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Causality Relationship between Electricity Consumption and Economic Growth in Indonesia and Thailand

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ABSTRACT

This paper examined the existence and direction of the causal relationship per capita electricity power consumption and per capita economic growth in Indonesia and Thailand. The results of analysis were used to suggest policymakers regarding formulation of electricity in Indonesia and Thailand. The data used in this study was the yearly data from 1971 to 2014. The Cointegration and Granger Causality approaches were employed. The empirical results overall showed that had established a long run correlation among consumption of electric power and economic growth. Moreover, the Granger Causality approach had recognized a one-way of casual direction flowing from electric power consumption to economic growth in Indonesia. Thailand, empirical results had no long run correlation among consumption of electric power and economic growth. The Granger Causality approach had recognized no way of casual direction flowing from electric power consumption to economic growth. Finally, these results implied that, in the context of Indonesia, policy maker should focus on electric power consumption and surplus electricity supply policies rather than focus on initiate electricity conservation. For Thailand, policymakers should focus on initiate electricity conversation policies rather than focus on surplus electricity supply.

Keywords: Electric Power Consumption, Economic Growth, The Causal Relationship
JEL Classifications: C13, C20

1. INTRODUCTION

Indonesia is the largest consumer in ASEAN, acounting for more than 36% of the region's energy demand and consuming 66% more than the second largest user, Thailand (International Energy Agency, 2013). The reason is Indonesia's electric demand is growing rapidly, driven by robust economic growth. Indonesia's population was 255.5 million in 2015, the middle class is predicted to grow to 141 million by 2020. Total electric demand was an average growth rate of 6%/year.In respond to continued economic driver, demand for electricity is projected to rise steadily.

Electrification of non-electrified households will be one major driver. In 2015, Indonesia's electrification rate was 88.3%, up from <68% in 2010 (International Energy Agency, 2016). However, electrification rates vary significantly across the country's 34 provinces and more than 17,000 islands, particularly between urban and rural regions. Although Jakarta has nearly full electrification, with an electrification rate over 99%, the rates of the far eastern regions of Nusa Tenggara Timur and Papua are just 59% and 43%, respectively (International Energy Agency, 2016).

In addition, many households have unreliable or low-quality access to power in terms of the number of hours of continuous electricity (International Energy Agency, 2016).

For Thailand, energy in Thailand refers to the production, storage, import and export and use of energy in the Southeast Asian nation of Thailand. Thailand's energy resources are modest and being depleted. The nation imports most of its oil and significant quantities of natural gas and coal. Its energy consumption has grown at an average rate of 3.3% from 2007 to 2017. Energy from renewables has only recently begun to contribute significant energy.

Moreover, according to the Ministry of Energy, the country's primary energy consumption in 2013 Mtoe (million tonnes of oil equivalent) was 118.3 Mtoe, rising to 133 Mtoe in 2018.

Due to the fact that both countries use electricity consumption at the top rank in ASEAN and we want to know the relationship between electricity consumption (electric power consumption) and economic growth. Therefore, it is important for policymakers to take action in the future for electrical power management which is becoming more and more important everyday and has an impact on environmental preservation as well. The content of this paper is divided into section as follows: review of literature, rational and scope of this study and research methodology.

The study detailed here is pursing the folowing objectives:
1. To examine the existence an direction of the causal relationship per capita electricity power consumption and per capita economic growth in Indonesia and Thailand.
2. To suggest policymakers regarding formulation of electricity in Indonesia and Thailand.

2. REVIEW OF LITERATURE

For this section, there are four types of causal relationships between electricity consumption and economic growth have been revealed by various authors:
1. Unidirectional causality runs from electricity consumption to economic growth.
2. Unidirectional causality runs form economic growth to electricity.
3. Bi-directional causality exists between electricity consumption to economic growth.
4. No causality exists between electricity consumption to economic growth.

In the present study, Tables 1-3 provide a summary of literature on the various hypotheses or relationships established among electricity consumption and economic growth. The authors have used several methodologies such as Cointegration, Vector Error Correction (VECM), Vector Autoregressive (VAR), the ARDL approach and Granger causality.

Table 1 offers a sequential view of empirical study that declares one way causal route from electricity consumption to economic growth. Table 2 summarizes literature which proved one way causal route from electricity consumption to economic growth. Table 3 presents bi-directional causality among electricity consumption to economic growth.

