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Article

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The Energy Demand Elasticity in Relation to Gross Domestic Product in Indonesia: Sectoral Approach

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ABSTRACT

This paper aims at estimating the energy demand elasticity in relation to gross domestic product in Indonesia based on data from 1995 to 2018. The sectors examined are industry, trading, transportation, and housing sectors. The method of analysis is the Autoregressive Distributed Lag (ARDL). An interesting estimation result here is that the elasticity of the industry sector is negative both short and long term. The other three sectors show positive elasticity. This paper contributes to the discussion of the energy demand ARDL model to be used as a reference in developing countries.

Keywords: The Elasticity of Energy Use, Sectoral, Economic Growth, Autoregressive Distributed Lag Model
JEL Classifications: C23, O11, O13

1. INTRODUCTION

Community welfare can be achieved through economic development. In economic development, energy is needed in many activities to drive the economy in many sectors. If there is not enough energy, it will be difficult to move the wheels of the economy. The more developed a country, the higher its energy needs.

Energy demand reflects the activity in each sector, logically without activity there is no use of energy, because it is assumed that all sectors act rationally and do not want to pay without a clear purpose. Each activity must produce economic benefits to economic growth (gross domestic product GDP), therefore it is necessary to study how much elasticity the use of energy has on economic growth in each sector. This is to assist the government in making policies related to the use of increasingly scarce fuels.

For all developed and developing countries, energy is an important factor of production such as capital and labor. In addition, energy demand is one of the basic indicators of development and economic growth. As stated by Halıcıoglu (2008), he stated that economic development and output can be determined together because economic development is closely related to energy demand and that higher economic development requires more energy demand. This is supported by Stern (2011), and Pirlogea and Cicea (2012) who are both conducting research to determine the key factors that have an impact on economic growth, using energy use variables.

In the energy sector, apart from the potential for renewable energy, Indonesia has a large capacity, the share of fossil fuels currently around 96% of total primary energy demand (NEC, 2015). In countries with growing populations, such as Indonesia, sustainable development requires them to increase not only national income, but also per capita income. The greater population growth will reduce the income per capita, if not balanced economic growth, because they use more natural capital, such as fossil fuels (UNU-IHDP and UNEP, 2012).

The deployment of renewable energy in Indonesia still faces some obstacles, such as lack of fiscal and financial incentives for investors, and limited access to advanced technologies (APERC, 2007). For example, the development of Indonesia's vast geothermal potential is constrained by a lack of technological capability and financial support, and by an electricity pricing structure that does not provide enough incentives for its distribution (Tanoto and Wijaya, 2011).

2. LITERATURE REVIEW

In fact, it has long been known the importance of studies on the elasticity of energy use to GDP not only in Indonesia, but in many countries. Namely studies that study the percentage change in energy use associated with a 1% change in gross domestic product (GDP). In a preliminary study, mentioning the separameters in slightly differentterms, eventhough the meaning is the same. For example, Adams and Miovic (1968) refer to this parameter as "energy elasticity," as is the case with Brookers (1972) and Ang (1991) they refer to this parameter as "energy coefficient." Then there are those who call it "income elasticity" from energy use and energy intensity and income growth (van Benthem, 2015). Furthermore, using cross-sectional data, Csereklyei et al. (2016) recently reported that the average long-term energy-GDP elasticity is around 0.7, and this has been quite stable over time.

Early economic growth theories (neoclassical and endogenous growth models) only analyzed the effect of primary production factors such as capital and labor on economic growth. While energy is only considered as a material used in the production process, and is often ignored, or only considered as an intermediate input. As Stern (1998) emphasizes the basic model of economic growth which is based on the neoclassical model proposed by Solow (1974), which does not include energy as a factor of production at all. According to this theory, the only cause of economic growth is technological progress. But technological progress is assumed to occur exogenously. Then, endogenous growth models seek to incorporate technological advances in growth models as a result of decisions taken by companies and individuals (Stern, 1998).

