The Impact of Population, Export, and Capital Formation to The Oil Consumption and Economic Growth in Indonesia

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ABSTRACT

The paper aims to investigate the relationship between oil consumption and economic growth by including several variables namely capital, population and export in Indonesia using annual data for the period 1965 – 2021. Granger causality employed to determine the direction of causal relationship between the variables where the result can illustrate the ability of the country in reducing the energy consumption and the impact on economic growth. The study note the variable are stationer at first difference and two cointegration exists between the variables. In the short-run, capital has positive influence oil consumption for one and two lag. GDP and export negatively influenceto oil consumption with maximum 2 lag period. In the long-run, capital and export oppositely influence oil consumption. The result of Granger causality supports the presence of conservation hypothesis between GDP and oil, GDP and export as well as GDP and capital. Feedback hypothesis confirms between oil consumption and export and oil consumption and population. The neutrality hypothesis exists between capital and oil consumption.Therefore, it can be concluded that the economic growth of Indonesia does not depend on the level of oil consumption. It implies that Indonesia government may impose energy conservation policy particularly oil without fear of negatively affecting economic growth.

Keywords:
Oil consumption, GDP, capital formation, population, export, Indonesia, causality.

1. Introduction

One of the main issues in the energy sector is efficiency of energy consumption. This issue is relatedto the increase of energy prices continuously and world encouragement to decrease the greenhouse emission. Indonesia, as one of developing countries as well as one of the largest energy consumer, needto be wiser in responding to the issue. The world encouragement to decrease the energy consumption via efficiency and decrease the environmental damage should be matched with the effect to the economic growth[1]. Since energy is very crucial for economic growth, then the consequences of policy implementation to decrease the energy consumption should be well considered. This reflects that there is a strong relationship between energy consumption and economic growth.

The direction of causality between energy consumption and economic growth becomes very important because the result can give an overview of the ability of the country in reducing the energy consumption[2]. For example, if the causality direction running from energy consumption to economic growth, then the implementation to reducing energy consumption should not be implement yet because it can give negative impact to the economic growth. Therefore, effort to determine the causality relationship between energy consumption and economic growth both in short and long term is very relevant to be carried out.

Related with the causality relationship between energy consumption and economic growth, there are four possible directions and its implications. First, if the unidirectional causal relationship running from energy consumption to economic growth (EC → GDP) which implies that limiting the energy consumption will bring the negative effect to the economic growth. This condition called growth hypothesis[3]. Second, if there is a unidirectional causal relationship running from economic growth to energy consumption (GDP → EC) which means that the increase of economic growth encourages increase in energy consumption. Thus, the implementation of energy conservation policy will not give harm to economic growth. This condition knew as conservation hypothesis[4]. Third, if there is a bi- directional causal relationship between the variables. It means that these two variables are interrelated.

This called as feedback hypothesis (EC ↔ GDP). Last, if there is no causal relationship between the variables which means that energy consumption and economic growth is not correlated. In this condition, the increasing or decreasing one of the variable will not affect to another variable. This situation called as neutrality hypothesis (EC ~ GDP)[2].

Some of the facts above become the background to this study. The main objective of this study is to examine the causal relationship between energy consumption and economic growth in Indonesia as well as discussing the policy implication. Some of other variables also included in this study namely capital, population and export as noted by Huang et al. (2008)[5], Shahbaz et al. (2013)[6] and Abdulrashid & Ozturk (2015)[7] that variable has a significant effect on the level of oil consumption.

The contribution of each variable to oil consumption also becomes another objective of this paper. Due to the strong relationship between oil consumption and those variables, then this paper will describe what will happen if the government decide to reduce energy consumption through efficiency and minimize the environmental damage. The variable of energy consumption in this paper is represented by oil since it the largest energy consumption in Indonesia as shown in figure 1.1.

