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ENERGY-ECONOMY NEXUS IN INDONESIA: A BIVARIATE CO-INTEGRATION ANALYSIS

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ABSTRACT

Inefficient pricing of energy products has become common feature of governments in many oil exporting developing countries. As developing countries, this can be justified only when the increased growth results from such higher energy consumption. To this end, the study examined the direction of causality between energy consumption and economic growth, and the possibility of a long run relationship between the two variables using Indonesia's time series for the period of 1971-2010. The Granger causality test revealed a unidirectional causation running from economic growth to energy consumption, and the existence of a long run relationship. The study therefore suggests the pursuance of major reforms to ensure appropriate pricing of energy products. This can help checkmate excessive consumption with no devastating harm to economic growth

Key Words: Energy Consumption, Economic Growth, Granger Causality, VAR and Indonesia
JEL Code: C22, O40, Q43, Q48

INTRODUCTION

The oil crisis of the 1970's brings to fore the importance of energy as an indispensable production input. Ever since, studies including that of (IEA, 2004) have found energy as a significant production factor aside labour and capital. In theory, the structure and sectoral shares of economic activity in a country as well as the stage of economic development largely determines the rate of energy consumption of that country. The expectation therefore is that energy consumption will be relatively low in largely agrarian and service economies but high in mainly industrialised economies. The energy sector is usually a small but fundamental part of most economies given its impact on the smooth workings of the economy. This is particularly true for most energy resource rich developing countries where the development and export of energy resources constitute a major stimulus to economic and social development. With the largest population in Southeast Asia and

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the fourth largest in the world, Indonesia's present economic profile as the world's third-fastest growing economy is facing a great challenge. The country has struggled to attract enough investment to meet its energy development goals due to inadequate infrastructure and complex regulatory business environment.

To the extent that energy exports remained a dominant source of revenue in any economy, it is obvious that large but periodic shocks from the world energy markets will continue to exert considerable influence on the nation's fiscal operations and economic performance. This underscores the fact that energy exports have greatly influenced Indonesia's economic growth in the past decades and the picture is not changing soon. Though, Indonesia is no longer a net exporter of oil, the country is a leading exporter of both coal and natural gas. As domestic energy needs grow, Indonesia is increasingly trying to concentrate on securing energy sources for its domestic market as well as reducing its fuel subsidy program in the face of rising oil prices.

The theoretical and empirical relationship between energy consumption and economic growth has initiated a great deal of interest in the academic circle. While the causality connection between energy-economy interactions is the most researched issue in recent time, the conclusions emanating from these studies are far from being unanimous. The increasing debate on causality test revolves round the different methodology and the inherent implications of the consequential outcomes for policy formulation. This present study has two distinct but interrelated objectives. These are is to ascertain the nature and direction of causal relationship between energy consumption and economic growth and extend the analysis to a co-integration analysis in other to establish whether, a long run relationship exists between the energy and growth.

While much attention has not been devoted to investigate the causal relationship between economic growth and energy consumption in Indonesia, the country is unique for this kind of investigation for a number of reasons. First, Indonesia is presently the world's third-fastest growing economy whose total primary energy consumption grew by nearly 50% between 1999 and 2008[2]. Coal consumption has tripled over the decade while oil consumption accounts for the about 44% of Indonesia's energy mix in 2009. From a net exporter to a net importer of oil in 2004, the country is struggling to attract sufficient investment to meet its energy development goals.