Literature that studies the causal relationship between energy demand and economic growth has advanced. The first relevant study that links between energy use and economic growth began around the late 1970s. In their pioneering work, Kraft and Kraft (1978) linked energy demand to economic growth (gross domestic product GDP), using annual US data from 1947 to 1974. They used Sims causality test procedures to infer causal relationships, and found that an increase in GNP leads to an increase in energy demand.

In another study, Erol and Yu (1987) applied the Sims and Granger causality procedure to examine the causal relationship between energy demand and real GNP in Japan, Germany, Italy, Canada, France, and England. The results show that there was a two-way causal relationship between two variables in Japan. In Germany and Italy, an increase in GNP led to an increase in energy demand. An increase in energy demand caused an increase in GNP in Canada, but there was no causal relationship between the two in France and the United Kingdom.

Long-term energy demand forecasts, usually based on the functional relationship between energy demand and economic activity (represented by GDP), therefore income elasticity, the percentage change in energy demand related to the percentage change in GDP, plays a key role in the forecast. Previous studies for developed countries found elasticities of >1 (Nordhaus, 1977).

In the literature on the relationship between energy demand and economic growth, it relies on the hypothesis that growth in energy demand plays an important role in economic growth both directly and as a complement to capital and labor. In this case Apergis and Payne (2012) relies on three hypotheses, namely the conservative hypothesis, the neutrality hypothesis, and the feedback hypothesis. The conservation hypothesis states that energy demand is determined by economic growth. The feedback hypothesis states it depends on the interdependent relationship between energy demand and economic growth. The neutrality hypothesis rests on the assumption that energy demand has a relatively small role in the process of economic growth.

The next literature review is that written by Tugcu et al. (2012) which classifies literature according to the type of energy consumed. The first focuses on studies that relate to aggregate energy demand and economic growth. The second group analyzes the relationship between renewable energy demand and economic growth. The last one, a study of the effects of both renewable and non-renewable energy demand with economic growth (Tugcu et al., 2012: 1944; Purnomo et al., 2023).

Our study aims to add information related to the analysis of the relationship between energy demand and economic growth, especially studying the elasticity of energy demand on economic growth. The study followed the elasticity of energy demand to economic growth by sector. Demand of energy that is not elastic to economic growth may deplete capital, reducing the capacity for economic development (Mumford, 2016).

In recent years stakeholders have paid attention that resources, especially those that are not renewable, should function as drivers of economic growth and reduce poverty (Aubynn, 2009). Whereas Mundial (2011) examine the policies that support this. This includes policies relating to the efficiency of resource extraction, the tax and royalty system, as well as those related to productive investment.

3. METHODOLOGY AND DATA

Energy usage data is sectoral data which includes the industrial sector; transportation; commercial; the household; and economic growth data, from the period 1995-2018. The data measurement was based on constant prices in 2010, in US dollars. Variables examined include GDP as a proxy for economic growth; the use of industrial energy sector (IND); the use of the energy sector of transportation (TR); the use of commercial energy sector (CO); and the use of the household energy sector (RE). To avoid heteroschedasticity all data is transformed into logarithms.

The data in this study is only 24 years, meaning that it includes small data, and has met the requirements of the relationship test both short term and long term, so that according to the provisions of Pesaran et al. (2001) the Auto-Regressive Distributed Lag (ARDL) model can be used. According to Nkoro and Uko (2016) the ARDL model has several advantages such as, “variables stands as a single equation, endogeneity is less problem because it is free of residual correlation. The main advantage of ARDL is the ability to identify the cointegrating vector where there are multiple cointegrating vectors. According to Pesaran et al. (2001), when there is a single long run relationship, ARDL can distinguish between dependent and explanatory variables. Another advantage of the ARDL model is the bound test approach that can be applied regardless of whether the understanding of the underlying regressors are integrated of order one (1) or order zero (0). Usually ARDL models produce unbiased estimates of long run models and valid t-statistics.