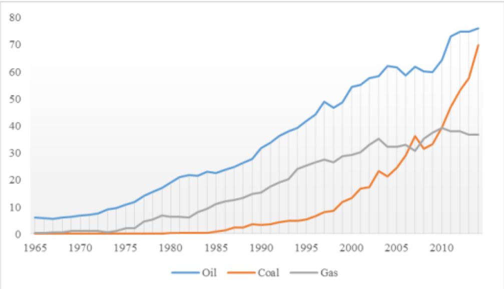


Figure 1.1. Indonesia Energy Consumption

The result of this paper is expected to give a new literature contribution in the field of energy management, since there is only a few studies on this area particularly in the case of Indonesia. The novelty presented in this study is the variable of oil consumption as a part of total energy consumption. Thus, by using this variable, the analysis of energy consumption can be more detail rather than using total energy consumption. Moreover, some additional variable besides GDP which has been evidenced has a significant effect on oil consumption are also included in this study. This allows the study to conduct further analysis of how variables affect oil consumption.

The remaining part of this paper is arranged as follows. Section two presents the literature review. Section three involves data and methodology. Section four deals with empirical findings and section five presents the conclusion of this study.

2. Methods

The data used in this study are secondary data of annual time series during 1965 – 2021. The data of energy consumption is represented by oil consumption (OIL) which defined as total fuel consumption obtained from British Petroleum (BP) Statistical Review 2021. Meanwhile, others data like gross domestic product (GDP), population (POP), capital (CAP) and export (EXP) are sourced from World Development Indicators (WDI) – World Bank. All data are transformed to natural logarithm in order to minimize the heteroskedasticity problem in estimation. The model in this study can be written as follows.

$$lnOIL_t = \alpha_0 + \alpha_1 lnGDP_t + \alpha_2 lnPOP_t + \alpha_3 lnCAP_t + \alpha_4 lnEXP_t$$

The method of analysis used in this study is Vector Autoregressive (VAR) and Vector Error Correction Model (VECM). The VAR method can be conceived as a non-structural approach (as opposed to structural approaches, such as the simultaneous equations) that describe the mutual relationship "causes" (causality) between variables in the system. VAR method assumes that all variables in the model are endogenous [27]. This method is used because not all economic theory is able to answer correctly and completely the relationship between variables. The use of the VAR / VECM model requires several steps as a prerequisite, the following is an explanation of the steps.

Time series analysis needs stationary data. Stationary is a condition of time series data which has mean, autocorrelation structure and variance distribution constant for over time. Test of unit root become so important to analyze whether the data is stationer or not. The existence of unit root in the data indicates that the data is not stationary and vice versa [28].

In another word, we can say that the data which can be used is the data that has no unit root. It is because the data which has a unit root would be difficult to do estimation and tend to have fluctuations that are not around the average. The spurious regression would probably happen if the non-stationary time series is regressed. This phenomenon can be known if the model has high R^2 but there is no meaningful relationship between the variables. The models will produce biased and incorrect conclusions. Unit root test can be performed using Augmented Dicky-Fuller (ADF) and Philip Peron (PP) tests. In order to determine whether there is unit root or not in the data, the result of ADF, PP, and KPSS t-statistic value should be compared with 1%, 5% and 10% McKinnon Critical Value. If the data is not stationer at the level, then the unit root test should do at the first difference where most of the data will stationer at this condition. After unit root test, the next step is cointegration test. However, the optimum lag should be determined previously. Determining the amount of lag (ordo) which will be used in the VAR model, can be found based on criteria of Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) or Hannan Quinnon Criterion (HQC).

The cointegration technique was first introduced by Engel and Granger in 1987, developed by Johansen in 1988 and refined by Johansen and Juselius in 1990. The cointegration test is used to determine whether the economic variables or financial variables have a long-run relationship or not. If cointegration exists between the variables, data analysis can be done in the long term and short term. Otherwise, if the cointegration is not existed, meaning that there is no long-run relationship between variables and data analysis can be done only in the short-term.

