t(y_s, x_s)}\right]^{1/2}} \quad (3)$$

In equation (3), the Malmquist TFP index change has been divided into two components, namely, technical efficiency change (TEC) and technological change (TC). The off-take ratio is a measure of the shift of output-oriented technical efficiency between time period, *s* and period of time. At the same time, the geometric mean value in the bracket shows two ratios that dominate the technological change between two periods of time, x_s and x_t. Therefore, the change in technical efficiency (TEC) can be written as:

$$\frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)} \quad (4)$$

The change in technical efficiency refers to the use of existing capital, labor, and other inputs to produce more output. The equation for the value of technological change (TC) is as follows:

$$\left[\frac{d_0^s(y_t, x_t)}{d_0^t(y_t, x_t)} \, x \, \frac{d_0^s(y_s, x_s)}{d_0^t(y_s, x_s)}\right]^{1/2} \quad (5)$$

Technological change (innovation) has reflected through changes in boundaries. As Squires and Reid (2004) stated, TC involves the development of new products or the development of new technologies that lead to the use of better production methods and the shift of subsequent production boundaries upwards. In particular, technological changes include new production processes (production innovation) and new product discovery (product innovation). With production innovation, firms manage to find more efficient methods of production using the existing input; thus, the output will grow more rapidly than input growth, and the average cost of production can be reduced. Theoretically, the Malmquist Index for TFP changes (TFPC) based on Cabanda's interpretation (2001) is the result of technical efficiency change (TEC) with technological change (TC), which can be expressed as:

$$\text{TFPC} = \text{TEC} \times \text{TC} \quad (6)$$

3.2. PVAR Approach

PVAR was estimated based on studies conducted by Love and Zicchino (2006) as follows:

$$Z_{it} = \Gamma_0 + \Gamma_{1\,Zit-1} + f_i + d_{c,t} + e_{it}$$

$$i = 1, 2, \ldots\ldots, N \quad t = 1, 2, \ldots\ldots, T \quad (7)$$

With i=1….N (N=10), t=1…T (T=34), while Z_{it} refers to macroeconomic variables [capital, labor, human capital (HC), foreign direct investment (FDI), TFP growth, and economic growth] for country i and year t (N X T). Γ_0 is the intercept parameter and Γ_1 matrix by taking into account the effects of lag. f_i refers to the constant effect of time unchanged, $d_{c,t}$ is a particular time for the country, and e_{it} refer to the error term. However, the correlation between fixed effects with regression tends to become a biased coefficient (Holltz-Eakin, Newey, & Rosen, 1988). Therefore, there are two methods to overcome the problem. First, uses the “Helmert” method by removing the constant effects (f_i) as a result of the difference between each variable and the average forward. Second, to standardize the model based on the generalized method of moments (GMM) system by using lag instead of regression as the instrument (Blundell and Bond, 1998). Using the VAR panel data method, it has the same basic structure restrictions for each cross-sectional unit.

3.3. Impulse Response Function (IRF)

The impulse response function (IRF) aims to see the effects of a variable’s shock on other variables in the system. IRF is a vital tool in the analysis of empirical causes and analysis of basic effectiveness (Love and Zicchino, 2006). To analyze the IRF it requires an estimate of the confidence interval. When the IRF matrix function has been obtained from the VAR coefficient estimation, the standard error should also be taken into account. The error IRF is calculated, and the confidence interval is produced using the Monte Carlo simulation.

$$\begin{bmatrix} lnCAP_{i,t} \\ lnLAB_{i,t} \\ HC_{i,t} \\ lnFDI_{i,t} \\ lnTFPG_{i,t} \\ Y_{i,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t lnCAP_{i,t} \\ \varepsilon_t lnLAB_{i,t} \\ \varepsilon_t HC_{i,t} \\ \varepsilon_t lnFDI_{i,t} \\ \varepsilon_t lnTFPG \\ \varepsilon_t Y_{i,t} \end{bmatrix} \quad (8)$$

Equation (8) shows the sequence of recursive models for macroeconomic variables. The model was based on the theory of endogenous growth, where capital contributes to higher economic growth, followed by labor, human capital, and FDI. Therefore, these variables can be compiled from the capital (CAP), labor (LAB), year of schooling (HC), foreign direct investment (FDI), TFP growth (TFPG), and economic growth (Y). Symbol i refers to the country, while symbol t refers to the year.