The ARDL model related to the variables used is as follows:

$$E = E_{IND} + E_{TR} + E_{CO} + E_{RE} \quad (1)$$

E = Energy demand
Y: Total gross domestic product
IND: Energy from industrial sector
TR: Transportation sector
CO: Commercial sector
RE: Residential sector

Differentiang equation (1) by time (t) dividing by E and denoting dx/dt by dot over the variables, then we have

$$\frac{\dot{E}}{E} = \frac{E_{IND}}{E}\frac{\dot{E}_{IND}}{E_{iIND}} + \frac{E_{TR}}{E}\frac{\dot{E}_{TR}}{E_{TR}} + \frac{E_{CO}}{E}\frac{\dot{E}_{CO}}{E_{CO}} + \frac{E_{RE}}{E}\frac{\dot{E}_{RE}}{E_{RE}} \quad (2)$$

Deviding by real growth rate of GDP $(\dot{Y}/Y)$ and using e_E to denote the Type equation here. Energy-GDP elasticity. Our estimates:

$$E_s = \alpha_s + \beta_s \mathrm{Y} + \varepsilon_s \quad (3)$$

$$\ln E_{IND} = \alpha_0 + \beta_{IND} \ln \mathrm{Y} + \varepsilon \quad (4a)$$

$$\ln E_{TR} = \alpha_0 + \beta_{TR} \ln \mathrm{Y} + \varepsilon \quad (4b)$$

$$\ln E_{CO} = \alpha_0 + \beta_{CO} \ln \mathrm{Y} + \varepsilon \quad (4c)$$

$$\ln E_{RE} = \alpha_0 + \beta_{RE} \ln \mathrm{Y} + \varepsilon \quad (4d)$$

$$\Delta E_s = \alpha_{s0} + \beta_{s1} Y_{t-1} + \sum_{t=0}^{n} \beta_1 \Delta Y_{t-1} + \varepsilon_t \quad (5)$$

S = Sectoral
n = Lag length
Δ = The first difference operator
H_0: No long run cointegration relationship between the variables tested
H_1: The exixtence of long run cointegration relationship between the variables tested.

Therefore the model including multiple equation to analyze the elasticity of four variables to GDP asfollow:

$$\Delta E = \alpha_0 + \partial_{IND1} Y_{t-1} + \varepsilon_{t-1} \quad (6a)$$

$$\Delta \mathrm{E} = \alpha_0 + \partial_{TR1} Y_{t-1} + \varepsilon_{t-1} \quad (6b)$$

$$\Delta \mathrm{E} = \alpha_0 + \partial_{CO1} Y_{t-1} + \varepsilon_{t-1} \quad (6c)$$

$$\Delta \mathrm{E} = \alpha_0 + \partial_{RE1} Y_{t-1} + \varepsilon_{t-1} \quad (6d)$$

Following equation (6) the error correction model (ECM) will be formulated to estimate the short run coefficient, consequently the ECM must be providing in the following equations:

$$\Delta E_s = \alpha_0 + \sum_{t=0}^{n} \beta_1 \Delta Y_{t-1} \sum_{t=0}^{n} \beta_2 \Delta E_{IND\,t-1} + \sum_{t=0}^{n} \beta_3 \Delta E_{TR\,t-1} + \sum_{t=0}^{n} \beta_4 \Delta E_{CO\,t-1} + \sum_{t=0}^{n} \beta_5 \Delta E_{RE\,t-1} + \varepsilon_t \quad (7)$$

This ARDL test has many advantages and first developed by Pesaran et al. (1999), and then extended by Pesaran et al. (2001) and has extensively been used in recent empirical modeling. The advantages of this test i.e: This test permit to test for co-integration even when all variables are 1(1) or (0) or mix of two; Unlike the previous test by Engel and Granger (1987) and Johansen (1991) Multivariate Co-integration Approach, the ARDL Bound Co-integration Test is not sensitive to the value of nuisance parameters in finite sample, thereby making it small sample properties superior; This test also unbiased long run estimates and valid in t-statistical even when some of the variables are endogenous.

4. EMPIRICAL RESULTS

4.1. Indonesian Economic Growth

Based on data from BPS (2018), Indonesia’s economic growth over the past 15 years has fluctuated. In 2005 economic growth reached 5.69%. Then in 2006 the growth decreased to 5.5%, but in 2007 rose again to 6.35%. In 2008 it decreased again to 6.01%, even in 2009 economic growth decreased again to 4.63%.

