

**THE RELATIONSHIP BETWEEN ELECTRICITY  
CONSUMPTION AND ECONOMIC GROWTH IN  
5 ASEAN COUNTRIES FROM  
1971-2013**

A THESIS

Presented as Partial Fulfillment of the Requirements  
To Obtain the Bachelor Degree in Economics Department



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## DECLARATION OF AUTHENTICITY

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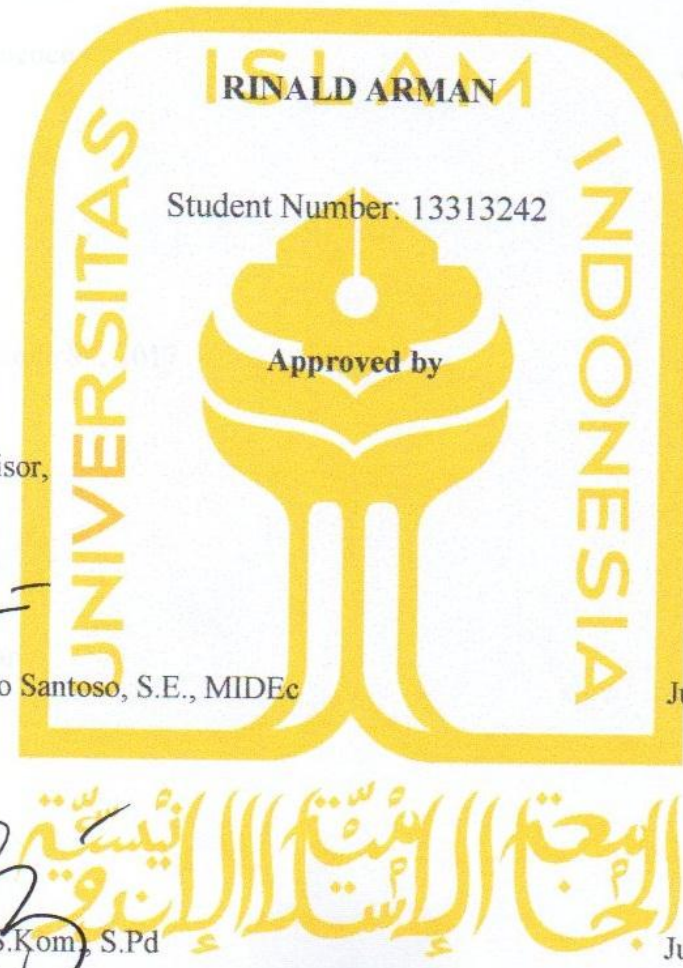
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## DECLARATION OF AUTHENTICITY

Herein I declare the originality of the thesis; I have not presented anyone else's work to obtain my university degree, nor have I presented anyone else's words, ideas or expression without acknowledgement. All quotations are cited and listed in the bibliography of the thesis. If in the future this statement is proven to be false, I am willing to accept any sanction complying with determined regulation or its consequence.

Yogyakarta, June 8<sup>th</sup>, 2017



Rinaldi Arman

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## ABSTRACT

This research aimed to analyze the relationship between Electricity Consumption and Economic Growth (GDP) in 5 ASEAN Countries from 1971-2013. This research used Secondary Data from the World Bank Development. The analysis of the data focused on Granger Causality and Error correction model analysis to see the results of the interpretation of the influence of short-term and long-term. The data used were electricity consumption and GNP of five ASEAN countries (Indonesia, Malaysia, Singapore, Thailand, Philippines) from 1971-2013.

The research concluded that in a short term relationship, electricity conservation policy through increased efficiency power supplies may avoid wasting electricity and manage electricity demand without affecting the benefits of electricity consumption in order not to adversely affect the economic growth that had been maintained very well. The research found a long-term relationship that indicated the large enough electric supply may cause the high level of economic growth and enabling technologies that may develop rapidly.

***Keywords: Electricity Consumption, Economic Growth, Causality Test, Error Correction Test***

## ABSTRAK

Penelitian ini bertujuan untuk menganalisa hubungan diantara Konsumsi Listrik dan Pertumbuhan Ekonomi (PDB) di 5 Negara ASEAN dari tahun 1971-2013. Penelitian ini menggunakan data sekunder dari World Bank Development. Analisis data yang digunakan yaitu fokus terhadap *Granger-Causality* dan *Error correction model analysis* untuk melihat hasil interpretasi pengaruh jangka pendek dan jangka panjang. Data yang digunakan adalah Konsumsi Listrik dan PNB dari 5 Negara ASEAN (Indonesia, Malaysia, Singapore, Thailand, Philippines) dari tahun 1971-2013.

Hasil penelitian menyimpulkan bahwa dalam hubungan jangka pendek, kebijakan konservasi listrik melalui peningkatan efisiensi pasokan listrik dapat menghindari pemborosan listrik dan mengelola permintaan listrik tanpa mempengaruhi manfaat dari pemakaian listrik agar tidak memberi dampak buruk pada pertumbuhan ekonomi yang telah dikelola dengan baik. Ditemukan hubungan jangka panjang menunjukkan bahwa pasokan listrik yang cukup besar menyebabkan tingkat pertumbuhan ekonomi yang tinggi dan memungkinkan teknologi untuk dapat berkembang pesat.

**Kata Kunci : Konsumsi Listrik, Pertumbuhan Ekonomi, Granger-Causality Test, Error Correction Test**

# CHAPTER I

## INTRODUCTION

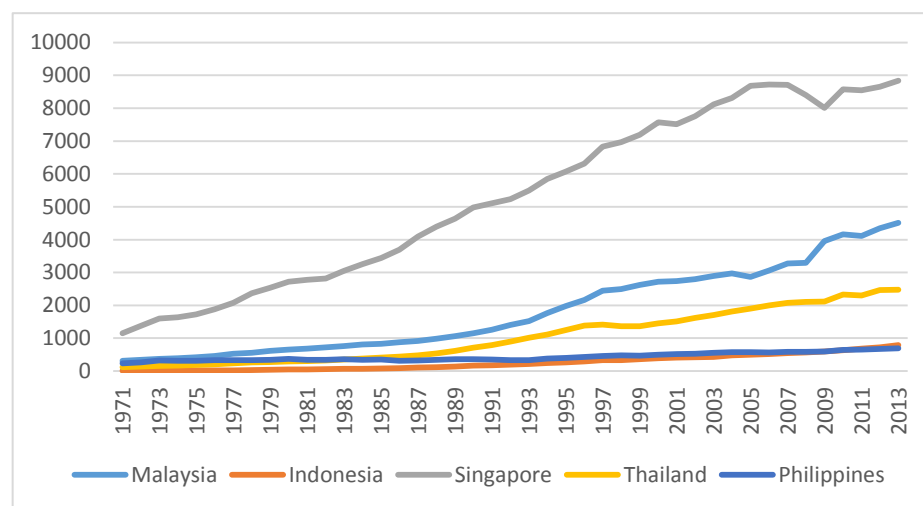
### 1.1 Background

The electricity consumption is growing in the society in the era of technology as the basic human life today. The large development activities from various sectors triggers the increase of electricity consumption in every area of each country. Everybody knows electricity has an important role and function as the development in the sector of economic. Therefore, the city is a place of settlements as well as various economic and social activities to use electricity that affected the economic growth in the society.

Electric power is produced to support the daily life and it also has the important role as an effort to achieve the goals of development. The availability of electricity in quantity, good-quality service and affordable prices are the key drivers to encourage the growth rate in other sectors. Development in various sectors is very important for the achievement of development objectives in a changing economic structure that will increase electricity demand with economic growth by The Millennium Development Goals (MDGs). In addition, MDGs takes the availability of electricity to become evenly distributed and widely used every day for the purposes to help the lives of people for the improvement of *Growth and Income Poverty Reduction, Hunger, Education, Gender Equality, Health, Environmental Sustainability, Water Supply and Sanitation* (Modi, McDade, Lallement, & Saghir, 2005). Besides that, from being one of the forms of energy that are ready to be used for consumption, electric power is one of the

factors that determines the achievement of national development goals. Electricity is extremely important for industry and communication as in the form of radio, television, e-mail, Internet, etc. Therefore, technology influences another aspects of our daily life that depends on electricity for all things in the world around us in our modern life (Borenstein, 2012). The causal relationship between electricity consumption and economic growth has increased. It can lead more efficient production because it is not very easy to fasten economic growth in developing countries which to rely more on the manufacturing sector that needs to consume more energy (Shahbaz & Feridun, 2011). Therefore, the construction of electric power will obtain a high priority because it is the main parameter of the growth of a country.

**Graph 1.1**  
**The Electric Power Consumption (kWh per capita)**  
**1971-2013**



Source: World Development Indicators (2013)

Electricity demand in 5 ASEAN countries is selected because these countries are included as the new stage of industrialization. Table 1.1 shows a

significant difference in each country such as Singapore, with the amount of electricity consumption of more than 5000kWh in average since 1993, Malaysia and Thailand with the amount power consumption of less than 5000kWh and more than 1000kWh starting from Malaysia in 1988 and Thailand in 1993, while Indonesia and the Philippines have less than 1000kWh until today. This difference may cause the development of energy supply, government policy, culture, and politics in each country have different impact on the stability or instability of conditions in the country. It can also gives an impact on the changes in real GDP and electricity consumption in each country directly or indirectly, then showed the result of economic growth and electricity consumption. Therefore, electricity consumption and economic growth are used as one of the parameters to consider the effectiveness and dynamics relate to the impact of a changing causality among variables (Malakhov, 2009).

Electricity consumption in a country is a very important thing in related with consumer needs for electricity in the process of economic growth. The investigation of electricity consumption and economic growth through the causal relationship between these variables is attempted to examine the linkage that particularly could find the potential effects in a pattern of casualties which influence the relationship between variables. The debated issue in economic where the variable takes unclear in the relationship between energy consumption and economic growth is leading to increase economic growth. The competitive demands for scarce resources in the developing countries by determining the direction of causality between energy consumption and economic growth had

been seriously done as the essential of electricity management for the significant impact of oil prices on global economy after the crisis in the 1970s (Barsky & Kilian, 2002). Generally, the energy shortage that is unrenewable resources and rising global oil prices will trigger inflation through cost inflation in all sectors, particularly industry must change components of production costs and cost of use in other sectors; thus, resulting in domestic inflation. The occurrence of domestic inflation will lead to the weakening of purchasing power which in turn will affect the decrease in the national income and slow down the economic growth. Natural energy as a natural resource should be utilized as much as possible for the prosperity of society, and its management should be based on the principle of sustainable development. The generated electricity in most of this country are use fuel oil, gas and coal to support and increase electricity production in decades (Talebi, Alvandizade, & Roshanroo, 2012).

**Table 1.2**

**Electricity production from oil, gas and coal sources (% of total)**

| <b>Year</b> | <b>Indonesia</b> | <b>Malaysia</b> | <b>Singapore</b> | <b>Thailand</b> | <b>Philippines</b> |
|-------------|------------------|-----------------|------------------|-----------------|--------------------|
| <b>2009</b> | 86.8             | 93.0            | 97.4             | 93.1            | 67.4               |
| <b>2010</b> | 84.1             | 94.0            | 97.4             | 94.4            | 73.7               |
| <b>2011</b> | 88.0             | 93.3            | 97.4             | 92.0            | 71.3               |
| <b>2012</b> | 88.4             | 92.6            | 97.3             | 91.6            | 71.5               |
| <b>2013</b> | 87.7             | 91.4            | 97.1             | 91.5            | 73.6               |

*Sources: World Development Indicators (2013)*

Until now, the fossil fuel is still the dominant source of energy in worldwide energy demand. When compared with energy demand conditions a few decades ago, the relative consumption patterns have not changed to much.

Dependence on fossil fuels, particularly in the fulfillment of consumption, is still relatively high at 97.1% with the highest percentage in Singapore, Indonesia 87.7%, Malaysia 91.4%, Thailand 91.5 and the lowest consumption in the Philippines 73.6% of the total energy consumption in the 5 countries. In 2013, the share of fossil fuels on average decreased to 88.26 percent. The decrease of fossil fuels consumption is affected by innovations to produce electric power by using wind, solar energy, nuclear etc. As the selected countries in the new stage of industrialization in ASEAN, the relationship between electricity consumption and GDP may influence the increases of CO<sub>2</sub> emissions for these 5 countries (Chen, Kuo, & Chen, 2007). Therefore, the increases of CO<sub>2</sub> emissions can give a negative impact on economic and political activities for the policy that can change GDP and electricity consumption that may affect and give disadvantages to the future. The issues of CO<sub>2</sub> emissions, as the effect due to the pressure of most ASEAN countries, mostly still use fuel gasoline to produce electricity consumption to support economic activity.