The causality test was first proposed by Engel and Granger. In simple, this test serves to know which variables affect other variables. In another word, we can say that Granger causality test can show us the direction of the causality, whether the direction of causality is run from x to y or vice versa [29]. If we illustrate x and y as variables in the Granger causality test, there are 4 types of relationship that might be interpreted from the equation of Granger. First, there is no causal relationship between two variables (x ~ y), this hypothesis called the neutral hypothesis. Second, there is one causality direction runs fromvariable x to variable y (x → y), while the third type is when causality direction runs from variable y tovariable x (y → x), these relationships called unidirectional causality. The fourth type of relationship iswhen there are two causality direction runs between two variables (x ↔ y), this relationship called bi- directional causality.

Vector Auto Regression (VAR) and Vector Error Correction Model (VECM) are econometrics model used to solve research problems quantitatively. Every variable in VAR is endogenous and it is explained by its own lag as well as the current and past values of other endogenous variables which included in the model. The use of VAR/VECM is depended on the result of unit root test and cointegration. If the variables have no unit root and stationer at the level, VAR analysis can be done at the level. The long-run analysis, without short-run, can be done including IRF and FEVD analysis. Another case, if the variables have unit root at the level, stationer at first difference and there is no cointegration exist, VAR analysis can be done at first difference but only in short-run. The last conditionif the variables have unit root, stationer at first difference and cointegration exist, then the analysis can be done using Vector Error Correction Model (VECM). Unlike VAR analysis which can only analyze one of two analysis that are short-run and long run, VECM model can analyze both of short-run and long run condition as well as IRF and FEVD[30].

Forecast Error Variance Decomposition (FEVD) is an instrument of VECM which used to get analysis about the long-run relationship. FEVD can be used to explain and predict the contribution of each variable through the shock of a certain variable. The contribution of each variable to the shock areassessing in percentage [31]. By using this method, we can predict the proportion of changes effect on a variable in case of shocks or changes of its variable in a period. Therefore, if we analyze variance decomposition result, we can measure the estimation of variance error of a variable that is how big the difference between before and after shocks happen, either the shock comes from other variables or the variable itself.

3. Results

1.1. Unit root test results

This study used some methods to test the stationary namely ADF and PP tests. The summary resultof ADF and PP tests are shown in the table 4.1.1.

Table 4.1.1
Unit Root Test Results

Null Hypothesis: Variable has a unit root								
Variable	ADF				PP			
	Level		Δ		Level		Δ	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Intercept	Trend & Intercept
LnOIL	0.622 (0.98)	-2.95 (0.15)	-6.19* (0.00)	-6.19* (0.00)	0.59 (0.98)	-2.97 (0.14)	-6.19* (0.00)	-6.14* (0.00)
LnGDP	-1.79 (0.37)	-1.71 (0.72)	-5.11* (0.00)	-5.40* (0.00)	-1.64 (0.45)	-1.30 (0.87)	-5.11* (0.00)	-5.38* (0.00)
LnPOP	-3.35 (0.01)	-1.54 (0.79)	-1.70 (0.42)	-5.56* (0.00)	-16.76* (0.00)	-2.34 (0.40)	-0.98 (0.75)	-0.68 (0.96)
LnCAP	-2.37 (0.15)	-1.53 (0.80)	-6.10* (0.00)	-6.44* (0.00)	-2.38 (0.15)	-1.55 (0.79)	-6.10* (0.00)	-6.43* (0.00)
LnEXP	-1.00 (0.74)	-2.46 (0.34)	-7.32* (0.00)	-7.32* (0.00)	-1.01 (0.74)	-2.56 (0.29)	-7.33* (0.00)	-7.33* (0.00)

Note: Δ is first difference. Variable are in natural logarithm. First line are t-statistics and second line are probability values.
* denotes significant at 1%, 5% and 10% level of significant.

The result of unit root tests show that unit roots are exist for all variable at the level which reflects that the variable is not stationer at the level. However, the unit root is not exist at the first difference forall variables, meaning that the variables are stationer at the first difference. Based on the result of this unit root test, the step is continuous to cointegration test to determine whether the model can be analyzedonly at short-run or both of short and long-run.