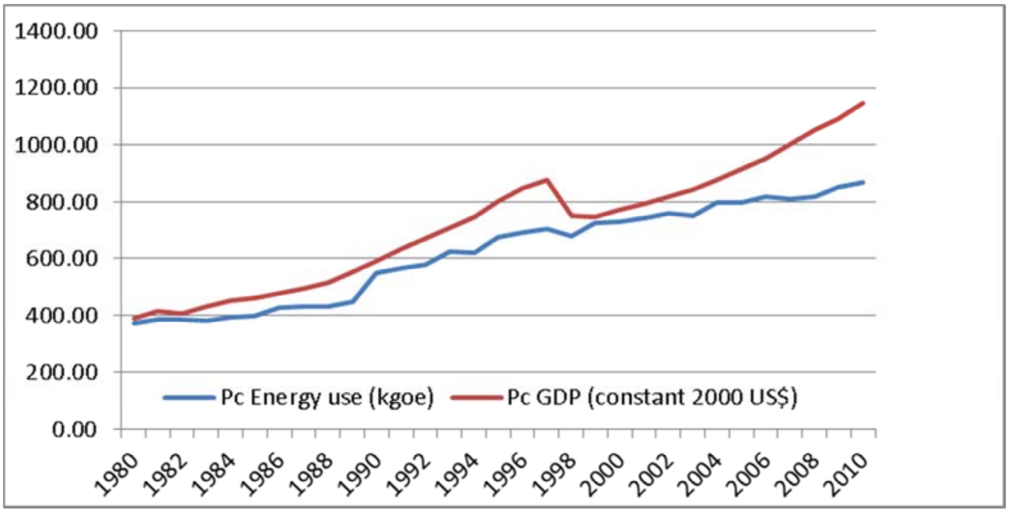
Between 1995 and 2005, consumption of refined products grew at about 4.7% annually but declined by about 2% in 2006 and 2007 due to 126% rise in the price of subsidized fuel implemented in 2005. Consumption had continued to grow afterwards exceeding 1.3 million barrels per day in 2009. Though, all current refinery output goes primarily to the domestic market, the countries refining capacity could only maintain about 70% of domestic demand for petroleum products. On the average, real per capita GDP and energy consumption grew at about 3.8% and

[2] EIA country analysis brief on Indonesia available at http://www.eia.gov/countries/cab.cfm?fips=ID

2.9% respectively between 1980 and 2010 (see figure-1). As the country become increasingly reliant on importation to meet rising local consumption of petroleum products, it is becomes highly imperative to assess the likely impact that this growth in energy demand portends for her economic emancipation.

Second, the outcomes of this type of investigation portends practical implications for policy and macroeconomic planning in Indonesia where government is currently contemplating on the removal of fuel subsides that account for nearly ten billion dollars in 2010 (about 10% of the government's tax revenues) in order to reduce high domestic energy consumption[3]. This kind of policies can only be justified if causality does not run from economic growth to energy consumption. The results of a causal relationship between energy consumption and economic growth, if established can be a valuable policy instrument in determining what variables can be influenced if economic growth is to proceed. The rest of the paper is arranged into four sections. Following this introduction is a brief review of related studies in section two. The third section explains the methodology while the results and interpretations are presented in section four. The study's conclusion is contained in the last section

Figure-1: Indonesia's real GDP and Energy Use per capita (1980-2010)



Source: Computed by the author from IEA energy balance data, 2012

[3]Indonesian parliament in 2010 approved a measure to remove fuel subsidies for all vehicles excluding motorcycles and public transportation vehicles. The policy which was initially slated for implementation in the greater Jakarta area by April 2011and nationwide by 2013 has been postponed indefinitely in March 2011 due to concerns over the effect on the economy.

REVIEW OF RELEVANT AND RECENT STUDIES

Paul and Bhattacharya, (2004) investigated the different direction of causality between energy consumption and economic growth by applying the co-integration approach together with the standard Granger causality test using Indian time series data between 1950 and 1996. They found evidence of bi-directional causality between energy consumption and growth. The study further applied the Johansen multivariate co-integration technique on the different set of variables and finds similar evidence on the energy-growth causality for India. Yoo, (2005) explored the short- and long-run causality between electricity consumption and economic growth in Korea using co-integration and error correction model employing annual data for the period of 1970-2002. The general results show the existence of bi-directional causality between electricity consumption and economic growth. This finding indicated that an increase in electricity consumption influences economic growth and growth stimulates additional electricity consumption. The paper by Nawas et al. (2012) studies the long and short run relationship between the real GDP and energy consumption at both the aggregates and sectoral level in Pakistan with time series data covering the period of 1977-2010. Their findings confirmed the existence of a long run relationship between energy consumption and real GDP in the industry and services sector with causality running from real GDP to energy consumption while causality runs from energy consumption to GDP in the agricultural sector with no evidence of long run relationship. At the aggregate level, the paper also finds evidence of a long run relationship and bidirectional causality between energy consumption and real GDP.