**Table 1.3**  
**CO<sub>2</sub> emissions (ton)**

| <b>Year</b> | <b>Malaysia</b> | <b>Indonesia</b> | <b>Singapore</b> | <b>Thailand</b> | <b>Philippines</b> |
|-------------|-----------------|------------------|------------------|-----------------|--------------------|
| <b>2009</b> | 198,802.7       | 446,409.6        | 37,018.4         | 270,419.2       | 77,568.1           |
| <b>2010</b> | 218,476.2       | 428,760.3        | 43,945.3         | 288,589.2       | 84,920.4           |
| <b>2011</b> | 220,405.0       | 573,379.5        | 38,327.5         | 290,342.1       | 85,584.1           |
| <b>2012</b> | 218,707.2       | 599,539.8        | 54,627.3         | 305,222.7       | 91,319.3           |
| <b>2013</b> | 236,510.5       | 479,364.9        | 50,556.9         | 303,117.9       | 98,238.9           |

*Source: World Development Indicators (2013)*

The increase of CO<sub>2</sub> emissions in Table 1.3 indicated that it tends to increase around 20-30 ton in Malaysia, Singapore, Thailand, and Philippines over

5 years. Indonesia has a fluctuating result of CO<sub>2</sub> emissions that tend to highly decrease since 2013. This data indicated the dynamic of industrialization toward these 5 ASEAN countries that use a huge amount of electricity that may influence CO<sub>2</sub> emissions gas. Thus, it tends to increase the awareness of global warming. Furthermore, the causal relationship between electricity consumption and economic growth has a significant implication due to the examination that affected these variables in each country.

Until now, a wide range of empirical studies had been done by academics and practitioners to clarify the relationship between economic growth and energy consumption in the domestic and national level, especially in ASEAN as the previous research for any researcher (Susanto & Laksana, 2013). Various empirical studies have shown various results because of the differences in the object of study, a period of research and analysis methods used by the researchers (Chen, Kuo, & Chen, 2007). Finally, based on the above description, this research intended to examine the causality between Electricity Consumption and Economic Growth. By this aspect, this research is formulated and entitled “The Relationship Between Electricity Consumption and Economic Growth in 5 ASEAN Countries from 1971-2013”.

## **1.2 Problem Formulation**

What is the Causality effect in the Short-run and Long-run of Electricity Consumption and Economic Growth from 1971-2013 in each 5 ASEAN Countries (Indonesia, Malaysia, Singapore, Thailand, Philippines)?

### **1.3 Research Objective**

The objective of analyzing the problem formulation is to examine the causality effect in Short-run and Long-run of Electricity Consumption and Economic Growth in each 5 ASEAN Countries (Indonesia, Malaysia, Singapore, Thailand, Philippines) from 1971-2013.

### **1.4 Research Contribution**

This research examines the causal relationship of Electricity Consumption and Economic Growth. By giving the information of electricity consumption condition, it may provide the benefits theoretically and also practically. Theoretically, it covered the field of economics especially economic condition results that deals with the improving of electricity sector for a contribution to the economic growth. Practically, it can be considered as the information for taking government intervention for the future of electrical production condition.

### **1.5 Writing Systematics**

#### **Chapter I Introduction**

This chapter presents Introduction, Problem Formulation, Problem Limitation, Research Objectives, Research Contribution, and Writing Systematics.

#### **Chapter II Review of Related Literature**

This chapter discusses concepts of consumption along with the definition, factors, relationship between variables and references to research problem

being examined. By the end of this chapter, hypotheses analysis is presented based on the literature of journal review.

### **Chapter III Research Method**

This chapter describes the type and objective of this study, sample data, data collection method, research variables, and analysis technique.

### **Chapter IV Data Analysis and Discussions**

This chapter discusses and analyses the data in hypotheses testing, and research findings.

### **Chapter V Conclusions and Recommendations**

This chapter shows the result and presents the conclusions, research limitations, and recommendations for institution and future researchers.

## **CHAPTER II**

### **REVIEW OF RELATED LITERATURE**

#### **2.1 Theoretical Review**

##### **2.1.1 Electricity as a Factor of Production**

In the industrial sector to determine the production and to ensure the use of industrial materials, several efforts are done to prevent residual pollutants or waste products (Stern, 2011). There is a minimum requirement for each production process that produces the goods with the minimum amount of energy required to improve the efficiency of the product level. Producing goods is done by looking at various forms of production process by estimating the energy used, cost of production, and the system of economic production in order to maximize the production process. Thus, the use of capital and labor in the long-run and natural resources must be considered by looking at energy and material which are two of the factors of production that might be reproduced again.

The use of fuel in energy can be supported by the energy from the sun and the internal heat of the earth as one of the ways of utilizing other energy. While some forms of energy may allow harmful effects on human health or environmental degradation, all methods - nuclear fuel, fossil, hydropower, wind power, biomass and the other energy can disrupt the existence of a better environment (Stern, 2011). Therefore, energy needs to be examined by seeking information from the impacts that enable the use of energy to be actively carried out with science approach that can process energy and use it very well. Energy as

a production factor can measure the use of capital and labor for production where the input between the results on production and output becomes very important. The economy can affect the capital, labor and land factors as the main factors of production with the use of fuel as another material, which is as the input to produce products.

### **2.1.2 Indicator of Electricity Consumption**

The analysis of consumption aggregate is part of the aggregate demand that affects the AD curve at the lower price level. The higher the consumption, the higher the aggregate demand. Thus, it may increase the economic activity. If one of the components of aggregate demand changes C, I, G and X, there will be an imbalance in which the planned aggregate expenditure is greater than the output. Thus, it will result shortage of output. Otherwise, if the aggregate expenditure is less than the output, there will be excess production that will decrease the aggregate demand (Sukirno, 2012).

### **2.1.3 Theory of Economic Growth**

#### **1. Multiplier Effect Theory**

Multiplier effect in an economy where the increase in national expenditures affects income and consumption is higher than the previous amount of national expenditures. The balance of the ever-changing national income of the two-sector, three-sector, and four-sector economies on the multiplier effect is used to see an increase or decrease of aggregate balance in the national income. The process of changing consumption that takes place can be seen on the change of

Consumption (C), Investment (I), Government (G), Export and Import (X-M) (Sukirno, 2012).

Economic growth is a process of development of activities in the economy that causes goods and services produced in a country increased in the society each year. The ability of a country can increase from period of time together with the growth of society due to the improvement of quality on the factors of production, technology, labor, and capital factors.

## **2. Classical Theory**

The classical theory of Smith and Ricardo (cited in Sukirno, 2006) thought that the states of economic growth is influenced by the increasing population from the four main factors in the classical theory of economic growth that is supported by land area, population, amount of goods and capital and technology used. The available natural resources is the most fundamental in the growth of economic to support production activities on economic activity according to classical theory.

## **3. Neo-Classical Theory**

The classical theory of Solow (cited in Sukirno, 2006) stated that the interest rate and wage levels are likely to change with the consumption process that affect growth process. The process of growth may change the variable. Thus, the possibility of substitution among factors of production may be involved in the production process because the variable has flexibility to change in the technology process as the effect but, Solow did not explain how improvements in technology come (cited in Stern, 2010). Therefore, technology is one of the main factors in

the process of economic growth, but it is one of the external factors (such as consumption, wage and tax). Solow uses a production function model that allows substitution between capital (K) and labor (L). Thus, the conditions for good economic growth in the Solow model are less restrictive due to the possible substitution between labor and capital.

#### **2.1.4 The Causal Relationship between Economic Growth and Electricity Consumption**

The study of causal relationships between the energy and economic growth in various forms is started with the work of Kraft (Chen, Kuo, & Chen, 2007), the causality run from GNP to energy consumption was initially found in the United States. Since then, researchers received a great deal of attention and link between energy and economic growth. This kind of energy become vital for economic growth in general thought of researchers and extended their ideas to examine the relationship between electricity consumption and economic growth. Meanwhile, electricity is expanding in areas of energy that changed their form related to economic activities (Stern, 2011). Electricity has been a key factor in improving standards of living as the basic of human life and create efficiency in demand side management to control the wastage of electricity and have a good improvement to reduce electricity consumption as the main role of efficiency in industry and technological progress. The causal relationship between electricity consumption and economic growth may take four important forms according to Pempetzoglou, (2014) and other explanation according to Chen, Kuo, & Chen (2007), Masuduzzaman (2012), and Srivastava (2016) as follows:

- a) The uni-directional causality running from electricity consumption to economic growth ( $ELE > GDP$ ). This showed a causal relationship that may give adverse effect on the economics growth which is called '*growth hypothesis*'. The increase of electricity consumption and economic growth will influence the inefficiency of industry and technological process as the factor of production. Thus, energy policies had an influence on the economic activity which was feasible for electric conservation. It was because the efficiency in demand side management failed to control the wastage of electricity that had bad improvement to reduce electricity consumption.
- b) The uni-directional causality running from economic growth to electricity consumption ( $ELE < GDP$ ). This showed that economic growth, gives little impact or no adverse effect on electricity consumption that may be implemented in the economic growth as a good result. It is called "*conservation hypothesis*". It may give good effect on the economic growth as a better result and it can also be implied on high improvement of industrial sector in using advanced technology or the energy policies to spread and distribute electric power to the society.
- c) The bi-directional causality created a relationship between electricity consumption and economic growth ( $ELE = GDP$ ). This affects each variable at the same time and could be called as "feedback hypothesis". It may imply negative impact on the economy activity in the management of electricity power, but the impact on the distribution of electricity power have a good effect on the increase of economic growth.

- d) The absence of causality on both variables (ELE x GDP). This means that an effect on electricity consumption and economic growth did not influence any directions and could be called as '*neutrality hypothesis*'. It may imply that good energy policy was made to decrease the wastage of electricity and give the adverse effect on the increases of economic growth because of the less improvement of technology used by industrial sector that support the increases of national income. For the other explanation, the government have no plan to improve electricity in the long-term and lack of improvement for the short-term.

## 2.1 Previous Studies

1. The research of Chen, Kuo, & Chen, (2007) from Taiwan was entitled “The Relationship between GDP and Electricity Consumption in 10 Asian Countries”. This research used ECM model of *Granger causality test* and panel unit root test, then it used sources from annual time series data (*Secondary data*) for the 10 newly industrializing and developing Asian countries. There are certain implications for policy that are based on the above empirical results. Firstly, the results of the causal relationship by using traditional methods in a single country data set show that there is a long-run causal relationship running from real GDP to electricity consumption in Hong Kong and Korea, but the reverse long-run causality does not exist. Secondly, the results of the panel causality tests between real GDP and electricity consumption for the 10 Asian countries indicated that a bi-directional long-run causality exists between electricity consumption and economic growth and that a uni-directional short-run causality runs from economic growth to electricity consumption, while the reverse relationship does not exist. Thirdly, the panel results of long-run causality show that an expansion in real GDP increases electricity consumption. With the advances taking place in many Asian countries, economic growth is causing the industrial and commercial sectors where electricity has been used as a basic energy input to expand.
2. The research of Talebi, Alvandizade, Roshanroo (2012) from Iran was entitled “Granger Causality Relationship Between Energy Consumption

and Economic Growth in Iran (1980-2009)". This research used *Granger causality test*, VAR model, and used *secondary data* from World Bank and Iran department Energy. The research results show that a causality relationship exists from economic growth to energy consumption meaning that the increase in energy consumption brings higher economic growth. As a result, higher rates of growth can be obtained with optimal energy consumption as well as improved production methods. Optimal energy consumption will also be gained by improving technology and saving. From this research findings, it can be inferred that energy consumption provides requirements for economic growth and national policies should be reduced in saving energy, considering economic growth does not deal with risk in future growth.

3. The research of Srivastava (2016) from India was entitled "Causal Relationship between Electricity Consumption and GDP: Plausible Explanation on Previously Found Inconsistent Conclusions for India". This study used cross-state panel data and ECM of *Granger causality* model. It also use Secondary data for 33 states from 2000 to 2013 from the Prowess database of the Centre for Monitoring Indian Economy (CMIE). By using panel data for 33 states from 2000 to 2013, and comparing pooled, fixed effect, and random effect models, we found evidence that the conclusions of the different models are not very consistent. For EC to income, the conclusion is converging, whereas, for income to EC there is divergence. Scrutinizing various models for India, we found confirmation

of bi-directional causality between electricity consumption and GDP. Furthermore, it is the increase in domestic and heavy industry electricity consumption that causes income growth and not the commercial, light industry, and agricultural electricity consumptions. The inconsistencies are found in the earlier literature because they have used a limited number of data points and does not take into an account the diversity of India. Therefore, we conclude that the research at the disaggregate level will give robust and conclusive findings not only because of the increased number of data points but also because of the removal of aggregation at the country level.