The decline in growth was mainly due to external factors, namely the impact of the global financial crisis, which not only affected Indonesia, but also other countries. During the year, the Central Bank of the United States (The Fed) raised interest rates which caused global commodity prices to rise. However, at that time Indonesia was able to maintain its economic growth even though it was slow, and Indonesia’s economic growth was among the three best in the world.

In 2010 the Indonesian economy grew again by 6.22%, even in 2011 the Indonesian economy grew by 6.49%, and in 2012 it grew by 6.23%, but the following 2 years declined again to 5.56% in 2013 and 5.01% in 2014.

During the new government under the leadership of President Joko Widodo started at the end of 2014, more emphasis on investment in infrastructure, and an increase in efficiency in different sectors, but the economy had not risen. In 2015 the

Indonesian economy weakened again and grew by only 4.88%. The budget deficit got bigger because of an increase in the number of imports and a decline in exports. Only in 2016, the impact of infrastructure development began to be seen, marked by economic growth rising to 5.03%, followed by 2017 with economic growth of 5.17%.

To overcome the ups and downs of economic growth, the government made various efforts to boost economic growth. One thing that emphasized was the equitable distribution of welfare, by expanding the reach for growth in eastern Indonesia, the border region, and other areas that are still lagging. Other efforts undertaken were to strengthen ultra-micro businesses, micro, small and medium enterprises and cooperatives. The government also made efforts to reduce inequality between regions and reduce disparities between income groups.

Sectorally, the government encourages sectors that have added value and can create greater employment opportunities. In this connection the investment climate is developed, improving the licensing system so as to create efficiency. An Online Single Submission (OSS) was made which made it easy to arrange investment permits. The implementation of the One Stop Integrated Service (OSTS) to reduce the bureaucratic chain making it easier for businessman.

4.2. Indonesia's Energy Conditions

Previously, Indonesia was an oil producing country that played a significant role in the world, resulting in a surplus of oil products. But now the situation is different, many studies have proven that in the future Indonesia has the potential to become an oil importer country, if the pattern of oil demand does not change.

The pattern of world energy demand, as well as in Indonesia at this time is still dominated by fossil energy in the form of oil, gas and coal. This is a threatening challenge in the energy sector. At present the condition of Indonesia's petroleum has gone up to a threshold (BPPT, 2018). Since 1991 Indonesian oil production has continued to decline. This was caused by the reduced productivity of oil wells owned. In 2018, from the production target of 800 thousand barrels per day, it would only reach around 773 thousand barrels. This amount was far below the production in 2017 which reached 949 thousand barrels per day (BPPT, 2018).

By contrast, in the areas of fuel demand, while oil production continues to decline, fuel demand has increased in line with population growth and population of motor vehicles, both motorcycles and cars. Car sales in 2017 reached 1079 million units, or there was an increase of almost 150% in 10 years, or an average increase of 15% per year. In the same period, motorcycle sales rose 33%, or 3.3% per year. Beyond that, PT KAI consumes 200 million liters of fuel per year on average annually. To overcome this, there are options that can be done, namely reducing fuel demand, or with a mixture of ethanol (premium) or biodiesel (diesel). The first choice obviously does not make sense, because the increase in population will automatically increase energy demand, especially fuel oil. Until now household demand expenditure is still the largest contributor to GDP. The biggest expenditure occurred in 2016 which reached 56.50% of GDP.

Based on Table 1 this study was conducted from 1985 to 2018 or 24 years of observation. The average GDP value of the Indonesian economy was 154.17 (billion USD), with a maximum GDP value of 257.70 (billion USD) and a minimum GDP value of 96.61 (billion USD).

4.3. The Unit Root Test

This test is to check the mean and variance of the variables change over time or not, and the time series data are stationary or not stationary. Here we check the unit root based on null hypothesis of non stationary against the alternative hypothesis of stationary data. The result of Augmented Dickey Fuller (ADF) test and Phillip Perron (PP) test of unit root are shown in Tables 2 and 3 below. From Table 2, the unit root test reveals that in levels all variables are not stationary, and at their first difference both test show that all variables are stationary at 5% and 10% significant level, except residential sector (RE).