The causal relationship between carbon dioxide emissions, nuclear and renewable energy consumption and real GDP in the United States over the period of 1960-2007 was investigated by Menyah and Wolde-Rufael, (2010). They reported one-way causality running from nuclear use to emissions without feedback and no causality from renewable to emissions with the modified version Granger causality test employed. Using a very recent data for the period of 1972-2011, Shahbaz et al. (2012) examined the relationship between both the renewable and non-renewable energy consumption and economic growth in case of Pakistan. The results of the ARDL bounds tests and the structural break co-integration and unit root tests indicated that both types of energy consumption, growth, labour and capital are co-integrated in the country while the VECM Granger causality tests reveal a feedback hypothesis for each of renewable energy, non-renewable energy consumption and capital with economic growth. Soytas and Sari, (2003) examined the time series properties of energy consumption and GDP and re-examines the causality relationship between the two series in the top 10 emerging markets and G-7 countries. The results showed bi-directional causality in Argentina, causality running from energy consumption to economic growth in France, Germany, Turkey and Japan, and from economic growth to energy consumption in Korea and Italy. With this, the study concluded that energy conservation might harm economic growth in the four countries where causality runs from consumption to growth.

Employing some recently developed tests for the unit root, heterogeneous co-integration, and error correction models for panel data, Lee, (2005) re-investigated the causality relationship between energy consumption and economic growth using data for the period of 1975-2001 in 18 developing countries. After allowing for the heterogeneous country effect, the results provided a clear empirical support for a long-run co-integration relationship and both long-run and short-run causalities running from energy consumption to economic growth and not vice versa. The study concluded from the result that energy conservation policy, either transitory or permanent might harm economic growth in developing countries. Similarly, the implicit assumption of panels' homogeneity by existing energy growth nexus was challenged by Akkemik and Goksal, (2012) study which examine the causality relationship between energy consumption and GDP for a large panel of 79 countries by accounting for panel heterogeneity. Using data for the period of 1980-2007, the results of the homogeneous causality and non-causality as well as the homogeneous causality and non-causality revealed that only about 10% of the countries studied exhibit a one-way granger causality while about 20% and 70% exhibit no Granger causality and bi-directional Granger causality respectively.

The possibility of implementing energy conservation policies in countries in the similar stages of development prompted the study by Lee, (2006) which investigated the possible relationship between energy consumption and national income in 11 major industrialised countries ascertain how feasible it is in these countries to restrain energy consumption without compromising economic growth. With the exception of the United Kingdom, Germany and Sweden where a neutral relationship exist, the results generally do not find evidence to support that the energy consumption and economic growth have neutral relationship. In all, the results indicated bidirectional causality in the United States, unidirectional causality from growth to energy consumption for Japan, Italy and France, and unidirectional running from energy consumption to economic growth in Switzerland, the Netherlands, Belgium and Canada.

The policies of energy subsidy which, in most oil exporting countries have resulted in substantial rise in domestic energy consumption engineered the study by Mehrara, (2007) observes the causal relationship between energy consumption per head and per capita GDP for 11 selected oil exporting countries in a panel analysis framework. The results of the unit root tests and the panel co-integration analysis show a unidirectional strong causality from economic growth to energy consumption for the sampled oil exporting countries. The study concludes that energy conservation through energy price reforms may not adversely affect economic growth in this group of countries. Mahmoodi and Mahmoodi, (2011) employed the ARDL bound test and the Toda-Yamamoto modified Granger causality test to examine the causal and the long-run relationship between renewable energy consumption and economic growth for seven developing countries in Asia. The findings provide evidence of one-way causality running from economic growth to renewable energy consumption in Iran, Pakistan, India and Syria; a bi-directional causality between renewable energy consumption and economic growth in Jordan and Bangladesh; and no causality for Sri Lanka.

Erbaykal, (2008) examined the possible effect of energy consumption at disaggregated level and growth relationship in Turkey with the bounds testing approach of co-integration test. Using oil and electricity energy consumption disaggregates and real income on Turkey for the period of 1970-2003. The co-integration test results showed that both oil consumption and electricity consumption has positive and statistically significant effect on economic growth in short run. The long run coefficients are generally statistically insignificant, but in long term, electricity consumption has negative effect on economic growth while oil consumption has positively effect. Mallick, (2009) investigated the link between energy use and economic growth using the Granger causality test on India's annual data for the period of 1970-2005. The tests suggested that economic growth fuels increased demand for both crude oil and electricity consumption while growth in coal consumption drives economic growth. The variance decomposition analysis of Vector Autoregression (VAR) however suggests the possibility of a bidirectional influence between electricity consumption and economic growth. On the whole, the study yielded mixed and contradictory results compared to the earlier studies on the India.