4. The research of Masuduzzaman (2012) from the United Kingdom was entitled “Electricity Consumption and Economic Growth in Bangladesh: Co-Integration and Causality Analysis”. This research used *Granger Causality* F test result and data sources on time series data (Secondary data) from 1981-2011 which was obtained from the annual report published by Bangladesh Power Development Board (BPDB) and Bangladesh Bureau of Statistics (BBS). The existence of long run equilibrium among the variables come from electricity consumption, while the causality results confirm unidirectional causal relationship running from electricity consumption to economic growth in the short run. The causality results also exhibit that electricity consumption causes investment and investment cause economic growth but not the vice versa. The source of causation, in the long run, was also found to be the error

correction terms from electricity consumption and economic growth in investment. The long run elasticity of economic growth with respect to electricity consumption and investment are higher than their short-run elasticity. This implies that over time higher electricity consumption and higher investment in Bangladesh give rise to more economic growth. Our overall findings indicate that Bangladesh is an energy (electricity) dependent country. This implies that an increase in electricity consumption raises economic growth. They also found that an increase in electricity consumption raises investment and obviously an increase in investment raises economic growth. Therefore, emphasis should be given on electricity generation and more investment.

5. The research of Susanto and Laksana (2013) from Indonesia was entitled “Testing Causality Between Energy Consumption and Economic Growth in ASEAN (1998-2010)”. This research used *Granger causality test* and secondary data which were obtained from the publication of the United Nations: Economic and Social Commission for Asia and Pacific. There was a one-way causality from economic growth to energy consumption in ASEAN countries. This suggested that the increase in economic growth led to the increase of income levels so that the energy consumption also increased. The increase in energy consumption was not much-added value so it did not have an impact on the rate of economic growth. Therefore, energy consumption had no effect on economic growth; thus, actual energy supply was not a limiting factor for economic growth. The

economy of ASEAN countries did not rely on energy consumption. Thus, the government had the flexibility to implement energy conservation policies. This policy did not have a negative impact on economic growth.

### **2.3 Hypothesis**

There is a positive relationship between electricity consumption and economic growth in 5 ASEAN countries.

## CHAPTER III

### RESEARCH METHOD

#### 3.1 Type of Study

##### 3.1.2 Granger-Causality test

This research used traditional Granger-Causality test and joint with ECMs model as a method to find the existence of both relationship (ELE and GDP) that can influence each variable or not (Chen, Kuo, & Chen, 2007). It is performed by using single country data which was set annually from 1971-2013 with 2 data which represented single country data set of the 5 ASEAN countries (Indonesia, Malaysia, Singapore, Thailand, Philippines). This research concerned about the causality between Electricity Consumption (ELE) and Economic Growth (GDP) in a single country data set.

Standard Granger-causality is applied to find short-run causality and Granger-causality test can be applied together along with ECM to long-run relationship after the Cointegration is found. If the Cointegration is not found in each country, standard Granger-causality test was used to find the long-run relationship cannot be performed. Thus, it was performed by using the unrestricted VAR and ECM that can be applied to obtain the ELE Granger-cause GDP in short-run. The estimate probability of long-run existence in ELE and GDP can be seen from coefficients  $\alpha_{13i}$  and the existence of a long-run causal relationship in ELE and GDP can be seen from coefficients  $\alpha_{14i}$ . This causal relationship represent t-statistic. Thus, for the ECM represent by t-test result and the joint F-test with the coefficient  $\alpha_{13i}$  and  $\alpha_{14i}$  can be showed as the result of

the long-run causality running from ELE to GDP for equations number (1) also GDP to ELE for equations number (2) in long term. The result of Granger-causality was performed by using the following formula (Chen, Kuo, & Chen, 2007):

$$\Delta ELE_t = \alpha_{11i} + \sum_{i=1}^{q_{11}} \alpha_{12i} \Delta ELE_{t-i} + \sum_{j=1}^{q_{12}} \alpha_{13i} \Delta GDP_{t-j} + \alpha_{14i} \varepsilon_{t-1} + u_t$$

$$\Delta GDP_t = \alpha_{21i} + \sum_{i=1}^{q_{21}} \alpha_{22i} \Delta GDP_{t-i} + \sum_{j=1}^{q_{22}} \alpha_{23i} \Delta ELE_{t-j} + \alpha_{24i} \varepsilon_{t-1} + u_t$$

Where:

$\Delta ELE_t$  = Variable of Electricity Consumption

$\Delta GDP_t$  = Variable of Economic Growth

$n$  = number of total observation

$\alpha$  = Parameters to be estimated

$q$  = number of lag (Akaike Criterion)

$u$  = uncorrected error term

$\varepsilon_{t-1}$  = error correction term from Cointegration relationship

The standard Granger-causality is showed with the coefficient  $\alpha_{12i}$  and  $\alpha_{22i}$  can be showed as the result of the short-run causality running from ELE to GDP for equations number (1) also GDP to ELE for equations number (2) in long term. The result of Granger-causality perform by using the following (Widarjono, 2013):

$$\Delta ELE_t = \sum_{i=1}^n \alpha_{11i} \Delta ELE_{t-i} + \sum_{i=1}^n \alpha_{12i} \Delta GDP_{t-i} + e_{1t}$$

$$\Delta GDP_t = \sum_{i=1}^n \alpha_{21i} \Delta GDP_{t-i} + \sum_{i=1}^n \alpha_{22i} \Delta ELE_{t-i} + e_{2t}$$

Where:

$\Delta ELE_t$  = Variable of Electricity Consumption

$\Delta GDP_t$  = Variable of Economic Growth

$n$  = The number of total observation

$\alpha$  = Parameters to be estimated

$q$  = The number of lag (Akaike Criterion)

$e_{1t}$  and  $e_{2t}$  = uncorrected error term

Granger causality test method of analysis is done to determine the relationship which is often called as a causal relationship. Finally, the Results of these two forms (Standart Granger-causality and Granger-causality ECMs) of regression models will obtain four possibilities regarding to the value of regression coefficients respectively as follow:

1.  $\sum_{i=1}^n \Delta GDP \neq 0$  and  $\sum_{i=1}^n \Delta ELE = 0$ , it means that there is *uni-directional* causality running from Electricity Consumption to Economic Growth.
2.  $\sum_{i=1}^n \Delta GDP = 0$  and  $\sum_{i=1}^n \Delta ELE \neq 0$ , it means that there is *uni-directional* causality running from Economic Growth to Electricity Consumption.
3.  $\sum_{i=1}^n \Delta GDP = 0$  and  $\sum_{i=1}^n \Delta ELE = 0$ , it means that there is *bi-directional* causality that creates a relationship between electricity consumption and economic growth that affected each variable at the same time.
4.  $\sum_{i=1}^n \Delta GDP \neq 0$  and  $\sum_{i=1}^n \Delta ELE \neq 0$ , it means that there is *absence of causality* on both variables that do not have any effect on electricity consumption and economic growth.

### 3.2 Data Collection Method

This research used secondary data: time series data which consist of 2 data from Electricity consumption and GDP (for each country) and 44 years' data from

1971-2013. The data were taken from World Development Indicators (The World Bank, 2013). The data encompassed Electricity Consumption (the total of electric to consume) and Economic Growth (GDP).

### **3.3 Research Variables**

#### **3.3.1 Electricity Consumption**

Electricity consumption refers to the number of the total of electricity to consume in 5 ASEAN countries 1971-2013. This research used the total of Electricity Consumption in Malaysia, Indonesia, Singapore, Thailand, Philippines.

#### **3.3.2 Economic Growth (GDP)**

Economic Growth is obtained from the total of the Real GDP based on constant price in 5 ASEAN country (Malaysia, Indonesia, Singapore, Thailand, Philippines) from 1971-2013.

### **1.4 Analysis Technique**

#### **3.4.1 Unit root test**

Unit root test was used to test stationary time series data. When a time series of data is not stationary, it can be said that the data was facing a unit root problem. The existence of the unit root problem can be observed by comparing the value of *t*-statistics regression results with test scores of *Augmented Dickey-Fuller* (ADF) and *Phillips and Perron* (PP) in the *first difference*. The tests of the data representation for first equation show that there is no time effect model while the second one has a fixed time effect, when the null hypothesis  $H_0: r = 0$  is accepted. This implies that the variables has a unit root and is not stationary. Therefore, if the value of ADF and PP are more than the critical value, the data is

stationer. Otherwise in the *first difference*, the model equation is as follows (Hakim, 2014):

Augmented Dickey Fuller(ADF) formula:

$$\Delta Y_t = \alpha Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i+1} + e_t$$

Phillips and Perron (PP) formula:

$$\Delta Y_t = \alpha Y_{t-1} + e_t$$

### 3.4.2 Lag Length test Criteria

According to Widarjono (2013), analyzing the model of lag is the most important to determine the length of lag for Granger causality ECM model and this is one of the problems in model specification. The step to determine the model of causality test is necessary to determine the optimal lag length as a step of requirement by using econometric tools of Eviews 9 in this research. The Eviews 9 consist of five methods:

-*Sequential Modified LR Test Statistic (LR)*

-*Final Prediction Error (FPE)*

-*Akaike Information Criterion (AIC)*

-*Schwarz Information Criterion (SC)*

-*Hannan – Quinn Criterion (HQ)*

Optimal Lag is selected based on the optimal lag that mostly consistently generated at different levels of lags to be tested.

### 3.4.3 Johansen Cointegration test

Cointegration test can only be done when the tested data is integrated into level at the same degree. If data time series is not stationary at level but become stationary at the same difference, the data is assumed to be co-integrated which means that they have relations (Widarjono, 2013). Cointegration test is done to finds whether there is long-term relationship between the independent variables and the dependent variable.

Johansen cointegration test is one of approaches that can be analyzed by the method of VAR. To test the changed un-stationary data, the Johansen test uses two different statistical tests such as trace test ( $\lambda_{\text{trace}}$ ) and maximum eigenvalue test ( $\lambda_{\text{max}}$ ). Trace test of  $H_0$  at cointegration equation  $\tau$  is an alternative cointegration equation  $k$ . The form of equation is as follows (Widarjono, 2013):

$$Q_t = -T \sum_{i=r+1}^k \log(1 - \lambda_i)$$

$H_0$  maximum eigen test of value test can be done by the following equation:

$$Q_{\text{max}} = -T(1 - \lambda_{i+1}) = Q_t - Q_{t+1}$$

## CHAPTER IV

### RESULT AND DATA ANALSYS

#### 4.1 Data Analysis

The analysis of causality between Electricity Consumption and Economic Growth during the period of 1971-2013 used Granger-causality to find short-run and long-run relationship by joint ECMs model.

##### 4.1.1 Lag Length Result

Lag length test is a methodology used to find the optimal lag length taken from the number of influence or a significant response, While the test results in the Lag Length is determined by the number of stars (\*) as the most recommended lag length of all criteria result.

**Table 4.1**  
**Lag Length Results**

| Country   | Lag | LR        | FPE       | AIC       | SC        | HQ        |
|-----------|-----|-----------|-----------|-----------|-----------|-----------|
| Indonesia | 11  | 14.75824* | 467552.0* | 17.87968* | 20.00753* | 18.57330* |
| Malaysia  | 12  | 8.407301  | 1.04e+09* | 25.19397* | 27.50685* | 25.94791* |
| Singapore | 12  | 9.838340* | 3.78e+10* | 28.78973* | 31.10261* | 29.54367* |

|             |    |           |           |           |           |           |
|-------------|----|-----------|-----------|-----------|-----------|-----------|
| Thailand    | 12 | 3.306552  | 26642160  | 21.53238* | 23.84526* | 22.28632* |
| Philippines | 1  | 164.5040* | 4786077.* | 21.05576  | 21.33331* | 21.14623* |

Sources: Primary data processed, 2017

#### 4.1.2 Unit Root Result

The analysis of time series used unit root test by ADF and PP to find stationary data. The first phase in a test of each variable was in the degree of 0 or the level with the hypothesis as follows: The value of all stationary data can also be known from the value of the probability. Small probability value of the critical probability value was  $\alpha = 1\%$ ,  $5\%$  or  $10\%$ . The results of the stationary variables at the first differentiation may also be examined through the value of probability in all variables that were smaller than the critical value of probability at  $1\%$ ,  $5\%$  and  $10\%$ . Because all variables had already had the stationary at the first difference, it is not necessary to proceed to the next level of stationary test.