Stability implies that the PVAR is invertible and has an infinite order vector moving-average (VMA) representation, providing known interpretation to estimated impulse-response functions and forecast error variance decompositions. The simple impulse-response functions $\emptyset_i$ maybe computed by rewriting the model as an as well as an infinite order VMA, where $\emptyset_i$ refer to VMA parameters.

$$\emptyset_i = \begin{cases} \sum_{j=1}^{i} \emptyset_{t-j} A_j{}^{I_k} & , \ i = 0 \\ & , \ i = 1,2,\dots \end{cases} \quad (9)$$

However, simple IRFs have no causal interpretation. Since the innovations, e_{it} are correlated contemporaneously, a shock on one variable is likely to be accompanied by shocks in other variables as well. Suppose we have a matrix P such that $P'P = \Sigma$. Then P may be used to orthogonalize the innovations as $e_{it}P^{-1}$ and to transform the VMA parameters into the orthogonalized impulse-responses$P\emptyset_{i.}$. The matrix effectively imposes identification restrictions on the system of dynamic equations. Sims (1980) proposed the Cholesky decomposition of Σ to impose a recursive structure on a VAR. The decomposition, however, is not unique but depends on the ordering of variables in Σ.

3.4. Forecast-Error Variance Decomposition

Variance decomposition (VDC) is to identify the variation of a variable as a result of self-shock or shock over other variables. Analysis of VDC can determine the percentage value of the variation contained in one variable as a result of other variables in the system. Therefore, this method is able to give information about the importance of a variable to another variable. The VDC is based on the VMA, which is similar to those found in the VAR model. The advantages of using VMA are to explain forecast errors in the form of:

$$Y_{it+h} - E[Y_{it+h}] = \sum_{i=0}^{h-1} e_{i(t+h-i)} \emptyset_i \tag{10}$$

Where Y_{it+h} is the observed vector t time $t + h$ and $E[Y_{it+h}]$ is the *h-step* ahead prediction vector made at time t. Similar to impulse-response functions, we orthogonalize the shocks using the matrix P to isolate each variable contribution to the forecast-error variance. The orthogonalized shocks $e_{it}P^{-1}$ have a covariance matrix I_k, which allows straightforward decomposition of the forecast error variance. More specifically, the contribution of a variable *m* to the h-step ahead forecast-error variance of variable *n* may be calculated as:

$$\sum_{i=0}^{h-1} \theta_{mn}^2 = \sum_{i=1}^{h-1} (i_n' \, P\emptyset_i i_m)^2 \tag{11}$$

Where i_s is the s-th column of I_k. In practice, the contributions are often normalized, relative to the h-step ahead forecast-error variance of variable *n* as follows:

$$\sum_{i=0}^{h-1} \theta_{.n}^2 = \sum_{i=1}^{h-1} i_n' \, \emptyset_i' \Sigma \emptyset_i i_n \tag{12}$$

Similar to impulse-response functions, confidence interval may be derived analytically or estimated using various resampling techniques.

4. RESULTS AND DISCUSSION

Based on the results of diagnostics checking, the autocorrelation test shows that the p-value is 0.0971, in which the value is higher than the p-value 0.05 (at 5% significant level). These findings revealed that the null hypothesis fails to be rejected, so there is no autocorrelation problem. The p-value of testing the presence of heteroscedasticity is 0.1536 also indicates that the estimation results are free from any heteroskedasticity problem. Besides, the multicollinearity test also found that the value of Variance Inflation Factor (VIF) for each variable used in this study is 1.33 out of 10. Thus, it can be concluded that there is no multicollinearity problem. Finally, stability tests based on Ramsey test show that the probability value is 0.1935, which greater than 0.05. Thus the null hypothesis fails to be rejected, and the estimation models are stable across the period.

4.1. Panel Unit Root Test

The results of the unit root test for Levin, Liu, and Chu (LLC) and Im, Pesaran, and Shin (IPS) (2003) procedures are reported in Table 1. The results showed that all variables (Y, lnCAP, lnLAB, HC, lnFDI and TFP growth) were stationary at the first differential I(1) at the significance level of 1% and 5%. This implies that they are all stationary, and thus the alternative hypothesis is accepted. This indicates that the variables are not stationary at level but stationary at first difference. Next, the PVAR technique is employed.