In an attempt to evaluate how important is the causal relationship between energy consumption and economic growth relative to labour and capita, Wolde-Rufael, (2009) re-examined the causal relationship between energy consumption and economic growth. The study adapts the variance decomposition analysis developed by Pesaran and Shin, (1998) for selected African countries in a multivariate framework by including labour and capital as additional variables. The results of the modified Granger causality analysis tend to reject the neutrality hypothesis for the energy–income relationship in fifteen out of the seventeen countries while the variance decomposition analyses show that energy is a mere contributing factor to output growth, which is not important when compared to capital and labour in eleven out of the seventeen countries. Generally, the results demands careful interpretation, as they are not adequately robust for valid inference. Wolde-Rufael, (2010) also tried to find out the dynamic relationship between economic growth, nuclear energy consumption, with labour and capital for India between 1969 and 2006 by applying the bounds test approach to co-integration. The empirical investigation revealed the existence of a short and a long run relationship between nuclear energy consumption and economic growth, and a positive and a statistically significant impact of nuclear energy consumption on India's economic growth. In addition, there is significant evidence of a positive and significant unidirectional causality running from nuclear energy consumption to economic growth without feedback from the variance decomposition implying that economic growth in India is dependent on nuclear energy consumption where a decrease in nuclear energy consumption may lead to a decrease in real income.

Kahsai et al. (2010) tested the empirical causal relationship between energy consumption and economic growth in a panel of low and middle income Sub-Saharan African countries using a panel unit root test and co-integration method. The results support the neutrality hypothesis in the short-run for low income countries and a strong bi-directional causality between energy consumption and growth in the long-run. The study attributed the dissimilar results for low and middle income countries to the role of income level in energy–growth causality and concluded that Sub-Saharan African countries should formulate sustainable development policies to enhance efficient allocation of resources in order to increase energy access in the region. The results of the empirical study by Menegaki, (2011) which used a random effect model within a multivariate panel framework to investigate the renewable energy and growth causality in 27 European countries. The results reported no evidence of causality between GDP and renewable energy consumption. Though the panel causality tests revealed that renewable energy, greenhouse gas emissions and employment are related in the short term, the co-integration estimates indicated at best, the neutrality hypothesis on the relationship between economic growth and renewable energy consumption in Europe. Shahbaz and Lean, (2012) investigated causality energy consumption and economic growth for Tunisian economy. They found cointegration between the variables and economic growth Granger causes energy consumption in long run as well as in short run.

METHODOLOGY

The considerations in modelling energy-economy interactions are quite numerous because of the pervasive role of energy in virtually all economic activities. This implies that if there were such thing as “an ideal model”, such would involve many disaggregated sectors of production with endogenous factor substitutions, many consumers, different factor endowments and consumption behaviour, and so forth. This may be neither feasible nor practicable for a single model to serve these diverse purposes. The literature has shown that the aspect of energy- economy interaction the researcher is interested in mainly determines the model/method used.

Since the purpose of this paper is to determine causal relationships between variables and examine the stability properties of the data (for the variables) as a prerequisite for co-integration and error correct analyses, the models described here will be specifically targeted at reaching empirical conclusions regarding the purpose. In all equations that follow, lower case Latin or Greek letters represents fixed parameters; upper case letters represent endogenous and exogenous variables; and the subscript t and i mainly stand for periods.

The Granger Test

This causality test proposed by Granger, (1969) assumed that the information relevant to the prediction of the respective variables is contained solely in the time series data on these variables. The test involves estimating the following regression equations below:

$$RG_t = \sum_{i-1}^{n} \alpha_i \, EC_{t-i} + \sum_{j-1}^{n} \beta_j \, RG_{t-j} + u_{1t} \; \dots\dots\dots\dots.1$$

$$EC_t = \sum_{i-1}^{n} \lambda_i \, EC_{t-i} + \sum_{j-1}^{n} \delta_j \, RG_{t-j} + u_{2t} \; \dots\dots\dots\dots.2$$

By assumption, the disturbances U_{1t} and U_{2t} are uncorrelated. The first equation above postulates that the current real gross domestic product RG_t relates to past values of RG_t itself as well as energy consumption EC_t while the second equation postulates similar behaviour for energy consumption EC_t.