1.2. Cointegration test results

The cointegration test used to find out whether there is a long-run relationship between the variables or not. Moreover, if the cointegration exists between the variables, this ensures that the regression is notspurious. The cointegration test result of Engle-Granger is revealed at the table 4.2.1 and 4.2.2. The nullhypothesis of Johansen cointegration is there is no cointegration between the variables. The null hypothesis can be rejected if the value of Trace Statistics and Max-Eigen Statistic is higher than criticalvalue as well as the probability is less than 5% level of significance and vice versa.

Table 4.2.1 Cointegration Rank Test (Trace)

	Trace			Max Eigen Value		
Null Hypothesis	Trace Statistics	0.05 Critical Value	Probability	Max-Eigen Statistic	0.05 Critical Value	Probability
r = 0*	149.02	88.80	0.00	79.01	38.33	0.00
r ≤ 1*	70.01	63.87	0.01	29.44	32.11	0.10
r ≤ 2	40.56	42.91	0.08	20.84	25.82	0.19

*denotes significant at 5% levels of significant

Based on the table above, the Cointegration Rank Test – Trace shows at least two cointegration between the variables while the Cointegration Rank Test – Maximum Eigenvalue shows that the variables cointegrated at least one. Therefore, due to the cointegration exist between the variables, the analysis can be continued to VECM and FEVD which will be preceded by the determining of leg-lengthand VAR stability test.

1.3. Granger causality test result

The first stage of conducting a Granger causality test is to construct a stable VAR model and not miss specified. In this case, the lag-length is very crucial because the proper lag-length can eliminate the problem of autocorrelation in the VAR system. In this study, the determination of optimum lag- length is based on the several criterion namely sequential modified LR test statistic (LR), Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). Table 4.3.1 reveals the optimum lag-length selected by several criteria. As shown in the table 4.3.1, the five criterions choose lag 3 as the optimum lag.

Table 4.3.1 Optimum Lag – length

Lag	LR	FPE	AIC	SC	HQ
0	NA	3.13	1.51	1.71	1.58
1	700.47	5.10	-14.12	-12.95	-13.67
2	183.67	1.05	-18.04	-15.89	-17.23
3	108.62*	1.09*	-20.39*	-17.27*	-19.21*

* Indicates lag order selected by the criterion

Based on cointegration test which showed that there is cointegration between the variables, the direction of causality between energy consumption and GDP is tested by using the Granger causality test. A variable can be inferred to have a causality relationship with the other variables if the probabilityvalue smaller than alpha (using the most stringent restriction of 10%). The direction of the causality further will be used to conclude the kind of hypothesis and policy implication which is related to the energy conservation policy. Tables 4.3.3 display the results of the Granger causality of oil consumptionand GDP.

Table 4.3.2 Granger Causality test results

Null Hypothesis	F-Stat.	Prob.	Null Hypothesis	F-Stat.	Prob.
GDP does not Granger Cause OIL	2.74	0.07*	CAP does not Granger Cause GDP	0.11	0.88
OIL does not Granger Cause GDP	0.97	0.38	GDP does not Granger Cause CAP	6.90	0.002**
POP does not Granger Cause OIL	3.44	0.04**	EXP does not Granger Cause GDP	0.06	0.93
OIL does not Granger Cause POP	21.06	4.E-07**	GDP does not Granger Cause EXP	7.13	0.002**
CAP does not Granger Cause OIL	1.50	0.23	EXP does not Granger Cause POP	12.08	7.E-05**
OIL does not Granger Cause CAP	0.03	0.96	POP does not Granger Cause EXP	1.36	0.26
EXP does not Granger Cause OIL	2.60	0.08*	POP does not Granger Cause GDP	3.45	0.04**
OIL does not Granger Cause EXP	2.68	0.07*	GDP does not Granger Cause POP	0.04	0.96

Note: Observation = 49. *,** denotes significant at 10% and 5% level of significant respectively.

The null hypothesis of Granger causality is there is no causal relationship between the variables andcan be rejected at the 5% and 10% level of significance if the probability is less than alpha 5% and 10%.The causal relationship between energy consumption and economic growth which is related to the readiness of a country to implement energy conservation shows that there is causality running from GDP to OIL consumption in the case of Indonesia (GDP → OIL). This condition support conservationhypothesis and indicates that economic growth of Indonesia does not depend on the oil consumption.