3. RATIONALE AND SCOPE OF THE STUDY

Since 1971, there has been growing demand of electricity in every sector in Indonesia and Thailand (as shown in Figures 1 and 2). An increase in the consumption of electricity is an indication of an expansion of production activities and improvement in living standard of citizens which may reflect advancement of an economy. However, it is not clear that the growth in electricity consumption is the key factor for economic development in Indonesia and Thailand. The former paper fails to testify the causality among these two variables in the evidence of Indonesia and Thailand. Therefore, this study seeks to explore the existence and route of the causal relationship between electricity consumption and economic growth in Indonesia and Thailand. Identification of the existence and direction of causal relation between electricity power consumption and economic growth may support policymakers in determining the steps to be taken towards the beginning and implementation of various electricity policies in Indonesia and Thailand.

Table 1: Empirical literature that declares one way causal route from electricity consumption to economic growth

Country	Authors	Methodology
Hong Kong (1966-2002)	Ho and Sui (2007)	Cointegration, VECM
Fuji Island (1971-2002)	Narayan and Singh (2007)	Cointegration, Granger causality approach
Malaysia (1972-2003)	Tang (2008)	ADRL bound test
Nigeria (1970-2005)	Ighodaro (2010)	Granger casuality test and Co-intergration approach
Nigeria (1971-2012)	Lyke (2015)	Cointegration and VECM

Table 2: Empirical literature that declares one way causal route from economic growth to electricity consumption

Country	Authors	Methodology
Indonesia (1971-2002)	Yoo and Kim (2006)	VAR and Granger causality test
Nepal (1980-2004)	Dhungel (2007)	Cointegration and VECM
Nepal (1980-2006)	Dhungel (2009)	Cointegration and Granger causality approach
Japan (1960-2007)	Sami (2011)	Cointegration and Causality
India (1974-2014)	Kumari and Sharma (2016)	Cointegration and Granger causality approach

Table 3: Empirical literature that declares bi-directional causality among electricity consumption to economic growth

Country	Authors	Methodology
Korea (1970-2002)	Yoo (2005)	Co-integraton and VECM
Barbados (1960-2004)	Lorde et al. (2010)	Granger causality and VAR
Portugal (1971-2009)	Shahbaz et al. (2011)	VECM and ARDL bound test
Portugal (1970-2005)	Tang et al. (2013)	VECM and cointegration

Figure 1: Relationship between per capita electricity consumption and per capita GDP of Indonesia

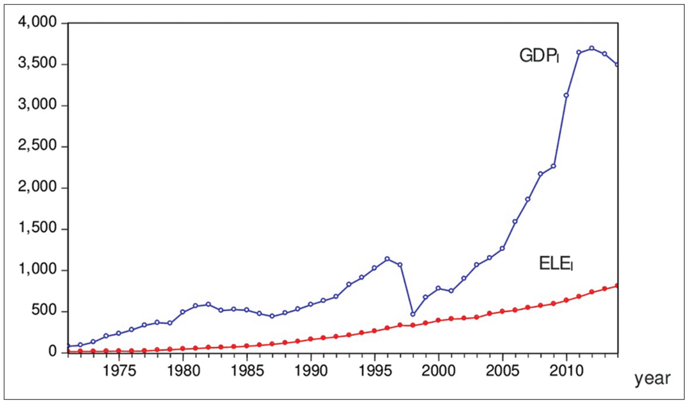
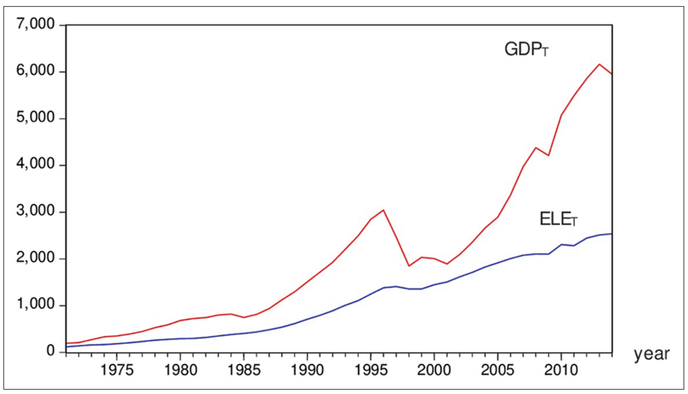