- *Unidirectional* causality from EC_t to RG_t is indicated in first equation if the estimated coefficient on the lagged EC_t are statistically significant as a group (i.e. $\sum\alpha_i \neq 0$) and the set of estimated coefficients on the lagged RG_t in second equation are statistically insignificant (i.e. $\sum\delta_i = 0$).
- *Unidirectional* causality from RG_t to EC_t is indicated if the set of the lagged EC_t coefficients in first equation are not statistically significant as a group (i.e. $\sum\alpha_i = 0$) and the test of the lagged RG_t coefficients in second equation is statistically significant (i.e. $\sum\delta_i \neq 0$).
- *Bilateral* causality is suggested when the sets of EC_t and RG_t coefficients are statistically significant in both equations.
- Independence is suggested when the sets of RG_t and EC_t coefficients are statistically insignificant in both equation.

The Vector Autoregressive (VAR) Model

The VAR is a non-structural, a-theoretic model that makes minimal theoretical demands on the structure of the model. The term 'autoregressive' is due to the appearance of the lagged value of the dependent variable on the right hand side and the term 'vector' derives from the fact that we are dealing with a vector of two (or more) variables.

The basic model is equations third and four below:

$$RG_t = \alpha + \sum_{j-1}^{k} \beta_j \, EC_{t-j} + \sum_{j-1}^{n} \gamma_j \, RG_{t-j} + u_{1t} \; \dots\dots\dots\dots.3$$

$$EC_t = \alpha' + \sum_{j-1}^{k} \theta_j \, EC_{t-j} + \sum_{j-1}^{n} \delta_j \, RG_{t-j} + u_{2t} \; \dots\dots\dots\dots.4$$

Where n is the highest number of lags required to capture most of the effect that the variables have on each other. The study uses the Akaike Information Criterion (AIC) to choose the optimal lag length. Each equation of the model will have the same number of lags since there is only one optimal lag for both equations. In this case, each of the equations is constraint to be linear and estimated with the ordinary least square (OLS).

Unit Root Tests for Integration

The variables in the VAR equation above may be integrated. The study tests this hypothesis using the Augmented Dickey-Fuller (Dickey and Fuller, 1979, 1981). The null hypothesis is that the series contains a stochastic trend, that is, the series is non-stationary or not integrated while the alternative hypothesis is that the process is stationary (or integrated) along the deterministic trend. The model for the ADF test is equations five and six below (note that *u* is white noise):

$$\Delta RG_t = \alpha + \delta t + \emptyset^{*} RG_{t-1} + \sum_{i=1}^{p-1} \emptyset_i \, \Delta RG_{t-i} + u \; \ldots\ldots\ldots\ldots.5$$

$$\Delta EC_t = \alpha + \delta t + \emptyset^{*} EC_{t-1} + \sum_{i=1}^{p-1} \emptyset_i \, \Delta EC_{t-i} + u \; \ldots\ldots\ldots\ldots.6$$

Co-integration Analysis

Many economic time series seems to follow ‘random walks’ suggesting the need to difference some variables before using them in a regression. While this is acceptable, differencing may result in loss of information about the long run relationship between two variables. Sometimes two variables will follow random walks but a linear combination of the variables will be stationary, hence the variables are co-integrated. If at least some of the variables are integrated, the VAR equations four and five are estimated subject to co-integrating restrictions. The study allows for the unrestricted co-integrating rank tests to determine the number of co-integrating equation

The Error-Correction Mechanism (ECM)

Given that the residuals from the above co-integrating regressions are stationary, and that the variables are co-integrated, the final stage of the process is to estimate the error correction mechanism (ECM). The ECM incorporates the full (short run) dynamics of each model as in equation 7 below:

$$\Delta RG_t = \alpha + \sum_{i=1}^{k} \gamma_i \, RG_{t-i} + \sum_{j=0}^{m} \lambda_j \, \Delta EC_{t-j} + \delta ECM_{t-1} + u \; \ldots\ldots\ldots\ldots.7$$

The δ_{t-1} is the disequilibria term, which captures the adjustment towards the long run equilibrium. If δ is significant, it tells the proportion of the disequilibria in RG_t in one period corrected in the next period. The study adopts the General to Specific (GTS) framework, which specifies an over parameterised error correction model to ensure that the dynamics of the model is not restricted by too short lag length. This process will permit at the end, a theory consistent and data coherent results.