The ARDL estimates are dynamically and structurally stable, consistent, and reliable. Based on Figures 1 and 2 through the cumulative sum of the recursive residual (CUSUM) and the cumulative sum of the squares of recursive residuals (CUSUMSQ) test, the graphical result that residuals were within the critical bounds at 5% level of significant.

4.4. Bound Co-integration Test

This test is approach to co-integration test the existence of long run relationship between the variables. From the lag length can help us in capturing the dynamic relationship to select the best

Table 1: Descriptive statistic

Measure	Y	IND	CO	TR	RE	OT
Mean	2,102,397	2.81E+08	27,860,725	2.19E+08	1.38E+08	29,924,770
Median	1,905,727	2.83E+08	24,952,581	1.79E+08	1.45E+08	29,818,538
Maximum	3,514,281	3.75E+08	43,153,003	3.91E+08	1.55E+08	38,791,254
Minimum	1,317,588	1.90E+08	14,182,727	1.06E+08	96,092,729	16,100,231
SD	707,850.4	51,943,240	9,859,460	92,785,729	17,023,503	5,434,639
Skewness	0.590218	0.101434	0.289657	0.490593	−1.285150	−0.682801
Kurtosis	2.005719	2.507431	1.554796	1.721808	3.412552	3.404464
Jarque-Bera	2.382023	0.283779	2.424218	2.596500	6.776638	2.028458
Probability	0.303914	0.867717	0.297569	0.273009	0.033765	0.362682
Sum	50,457,527	6.73E+09	6.69E+08	5.26E+09	3.32E+09	7.18E+08
Sum square deviation	1.15E+13	6.21E+16	2.24E+15	1.98E+17	6.67E+15	6.79E+14
Observations	24	24	24	24	24	24

SD: Standard deviation

Table 2: Phillips-Perron unit root test

Measure	t-Statistic	At level				
		LOG (Y)	LOG (IND)	LOG (TR)	LOG (CO)	LOG (RE)
With constant	T-statistic	1.1979	−2.0471	−0.2355	−1.0914	−4.0830***
With constant and trend	T-statistic	−2.5697	−2.3239	−2.0943	−2.2473	−2.3626
Without constant and trend	T-statistic	4.4171	1.5994	4.3571	4.0482	1.8731
Measure	**t-Statistic**	**At first difference**				
		d (LOG[Y])	d (LOG[IND])	d (LOG[TR])	d (LOG[CO])	d (LOG[RE])
With constant	T-statistic	−3.7691**	−4.5357***	−3.7427**	−5.1788***	−2.5139
With constant and trend	T-statistic	−4.3955**	−5.5083***	−3.6585**	−5.0825***	−3.1503
Without constant and trend	T-statistic	−2.4786**	−4.2225***	−2.4695**	−3.5478***	−2.2716**

Source: Data processing result, 2022. * ,** and ***Significant at 10%, 5%, and 1% respectively

Table 3: Unit result of unit root test (Augmented Dickey Fuller)

Measure	t-Statistic	At level				
		LOG (Y)	LOG (IND)	LOG (TR)	LOG (CO)	LOG (RE)
With constant	T-statistic	−1.0687	−2.1143	−0.2355	−1.0725	−4.3741***
With constant and trend	T-statistic	−1.0291	−2.8129	−2.6644	−2.1824	−2.7240
Without constant and trend	T-statistic	17.6061	0.9789	4.3571	3.7973	1.0272
Measure	**t-Statistic**	**At first difference**				
		d (LOG[Y])	d (LOG[IND])	d (LOG[TR])	d (LOG[CO])	d (LOG[RE])
With constant	T-statistic	−16.4894***	−4.1777***	−3.7311**	−5.1788***	−2.6305
With constant and trend	T-statistic	−3.2687	−3.8638**	−3.6479**	−5.0825***	−3.1503
Without constant and trend	T-statistic	−1.8374*	−4.0375***	−2.5222**	−2.2508**	−2.4225**

Source: Data processing result, 2022. *,** and ***Significant at 10%, 5%, and 1% respectively

ARDL model to estimate. Based on Table 4, the result shows that it is evident that for all the normalized equation, the estimated F-statistic of 35.49763 is above the upper critical bound at 5% significant level. Thus we fail to accept the null hypothesis, meaning that we can treat the developed models. Meaning the there is existence of a long run equilibrium relationship between energy use and GDP elasticity in Indonesia during 1995 to 2018.