1.4. VECM result

The result of VECM indicates that the variables are towards to the equilibrium in the long-run. It can be seen from the negative sign at the Error Correction Model (ECM). In the long-run analysis, oil consumption significantly influenced by capital and export at the 1% level of significant. The variable capital negatively influences oil consumption with 2.89 and oppositely export influence oil consumptiondirectly proportional with 3.96. The summary result of VECM shows at table 4.4.1.

Table 4.4.1 VECM result

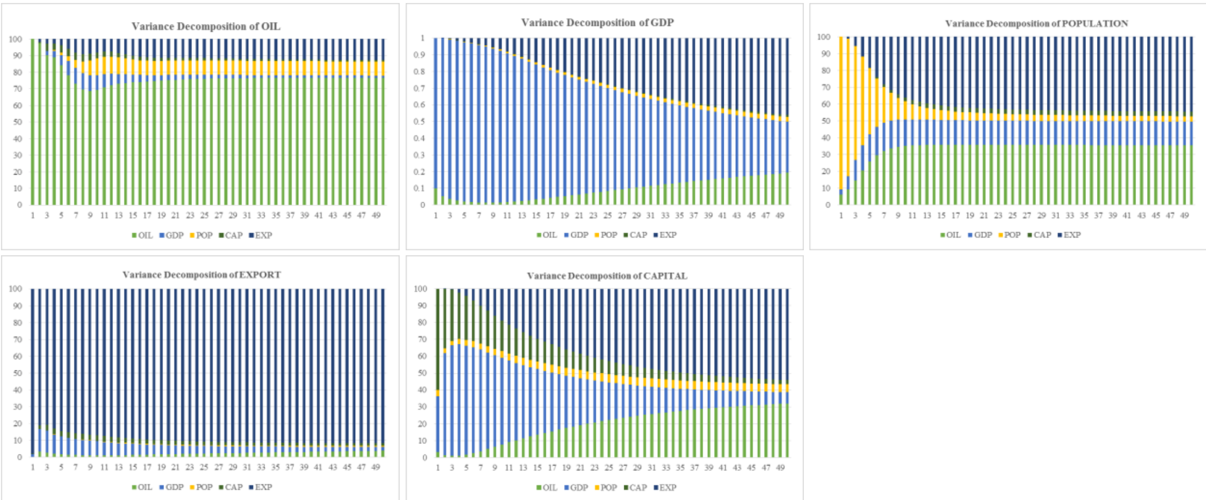
Short-term Model			Long-term Model		
Variables	Coefficient	T-Statistics	Variables	Coefficient	T-Statistics
CointEq1	–0.280	–3.485**	GDP(-1)	–1.056	0.472
D(LnOIL(-1))	0.123	0.820	POP(-1)	10.441	–1.949
D(LnOIL(-2))	0.095	0.618	CAP (-1)	–2.892	5.327**
D(LnGDP(-1))	2.462	0.227	EXP (-1)	3.966	–5.112**
D(LnGDP(-2))	–25.466	–2.053*	C	535.059	
D(LnPOP(-1))	–1037.023	0.145			
D(LnPOP(-2))	178.908	1.615			
D(LnCAP(-1))	4.260	3.358**			
D(LnCAP (-2))	8.439	–2.375*			
D(LnEXP (-1))	–7.380	–1.572			
D(LnEXP (-2))	–4.345	4.360**			

, denotes significant at 5% (>2.014) and 1% (2,689) level of significant respectivel*

1.5. FEVD result

The FEVD analysis can be used to predict the contribution of each variable through shock or certain changes of variables. The result of FEVD shows that export and oil are the variable that gives the most influence to other variables. Oil consumption influenced by itself at 97% in the beginning of period and decline until 68% before stable at almost 70% at the end of period, this result in line with the Granger causality result which showed that oil consumption is not affected by GDP. Meanwhile, GDP is also influenced by itself at the beginning period with around 95%.