Table 1: Unit Root Test, LLC and IPS

Variables	**LLC**		**IPS**	
	I(0)	I(1)	I(0)	I(1)
Y	-2.514**	-9.707***	-6.812***	-13.865***
lnCAP	-0.207	-3.799**	2.945	-4.630***
lnLAB	1.823**	-4.482***	0.793	-6.581***
HC	-0.5190	-3.188**	1.607	-4.652***
lnFDI	-3.717**	-9.761***	-3.357**	-11.462***
TFP growth	-6.584***	-10.655***	-6.107***	-13.480***

Notes: *** and ** indicate the level of significance at respectively 1% and 5%

4.2. PVAR Test

The selection of lags optimum is determined using the values of AIC, HQC, and SBC. The choice of the lag length on the PVAR model is determined by the tests of moment selection criterion, as suggested by Andrews and Lu (2001). This criterion consists of a vector construction that aims to minimize the modified Akaike information criterion (MAIC), the modified Bayesian information criterion (MBIC), and the modified Hannan-Quinn information criterion (MQIC). Based on Table 2, it can be concluded that the best lag for this study is lag one, as proposed by MBIC and MQIC.

Table 2: Selection of lag between AIC, SBC, and HQC

Lags	**J**	**NILAI-J**	**MBIC**	**MAIC**	**MQIC**
1	151.232	0.004	-461.116*	-64.768	-223.565*
2	65.454	0.694	-342.778	-78.547*	-184.411
3	21.587	0.972	-182.528	-50.413	-103.345

Notes: symbol * show a minimum value for lag selection

Table 3 shows the regression analysis of the VAR model. The VAR model shows the coefficient value for each row variable against the column variable lag. According to the results, the effect of the lag of capital stock change and the lag effect of employment upon economic growth is 0.000, respectively, whereas the lag effect of human capital and lag effect of foreign direct investment on economic growth is -0.004 and -0.022, respectively. However, the impact of the lag of TFP growth on economic growth is 0.155 and significant. These results suggest that the effect of the lag of TFP growth on economic growth is substantial in the selected ASEAN+3 countries compared to the lag effects of other variables. The coefficient of the lag effect of TFP is also significant, and positive indicates that TFP growth can affect the economic growth of the selected ASEAN+3 countries.