Figure 2: Relationship between per capita electricity consumption and per capita GDP of Thailand



4. DATA AND RESEARCH METHODOLOGY

4.1. Data Collection and Variables

We have used yearly data of ELE and GDP of two ASEAN countries for the period 1971-2014 such as Indonesia and Thailand. The data are graphically represented in Figures 1 and 2. The World Bank Indicator has been the source of data for both study variables. Data on gross domestic product (GDP) per capita is measured in current U.S. dollar and electric power consumption per capita is measured in kWh. GDP has been used as a variable of economic growth and ELE has been used as a variable of electric power consumption.

4.2. Research Methodology

For testing whether economic growth causes to electric power consumption or not, the following simple model was used:

$$Y_t = \text{simpl}\mu_t$$

However, in this study we rely for two ASEAN countries such as Indonesia and Thailand. So we can write this model again as follows:

$$GDP_I = \alpha_I + \beta ELE_I + \mu_{tI} \quad (1)$$

$$GDP_T = \alpha_T + \beta ELE_T + \mu_{tT} \quad (2)$$

Where, GDP_I= GDP per capita (Current US$) of Indonesia
ELE_I=Per capita electric power consumption (kWh) of Indonesia
GDP_T=GDP per capita (Current US$) of Thailand
ELE_T=Per capita electric power consumption (kWh) of Thailand
α_I and α_T = constant
μ_{tI} and μ_{tT} = error term
t = time trend

We assume that the electric power consumption and economic growth have a relationship and cause to each other. To test this hypothesis in EVIEWS 9 software, the Johansen cointegration and Granger Causality methodologies were used. Testing the stationary of both study variables formed the first step of the analysis. To this end, Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test were applied (Phillips and Perron, 1988). Moreover, before establishing the causal direction between electric power consumption and economic growth, we checked the cointegration between the variables, which helps to discover the existence of an association between GDP_I and ELE_I including GDP_T and ELE_T.

For this, we employ a superior test for cointegration, the Johansen Cointegration method (Johansen, 1991; Johansen and Juselius, 1990).

$$\Delta Y_t = \beta_0 + \delta_{(Y-1)} + \gamma_1 \Delta Y_{tY} + \gamma_2 \Delta Y_{tY} + Y \gamma_p \Delta Y_{tY} + \mu_t \quad (3)$$

Here, series are denoted by Y_t and an iid error term represented as μ_t (Dickey and Fuller, 1979; Phillips and Perron, 1988). Adequate lags in relation to ΔY_t are comprised for whitening errors. In the present article SBC (Schwarz Baysian Criterion) is applied for selection of lag length. Equation 3 help to examine the null hypothesis and as follows: δ is equal to 0 as instead the 1 tailed alternative that δ is not positive. Stationarity of Y_t cannot be rejected if δ appeared negative.

Next, we check the presence of a strong association among the study variables by employing the Johansen cointegration method for the series which have same integrated order. While testing the cointegration between study variables, Johansen cointegration approach provides two (LR) likelihood ratio tests based on trace value and maximum Eigen value. If two or more series (whether they are trended in nature) move in same direction for a long period and display a constant variance, then the results of cointegration shows that the series have long-run relationship. On the other hand, a weak cointegration shows no presence of a long-run relationship between the selected variables.

Particularly, if Y_t is a vector of random variables and it reveal that a p-lag VAR (vector auto regression) with Gaussian error of the following from

Cointegration approach developed by Johansen's (1991) starts with its beginning step in VAR of p assumed by the formula mentioned below

$$y_t = \mu + A_1 y_{t-1} + \ldots + A_p y_{t-p} + \varepsilon_t \quad (4)$$

Where y_t is an $n \times 1$ vector of variables that are integrated of order one – commonly denoted I(1) and ε_t is an $n \times 1$ vector of innovations. This VAR can be re-written as

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (5)$$

Where $\Pi = \sum_{i=1}^{p} A_i - I$ and $\Gamma_i = n \sum_{j=i+1}^{p} A_j$ (6)

If the coefficient matrix Π has reduced rank $r < n$, then there exist $n \times r$ matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is stationary. r is the number of cointegrating relationships, the elements of α are known as the adjustment parameters in the vector error correction model and each column of β is a cointegrating vector. It can be shown that for a given r, the maximum likelihood estimator of β defines the combination of y_{t-1} that yields the r largest canonical correlations of Δy_{t-1} with y_{t-1} after correcting for lagged differences and deterministic variables when present. Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix: the trace test and maximum eigenvalue test, shown in equations 7 and 8 respectively.