Figure 4.5.1 Forecast Error Variance Decomposition



However, the influence of exports and oil consumption gradually increases through GDP and causes the decreasing of GDP in influencing itself until 40%, this trend continues until the end of the period. Export has the biggest portion in influencing shock of GDP rather than oil consumption while the other variables like capital and population are not contributing to the shock of GDP significantly. Oil consumption contributed to the shock of a population with around 35%, the rest are export with approximately 45% followed by GDP with 15%. Moreover, the shock of export is influenced by itself for the whole period with approximately 89%. Oil caused the shock of export with very small percentage of around 1% – 3% only. Lastly, export gives the largest impact on capital in the long-run. The shock contribution of export is very small at the beginning of period even start from 0%. Nevertheless, the portion increases gradually until the peak at 54% and keep an increase until the end of the period. The shock contribution of oil to capital is large enough with maximum 32% although not as large as export. The result of variance decomposition can be shown at figure 4.5.1.

4. Discussion

There is only a little study related with energy consumption and economic growth which focus only on Indonesia because of most of the studies on energy consumption and using several countries including Indonesia. The study which focuses on Indonesia as the case study conducted by Arifin & Syahruddin (2011)[8]. They analyzed the causal relationship between economic growth and three types of energy that are non-renewable energy consumption and renewable energy consumption which are divided into two namely renewable energy consumption and total electricity generated from renewable power plants. The result shows that there is no causal relationship between non-renewable energy consumption and economic growth. However, growth hypothesis found between renewable electricity and economic growth. This condition indicates that if the consumption of renewable energy is increased, it can lead to increase the economic growth. Slowly, it can reduce the dependence of economic growth on non-renewable energy consumption.

Another study in the case of Indonesia conducted together with other countries. Asafu-Adjaye (2000)[9] analyzed the causal relationship between commercial energy use, GDP, and price of energy. In the case of Indonesia, the study revealed that neutrality hypothesis confirmed between energy consumption and economic growth in the short-run. Therefore, the implementation of energy conservation policy will not give any significant effect on economic growth in the short-run. However, the policy makers have to be careful because in the long term growth hypothesis is confirmed which illustrates that the reduction of energy consumption will lead the negative growth of an economy.

Fatai et al. (2004)[10] employed ARDL and Granger causality to examine the relationship between economic growth and disaggregate energy consumption namely oil, coal, gas, and electricity. New Zealand, Australia and several Asian countries including Indonesia chose as the case for the period 1960

– 1999. The result shows conservation hypothesis existed in developed countries like New Zealand and Australia.

Meanwhile, for developing countries, growth hypothesis exists in Indonesia and India as well as feedback hypothesis confirmed in Philippines and Thailand. Unlike what happened in developing countries, the dependence of economic growth on energy consumption in developed countries tends to be low. Therefore, the energy conservation policy is more suitable to be implemented in developed countries rather than developing countries.

Chiou-Wei et al. (2008)[4] analyzed total energy consumption in the several countries of ASIAN including Indonesia and USA during the period 1954 – 2006. The study employed non-Granger causality as the further test of Granger causality. The result reveals that non-Granger causality exists in the five ASIAN countries including Indonesia. Specifically for Indonesia, linear Granger causality found running from energy consumption to GDP and support growth hypothesis. Meanwhile, the nonlinear Granger causality shows the feedback hypothesis.

Yildirim et al. (2014)[11] used 11 countries for the 1980 – 2011 period to examine the causal relationship between total energy consumption and economic growth. The result of Granger causality reveals that conservation hypothesis is valid for all countries, including Indonesia, except Turkey which shows growth hypothesis. In another study, Azam et al. (2015)[12] examined the causal relationship between energy consumption and economic growth in the five ASEAN countries during the period 1980 – 2012. The study argued conservation hypothesis for all countries in the case study except Indonesia which indicates neutrality hypothesis.

Apart from the scope of case studies, the study of energy consumption is also growing in terms of methodology. Due to the case study in the several countries shows different result, therefore some studies employed panel data in order to get a general conclusion about the relationship between energy consumption and economic growth for some countries which are incorporated in the same region or organization.