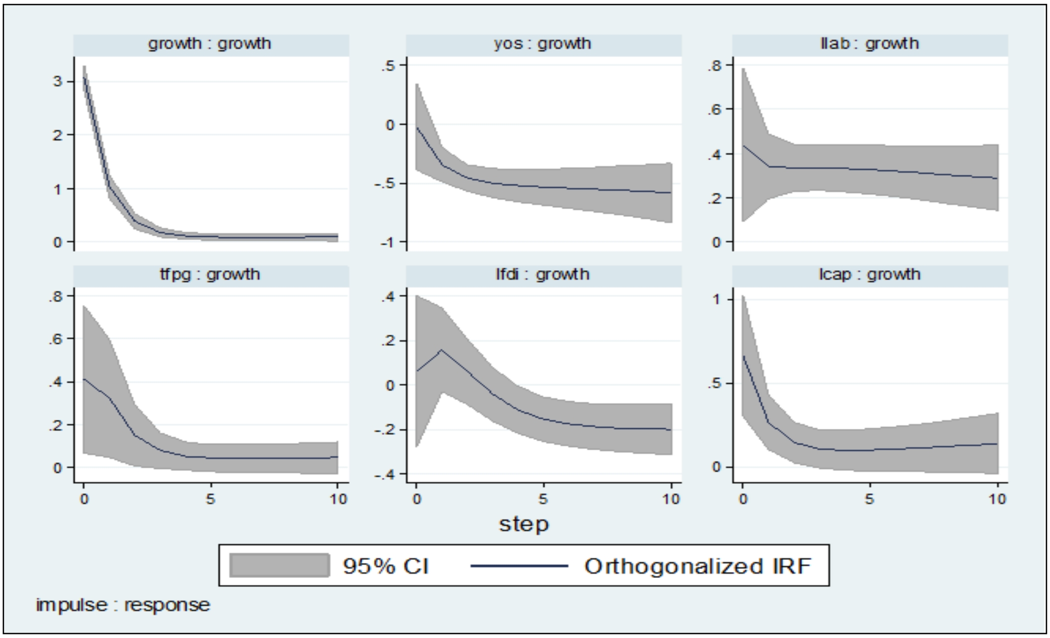
Table 3: Regression Analysis model VAR

The response of (Dependent Variable)	Lag Response of					
	lnCAP(-1)	**lnLAB(-1)**	**HC(-1)**	**lnFDI(-1)**	**TFPG(-1)**	**Y(-1)**
lnCAP	0.983	-0.013	-0.111	-0.026	1.709	0.076
	(0.011)***	(0.004)**	(0.026)***	(0.179)	(1.213)	(0.472)
lnLAB	0.152	1.001	0.144	3.816	-2.549	10.672
	(0.024)***	(0.008)***	(0.051)**	(0.667)***	(2.061)	(0.989)***
HC	-0.024	-0.003	0.986	-0.300	0.826	-1.962
	(0.004)***	(0.002)	(0.0109)***	(0.097)**	(0.461)*	(0.181)***
lnFDI	0.001	-0.001	0.0060	0.491	0.089	0.075
	(0.000)**	(0.000)***	(0.010)**	(0.074)***	(0.051)*	(0.033)**
TFPG	0.000	-0.001	-0.001	0.007	0.105	0.026
	(0.000)*	(0.000)	(0.001)	(0.006)	(0.075)	(0.017)
Y	0.000	0.000	-0.004	-0.022	0.155	0.338
	(0.001)	(0.000)**	(0.001)**	(0.010)**	(0.034)***	(0.031)***

Notes: *** and ** indicate the level of significance at respectively 1% and 5%

Figure 2 shows the result of the panel impulse response function (IRF). The IRF is used to predict the effects of a contemporaneous shock from one variable to another variable over a period of time. As can be seen in Figure 2, the solid line is the estimated responses, whereas both dot lines representing the confident interval (upper bound and lower bound). Both confident intervals are important in explaining whether the propagation of the shocks is statistically significant or not. Specifically, the response is significant if the solid line has a positive (negative) sign, and both confident intervals (upper and lower bound) also have a positive (negative) value, whereas the response is not statistically significant if the solid line has a positive (negative) value; however, the upper bound has a positive value, and the lower bound has a negative value or close to zero. The confidence interval is constructed using the Monte Carlo simulation method, with 200 times of replications (bootstrapping).

Figure 2: Impulse Response Function (IRF)



Note: IRF for all variables is lag 1. Errors are 5% on each side generated by Monte-Carlo with 200 reps.

So, based on Figure 2, the estimated responses (the solid line) of the economic growth on TFP shock has a positive sign, and both confident intervals (upper and lower bound) also have a positive value before the period of three years. The economic growth has an immediate highest response by 0.40 percent following the shock of TFP growth. This suggests that new discoveries in Research and Development (R&D), new technologies, and the availability of a more educated and skilled workforce are significant to contribute to economic growth in response to the positive shocks in the TFP. The findings of this study are consistent with some previous studies, for example, (Hafiz et al., 2010; Lee & Hong, 2012; Rahmah et al., 2017), who found that TFP growth is positively and significantly influenced the economic growth. However, after three years, the response of the economic growth upon TFP shocks for the selected ASEAN+3 countries is not statistically significant because the upper bound has a positive value, and the lower bound has close to zero. One of the main reasons is that the technology produced in the present year may have become outdated or obsolete in the long run; therefore, that will affect the productivity of labor and capital and then will affect the economic growth.

The response of economic growth on the shock of capital stock (lnCAP) is positive and statistically significant for up to two years. The shock of capital stock upon economic growth also has an immediate response, in which economic growth has increased by 0.60 percent in response to the capital stock shocks. The main reason is that an increase in capital stock will increase domestic output via the supply side of economics. These findings are in line with Van der Eng (2009) and Park (2012), who argued that capital stock growth is a crucial factor in accelerating economic growth compared to other variables such as productivity and human capital. However, after the two years, the response of economic growth on the shocks of capital stock are not statistically significant. One of the possible explanations is that the low levels of savings become a barrier to sustain the capital stock in the future; therefore, this will hinder the ability of a country to sustain its economic growth in the long run.

The shocks of employment (lnLAB) on economic growth is positive and statistically significant for the whole year. The economic growth has an immediate highest response by 0.41 percent following the shock of employment. This is because an increase in employment quality in terms of competitiveness and productivity can stimulate economic growth immediately. However, after the second period, the effect of employment on economic growth is marginally decreased, however still statistically significant up to 10 years. The main reason due to labor migration to other countries that offer higher benefits; however, this does not affect the overall economic growth in selected ASEAN+3 economies. The existing employees, who are not of high performing or skilled quality, may still significantly contribute to economic growth.