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln = (1 = \hat{\lambda}_i) \quad (7)$$

$$J_{max} = -T \Sigma \ln(1 - \hat{\lambda}_{r+1}) \quad (8)$$

Here T is the sample size and λ_i is the i: th largest canonical correlation. The trace test tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. The maximum Eigen value test, on the other hand, tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of $r + 1$ cointegrating vectors. Neither of these test statistics follows a chi square distribution in general; asymptotic critical values can be found in Johansen and Juselius (1990) and are also given by most econometric software packages. Since the critical values used for the maximum Eigen value and trace test statistics are based on a pure unit-root assumption, they will no longer be correct when the variables in the system are near-unit-root processes. Thus, the real question is how sensitive Johansen's procedures are to deviations from the pure-unit root assumption.

Although Johansen's methodology is typically used in a setting where all variables in the system are I(1), having stationary variables in the system is theoretically not an issue and Johansen (1995) states that there is little need to pre-test the variables in the system to establish their order of integration. If a single variable is I(0) instead of I(1), this will reveal itself through a cointegrating vector whose space is spanned by the only stationary variable in the model. For instance, if the system in equation 7 describes a model in which $y_t = (y_{1,t}\ y_{2,t})'$ where $y_{1,t}$ is I(1) and $y_{2,t}$ is I(0), one should expect to find that there is one cointegrating vector in the system which is given by $\beta = (01)'$. In the case where Π has full rank, all n variables in the system are stationary.

5. EMPIRICAL ANALYSIS AND RESULTS

Generally, in time series analysis, the primary stage is to investigate the integrated order of the study variables. ADF and PP approaches have been used in this study for checking the order of integration.

Let us consider the following model:

$$Y_t = \alpha + \beta X + \varepsilon_t$$

Where Y_t = GDP per capita (Current US \$) (GDP_I and GDP_T), t = time trend, α = constant, X = Per capita electric power consumption (kWh) (ELE_I and ELE_T), ε_t = error term.

We want to test the hypothesis of the existence of a unit root. The null and alternative hypotheses can be formulated as follows:
H_0: α = 1 (unit root)
H_1: α < 1 (Integrated of order zero)

5.1. Results of the Unit Root Test

It is that all series of data for electric power consumption and economic growth have been converted into log form and shown in Tables 4 and 5, respectively. Tables 4 and 5 summarize the outcomes of the unit root and found almost all the considered series on 1 difference after taking log. If the series intergrated on I(0) then, it should be rejected and converted into I(1) to apply the next step Johansen cointegration . Therefore, the results in below tables that the series are stationary and both are I(1) in nature. If stationarity of study variables is found at the first step of the methodology, then we apply cointegration approach in the next step.

5.2. Empirical Results of Cointegration Tests

This part examines the cointegration between the study variables. To find a long-term relationship between the study variables, we have used the Johansen Cointegration approach, which is a superior test for checking cointegration between them. Table 6 shows the results from this test of Indonesia, in which trace and Max Eigen value test indicates that there is one cointegration between the study variables. It means that there is long-run relationship between electricity consumption and economic growth in Indonesia. Table 7 shows the results from the test of Thailand, in which trace and Max Eigen value test indicates that there is no cointegration between the study variables. It means that there is no long-run relationship between electricity consumption and economic growth in Thailand.