Lee (2005)[13] examined the relationship between energy consumption and economic growth in 18 developing countries including Indonesia for the period 1975 – 2001. The study confirmed the growth hypothesis for all countries in the study. This result supported the result found by Fatai et al. (2004)[10] which exposed that economic growth in developing countries has great dependency with energy consumption. Therefore, the energy conservation policy may harm the economic growth regardless of being transitory or permanent.

The discussion about oil consumption and economic growth using panel data in the group countries also administered by Mahadevan & Asafu-Adjaye (2007)[14]. They concern with 20 countries which are grouped as net energy exporter and importer, short-run and long-run as well as developed and developing countries. In the case of Indonesia, at that time, which was classified as net energy exporter and developing countries, the study shows that feedback and conservation hypothesis exist in the short and long-run respectively. In addition, panel data of net energy exporter showed the same result with panel data for exporter developing countries that are feedback and conservation hypothesis for short and long-run respectively.

Other researchers who carry the causal relationship between energy consumption and economic growth using panel data are Apergis & Payne (2010)[15] who used 15 emerging market economies for the period 1980 – 2006. Slightly different from the other studies which used total energy consumption, the variable of energy consumption in this study is represented by coal consumption. The panel data highlights the feedback hypothesis both in short and long-run. Al-mulali & Mohammed (2015)[16] expanded the study conducted by Apergis & Payne (2010)[15] where they examined the causal relationship between four types of energy consumption and economic growth by sector in the 16 emerging market including Indonesia.

The panel data Granger causality result exhibits feedback hypothesis between the consumption of oil, gas, and renewable energy with manufacturing, industrial and services sector as well as coal consumption and services sector. Meanwhile, the growth hypothesis confirmed for the relationship between oil consumption and agriculture sectors as well as coal consumption with manufacturing and industrial sectors. Last, the conservation hypothesis existed for the relationship between agriculture sector and coal consumption. Rezitis and Ahammad (2015)[17] studied the dynamic relationship between energy consumption and economic growth in nine ASEAN countries together with Indonesia using panel data framework during the period 1990–2012. The panel data Granger causality shows the growth hypothesis, meaning that the economy of all countries in ASEAN is very depended on the energy consumption.

In addition, the impulse responds function shows that in case of a shock on any of the variables, it takes about 3 – 4 years for the variable to reach the equilibrium from the initial shock. The last study discussed energy consumption and economic growth which included Indonesia as one of the case studies in the panel data framework conducted by Fang & Chang (2016)[18]. Aside from panel data, they also test the Granger causality for individual countries. Using annual data from 1970 to 2011 for 16 countries in Asia Pacific, the panel Granger causality found conservation hypothesis for this region. Meanwhile, the various result is found in the individual test. Particularly, in the case of Indonesia, the Granger causality shows neutrality hypothesis, where the same result also found for Bangladesh, China, Hong Kong, Malaysia, New Zealand, Philippines, Singapore, Thailand and Vietnam.

Table 2.2.1
Some studies on the relationship between energy consumption and economic growth in the case of Indonesia

Author (Year)	Period	Countries	Result
Yildirim et al (2014)	1980 – 2011	Turkey. Bangladesh, Egypt, Indonesia, Iran, Korea, Mexico, Pakistan, Philippines.	Growth Hypothesis Conservation Hypothesis
Azam et al. (2015)	1980 – 2012	Indonesia. Malaysia, Thailand, Singapore, Philippines	Neutrality Hypothesis Conservation Hypothesis
Rezitis (2015)	1990 – 2012	Bangladesh, Brunei Darussalam, India, Indonesia, Malaysia, Pakistan, the Philippines, Sri Lanka and Thailand	Growth Hypothesis
Fang & Chang (2016)	1970 – 2011	Australia. Bangladesh, China, Hong Kong, Indonesia, Japan, Malaysia, New Zealand, Philippines, Singapore, Thailand, Vietnam. Korea, Pakistan, Taiwan India.	Conservation Hypothesis Neutrality Hypothesis
			Growth Hypothesis Feedback Hypothesis

Based on previous research that has been presented in the literature review, the scope of discussion on the causality relationship between energy consumption and economic growth should be expanded by adding some other variables such as population, capital, and export. It is useful to provide a broader and more detailed analysis and show that so many macroeconomic variables that have the relationship with the level of energy consumption besides economic growth. In addition, there are only a few studies of the causality relationship between energy consumption and economic growth which focus on Indonesia as a case study, and even there is no study of causal relationship between energy consumption and economic growth which include some additional variables besides economic growth and energy consumption in the case of Indonesia.