**Table 4.2**  
**Unit Root Results**

| Country     | Variable | Lag<br>1 | Lag<br>2 | ADF                 |          | PP                     |          |                 |          |                    |          |
|-------------|----------|----------|----------|---------------------|----------|------------------------|----------|-----------------|----------|--------------------|----------|
|             |          |          |          | No time effects (1) |          | Time fixed effects (2) |          | No time effects |          | Time fixed effects |          |
|             |          |          |          | level               | $\Delta$ | Level                  | $\Delta$ | level           | $\Delta$ | level              | $\Delta$ |
|             |          |          |          |                     |          |                        |          |                 |          |                    |          |
| Indonesia   | ELE      | 2        | 2        | 1.0000              | 0.9815   | 0.9995                 | 0.7203   | 1.0000          | 0.0000** | 0.9995             | 0.0024*  |
|             | GDP      | 0        | 0        | 0.9999              | 0.0012*  | 0.9980                 | 0.0022*  | 0.9999          | 0.0011*  | 0.9980             | 0.0025*  |
| Malaysia    | ELE      | 9        | 9        | 1.0000              | 0.7617   | 0.6132                 | 0.6979   | 0.9999          | 0.0000*  | 0.9023             | 0.0000*  |
|             | GDP      | 0        | 1        | 0.9995              | 0.0000*  | 0.9855                 | 0.0004*  | 0.9999          | 0.0000*  | 0.9855             | 0.0000*  |
| Singapore   | ELE      | 8        | 7        | 0.2005              | 0.9280   | 0.7424                 | 0.9999   | 0.7640          | 0.0000*  | 0.9137             | 0.0002*  |
|             | GDP      | 9        | 3        | 0.9999              | 0.2632   | 0.8756                 | 0.2488   | 0.9999          | 0.0013*  | 0.9673             | 0.0034*  |
| Thailand    | ELE      | 0        | 2        | 0.9999              | 0.0966   | 0.3990                 | 0.1304   | 0.9998          | 0.0000*  | 0.5528             | 0.0000*  |
|             | GDP      | 1        | 1        | 0.9981              | 0.0029*  | 0.9641                 | 0.0042*  | 0.9998          | 0.0035*  | 0.9848             | 0.0041*  |
| Philippines | ELE      | 0        | 0        | 0.9836              | 0.0000*  | 0.9261                 | 0.0000*  | 0.9839          | 0.0000*  | 0.9271             | 0.0000*  |
|             | GDP      | 0        | 0        | 1.0000              | 0.0029*  | 1.0000                 | 0.0028*  | 1.0000          | 0.0023*  | 0.9997             | 0.0024*  |

Sources: Primary data processed, 2017

#### 4.1.3 Johansen Cointegration Result

Cointegration testing used optimal length lag in accordance with the previous test for the deterministic assumptions in order to form a cointegration equation. This was based on Akaike Information Criterion (AIC) to find the test results through Johansen Cointegration approach. The terms of cointegration was integrated throughout its variable on the same level where the results of these was needed to find the relationship of short-term and long-term between dependent and independent variables by looking at the probability value of  $\alpha \leq 0.05$ . This means that they have a long-run relationship among variables.

**Table 4.3**  
**Johansen Cointegration Results**

| Country     | Null Hypothesis | Optimal Lag | Test statistic |                |             |           |                |             |
|-------------|-----------------|-------------|----------------|----------------|-------------|-----------|----------------|-------------|
|             |                 |             | Max eigenvalue |                |             | Trace     |                |             |
|             |                 |             | Max-Eigen      | Critical Value | Probability | Trace     | Critical Value | Probability |
| Indonesia   | $r = 0$         | 11          | 32.69759*      | 14.26460       | 0.0000      | 37.20338* | 15.49471       | 0.0000      |
|             | $r \leq 1$      |             | 4.505784*      | 3.841466       | 0.0338      | 4.505784* | 3.841466       | 0.0338      |
| Malaysia    | $r = 0$         | 12          | 23.03979*      | 14.26460       | 0.0016      | 39.25937* | 15.49471       | 0.0000      |
|             | $r \leq 1$      |             | 16.21958*      | 3.841466       | 0.0001      | 16.21958* | 3.841466       | 0.0001      |
| Singapore   | $r = 0$         | 12          | 75.74765*      | 14.26460       | 0.0000      | 89.73949* | 15.49471       | 0.0000      |
|             | $r \leq 1$      |             | 13.99184*      | 3.841466       | 0.0002      | 13.99184* | 3.841466       | 0.0002      |
| Thailand    | $r = 0$         | 12          | 118.6295*      | 14.26460       | 0.0001      | 121.1623* | 15.49471       | 0.0001      |
|             | $r \leq 1$      |             | 2.532831       | 3.841466       | 0.1115      | 2.532831  | 3.841466       | 0.1115      |
| Philippines | $r = 0$         | 1           | 5.803529       | 14.26460       | 0.6386      | 8.050508  | 15.49471       | 0.4600      |
|             | $r \leq 1$      |             | 2.246978       | 3.841466       | 0.1339      | 2.246978  | 3.841466       | 0.1339      |

Sources: Primary data processed, 2017

#### 4.1.4 Granger-Causality result

The standard Granger-causality and Granger-causality ECMs approach could be applied after Cointegration result was found for each single country data set. For country where there was no Cointegration, the causality test was applied

by using unrestricted VAR. Hypotheses was done to determine whether there was a relationship among the variables in the test. If the probability  $> \alpha$  (5%), there is no Granger-causality and if the probability value  $< \alpha$  (5%), there is Granger-causality in short-run and long-run.

**Table 4.4**  
**Granger-Causality Results (Short-run and Long-run)**

| Country     | Null Hypothesis                | Sources of Causation  |                      |                        |                                                    |
|-------------|--------------------------------|-----------------------|----------------------|------------------------|----------------------------------------------------|
|             |                                | Short-run             |                      | Long-run               |                                                    |
|             |                                | <i>F</i> -Statistics  |                      | <i>t</i> -Statistics   |                                                    |
|             |                                | $\Delta$ ELE          | $\Delta$ GDP         | $\epsilon$ t-1         |                                                    |
| Indonesia   | ELE does not Granger Cause GDP | 6.91371*<br>(0.0036)  |                      | 0.241403<br>(0.8106)   | bi-directional                                     |
|             | GDP does not Granger Cause ELE |                       | 5.64290*<br>(0.0074) | 1.962845**<br>(0.0572) | (ELE $\leftrightarrow$ GDP) (ELE $\leftarrow$ GDP) |
| Malaysia    | ELE does not Granger Cause GDP | 1.40711<br>(0.3520)   |                      | -0.230223<br>(0.8192)  | uni-directional                                    |
|             | GDP does not Granger Cause ELE |                       | 4.38210*<br>(0.0405) | 2.176533*<br>(0.0360)  | (ELE $\leftarrow$ GDP) (ELE $\leftarrow$ GDP)      |
| Singapore   | ELE does not Granger Cause GDP | 1.27120<br>(0.4031)   |                      | 0.505091<br>(0.6165)   | uni-directional                                    |
|             | GDP does not Granger Cause ELE |                       | 8.95675*<br>(0.0068) | -0.685326<br>(0.4974)  | (ELE $\leftarrow$ GDP) (ELE $\neq$ GDP)            |
| Thailand    | ELE does not Granger Cause GDP | 3.55653**<br>(0.0650) |                      | -0.059089<br>(0.9532)  | bi-directional                                     |
|             | GDP does not Granger Cause ELE |                       | 5.39016*<br>(0.0247) | 0.06413<br>(0.9492)    | (ELE $\leftrightarrow$ GDP) (ELE $\neq$ GDP)       |
| Philippines | ELE does not Granger Cause GDP | 0.70954<br>(0.4047)   |                      | -                      | absence of causality                               |
|             | GDP does not Granger Cause ELE |                       | 2.12715<br>(0.1527)  | -                      | (ELE $\neq$ GDP)                                   |

Sources: Primary data processed, 2017, \*5% at significant level, \*\*10% at significant level.

## 4.2 Interpretation of Regression Result

### 2. Lag Length

According to Table 4.1 the results showed that Indonesia had the lag length of 11, Malaysia had the lag length of 12, Singapore had the lag length of 12, Thailand had the lag length in lag 12, and Philippines had the lag length of 1 which was the most optimal lag. This was based on the consideration that it was recommended by all four methods of testing such as FPE, AIC, SC, HQ which

was indicated by an asterisk (\*) and showed the optimal lag for each data to be used in the Granger-Causality test.

### 3. Unit root test

Based on the data of unit root test in Table 4.2, ELE and GDP was indicated by asterisk (\*) at the current *level* and *1st differences* with the two criteria of *Intercept* and *Intercept-trend* through the ADF and PP test result as follow:

#### *a. Intercept*

- The probability of ELE at the current *1<sup>st</sup> differences* from ADF test result was  $0.9815 > \alpha$  (5%). Thus, the data is not stationary.
- The probability of GDP at the current *1<sup>st</sup> differences* from ADF test result was  $0.0012 < \alpha$  (5%). Thus, the data is stationary.
- The probability of ELE at the current *1st differences* from PP test result was  $0.7059 > \alpha$  (5%). Thus, the data was not stationary. It was continued with *2nd differences* test result of  $0.0000 < \alpha$  (5%). Thus, the data was stationary.
- The probability of GDP at the current *1st differences* from PP test result was  $0.0011 < \alpha$  (5%). thus, the data was stationary.

#### *b. Intercept and Trend*

- The probability of ELE at the current *1st differences* from ADF test result was  $0.7203 > \alpha$  (5%). Thus, the data was not stationary.
- The probability of GDP at the current *1st differences* from ADF test result was  $0.0022 < \alpha$  (5%). Thus, the data was stationary.

- The probability of ELE at the current *1st differences* from PP test result was  $0.0024 < \alpha$  (5%). Thus, the data was stationary.
- The probability of GDP at the current *1st differences* from PP test result was  $0.0025 < \alpha$  (5%). Thus, the data was stationary.

The result was shown by asterisk symbol at 1<sup>st</sup> differences where all data except Indonesia for PP did not have time effect for the 2<sup>nd</sup> differences (\*\*). It became stationary from ADF and PP result.

#### 4. Johansen Cointegration

Based on the data in Table 4.2, the result of Johansen Cointegration for *Max-eigen* and *Trace* statistic showed more *critical value* which was indicated by asterisk (\*) from the probability result of  $\alpha \leq 0.05$  as follow:

- The *likelihood ratio* of Indonesia at  $r = 0$  and  $\leq 1$  had the result of *Max-eigen* at  $32.69759 > 14.26460$  and  $4.505784 > 3.841466$  with the probability of 0.0000 and 0.0338, *Trace* at  $37.20338 > 15.49471$  and  $4.505784 > 3.841466$  with the probability of 0.0000 and 0.0338. This test indicated 2 cointegrations at the level of  $\alpha \leq 0.05$ .
- The *likelihood ratio* of Malaysia at  $r = 0$  and  $\leq 1$  had the result of *Max-eigen* at  $23.03979 > 14.26460$  and  $16.21958 > 3.841466$  with the probability of 0.0016 and 0.0001, *Trace* at  $39.25937 > 15.49471$  and  $16.21958 > 3.841466$  with the probability of 0.0000 and 0.000. This test indicated 2 cointegrations at the level of  $\alpha \leq 0.05$ .
- The *likelihood ratio* of Singapore at  $r = 0$  and  $\leq 1$  had the result for *Max-eigen* at  $75.74765 > 14.26460$  and  $13.99184 > 3.841466$  with the probability of

0.0000 and 0.0002, *Trace* at 89.73949 > 15.49471 and 13.99184 > 3.841466 with the probability of 0.0000 and 0.0002. This test indicated 2 cointegrations at the level of  $\alpha \leq 0.05$ .

- The *likelihood ratio* of Thailand at  $r = 0$  and  $\leq 1$  had the result of *Max-eigen* at 118.6295 > 14.26460 and 2.532831 < 3.841466 with the probability of 0.0001 and 0.1115, *Trace* at 121.1623 > 15.49471 and 2.532831 < 3.841466 with the probability of 0.0001 and 0.1115. This test indicated 1 cointegration at the level of  $\alpha \leq 0.05$ .
- The *likelihood ratio* of Philippines at  $r = 0$  and  $\leq 1$  had the result of *Max-eigen* at 5.803529 < 14.26460 and 2.246978 < 3.841466 with the probability of 0.6386 and 0.1339, *Trace* at 8.050508 < 15.49471 and 2.246978 < 3.841466 with the probability of 0.4600 and 0.1339. This test indicated no cointegration at the level of  $\alpha \leq 0.05$ .

## 5. Granger-Causality

According to Table 4.4, the short-run causality was performed by standard Granger-causality for each 5 country while, in Indonesia, Malaysia, Singapore and Thailand was cointegrated and could be applied by using ECM and Philippines had no Cointegration that can be applied by using unrestricted VAR to find the result from long-run relationship. The result was indicated by asterisk (\*).