4.5. Test of Elasticity

Here we want to test the 1% change in each of energy use of four factors associated with a 1% change in GDP. The previous study on this topic has been conducted by (e.g. Nakicenovic et al., 1998; Judson et al., 1999; Smil, 2000; Medlock and Soligo, 2001; Lascaroux, 2011; Arsenau, 2012), that resulted the contribution of end-use sector to the aggregate energy-GDP elasticity are less well understood. Our estimates are potentially useful for energy planning and forecasting in Indonesia.

Our study involves studying final energy use by four sectors that have been mentioned before. Based on Table 5 the long run coefficients are statistically significant at 1% significant level. The result show that all variable are positively elastic to change in GDP, except industrial sector that has negative elasticity. These indicates that a 1% change in energy use of primary solid biofuels of transportation sector, commercial sector, and residential sector have 0.224706%; 0.771167%; 0.626047% respectively increased changing in GDP. Compared to all variables, the commercial sector contributed the biggest positive change in GDP. In contrast, for every 1% change in energy use of industrial sector, decreased 0.341321% in GDP.

Table 4: Bounds test results

Test statistic	Value	Significant (%)	I (0)	I (1)
F-statistic	35.49763	10	2.2	3.09
K	4	5	2.56	3.49
		2.5	2.88	3.87
		1	3.29	4.37

Table 5: Long run model result

Variable	Coefficient	SE	T-statistic	Probability
LOG (IND)	−0.341321	0.149428	−2.284179	0.0624
LOG (TR)	0.224705	0.149504	1.503009	0.1835
LOG (CO)	0.771167	0.163318	4.721876	0.0033
LOG (RE)	0.626047	0.218593	2.863983	0.0287
C	−8.013924	4.118063	−1.946042	0.0996

SE: Standard error

This result differ from the similar studi in Australia, Burke and Csereklyei, 2016, using time series data 1960-2010 from 132 countries resulted that residential energy use is very inelastic to GDP. Residential use of energy is more tighly linked to GDP, as is emergy use by the transportation, industrial, and service sectors. Other result shown by Petrice 1986, used data from 1950 to 1980 in 18 countries resulted that on average the elasticity was eual to or >1 before cricis event (1973). As far as after crisis periods the average elasticity is 0.74 (23 examples). However, seven examples (out of 23 examples) correspond to an elasticity >1.1. But in five instances (out of seven) the elasticity drop to 0.6. In 15 cases (out of 23) the elasticity is <0.75, but in eight (out of 15) show an energy-growth correlation coefficient which invalidates the calculation. There remain therefore seven cases at most which are meaningful from a purely statistical point of view and their average elasticity is 0.56.

Table 6: The result of short run model

Variable	Coefficient	SE	T-statistic	Probability
DLOG (Y[−1])	−0.103104	0.053880	−1.913588	0.1042
DLOG (IND)	−0.007231	0.020451	−0.353548	0.7358
DLOG (IND[−1])	0.118564	0.020549	5.769739	0.0012
DLOG (IND[−2])	0.127675	0.019932	6.405643	0.0007
DLOG (CO)	0.344941	0.035907	9.606519	0.0001
DLOG (CO[−1])	−0.036884	0.038178	−0.966114	0.3713
DLOG (CO[−2])	−0.178943	0.034901	−5.127120	0.0022
DLOG (RE)	−0.216543	0.080237	−2.698806	0.0356
DLOG (RE[−1])	−0.314808	0.078066	−4.032599	0.0069
CointEq(−1)*	−0.514833	0.026054	−19.76041	0.0000
R^2	0.974601	Mean dependent var		0.039888
Adjusted R^2	0.953820	SD dependent var		0.043460
SE of regression	0.009339	Akaike info criterion		−6.203404
Sum squared resid	0.000959	Schwarz criterion		−5.706012
Log likelihood	75.13574	Hannan-Quinn criterion		−6.095457
Durbin–Watson statistic	2.810180			