In contrast, the positive of FDI shock is not statistically significant in influencing the economic growth for up to four years period. However, after four years ahead, FDI shocks have a negative impact and statistically substantial on economic growth. The possible explanation is likely because foreign investors bringing back the capital (profit) to their home countries, and this action will hinder economic growth in the long run. Other reasons are FDI inclusion also depends on the extent of technology in the recipient countries (Durham, 2004). Besides, there is also the possibility of foreign investors failing to produce positive external factors to economic growth in recipient countries due to bringing their old technology. These findings are consistent with Gorg and Greenaway (2003), who proved that FDI harms economic growth.

The results show that the shocks of human capital (proxy by years of schooling) have a negative and significant effect on the economic growth in selected ASEAN-3 economies. The economic growth has an immediate response by -0.60 per cent following the shock of human capital. This situation illustrates that educational attainment alone does not necessarily affect the economic growth of a country, but more importantly, is the involvement of its people in producing the output. A study by Devarajan, Swaroop, and Zou (1996) also found that the relationship between education and economic growth was negative.

Table 4 shows the forecast error variance decomposition (FEVD) analysis. The variance decomposition analysis is based on a period of 10 years ahead. The results of the study showed that the capital stock variable could account for 3.99 percent of the variation in economic growth for the next ten years. Meanwhile, the labor could account for 7.40 percent of the variation in economic growth, and human capital could account for 15.64 percent of the variation in economic growth. Furthermore, FDI in ASEAN+3 countries can also explain the 1.14 percent of the variation in economic growth, while TFP growth could account for 2.04 percent of the variation in economic growth. Therefore, in the next ten years, human capital is more significant in explaining the variations of long-term economic growth, followed by employment, capital stock, TFP growth, and FDI. This shows that the role of human capital on economic growth is crucial. Education contributions to economic growth can occur through its ability to improve the efficiency, productivity, and competitiveness of the workforce. Besides, higher quality labor can be produced through education as well, and this allows them to be more efficient and productive. According to Todaro (1997), statistics are showing that the source of economic development of developed countries did not come from the growth of physical capital but growth in human capital, which is an essential source of economic growth.

Table 4: Variance Decompositions Analysis

Variables	lnCAP	lnLAB	HC	lnFDI	TFP Growth	Y
lnCAP	**0.7535**	0.0798	0.1529	0.0027	0.0060	0.0051
lnLAB	0.0104	**0.9566**	0.0078	0.0202	0.0005	0.0046
HC	0.0623	0.0308	**0.8616**	0.0279	0.0071	0.0104
lnFDI	0.0028	0.0245	0.0101	**0.9600**	0.0003	0.0013
TFPG	0.0026	0.0131	0.0019	0.0042	**0.9732**	0.0050
Y	0.0399	0.0740	0.1564	0.0114	0.0204	**0.6978**

Note: Per cent of variation in the row variable (10 periods ahead) explained by column variable.

5. CONCLUSIONS

Understanding how the factors of production and FDI affect economic growth is crucial for the country to plan and strategize their growth strategies, whether the policy to enhancing the economic growth should focus more on the demand side or supply-side variables. Therefore, this study is the first attempt to examine the effects of the factor of production shocks (capital, labor, human capital, TFPG, and FDI) shocks upon the economic growth in selected ASEAN+3 economies. A Panel VAR (PVAR) approach has been used in analyzing the propagation of all shock through the impulse response and variance decomposition approach.

The main findings from the PVAR analysis showed that shocks on macroeconomic variables could affect economic growth in the selected ASEAN+3 countries. The results of the impulse response function show that economic growth has a positive response to TFP growth shocks. Besides, the results of variance decomposition showed that human capital is more dominant factors in explaining variations in economic growth compared to the capital stock, employment, TFP, and FDI. Therefore, human capital is a crucial indicator in influencing economic growth in the selected ASEAN+3 countries, as it provides the most significant variation in economic growth for the next ten years. These findings suggest that the selected ASEAN+3 economies, need to improve their education quality and ensure that every citizen has access to higher education, as higher education also indirectly produces more qualified and efficient workers.