### a. Indonesia

- In Indonesia, short-run causal relationship running from Electricity Consumption to GDP had Granger causality because the probability value was  $0.0036 < \alpha$  (5%) and short-run causal relationship running from GDP to

Electricity Consumption had Granger-causality because the probability value was  $0.0074 < \alpha$  (5%).

- In Indonesia, long-run causal relationship running from Electricity Consumption to GDP did not have Granger causality because the probability value was  $0.8106 > \alpha$  (10%) and long-run causal relationship running from GDP to Electricity Consumption had Granger-causality because the probability value was  $0.0572 < \alpha$  (10%).

b. Malaysia

- In Malaysia, short-run causal relationship running from Electricity Consumption to GDP did not have Granger-causality because the probability value was  $0.3520 > \alpha$  (10%) and short-run causal relationship running from GDP to Electricity Consumption had Granger causality because the probability value was  $0.0405 < \alpha$  (5%).
- In Malaysia, long-run causal relationship running from Electricity Consumption run on GDP did not have Granger-causality because the probability value was  $0.8192 > \alpha$  (10%) and long-run causal relationship running from GDP run to Electricity Consumption had Granger causality because the probability value was  $0.0360 < \alpha$  (5%).

c. Singapore

- In Singapore, there is a short-run causal relationship running from Electricity Consumption to GDP did not have Granger-causality because the probability value was  $0.4031 > \alpha$  (10%) and short-run causal relationship running from

GDP to Electricity Consumption had Granger-causality because the probability value was  $0.0068 < \alpha$  (5%).

- In Singapore, long-run causal relationship running from Electricity Consumption to GDP did not have Granger-causality because the probability value was  $0.6165 > \alpha$  (10%) and long-run causal relationship from GDP to Electricity Consumption did not have Granger-causality because the probability value was  $0.4974 > \alpha$  (10%).

#### d. Thailand

- In Thailand, short-run causal relationship running from Electricity Consumption to GDP had Granger-causality because the probability value was  $0.0650 < \alpha$  (10%) and short-run causal relationship running from GDP to Electricity Consumption had Granger causality because the probability value was  $0.0247 < \alpha$  (5%).
- In Thailand, long-run causal relationship running from Electricity Consumption to GDP did not have Granger-causality because the probability value was  $0.9532 > \alpha$  (10%) and long-run causal relationship running from GDP to Electricity Consumption did not have Granger-causality because the probability value was  $0.9492 > \alpha$  (10%).

#### e. Philippines

- In Philippines, short-run causal relationship running from Electricity Consumption to GDP did not have Granger-causality because the probability value was  $0.4047 > \alpha$  (10%) and short-run causal relationship running from

GDP to Electricity Consumption did not have Granger-causality because the probability value was  $0.1527 > \alpha$  (10%).

After the data was analyzed by using Granger-Causality test with joint ECMs model, it was found that the short-run relationship and long-run existence showed:

- Indonesia had the *bi-directional* causality in short-run was exist relationship between electricity consumption and economic growth called as "*feedback hypothesis*", and *uni-directional* causality in long-run was exist running from economic growth to electricity consumption called as "*conservation hypothesis*".
- Malaysia had the *uni-directional* causality in short-run was exist running from economic growth to electricity consumption called as "*conservation hypothesis*", and *uni-directional* causality in long-run was exist running from economic growth to electricity consumption called as "*conservation hypothesis*".
- Singapore had the *uni-directional* causality in short-run was exist running from economic growth to electricity consumption called as "*conservation hypothesis*", and *absence causality* in long-run did not have causal relationship running between economic growth and electricity consumption called as "*neutrality hypothesis*".
- Thailand had the *bi-directional* causality in short-run was exist relationship between electricity consumption and economic growth called as "*feedback*".

*hypothesis*", and *absence causality* in long-run did not have causal relationship running between economic growth and electricity consumption called as "*neutrality hypothesis*".

- Philippines had *absence causality* in short-run did not have causal relationship running between economic growth and electricity consumption called as "*neutrality hypothesis*".

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

The results of the analysis of causality in Short-run and Long-run of Electricity Consumption and Economic Growth in each 5 ASEAN Country (Indonesia, Malaysia, Singapore, Thailand, Philippines) in the period of 1971-2013 are as follow:

#### 5.1 Conclusion

The result of causal relationship running follows:

- a) The uni-directional causality running from electricity consumption to economic growth ( $ELE \rightarrow GDP$ ) was not found in any of the 5 countries neither short-run and long-run. This showed a causal relationship that may give adverse effect on the economic growth which is called '*growth hypothesis*'. The increase of electricity consumption and economic growth will influence the inefficiency of industry and technological process as the factor of production. Thus, energy policies would have an influence on the economic activity which was feasible for electric conservation. It was because the efficiency in demand side management failed to control the wastage of electricity that had bad improvement to reduce electricity consumption.
- b) The uni-directional causality running from economic growth to electricity consumption ( $ELE \leftarrow GDP$ ) which was found in Malaysia, Singapore and Thailand was short-run while in Indonesia and Malaysia was long-run. This showed that economic growth gives little impact or no adverse effect on

electricity consumption that may be implemented in the economic growth as a good result. It is called “*conservation hypothesis*”. It may give good effect on the economic growth as a better result and it can also be implied on high improvement of industrial sector in using advanced technology or the energy policies to spread and distribute electric power to the society.

- c) The bi-directional causality created a relationship between electricity consumption and economic growth ( $ELE \leftrightarrow GDP$ ) which was found in Indonesia and Malaysia was short-run while long-run was not found in any of the 5 countries. This affects each variable at the same time and could be called as "feedback hypothesis". It may imply negative impact on the economy activity in the management of electricity power, but the impact on the distribution of electricity power have a good effect on the increase of economic growth.
- d) The absence of causality on both variables ( $ELE \neq GDP$ ) which was found in Philippines was short-run, while in Singapore and Thailand long-run did not exist. This means that an effect on electricity consumption and economic growth did not influence any directions and could be called as ‘*neutrality hypothesis*’. It may imply that good energy policy was made to decrease the wastage of electricity and give the adverse effect on the increases of economic growth because of the less improvement of technology used by industrial sector that support the increases of national income. For the other explanation, the government have no plan to improve electricity in the long-term and lack of improvement for the short-term.

## **5.2 Recommendations**

The electricity consumption is one of main factors of complicated and vital problem issued by all countries in the world, while economic growth can be reflected to show the development of it. As the researcher tried to find the result of each country in 5 ASEAN countries which influence the electricity and GDP, it should synergize the effectiveness analyses of electricity consumption. Each country should be aware of making energy policy to support the reduction of electricity wastage and good management in the distribution of electric power. Thus, the country will get a better impact on industrialization by using advanced technology or SME's (upper and lower level of market activity).

For further research, other factors could be added to indicate causal relationship on electricity consumption to drive and look forward for finding the different result and examine the other subject such as poverty, infrastructure and other factors.

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# APPENDICES

## Appendix 1 GDP Per-Capita

GDP per capita (current billion US\$)

| Year | MLS<br>GDP | IDN<br>GDP | SGP GDP | THL<br>GDP | PHL<br>GDP |
|------|------------|------------|---------|------------|------------|
| 1971 | 379.6      | 83.5       | 1070.8  | 194.3      | 201        |
| 1972 | 440.1      | 95.9       | 1263.7  | 209.4      | 211.4      |
| 1973 | 652.6      | 138.2      | 1684.3  | 269.9      | 258.4      |
| 1974 | 789.6      | 213.6      | 2339.6  | 332.1      | 343.2      |
| 1975 | 755.3      | 245.9      | 2489.8  | 351.5      | 360.7      |
| 1976 | 877        | 293.5      | 2758.7  | 391.5      | 402.7      |
| 1977 | 1019.2     | 352.4      | 2845.8  | 445.3      | 450.1      |
| 1978 | 1240.1     | 386        | 3193.3  | 528.5      | 506.1      |
| 1979 | 1570.9     | 382.7      | 3899.5  | 589.7      | 596.4      |
| 1980 | 1770.2     | 528.9      | 4927    | 682.8      | 684.7      |
| 1981 | 1763.4     | 612.5      | 5595.2  | 720.9      | 731.7      |
| 1982 | 1843       | 613        | 6075.6  | 742.7      | 741.8      |
| 1983 | 2033       | 540.2      | 6629.9  | 797.9      | 645.5      |
| 1984 | 2213.7     | 542.3      | 7223.2  | 817.9      | 594        |
| 1985 | 1979.2     | 529.3      | 6995.2  | 747.5      | 565.8      |
| 1986 | 1709.7     | 475.4      | 6793.7  | 813.1      | 535.2      |
| 1987 | 1926.6     | 442.1      | 7531.2  | 936.2      | 579.2      |
| 1988 | 2050.4     | 507.4      | 8902.5  | 1122.6     | 643.8      |
| 1989 | 2194       | 569.2      | 10380.2 | 1294.5     | 705        |
| 1990 | 2417.4     | 630.7      | 11864.5 | 1508.3     | 715.3      |
| 1991 | 2626.6     | 694.2      | 14505   | 1716.6     | 715.1      |
| 1992 | 3080.9     | 740.9      | 16144   | 1929.5     | 814        |
| 1993 | 3395.5     | 827.8      | 18302.4 | 2213.2     | 815.7      |
| 1994 | 3685.9     | 912.1      | 21578.5 | 2497.9     | 939.1      |
| 1995 | 4280       | 1026.3     | 24936.8 | 2856.2     | 1061.3     |
| 1996 | 4743.7     | 1137.3     | 26263   | 3056.8     | 1159.7     |
| 1997 | 4585.7     | 1063.6     | 26386.5 | 2480.5     | 1127.3     |
| 1998 | 3227.8     | 463.9      | 21824   | 1855.9     | 967.2      |
| 1999 | 3456.5     | 671        | 21795.7 | 2043.9     | 1088       |
| 2000 | 4004.6     | 780.1      | 23792.6 | 2016       | 1039.7     |
| 2001 | 3878.8     | 748.2      | 21577.1 | 1897       | 958        |
| 2002 | 4132.7     | 900.1      | 22016.8 | 2094       | 1000.8     |
| 2003 | 4431.2     | 1065.7     | 23573.6 | 2349.4     | 1011.3     |
| 2004 | 4924.6     | 1150.3     | 27405.3 | 2643.5     | 1080.1     |
| 2005 | 5564.2     | 1263.5     | 29869.9 | 2874.4     | 1196.5     |
| 2006 | 6194.7     | 1590.2     | 33579.9 | 3351.1     | 1395.2     |
| 2007 | 7240.7     | 1860.6     | 39223.6 | 3962.8     | 1678.9     |
| 2008 | 8486.6     | 2167.9     | 39721   | 4384.8     | 1929.1     |
| 2009 | 7312       | 2262.7     | 38577.6 | 4231.1     | 1836.9     |
| 2010 | 9069       | 3125.2     | 46569.7 | 5111.9     | 2145.2     |

|      |         |        |         |        |        |
|------|---------|--------|---------|--------|--------|
| 2011 | 10427.8 | 3647.6 | 53093.7 | 5539.5 | 2371.9 |
| 2012 | 10834.7 | 3700.5 | 54451.2 | 5915.2 | 2604.7 |
| 2013 | 10973.7 | 3631.7 | 55617.6 | 6225.1 | 2787   |