RESULTS AND ANALYSIS

The Data Sets

The data for the study is of the time series form and was collected for two variables namely, real gross domestic product measured in (constant 2000 $US) and the total final energy consumption in (kilogramme of oil equivalents). The data were sourced from IEA, (2012) covering the period of 1971-2010. The choice of real gross domestic product (RG_t) is because it gives the clearest picture of economic activities in an economy on the one hand and because it is inflation adjusted, it gives the accurate picture of the change(s) in economic output over the relevant years. The total final energy use offers a unique advantage over the total primary energy employed by some studies because it measures what is actually used by to all sectors of the economy and avoids transformation losses, which may overstate actual consumption if primary energy is used. The complete results are in the appendices but the abridge results are presented below

The Granger Causality Results

Table-1 below, which presents the results of the Granger-Causality test (equations 1 and 2). From the results, the null hypothesis that real gross domestic product (RG_t) does not Granger cause energy consumption (EC_t) was rejected because the F-statistic (5.1159) is statistically significant at 5% level while the null hypothesis that EC_t does not Granger cause RG_t cannot be rejected since the F-statistic (0.5484) is insignificant even at 10% level. What these amount to is that there is a **one-way** causality running from economic growth to energy consumption in Indonesia.

Table-1: Granger Causality Results for Indonesia

Null Hypothesis:	Observation	F-Statistic	Prob.	Decision
RG_t does not Granger Cause EC_t	38	5.11589	0.0116	Reject Null
EC_t does not Granger Cause RG_t		0.54836	0.5831	Do Not Reject Null

The Vector Autoregressive (VAR) Model Results

The results of the VAR models (equations 3 and 4) are in table 2 below. The optimal lag length chosen using the Akaike Information Criterion for each dependent and the other independent variable in each equation is two (2). Equation 3 hypothesizes the dependence of current economic growth (RG_t) on itself at lags 1 and 2, and the immediate past values of energy consumption (RG_t). The result shows that, RG_t is positively related to its immediate past values and negatively related to lag 2 values but is not statistically significant with both lag values of EC_t. Equation 4 postulates the dependence of EC on its lag 1 and 2 values and past values of RG_t. The results show that a unit increase in EC_t at lag 1 will result in 0.797 unit increase in current energy use and 0.33 units in lagged RG_t values. Overall, the results confirm the causality test that economic growth influences energy consumption and not vice versa.

Table-2: The Vector Autoregressive (VAR) Model Results for Indonesia

Vector Auto-regression Estimates						
Variable		**EC_t**			**RG_t**	
EC(-1)	0.7966	(0.2538)	[3.1384]	0.2207	(0.2498)	[0.8833]
EC_t(-2)	-0.2109	(0.2600)	[-0.8113]	-0.1112	(0.2559)	[-0.4343]
RG_t(-1)	0.0536	(0.1851)	[0.2895]	1.2224	(0.1822)	[6.7076]
RG_t(-2)	0.3281	(0.2028)	[1.6179]	-0.2867	(0.1996)	[-1.4356]
C	4309.231	(2489.95)	[1.7306]	241.0561	(2451.05)	[0.0983]
R-squared		0.990142			0.9936	
Adj. R-squared		0.9889			0.9928	
F-statistic		828.61			1286.59	

Unit Root Tests for Integration Results

The study uses both the Augmented Dickey-Fuller (ADF) and the Philip Perron (PP) tests criteria to conduct unit root test on the two variables i.e. RG_t and EC_t, and the lag lengths chose automatically based on Schwarz Information Criterion (SIC). The results in table 3 below show that both variables are not stationary at level but at first difference. Hence, both series RG_t and EC_t are I(1) where the computed ADF t-Statistics (EC_t, -4.162) and (RG_t, -4.426) and the PP t-Statistics (EC, -3.801) and (RG, -4.446) are statistically significant at 5% levels.