5.3. Empirical Findings from the Granger Causality test (Granger, 1969)

Granger Causality results summarized in Table 8 provide strong evidence for a unidirectional causality running from ELE_I to GDP_I as statistically proved by the probability value 0.0030*, which is less than 0.05. For the first null hypothesis, our probability value is 0.3159, which is more than 5%, so the first hypothesis will not be rejected. This supports the first null hypothesis which means that an increase or decrease in GDP_I does not affect ELE_I. For the second null hypothesis, the probability value is 0.0030 which is less than 5%. Thus, the second hypothesis is rejected, which

Table 4: Unit root test for $logELE_I$ and $logGDP_I$

Variables	ADF test statistic				PP test statistic			
	Intercept		Intercept and trend		Intercept		Intercept and trend	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
$logELE_I$	7.9937	−0.7840	0.1566	−5.4657***	7.3776	−2.6169	0.1652	−5.3958***
$logGDP_I$	1.4064	−4.3406***	−0.4005	−4.5458***	1.1037	−4.7507***	−0.6216	−4.5117***

*=10% significant level, ** = 5% significant level, ***=1% significant level

Table 5: Unit root test for $logELE_T$ and $logGDP_T$

Variables	ADF test statistic				PP test statistic			
	Intercept		Intercept and trend		Intercept		Intercept and trend	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
$logELE_T$	2.2153	−5.1989***	−2.1361	−5.8877***	1.8695	−5.3184***	−2.1223	−5.9356***
$logGDP_T$	1.6072	−4.1768***	−1.6066	−4.3406***	1.1421	−4.1290***	−1.1236	−4.3661***

*=10% significant level, **=5% significant level, ***=1% significant level

Table 6: Result of Johansen test for cointegration in Indonesia

Hypothesized	Eigenvalue	Cointegration rank test (Trace value)		Cointegration rank test (Max-Eigen value)	
		Trace statistic	Critical value	Max-Eigen statistic	Critical value
None *	0.338802	20.30729	15.49471	17.37545	14.26460
At most 1	0.067425	2.931837	3.841466	2.931837	3.841466

Trace and Eigen value test indicate 1 cointegration at 5% significant level

Table 7: Result of Johansen test for cointegration in Thailand

Hypothesized	Eigenvalue	Cointegration rank test (Trace value)		Cointegration rank test (Max-Eigen value)	
		Trace statistic	Critical value	Max-Eigen statistic	Critical value
None	0.101827	5.803339	15.49471	4.510478	14.26460
At most 1	0.030313	1.292861	3.841466	1.292861	3.841466

Trace and Eigen value test indicate no cointegration at 5% significant level

Table 8: Result of granger causality test in Indonesia

Null hypothesis	Obs.	lag	F-statistic	p-value	Decisions	Results
$logGDP_I$ does not Granger Cause $logELE_I$	42	2	1.18897	0.3159	Do not rejected	GDP_I does not cause ELE_I
$logELE_I$ does not Granger Cause $logGDP_I$	42	2	6.84675	0.0030*	Rejected	ELE_I cause to GDP_I

Granger test among GDP_I and ELE_I of Indonesia from 1971 to 2014. *Indicates the rejection of null hypothesis at 5% significant level.

Table 9: Result of granger causality test in Thailand

Null hypothesis	Obs.	lag	F-statistic	p-value	Decisions	Results
$logGDP_T$ does not Granger Cause $logELE_T$	42	2	0.28608	0.7528	Do not rejected	GDP_T does not cause ELE_T
$logELE_T$ does not Granger Cause $logGDP_T$	42	2	2.12777	0.1334	Do not rejected	ELE_T does not cause GDP_T

Granger test among GDP_T and ELE_T of Thailand from 1971 to 2014. *Indicates the rejection of null hypothesis at 5% significant level.

means electricity consumption in Indonesia leads to economic growth of Indonesia.

But for Granger Causality results summarized in Table 9 provide strong evidence for a nondirectional causality running from ELE_T to GDP_T as statistically proved by the probability value 0.1334, which is more than 0.05, so the first hypothesis will not be rejected. This supports the first null hypothesis which means that an increase or decrease in ELE_T does not affect GDP_T, which means electricity consumption in Thailand does not lead to economic growth of Thailand.

Therefore, the Granger Causality test results indicate that the electricity consumption of Indonesia is not dependent on the Indonesia economy. Unidirectional causality from electricity consumption to economic growth for the time period 1971-2014 shows that an increase or decrease in electricity consumption may affect the economic growth in Indonesia, but not vice-versa.