*Sources : World Development Indicators*

## Appendix 2 The Electric Power Consumption

The Electric Power Consumption (kWh per capita)

| Year | MLS<br>ELE | IDN ELE | SGP ELE | THL<br>ELE | PHL<br>ELE |
|------|------------|---------|---------|------------|------------|
| 1971 | 309.8      | 14.3    | 1154.8  | 120.3      | 235.8      |
| 1972 | 343.2      | 15.9    | 1371    | 140.2      | 260.5      |
| 1973 | 370.2      | 15.8    | 1599.2  | 161.5      | 321.9      |
| 1974 | 395.1      | 19.2    | 1634.2  | 165.8      | 309.4      |
| 1975 | 424.7      | 21.4    | 1728.1  | 183.8      | 314.5      |
| 1976 | 461.8      | 18.3    | 1884.6  | 206.7      | 329.2      |
| 1977 | 526.7      | 21.7    | 2073.7  | 233.6      | 328.2      |
| 1978 | 557.6      | 31.7    | 2368.3  | 261.7      | 328.5      |
| 1979 | 616.2      | 38.7    | 2529.5  | 278.6      | 345.4      |
| 1980 | 657.1      | 46.2    | 2718.4  | 290.5      | 373.5      |
| 1981 | 686.6      | 52.3    | 2778.7  | 299        | 337.3      |
| 1982 | 725        | 61.4    | 2814.3  | 320.4      | 338.1      |
| 1983 | 762.6      | 66.1    | 3045.8  | 349        | 362.5      |
| 1984 | 808.7      | 71.4    | 3255.6  | 380.7      | 341.3      |
| 1985 | 833.9      | 79.7    | 3444.1  | 405.8      | 350.1      |
| 1986 | 874.3      | 92      | 3693.6  | 434.8      | 311.4      |
| 1987 | 914.1      | 104.3   | 4088.6  | 483.2      | 319.4      |
| 1988 | 986.7      | 119.5   | 4399    | 538.1      | 343.1      |
| 1989 | 1065.3     | 137.5   | 4639.2  | 614.5      | 360.6      |
| 1990 | 1145.8     | 162.5   | 4983    | 709.2      | 360.7      |
| 1991 | 1253.4     | 177.9   | 5104.8  | 792.2      | 353.9      |
| 1992 | 1404.2     | 194.3   | 5236.6  | 894.1      | 335        |
| 1993 | 1516.9     | 212.8   | 5500    | 1010.3     | 335.2      |
| 1994 | 1764.9     | 240     | 5842.6  | 1109.2     | 377.2      |
| 1995 | 1981.6     | 263.6   | 6069.2  | 1251.9     | 398.5      |
| 1996 | 2162.8     | 297.2   | 6312.7  | 1385.8     | 428.3      |
| 1997 | 2444.1     | 331.3   | 6829.2  | 1417.1     | 462.2      |
| 1998 | 2497.8     | 331.1   | 6965.8  | 1366.5     | 478.6      |
| 1999 | 2620.7     | 357     | 7187.7  | 1365.5     | 467.7      |
| 2000 | 2720.5     | 390.4   | 7575.4  | 1454.1     | 499.7      |
| 2001 | 2733.9     | 411.4   | 7516.2  | 1507.7     | 519.3      |
| 2002 | 2798.2     | 417.5   | 7756.3  | 1615.9     | 522.8      |
| 2003 | 2894.7     | 428.9   | 8113.6  | 1706.6     | 556        |
| 2004 | 2967.7     | 474.4   | 8314.3  | 1815.8     | 576        |
| 2005 | 2862       | 500.7   | 8677.7  | 1901.8     | 577.5      |
| 2006 | 3058.4     | 516.2   | 8719.6  | 1994.3     | 569.7      |
| 2007 | 3271.6     | 546.3   | 8706.6  | 2074.9     | 584.5      |
| 2008 | 3290.8     | 570.3   | 8401    | 2107.9     | 588.5      |
| 2009 | 3952.6     | 594.3   | 8013.3  | 2111.2     | 593.9      |
| 2010 | 4158.6     | 636.6   | 8571.5  | 2325.2     | 644.3      |

|      |        |       |        |        |       |
|------|--------|-------|--------|--------|-------|
| 2011 | 4113.8 | 680.7 | 8549.5 | 2304.8 | 650.7 |
| 2012 | 4345.5 | 718.7 | 8654.4 | 2468.1 | 672.4 |
| 2013 | 4512   | 787.7 | 8839.7 | 2470.8 | 692.1 |

Sources : World Development Indicators

### Appendix 3 Lag Length Criterion

#### Indonesia

VAR Lag Order Selection Criteria

Endogenous variables: IDN\_ELE IDN\_GDP

Exogenous variables: C

Date: 12/06/16 Time: 14:44

Sample: 1971 2013

Included observations: 31

| Lag | LogL      | LR        | FPE       | AIC       | SC        | HQ        |
|-----|-----------|-----------|-----------|-----------|-----------|-----------|
| 0   | -444.5443 | NA        | 1.11e+10  | 28.80931  | 28.90182  | 28.83947  |
| 1   | -323.4272 | 218.7922  | 5831747.  | 21.25337  | 21.53091  | 21.34384  |
| 2   | -319.4389 | 6.690088  | 5862278.  | 21.25412  | 21.71670  | 21.40491  |
| 3   | -316.2064 | 5.005109  | 6222750.  | 21.30364  | 21.95124  | 21.51474  |
| 4   | -314.0513 | 3.058792  | 7140518.  | 21.42267  | 22.25530  | 21.69409  |
| 5   | -310.3272 | 4.805378  | 7491111.  | 21.44046  | 22.45813  | 21.77220  |
| 6   | -309.2150 | 1.291565  | 9447258.  | 21.62677  | 22.82947  | 22.01882  |
| 7   | -299.3110 | 10.22351  | 6897954.  | 21.24587  | 22.63360  | 21.69823  |
| 8   | -298.5953 | 0.646362  | 9367423.  | 21.45776  | 23.03052  | 21.97044  |
| 9   | -286.3621 | 9.470895  | 6283594.  | 20.92659  | 22.68438  | 21.49958  |
| 10  | -259.7291 | 17.18260  | 1755524.  | 19.46639  | 21.40921  | 20.09970  |
| 11  | -231.1350 | 14.75824* | 467552.0* | 17.87968* | 20.00753* | 18.57330* |
| 12  | -228.6961 | 0.944079  | 763767.4  | 17.98039  | 20.29328  | 18.73434  |

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

#### Malaysia

VAR Lag Order Selection Criteria

Endogenous variables: MLS\_ELE MLS\_GDP

Exogenous variables: C

Date: 12/06/16 Time: 15:28

Sample: 1971 2013

Included observations: 31

| Lag | LogL      | LR        | FPE      | AIC      | SC       | HQ       |
|-----|-----------|-----------|----------|----------|----------|----------|
| 0   | -522.0688 | NA        | 1.66e+12 | 33.81089 | 33.90341 | 33.84105 |
| 1   | -429.8300 | 166.6250  | 5.59e+09 | 28.11806 | 28.39561 | 28.20854 |
| 2   | -427.2606 | 4.309866  | 6.15e+09 | 28.21036 | 28.67294 | 28.36115 |
| 3   | -425.6976 | 2.420202  | 7.27e+09 | 28.36759 | 29.01519 | 28.57869 |
| 4   | -422.6530 | 4.321263  | 7.88e+09 | 28.42923 | 29.26187 | 28.70065 |
| 5   | -417.6237 | 6.489481  | 7.60e+09 | 28.36282 | 29.38049 | 28.69455 |
| 6   | -417.5695 | 0.062952  | 1.03e+10 | 28.61739 | 29.82009 | 29.00944 |
| 7   | -413.6356 | 4.060739  | 1.10e+10 | 28.62165 | 30.00938 | 29.07402 |
| 8   | -400.7436 | 11.64439* | 6.82e+09 | 28.04798 | 29.62074 | 28.56066 |

|    |           |          |           |           |           |           |
|----|-----------|----------|-----------|-----------|-----------|-----------|
| 9  | -388.7350 | 9.297013 | 4.64e+09  | 27.53129  | 29.28908  | 28.10429  |
| 10 | -378.1314 | 6.841014 | 3.65e+09  | 27.10525  | 29.04807  | 27.73856  |
| 11 | -362.2254 | 8.209587 | 2.20e+09  | 26.33712  | 28.46497  | 27.03075  |
| 12 | -340.5065 | 8.407301 | 1.04e+09* | 25.19397* | 27.50685* | 25.94791* |

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

## Singapore

VAR Lag Order Selection Criteria

Endogenous variables: SGP\_ELE SGP\_GDP

Exogenous variables: C

Date: 12/06/16 Time: 15:38

Sample: 1971 2013

Included observations: 31

| Lag | LogL      | LR        | FPE       | AIC       | SC        | HQ        |
|-----|-----------|-----------|-----------|-----------|-----------|-----------|
| 0   | -596.9000 | NA        | 2.07e+14  | 38.63871  | 38.73122  | 38.66886  |
| 1   | -487.4028 | 197.8013  | 2.29e+11  | 31.83244  | 32.10999  | 31.92291  |
| 2   | -480.8513 | 10.98967  | 1.95e+11  | 31.66783  | 32.13040  | 31.81861  |
| 3   | -476.0763 | 7.393488  | 1.88e+11  | 31.61783  | 32.26544  | 31.82893  |
| 4   | -471.3422 | 6.719412  | 1.82e+11  | 31.57046  | 32.40310  | 31.84188  |
| 5   | -466.5703 | 6.157331  | 1.79e+11  | 31.52066  | 32.53833  | 31.85240  |
| 6   | -465.3838 | 1.377800  | 2.24e+11  | 31.70218  | 32.90488  | 32.09423  |
| 7   | -463.5360 | 1.907450  | 2.76e+11  | 31.84103  | 33.22876  | 32.29340  |
| 8   | -449.5614 | 12.62224  | 1.59e+11  | 31.19751  | 32.77027  | 31.71019  |
| 9   | -438.2163 | 8.783281  | 1.13e+11  | 30.72363  | 32.48142  | 31.29663  |
| 10  | -434.1992 | 2.591672  | 1.36e+11  | 30.72253  | 32.66535  | 31.35584  |
| 11  | -421.6565 | 6.473660  | 1.02e+11  | 30.17139  | 32.29924  | 30.86501  |
| 12  | -396.2408 | 9.838340* | 3.78e+10* | 28.78973* | 31.10261* | 29.54367* |

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

## Thailand

VAR Lag Order Selection Criteria

Endogenous variables: THL\_ELE THL\_GDP

Exogenous variables: C

Date: 12/06/16 Time: 15:39

Sample: 1971 2013

Included observations: 31

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|-----|------|----|-----|-----|----|----|
|-----|------|----|-----|-----|----|----|

|    |           |           |           |           |           |           |
|----|-----------|-----------|-----------|-----------|-----------|-----------|
| 0  | -488.8527 | NA        | 1.94e+11  | 31.66792  | 31.76043  | 31.69808  |
| 1  | -379.1705 | 198.1356  | 2.13e+08  | 24.84971  | 25.12726  | 24.94018  |
| 2  | -376.7295 | 4.094561  | 2.36e+08  | 24.95029  | 25.41287  | 25.10108  |
| 3  | -371.6396 | 7.881103  | 2.22e+08  | 24.87998  | 25.52758  | 25.09108  |
| 4  | -364.5589 | 10.05001  | 1.86e+08  | 24.68122  | 25.51386  | 24.95264  |
| 5  | -363.6756 | 1.139758  | 2.34e+08  | 24.88230  | 25.89997  | 25.21403  |
| 6  | -356.0840 | 8.816125  | 1.94e+08  | 24.65058  | 25.85328  | 25.04263  |
| 7  | -343.8238 | 12.65562  | 1.22e+08  | 24.11767  | 25.50540  | 24.57003  |
| 8  | -340.2468 | 3.230835  | 1.38e+08  | 24.14496  | 25.71772  | 24.65764  |
| 9  | -327.2045 | 10.09726  | 87613814  | 23.56158  | 25.31937  | 24.13458  |
| 10 | -301.9231 | 16.31063* | 26707917  | 22.18858  | 24.13141  | 22.82190  |
| 11 | -292.2938 | 4.969923  | 24179072* | 21.82541  | 23.95326  | 22.51904  |
| 12 | -283.7519 | 3.306552  | 26642160  | 21.53238* | 23.84526* | 22.28632* |

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

## Philippines

VAR Lag Order Selection Criteria

Endogenous variables: PHL\_ELE PHL\_GDP

Exogenous variables: C

Date: 12/06/16 Time: 15:40

Sample: 1971 2013

Included observations: 31

| Lag | LogL      | LR        | FPE       | AIC       | SC        | HQ        |
|-----|-----------|-----------|-----------|-----------|-----------|-----------|
| 0   | -411.4290 | NA        | 1.32e+09  | 26.67284  | 26.76535  | 26.70300  |
| 1   | -320.3643 | 164.5040* | 4786077.* | 21.05576  | 21.33331* | 21.14623* |
| 2   | -319.6686 | 1.166880  | 5949837.  | 21.26894  | 21.73152  | 21.41973  |
| 3   | -319.3271 | 0.528838  | 7610651.  | 21.50497  | 22.15258  | 21.71608  |
| 4   | -318.0171 | 1.859332  | 9222470.  | 21.67852  | 22.51116  | 21.94994  |
| 5   | -316.4623 | 2.006172  | 11128786  | 21.83628  | 22.85395  | 22.16801  |
| 6   | -315.2089 | 1.455573  | 13907537  | 22.01348  | 23.21618  | 22.40553  |
| 7   | -311.0132 | 4.331115  | 14675887  | 22.00085  | 23.38858  | 22.45321  |
| 8   | -304.2427 | 6.115232  | 13485103  | 21.82211  | 23.39487  | 22.33479  |
| 9   | -301.0965 | 2.435818  | 16257366  | 21.87719  | 23.63498  | 22.45019  |
| 10  | -293.3581 | 4.992466  | 15369484  | 21.63601  | 23.57883  | 22.26932  |
| 11  | -277.2040 | 8.337630  | 9133491.  | 20.85187  | 22.97972  | 21.54550  |
| 12  | -272.2304 | 1.925273  | 12669133  | 20.78906* | 23.10194  | 21.54300  |