Table-3: ADF and PP Unit Root Test Results

Null Hypotheses: D(RG_t) has a unit root; D(EC_t) has a unit root							
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)							
Variables	ADF Unit Root Test Results	t-Statistic	Prob. value	Order of Integration	PP Unit Root Test Results	Adj. t-Stat	Prob. Value
EC_t	-3.5298	-0.7995	0.9570	I(0)	-3.5298	-0.4919	0.9798
δEC_t	-3.5331	-4.1639	0.0115	I(1)	-3.5331	-3.8026	0.0273
RG_t	-3.5331	-1.1428	0.9079	I(0)	-3.5298	-0.7911	0.9578
δRG_t	-3.5331	-4.4261	0.0059	I(1)	-3.5331	-4.4461	0.0056

Co-integration Analysis

The study tests whether energy consumption (EC_t) and economic growth (RG_t) have a co-integrating relationship or not. All the relevant statistics from the results in Table-4 confirm the existence of co-integration and in-fact, two co-integrating equation exist. In addition, the result shows that RG_t and EC_t have a linear combination**.** The Durbin-Watson statistics confirm that the residual is stationary. In all, this result implies that there exists a long run equilibrium relationship between economic growth and energy consumption or that both variables do not follow “random walks” in the end.

Table-4: Co-integration Test Results

Null Hypothesis: ECM has a unit root					
Augmented Dickey-Fuller test statistic					
		t-Statistic		Prob.*	
Augmented Dickey-Fuller test statistic		-6.5582		0.0003	
Test critical values:		1% level	5% level		10% level
		-4.2529	-3.5485		-3.2071
	Coefficient	Std. Error	t-Statistic		Prob.
ECM(-1)	-1.0116	0.182	-5.5628		0.0000
Constant	-218.1962	1060.849	-0.2057		0.8384
1971	8.6504	48.644	0.1778		0.8600
R-squared	0.5015	Log likelihood		-316.2795	
Adj.R-squared	0.4694	F-statistic		15.5940	
Durbin-Watson	1.9751	Prob(F-statistic)		0.0000	

Estimation Results for Error-Correction Mechanism (ECM)

Table-5 below presents the results of the short run dynamic specification in terms of the error-correction mechanism (ECM). In the regression, $\delta(EC_t)$ and ECM(-1) capture the short run disturbances and adjustment toward the long run equilibrium respectively. The results show that short run changes in energy consumption has significant positive effects on economic growth but the error correct term is statistically insignificant and correct about 0.001 of the discrepancy between the actual and the long run or equilibrium value of RG_t in a year.

Table- 5: Error-Correction Mechanism (ECM) Results

Dependent Variable: $D(RG_t)$				
	Coefficient	Std. Error	t-Statistic	Prob.
δ (EC_t)	0.004567	0.0005	5.8494	0.0000
ECM(-1)	0.002209	0.0008	1.3324	0.1264
Constant	-4.811326	2.1861	-1.3046	0.1916
R-squared	0.59270	F-statistic		27.0541
Adjusted R-squared	0.55997	Prob(F-statistic)		0.0000
Durbin-Watson	1.51754	Akaike info criterion		8.1831

CONCLUSION AND POLICY IMPLICATIONS

Policy makers in Indonesia are committed to managing the country’s domestic oil consumption given the huge financial implication of the growing importation of refined petroleum products. In 2005, the country increased the price of subsidized fuel by about 126% to achieve about 2% reduction in consumption in 2006 and 2007. In 2010, Indonesian parliament approved a measure to remove fuel subsidies for all vehicles excluding motorcycles and public transportation vehicles. The concern about the economic effects of the policy which was initially slated for nationwide implementation by 2013 has led to its deferment.

Inefficient pricing of energy products has become common phenomenon in most resource rich developing countries. Aside the fiscal burden on government budget, setting domestic prices below competitive market level usually results in higher domestic energy consumption and hence higher greenhouse gas emission. On purely efficiency grounds, this kind of policy can be reasonable if it is established that increased growth results from such higher energy consumption.

To this end, the study examined the direction of causality between energy consumption and economic growth, and the possibility of a long run relationship between the two variables. The Granger causality test revealed a unidirectional causation running from economic growth to energy consumption, and the existence of a long run relationship. Since causality runs from economic growth to energy consumption, energy conservation appears viable and may not be injurious to economic growth. Hence, major reforms that will ensure appropriate pricing of energy products can be implemented in Indonesia to checkmate excessive consumption.

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