The policy implications of this study have several important aspects. First, the vital role of TFP on growth implied that the selected ASEAN+3 economies need to discoveries the new technological by allocating more spending in R&D activities, and also need to encourage the participation from the private sector to complement the role of government in this activity. Second, human capital also can be influencing economic growth in the selected ASEAN+3 countries, in which this can be achieved through education, the skill of employee, and productivity. Besides, each country also needs a highly educated and highly skilled labor force capable of inculcating ideas and innovations and transforming innovation into the latest goods and services that can capture the global marketplace. Furthermore, the role of employers is also essential in ensuring that workers have provided with on-the-job training or off-the-job training, which will enhance their productivity. Third, the emphasis on technology is also critical to every country. It is a challenge for every country to make changes in line with the world digital transformation to remain competitive. This can be achieved by ensuring inclusive development within a country. We also suggest future research needs to be more comprehensive by comparing Asian groups or comparing countries within groups of high-income, moderate-income, and low-income countries or maybe can use another approach to test the baseline model.

REFERENCES

Andrews, D.W.K. & Lu, B. (2001). Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models. *Journal of Econometrics, 101*(1), 123-164.

Asian Productivity Organization (APO) (2016). *APO Productivity Databook*. Tokyo: Keio University Press Inc.

Atif, A., Noreha, H. & Ishak, Y. (2013). The impact of human capital on economic growth: the case of selected Arab countries. *International Journal of West Asian Studies, 5*(2), 77-96.

Banerjee, R. & Roy, S. S. (2014). Human capital, technological progress and trade: what explains India's long run growth?. *Journal of Asian Economics, 30,* 15-31.

Blundell, R. & Bond, S. (1998). Initial conditions and moment in dynamic panel data models. *Journal of Econometrics, 87,* 115-143.

Bosworth, B. & Collins, S. M. (2008). Accounting for growth: comparing China and India. *Journal of Economic Perspective, 22,* 45-66.

Cabanda, E. (2001). A comparative study of Asian telecommunication policy reform in Japan, Malaysia and Philippines. *Asian Study on Pacific Coast*.

Devarajan, S., Swaroop, V. & Zou, H. (1996). The composition of public expenditure and economic growth. *Journal of Monetary Economics, 37,* 313-344.

Durham, J. B. (2004). Absorptive capacity and the effects of foreign direct investment and equity foreign portfolio investment on economic growth. *European Economic Review, 48*(2), 285-306.

Elsadig, M. A & Krishnasamy, G. (2013). Human capital investment to achieve knowledge-based economy in ASEAN-5: DEA application. *Journal of the Knowledge Economy, 4*(4), 331–342.

Elsadig, M. A. (2010). The role of FDI intensity in achieving productivity-driven growth in Malaysian economy. *Applied Econometrics and International Development, 10*(1), 195-208.

Fare, R., Grosskopf, S., Norris, M. & Zhang, Z. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. *The American Economic Review, 84*(1), 66-83.

Fauzi, H. & Nooraini, S. (2012). Economic growth in ASEAN-4 countries: a panel data analysis. *International Journal of Economics and Finance, 4*(9), 119-129.

Gorg, H. & Greenaway, D. (2003). Much ado about nothing. Do domestic firms really benefit from FDI. *The World Bank Research Observer, 19*(2), 171-197.

Growth, C., Domenech, M. G. & Srinivasan, S. (2003). Measuring total factor productivity for the United Kingdom. Bank of England Quarterly Bulletin: *United Kingdom: Springer*.

Hafiz, K. A., Ilyas, T. M., & Afzal, M. (2010). Exploring the effect of total factor productivity growth on future output growth: evidence from a panel of east Asian countries. *Pakistan Economic and Social Review, 48*(1), 105-122.

Han, M.J. (2003). *Testing the predictive ability of measures of total factor productivity growth.* (Unpublished doctoral dissertation), University of Missouri, Columbia.

Holtz-Eakin, D., Newey, W. & Rosen, H.S. (1988). Estimating vector autoregressions with panel data. *Econometrica, 56,* 1371-1395.

Idris, J. & Rahmah, I. (2005). *Total factor productivity growth in malaysian manufacturing sector.* MRPA Paper No. 1966.

Im, K.S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics,115,* 53-74.

Ishak, Y., Rahmah, I. & Zulkifly, O. (2011). Kebolehan, prestasi dan daya saing pekerja di sektor pendidikan swasta di Malaysia. *Jurnal Ekonomi Malaysia, 45,* 61-70.

Kim, J., & Park, J. (2017). The role of total factor productivity growth in middle-income countries. *ADB Economics Working Paper Series No. 527.* Asian Development Bank. 1-34.