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

## Appendix 4 Unit Root Test

### Indonesia

#### *-Level, Intercept*

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| IDN_ELE | 1.0000 | 0   | 9       | 42  |
| IDN_GDP | 0.9999 | 0   | 9       | 42  |

Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| IDN_ELE | 1.0000 | 3.0       | 42  |
| IDN_GDP | 0.9998 | 2.0       | 42  |

#### *-1st Differences, Intercept*

Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(IDN_ELE) | 0.9815 | 2   | 9       | 39  |
| D(IDN_GDP) | 0.0012 | 0   | 9       | 41  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(IDN_ELE) | 0.7059 | 2.0       | 41  |
| D(IDN_GDP) | 0.0011 | 1.0       | 41  |

#### *(2st Differences, Intercept)*

Intermediate Phillips-Perron test results D(UNTITLED,2)

| Series       | Prob.  | Bandwidth | Obs |
|--------------|--------|-----------|-----|
| D(IDN_GDP,2) | 0.0000 | 21.0      | 40  |
| D(IDN_ELE,2) | 0.0000 | 15.0      | 40  |

**-Level, Intercept and Trend**

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| IDN_ELE | 0.9995 | 0   | 9       | 42  |
| IDN_GDP | 0.9980 | 0   | 9       | 42  |

Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| IDN_ELE | 0.9995 | 2.0       | 42  |
| IDN_GDP | 0.9980 | 0.0       | 42  |

**-1st Differences, Intercept and Trend**

Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(IDN_ELE) | 0.7203 | 2   | 9       | 39  |
| D(IDN_GDP) | 0.0022 | 0   | 9       | 41  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(IDN_ELE) | 0.0024 | 1.0       | 41  |
| D(IDN_GDP) | 0.0025 | 2.0       | 41  |

**Malaysia****-Level, Intercept**

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| MLS_ELE | 1.0000 | 8   | 9       | 34  |
| MLS_GDP | 0.9995 | 0   | 9       | 42  |

Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| MLS_ELE | 0.9999 | 4.0       | 42  |
| MLS_GDP | 0.9999 | 3.0       | 42  |

**-1st Differences, Intercept**

Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(MLS_ELE) | 0.7617 | 9   | 9       | 32  |
| D(MLS_GDP) | 0.0000 | 0   | 9       | 41  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(MLS_ELE) | 0.0000 | 5.0       | 41  |
| D(MLS_GDP) | 0.0000 | 2.0       | 41  |

**-Level, Intercept and Trend**

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| MLS_ELE | 0.6132 | 9   | 9       | 33  |
| MLS_GDP | 0.9855 | 0   | 9       | 42  |

Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| MLS_ELE | 0.9023 | 4.0       | 42  |
| MLS_GDP | 0.9855 | 0.0       | 42  |

**-1st Differences, Intercept and Trend**

Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(MLS_ELE) | 0.6979 | 9   | 9       | 32  |
| D(MLS_GDP) | 0.0004 | 1   | 9       | 40  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(MLS_ELE) | 0.0000 | 4.0       | 41  |
| D(MLS_GDP) | 0.0000 | 1.0       | 41  |

## Singapore

**-Level, Intercept**

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| SGP_ELE | 0.2005 | 8   | 9       | 34  |
| SGP_GDP | 0.9999 | 9   | 9       | 33  |

Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| SGP_ELE | 0.7640 | 3.0       | 42  |
| SGP_GDP | 0.9999 | 0.0       | 42  |

**-1st Differences, Intercept**

Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(SGP_ELE) | 0.9280 | 7   | 9       | 34  |
| D(SGP_GDP) | 0.2632 | 2   | 9       | 39  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(SGP_ELE) | 0.0000 | 3.0       | 41  |
| D(SGP_GDP) | 0.0013 | 1.0       | 41  |

**-Level, Intercept and Trend**

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| SGP_ELE | 0.7424 | 7   | 9       | 35  |
| SGP_GDP | 0.8756 | 3   | 9       | 39  |

## Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| SGP_ELE | 0.9137 | 3.0       | 42  |
| SGP_GDP | 0.9673 | 1.0       | 42  |

**-1st Differences, Intercept and Trend**

## Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(SGP_ELE) | 0.9999 | 9   | 9       | 32  |
| D(SGP_GDP) | 0.2488 | 2   | 9       | 39  |

## Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(SGP_ELE) | 0.0002 | 3.0       | 41  |
| D(SGP_GDP) | 0.0034 | 3.0       | 41  |

## Thailand

**-Level, Intercept**

## Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| THL_ELE | 0.9999 | 0   | 9       | 42  |
| THL_GDP | 0.9981 | 1   | 9       | 41  |

## Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| THL_ELE | 0.9998 | 2.0       | 42  |
| THL_GDP | 0.9998 | 3.0       | 42  |

**-1st Differences, Intercept**

## Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(THL_ELE) | 0.0966 | 1   | 9       | 40  |
| D(THL_GDP) | 0.0029 | 0   | 9       | 41  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(THL_ELE) | 0.0000 | 3.0       | 41  |
| D(THL_GDP) | 0.0035 | 2.0       | 41  |

**-Level, Intercept and Trend**

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| THL_ELE | 0.3990 | 2   | 9       | 40  |
| THL_GDP | 0.9641 | 1   | 9       | 41  |

Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| THL_ELE | 0.5528 | 0.0       | 42  |
| THL_GDP | 0.9848 | 3.0       | 42  |

**-1st Differences, Intercept and Trend**

Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(THL_ELE) | 0.1304 | 1   | 9       | 40  |
| D(THL_GDP) | 0.0042 | 0   | 9       | 41  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(THL_ELE) | 0.0000 | 1.0       | 41  |
| D(THL_GDP) | 0.0041 | 1.0       | 41  |

## Philippines

**-Level, Intercept**

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| PHL_ELE | 0.9836 | 0   | 9       | 42  |
| PHL_GDP | 1.0000 | 0   | 9       | 42  |

Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| PHL_ELE | 0.9839 | 1.0       | 42  |
| PHL_GDP | 1.0000 | 3.0       | 42  |

**-1st Differences, Intercept**

Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(PHL_ELE) | 0.0000 | 0   | 9       | 41  |
| D(PHL_GDP) | 0.0029 | 0   | 9       | 41  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(PHL_ELE) | 0.0000 | 2.0       | 41  |
| D(PHL_GDP) | 0.0023 | 3.0       | 41  |

**-Level, Intercept and Trend**

Intermediate ADF test results UNTITLED

| Series  | Prob.  | Lag | Max Lag | Obs |
|---------|--------|-----|---------|-----|
| PHL_ELE | 0.9261 | 0   | 9       | 42  |
| PHL_GDP | 1.0000 | 0   | 9       | 42  |

Intermediate Phillips-Perron test results UNTITLED

| Series  | Prob.  | Bandwidth | Obs |
|---------|--------|-----------|-----|
| PHL_ELE | 0.9271 | 2.0       | 42  |
| PHL_GDP | 0.9997 | 3.0       | 42  |

***-1st Differences, Intercept and Trend***

Intermediate ADF test results D(UNTITLED)

| Series     | Prob.  | Lag | Max Lag | Obs |
|------------|--------|-----|---------|-----|
| D(PHL_ELE) | 0.0000 | 0   | 9       | 41  |
| D(PHL_GDP) | 0.0028 | 0   | 9       | 41  |

Intermediate Phillips-Perron test results D(UNTITLED)

| Series     | Prob.  | Bandwidth | Obs |
|------------|--------|-----------|-----|
| D(PHL_ELE) | 0.0000 | 0.0       | 41  |
| D(PHL_GDP) | 0.0024 | 3.0       | 41  |

## Appendix 5 Johansen Cointegration

### Indonesia

Date: 12/15/16 Time: 19:07  
Sample (adjusted): 1983 2013  
Included observations: 31 after adjustments  
Trend assumption: Linear deterministic trend  
Series: IDN\_GDP IDN\_ELE  
Lags interval (in first differences): 1 to 11

#### Unrestricted Cointegration Rank Test (Trace)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Trace<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|--------------------|------------------------|---------|
| None *                       | 0.651724   | 37.20338           | 15.49471               | 0.0000  |
| At most 1 *                  | 0.135279   | 4.505784           | 3.841466               | 0.0338  |

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

#### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Max-Eigen<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|------------------------|------------------------|---------|
| None *                       | 0.651724   | 32.69759               | 14.26460               | 0.0000  |
| At most 1 *                  | 0.135279   | 4.505784               | 3.841466               | 0.0338  |

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

### Malaysia

Date: 12/15/16 Time: 19:07  
Sample (adjusted): 1984 2013  
Included observations: 30 after adjustments  
Trend assumption: Linear deterministic trend  
Series: MLS\_GDP MLS\_ELE  
Lags interval (in first differences): 1 to 12

#### Unrestricted Cointegration Rank Test (Trace)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Trace<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|--------------------|------------------------|---------|
| None *                       | 0.536057   | 39.25937           | 15.49471               | 0.0000  |
| At most 1 *                  | 0.417632   | 16.21958           | 3.841466               | 0.0001  |

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

#### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Max-Eigen<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|------------------------|------------------------|---------|
| None *                       | 0.536057   | 23.03979               | 14.26460               | 0.0016  |
| At most 1 *                  | 0.417632   | 16.21958               | 3.841466               | 0.0001  |

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

## Singapore

Date: 12/15/16 Time: 19:06

Sample (adjusted): 1984 2013

Included observations: 30 after adjustments

Trend assumption: Linear deterministic trend

Series: SGP\_GDP SGP\_ELE

Lags interval (in first differences): 1 to 12

#### Unrestricted Cointegration Rank Test (Trace)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Trace<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|--------------------|------------------------|---------|
| None *                       | 0.919935   | 89.73949           | 15.49471               | 0.0000  |
| At most 1 *                  | 0.372740   | 13.99184           | 3.841466               | 0.0002  |

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

#### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Max-Eigen<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|------------------------|------------------------|---------|
| None *                       | 0.919935   | 75.74765               | 14.26460               | 0.0000  |
| At most 1 *                  | 0.372740   | 13.99184               | 3.841466               | 0.0002  |

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

## Thailand

Date: 12/15/16 Time: 19:05  
Sample (adjusted): 1984 2013  
Included observations: 30 after adjustments  
Trend assumption: Linear deterministic trend  
Series: THL\_GDP THL\_ELE  
Lags interval (in first differences): 1 to 12

### Unrestricted Cointegration Rank Test (Trace)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Trace<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|--------------------|------------------------|---------|
| None *                       | 0.980828   | 121.1623           | 15.49471               | 0.0001  |
| At most 1                    | 0.080962   | 2.532831           | 3.841466               | 0.1115  |

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Max-Eigen<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|------------------------|------------------------|---------|
| None *                       | 0.980828   | 118.6295               | 14.26460               | 0.0001  |
| At most 1                    | 0.080962   | 2.532831               | 3.841466               | 0.1115  |

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

## Philippines

Date: 12/15/16 Time: 19:06  
Sample (adjusted): 1973 2013  
Included observations: 41 after adjustments  
Trend assumption: Linear deterministic trend  
Series: PHL\_GDP PHL\_ELE  
Lags interval (in first differences): 1 to 1

### Unrestricted Cointegration Rank Test (Trace)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Trace<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|--------------------|------------------------|---------|
| None                         | 0.131988   | 8.050508           | 15.49471               | 0.4600  |
| At most 1                    | 0.053330   | 2.246978           | 3.841466               | 0.1339  |

Trace test indicates no cointegration at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized<br>No. of CE(s) | Eigenvalue | Max-Eigen<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|------------------------|------------------------|---------|
| None                         | 0.131988   | 5.803529               | 14.26460               | 0.6386  |
| At most 1                    | 0.053330   | 2.246978               | 3.841466               | 0.1339  |

Max-eigenvalue test indicates no cointegration at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

## Appendix 6 Standard Granger-Causality

### Indonesia

Pairwise Granger Causality Tests

Date: 12/13/16 Time: 20:46

Sample: 1971 2013

Lags: 11

| Null Hypothesis:                       | Obs | F-Statistic | Prob.  |
|----------------------------------------|-----|-------------|--------|
| IDN_ELE does not Granger Cause IDN_GDP | 32  | 6.91371     | 0.0036 |
| IDN_GDP does not Granger Cause IDN_ELE |     | 5.64290     | 0.0074 |

### Malaysia

Pairwise Granger Causality Tests

Date: 12/13/16 Time: 20:47

Sample: 1971 2013

Lags: 12

| Null Hypothesis:                       | Obs | F-Statistic | Prob.  |
|----------------------------------------|-----|-------------|--------|
| MLS_ELE does not Granger Cause MLS_GDP | 31  | 1.40711     | 0.3520 |
| MLS_GDP does not Granger Cause MLS_ELE |     | 4.38210     | 0.0405 |