SE: Standard error, SD: Standard deviation

Figure 1: Cumulative sum (CUSUM) of recursive residual

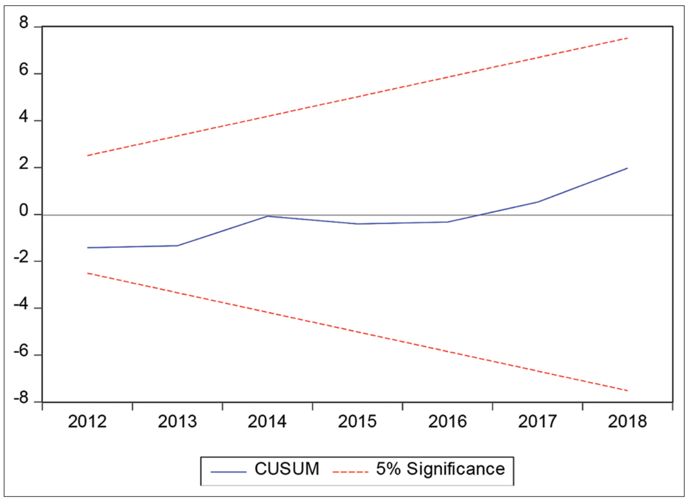
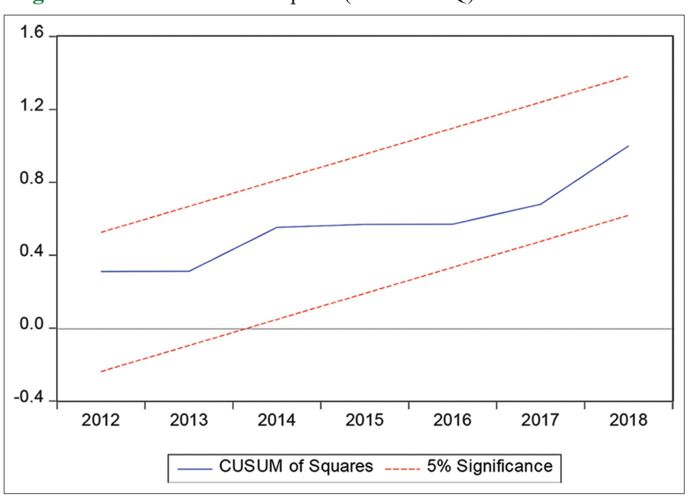


Figure 2: Cumulative sum square (CUSUMSQ) of recursive residual



For the empirical short run, we can Table 6. The result shows that like in long run energy use in industrial sector with negative elasticity. This must be a special attention to the Indonesian government to role of industrial sector in economic development, especially related to energy use. As mention above that the use of all resources must be productive and efficient.

5. CONCLUSION

This study investigates the long run interrelationship between energy consumption in four sectors; industrial, transportation, commercial, and residential sectors toward economic growth in Indonesia periods of 1995-2018. We used the ARDL model bound approach to test the existence of long run relationship between economic growth and four sectors mentioned above. While to test the elasticity of energy consumption of four sectors and economic growth used the coefficient of log equation 4 and Table 5.

The empirical results confirm the existence of long run relationship between energy consumption of four sectors and economic growth. Based on the ARDL model, the long run elasticities are statistically significant at 1% significant level. The energy consumption of three sectors, transportation, commercial, and residential have positively elasticity toward economic growth, except industrial sector that show negative elasticity.

Based on the result government must pay more attention especially to industrial sector due to the negative elasticity toward economic growth. This sector must support economic growth with higher productivity and efficiency. There must be appropriate and accurate policy with learn and compare to other countries that successfully applied the similar policy.

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