Kim, J. I. & Lau, L. J. (1994). The sources of economic growth of the East Asian newly industrialized countries. *Journal of the Japaneese and International Economics, 8*(3), 235-271.

Lai, W. S. & Ishak, Y. (2014). Pengumpulan modal insan dan pertumbuhan ekonomi di Malaysia - mengkaji nexus jangka panjang. *Jurnal Ekonomi Malaysia, 48*(1), 155-165.

Lai, W. S. & Ishak, Y. (2015). Comparative study of Malaysia human capital with selected ASEAN and developed countries: a fuzzy topsis method. *Journal of Society and Space, 11*(6), 11-22.

Lee, B. (1998). The Sources of economic growth and the role of industrial policy in Seoul, Korea. *Korea Economic Research Institute*.

Lee, J. W. & Hong, K. (2012). Economic growth in Asia: determinants and prospects. *Japan and the World Economy, 24*, 101-113.

Leonardo, E. T. C. & Luis, F. C. R. (2015). Patterns of TFP growth in Mexico: 1991-2011. *North American Journal of Economics and Finance, 34,* 398-420.

Love, I. & Zicchino, L. (2006). Financial development and dynamic investment behavior: evidence from panel vector autoregression. *The Quarterly Review of Economics and Finance, 46,* 190-210.

Lucas, R. E. Jr. (1988). On the mechanics of economics development. *Journal Of Monetary Economics, 22*(1), 3-42.

Malaysian Productivity Corporation (MPC). 2016. *Laporan Produktiviti 2016/2017*. Selangor: MPC

Oguchi, N., Amdzah, B. A., & Shafii. (2002). Productivity of foreign and domestic firms in the Malaysian manufacturing industry. *Asian Economic Journal, 16*(3), 215-228.

Ozturk, Ayse. (2016). Examining the economic growth and the middle-income trap from the perspective of the middle class. *International Business Review, 25*(3), 726–38.

Park, J. (2012). Total factor productivity growth for 12 Asian Economies: the past and the future. *Japan and the World Economy, 24,* 114-127.

Rahmah, I. & Idris. J. (2009). Sumbangan perubahan teknologi terhadap pertumbuhan output industri skel kecil dan sederhana di Malaysia. *Jurnal Ekonomi Malaysia, 16*(2), 39–61.

Rahmah, I., Noorasiah, S. & Idris, J. (2014). Total factor productivity and its contribution to Malaysia's economic growth. *Research Journal of Applied Sciences, Engineering and Technology, 7*(23), 4999-5005.

Rahmah, I., Noorasiah, S. & Siti Rohayu, N. (2017). Total factor productivity and its contribution to Malaysia's palm oil- based industry output growth. *Review of Integrative Business And Economics Research, 6*(4), 180-195.

Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy, 94,* 1002-1037.

Saleem, H., Shahzad, M., Bilal Khan, & Khilji, B.A. (2019). Innovation, total factor productivity and economic growth in Pakistan: a policy perspective. *Journal of Economic Structures, 8*(7), 1-18.

Sims, C. A. (1980). Macroeconomics and reality. *Econometrica, 48*(1), 1-48.

Squires, D. & Reid, C. (2004). Measuring fishing capacity in tuna fisheries: Data Envelopment Analysis industry surveys and data collection, *FAO Fisheries Proceedings*, 87-98.

The Conference Board Economy Database. (2015). *Output, labor and labor productivity, 1950-2015*. The Conference Board of Canada.

The Conference Board. (2014). *Global Economics Outlook. The Conference Board Total Economy Database*. Canada: The Conference Board.

Todaro, M.P. (1997). *Economic Development (*6th ed). New York: Addison Wesley.

Uzawa, H. (1965). Optimal Technical Change in an Aggregative Model of Economic Growth. *International Economic Review, 6,* 18–31.

Van der Eng, P. (2009). Total factor productivity and economic growth in Indonesia. *Working Paper No. 2009/01.* Canberra: The Australian National University.

Van der Eng, P. (2010). The sources of long term economic growth in Indonesia, 1880-2008. *Explorations Economics History, 47*(3), 294-309.

Yalcinkaya, O., Huseyni, I., & Celik, A. K. (2017). The impact of total factor productivity on economic growth for developed and emerging countries: a second-generation panel data analysis. *The Journal of Applied Economic Research, 11*(4), 404-417.