### Singapore

Pairwise Granger Causality Tests

Date: 12/13/16 Time: 20:48

Sample: 1971 2013

Lags: 12

| Null Hypothesis:                       | Obs | F-Statistic | Prob.  |
|----------------------------------------|-----|-------------|--------|
| SGP_ELE does not Granger Cause SGP_GDP | 31  | 1.27120     | 0.4031 |
| SGP_GDP does not Granger Cause SGP_ELE |     | 8.95675     | 0.0068 |

### Thailand

Pairwise Granger Causality Tests

Date: 12/13/16 Time: 20:48

Sample: 1971 2013

Lags: 12

| Null Hypothesis:                       | Obs | F-Statistic | Prob.  |
|----------------------------------------|-----|-------------|--------|
| THL_ELE does not Granger Cause THL_GDP | 31  | 3.55653     | 0.0650 |
| THL_GDP does not Granger Cause THL_ELE |     | 5.39016     | 0.0247 |

## Philippines

Pairwise Granger Causality Tests

Date: 12/13/16 Time: 20:49

Sample: 1971 2013

Lags: 1

| Null Hypothesis:                       | Obs | F-Statistic | Prob.  |
|----------------------------------------|-----|-------------|--------|
| PHL_ELE does not Granger Cause PHL_GDP | 42  | 0.70954     | 0.4047 |
| PHL_GDP does not Granger Cause PHL_ELE |     | 2.12715     | 0.1527 |

## Appendix 7 Granger Causality ECMs

### Indonesia

Dependent Variable: IDN\_ELE  
 Method: Least Squares  
 Date: 12/21/16 Time: 22:05  
 Sample (adjusted): 1973 2013  
 Included observations: 41 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | 4.362876    | 2.496342              | 1.747708    | 0.0888   |
| IDN_ELE(-1)        | 1.027023    | 0.014141              | 72.62602    | 0.0000   |
| IDN_GDP(-1)        | 0.007705    | 0.003561              | 2.163641    | 0.0370   |
| IDNRESID01(-1)     | 0.041197    | 0.170655              | 0.241403    | 0.8106   |
| R-squared          | 0.998371    | Mean dependent var    |             | 274.1220 |
| Adjusted R-squared | 0.998238    | S.D. dependent var    |             | 229.5914 |
| S.E. of regression | 9.636098    | Akaike info criterion |             | 7.461377 |
| Sum squared resid  | 3435.613    | Schwarz criterion     |             | 7.628555 |
| Log likelihood     | -148.9582   | Hannan-Quinn criter.  |             | 7.522254 |
| F-statistic        | 7556.825    | Durbin-Watson stat    |             | 1.891878 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

Dependent Variable: IDN\_GDP  
 Method: Least Squares  
 Date: 06/15/17 Time: 11:49  
 Sample (adjusted): 1973 2013  
 Included observations: 41 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | 26.90815    | 47.14722              | 0.570726    | 0.5716   |
| IDN_GDP(-1)        | 0.957135    | 0.067261              | 14.23010    | 0.0000   |
| IDN_ELE(-1)        | 0.434280    | 0.267079              | 1.626034    | 0.1124   |
| IDNRESID01(-1)     | -6.326398   | 3.223076              | -1.962845   | 0.0572   |
| R-squared          | 0.966337    | Mean dependent var    |             | 1059.383 |
| Adjusted R-squared | 0.963608    | S.D. dependent var    |             | 954.0010 |
| S.E. of regression | 181.9924    | Akaike info criterion |             | 13.33827 |
| Sum squared resid  | 1225486.    | Schwarz criterion     |             | 13.50545 |
| Log likelihood     | -269.4346   | Hannan-Quinn criter.  |             | 13.39915 |
| F-statistic        | 354.0450    | Durbin-Watson stat    |             | 1.466234 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

## Malaysia

Dependent Variable: MLS\_ELE

Method: Least Squares

Date: 12/22/16 Time: 19:51

Sample (adjusted): 1973 2013

Included observations: 41 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | 42.65217    | 30.56313              | 1.395544    | 0.1712   |
| MLS_ELE(-1)        | 0.936041    | 0.043866              | 21.33877    | 0.0000   |
| MLS_GDP(-1)        | 0.048247    | 0.020530              | 2.350009    | 0.0242   |
| MLSRESID01(-1)     | -0.041173   | 0.178838              | -0.230223   | 0.8192   |
| R-squared          | 0.993341    | Mean dependent var    |             | 1905.832 |
| Adjusted R-squared | 0.992801    | S.D. dependent var    |             | 1282.682 |
| S.E. of regression | 108.8286    | Akaike info criterion |             | 12.30989 |
| Sum squared resid  | 438215.8    | Schwarz criterion     |             | 12.47707 |
| Log likelihood     | -248.3528   | Hannan-Quinn criter.  |             | 12.37077 |
| F-statistic        | 1839.877    | Durbin-Watson stat    |             | 1.972814 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

Dependent Variable: MLS\_GDP

Method: Least Squares

Date: 06/15/17 Time: 12:24

Sample (adjusted): 1973 2013

Included observations: 41 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | -43.75018   | 136.8475              | -0.319700   | 0.7510   |
| MLS_GDP(-1)        | 0.973327    | 0.091925              | 10.58822    | 0.0000   |
| MLS_ELE(-1)        | 0.203499    | 0.196410              | 1.036089    | 0.3069   |
| MLSRESID01(-1)     | 1.742862    | 0.800751              | 2.176533    | 0.0360   |
| R-squared          | 0.973043    | Mean dependent var    |             | 3886.907 |
| Adjusted R-squared | 0.970857    | S.D. dependent var    |             | 2854.424 |
| S.E. of regression | 487.2841    | Akaike info criterion |             | 15.30804 |
| Sum squared resid  | 8785493.    | Schwarz criterion     |             | 15.47522 |
| Log likelihood     | -309.8148   | Hannan-Quinn criter.  |             | 15.36892 |
| F-statistic        | 445.1880    | Durbin-Watson stat    |             | 1.719878 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

## Singapore

Dependent Variable: SGP\_ELE

Method: Least Squares

Date: 12/22/16 Time: 19:52

Sample (adjusted): 1973 2013

Included observations: 41 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | 167.7897    | 83.60882              | 2.006841    | 0.0521   |
| SGP_ELE(-1)        | 1.024754    | 0.027778              | 36.89049    | 0.0000   |
| SGP_GDP(-1)        | -0.006495   | 0.004743              | -1.369427   | 0.1791   |
| SGPRESID01(-1)     | 0.082010    | 0.162367              | 0.505091    | 0.6165   |
| R-squared          | 0.995214    | Mean dependent var    |             | 5491.112 |
| Adjusted R-squared | 0.994826    | S.D. dependent var    |             | 2522.729 |
| S.E. of regression | 181.4577    | Akaike info criterion |             | 13.33239 |
| Sum squared resid  | 1218295.    | Schwarz criterion     |             | 13.49957 |
| Log likelihood     | -269.3140   | Hannan-Quinn criter.  |             | 13.39327 |
| F-statistic        | 2564.755    | Durbin-Watson stat    |             | 2.022513 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

Dependent Variable: SGP\_GDP

Method: Least Squares

Date: 06/15/17 Time: 12:25

Sample (adjusted): 1973 2013

Included observations: 41 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | 90.00358    | 963.6920              | 0.093395    | 0.9261   |
| SGP_GDP(-1)        | 1.017733    | 0.054666              | 18.61724    | 0.0000   |
| SGP_ELE(-1)        | 0.176316    | 0.320178              | 0.550681    | 0.5852   |
| SGPRESID01(-1)     | -1.282567   | 1.871470              | -0.685326   | 0.4974   |
| R-squared          | 0.983354    | Mean dependent var    |             | 19583.77 |
| Adjusted R-squared | 0.982005    | S.D. dependent var    |             | 15591.29 |
| S.E. of regression | 2091.518    | Akaike info criterion |             | 18.22164 |
| Sum squared resid  | 1.62E+08    | Schwarz criterion     |             | 18.38881 |
| Log likelihood     | -369.5435   | Hannan-Quinn criter.  |             | 18.28251 |
| F-statistic        | 728.6012    | Durbin-Watson stat    |             | 1.493589 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

## Thailand

Dependent Variable: THL\_ELE

Method: Least Squares

Date: 12/22/16 Time: 19:53

Sample (adjusted): 1973 2013

Included observations: 41 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | 33.69086    | 14.91955              | 2.258168    | 0.0299   |
| THL_ELE(-1)        | 1.030315    | 0.035271              | 29.21179    | 0.0000   |
| THL_GDP(-1)        | -0.004126   | 0.017276              | -0.238805   | 0.8126   |
| THLRESID01(-1)     | -0.010181   | 0.172302              | -0.059089   | 0.9532   |
| R-squared          | 0.995565    | Mean dependent var    |             | 1091.917 |
| Adjusted R-squared | 0.995205    | S.D. dependent var    |             | 767.7322 |
| S.E. of regression | 53.16270    | Akaike info criterion |             | 10.87706 |
| Sum squared resid  | 104572.1    | Schwarz criterion     |             | 11.04424 |
| Log likelihood     | -218.9797   | Hannan-Quinn criter.  |             | 10.93794 |
| F-statistic        | 2768.303    | Durbin-Watson stat    |             | 1.932545 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

Dependent Variable: THL\_GDP

Method: Least Squares

Date: 06/15/17 Time: 12:27

Sample (adjusted): 1973 2013

Included observations: 41 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | 9.818770    | 70.48933              | 0.139294    | 0.8900   |
| THL_GDP(-1)        | 1.012587    | 0.081624              | 12.40552    | 0.0000   |
| THL_ELE(-1)        | 0.107734    | 0.166640              | 0.646507    | 0.5219   |
| THLRESID01(-1)     | 0.052206    | 0.814061              | 0.064130    | 0.9492   |
| R-squared          | 0.978008    | Mean dependent var    |             | 2105.834 |
| Adjusted R-squared | 0.976225    | S.D. dependent var    |             | 1628.978 |
| S.E. of regression | 251.1740    | Akaike info criterion |             | 13.98264 |
| Sum squared resid  | 2334270.    | Schwarz criterion     |             | 14.14981 |
| Log likelihood     | -282.6440   | Hannan-Quinn criter.  |             | 14.04351 |
| F-statistic        | 548.4823    | Durbin-Watson stat    |             | 1.438742 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

## Philippines

Vector Autoregression Estimates

Date: 12/21/16 Time: 22:14

Sample (adjusted): 1973 2013

Included observations: 41 after adjustments

Standard errors in ( ) & t-statistics in [ ]

|                                         | PHL_ELE                             | PHL_GDP                              | PHLRESID01                           |
|-----------------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|
| PHL_ELE(-1)                             | 0.933597<br>(0.06763)<br>[ 13.8049] | 0.264229<br>(0.30925)<br>[ 0.85443]  | -0.075543<br>(0.06763)<br>[-1.11704] |
| PHL_GDP(-1)                             | 0.019561<br>(0.01413)<br>[ 1.38417] | 1.036878<br>(0.06462)<br>[ 16.0452]  | 0.012972<br>(0.01413)<br>[ 0.91794]  |
| PHLRESID01(-1)                          | 0.013503<br>(0.16279)<br>[ 0.08295] | -0.075927<br>(0.74441)<br>[-0.10200] | 0.013503<br>(0.16279)<br>[ 0.08295]  |
| C                                       | 20.19605<br>(17.8477)<br>[ 1.13158] | -85.33272<br>(81.6136)<br>[-1.04557] | 20.19605<br>(17.8477)<br>[ 1.13158]  |
| R-squared                               | 0.972338                            | 0.977703                             | 0.034342                             |
| Adj. R-squared                          | 0.970095                            | 0.975895                             | -0.043954                            |
| Sum sq. resids                          | 16256.35                            | 339924.2                             | 16256.35                             |
| S.E. equation                           | 20.96094                            | 95.84958                             | 20.96094                             |
| F-statistic                             | 433.5247                            | 540.8041                             | 0.438616                             |
| Log likelihood                          | -180.8212                           | -243.1461                            | -180.8212                            |
| Akaike AIC                              | 9.015666                            | 12.05591                             | 9.015666                             |
| Schwarz SC                              | 9.182844                            | 12.22308                             | 9.182844                             |
| Mean dependent                          | 438.0268                            | 1019.080                             | 0.318763                             |
| S.D. dependent                          | 121.2103                            | 617.3584                             | 20.51492                             |
| Determinant resid covariance (dof adj.) |                                     | 0.000000                             |                                      |
| Determinant resid covariance            |                                     | 0.000000                             |                                      |