6. CONCLUSION

This study examines the existence of long term relationship and direction of causality among consumption of electric power and economic growth in Indonesia for the period 1971-2014 by using data collected from the World Bank indicator. Empirical results using the Johansen cointegration approach has established a long run correlation among consumption of electric power and economic growth. Moreover, the Granger Causality approach has recognized a one-way of causal direction flowing from electric power consumption to economic growth. Outcomes of this study indicate that an increase or decrease in electric power consumption affect economic growth and variation in electric power consumption leads to changes in economic growth. These results imply that, in the context of Indonesia, policymakers should focus on electric power consumption and surplus electricity supply policies rather than focus on initiate electricity conservation.

Thailand, empirical results using the Johansen cointegration approach has no long run correlation among consumption of electric power and economic growth. Moreover, the Granger Causality approach has recognized no way of causal direction flowing from electric power consumption to economic growth. Outcomes of this study indicate that an increase or decrease in electric power consumption does not affect economic growth and variation in electric power consumption does not lead to changes in economic growth. These results imply that, in the context of Thailand, policymakers should focus on initiate electricity conversation policies rather than focus on surplus electricity supply. Conservation of electricity is cheaper than production of new electricity and it avoids the environmental costs in electric power generation.

REFERENCES

Dhungel, K. (2007), A causal relationship between energy consumption and economic growth in Nepal. Asia-Pacific Journal of Rural Development, 15(1), 137-150.

Dhungel, K. (2009), Does economic growth in Nepal cause electricity consumption. Hydro Nepal Journal of Water Energy and Environment, 5, 37-41.

Granger, C.W.J. (1969), Investigating causal relations by econometric models and cross-spectral methods. Econometrica, 37(3), 424-438.

Ho, C.Y., Siu, K.W. (2007), A dynamic equilibrium of electricity consumption and GDP in Hong Kong: an Empirical Investigation. Energy Policy, 35(4), 2507-2513.

Ighodaro, C.A. (2010), Co-integration and causality relationship between energy consumption and economic growth further empirical evidence for Nigeria. Journal of Business Economics Management, 11(1), 97-111.

International Energy Agency. (2013), Southeast Asia Energy Outlook: World Energy Outlook Special Report. Paris: International Energy Agency. Available from: https://www.iea.org/publications/freepublications/publication/SoutheastAsiaEnergyOutlook_WEO2013SpecialReport.pdf.

International Energy Agency. (2016), Reducing Emissions from Fossil-fired Generation: Indonesia, Malaysia and Viet Nam. Paris: International Energy Agency.

Johansen, S. (1991), Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. Econometrica, 59(6), 1551-1580.

Johansen, S. (1995), A statistical analysis of cointegration for I(2) variables. Econometric Theory, 11(1), 25-59.

Johansen, S., Juselius, K. (1990), Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52(2), 169-210.

Kumari, A., Sharma, A.K. (2016), Analyzing the causal relations between electric power consumption and economic growth in India. The Electricity Journal, 29, 28-35.

Lyke, B.N. (2015) Electricity consumption and economic growth in Nigeria: A revisit of the energy growth debate. Energy Economics, 51, 166-176.

Narayan, P.K., Singh, B. (2007), The electricity consumption and GDP nexus for the Fuji Islands. Energy Economics, 291(6), 1141-1150.

Phillips, P.C., Perron, P. (1988), Testing for a unit root in time series regression. Biometrika, 75(2), 335-346.

Sami, J. (2011), Multivariate cointegration and causality between exports, electricity consumption and real income per capita: Recent evidence from Japan. International Journal of Energy Economics and Policy, 1(3), 59-68.

Shahbaz, M., Tang, C.F., Shabbit, M.S. (2011), Electricity consumption and economic growth nexus in Portugal using cointegration and causality approaches. Energy Policy, 39(6), 3529-3536.

Tang, C.F. (2008), A re-examination of the relationship between electricity consumption and economic growth in Malaysia. Energy Policy, 36(8), 3077-3085.

Tang, C.F., Shahbaz, M., Aroun, M. (2013), Re-investigating the electricity consumption and economic growth nexus in Portugal. Energy Policy, 62, 1515-1524.

Yon, S.H., Kim, Y. (2006), Electricity generation and economic growth in Indonesia. Energy Policy, 31(14), 2890-2899.

Yoo, S.H. (2005), Electricity consumption and economic growth evidence from Korea. Energy Policy, 33(12), 1627-1632.