Consequently, this study tries to cover the gap between the studies by examining the relationship between energy consumption particularly oil and energy consumption with some additional variables namely population, capital, and export. Investigating energy consumption – economic growth relationship with population, capital and export are essential as other variables besides economic growth have diverse effects on the level of energy consumption as well as economic growth.

5. Conclusion

This paper investigates the causal relationship between energy consumption particularly oil and economic growth incorporating capital, population and export as potential determinants of oil consumption and economic growth in the case of Indonesia during the period 1965 – 2019. This paper employed ADF and PP tests to find the existence of unit root, Johansen test to detect the cointegration, Granger causality to discover the causal relationship and FEVD to analyze the contribution of each variable through the shock or changes of oil consumption and GDP. The empirical result reveals that all variables are stationer at the first difference, then test continues to find out the long-run relationship between the variables. Next, the test presence the cointegration between the variables. The unidirectional causality running from economic growth to oil consumption observed for the Granger causality test and supports conservation hypothesis. This implies that implementing energy efficiency and energy conservation policy will not result in any decrease of the Indonesian economic growth.

The results indicate that Indonesia's economic growth does not depend on oil consumption gives a positive signal for policy makers to start implementing efficiency in the oil consumption and energy conservation policies in Indonesia. In addition, with fluctuations in oil prices that always cause negative impacts on the economy, it is appropriate that the conversion policy from oil to gas should proceed to other sectors. This program has been successfully implemented in Indonesia since 2007, most of these programs just cover household and transportation sectors but not the industrial sector yet.

The conversion program from oil to natural gas in various sectors should be a priority of Indonesia's energy policy by considering several things. First, the fluctuation of natural gas price is relatively stable rather than oil price. Second, Indonesia has a huge natural gas reserve and noted as the largest natural gas reserve in the world with 222 trillion cubic feet in Natuna Island. Third, natural gas is eco-friendly fuel compared with oil and coal in emissions produced.

The further result shows evidence of feedback hypothesis between oil consumption with population and export as well as capital and population. This implies that the decline in oil consumption will negatively impact hence population and export. The similar impact also occurs for the relationship between capital and population. The neutrality hypothesis found between oil consumption which reflects that anything happens with one variable will not bring any effect to the other variable. The other findings show the unidirectional causality running from GDP to capital and export. This indicates that increase in economic growth will raise capital and export. The growth hypothesis also reveals between population and GDP which indicates that the upturn of population will lead the rise of economic growth.

The cointegration result exhibits there are two cointegrations exist between the variables. VECM model interprets that GDP, export, and capital affect oil consumption significantly in the short-run while capital and export effect substantially to oil consumption in the long-run. Oil and export tend to stable in facing the shock from outside because most of the shock contribution come from themselves. Oppositely, these variable gives a significant contribution to the shock of other variables like population, GDP, and capital. As a conclusion, this study predicts that Indonesia is in appropriate condition to do efficiency in the oil sector as well as implement energy conservation policy because the economic growth does not depend on the level of oil consumption as shown by Granger causality result which supports conservation hypothesis. However, due to the level of oil consumption contributes to the shockof other variables, the policymakers should be more careful in implementing policies to reduce oil consumption.

A limitation of this study is the utilization of aggregated data of oil consumption. By using disaggregate data, the analysis can be more detail as oil is consumed by the several sectors such as industrial, transportation, household and commercial. Further research may use other variables in the analysis in order to acquire more information that may influenced by the reduction of oil consumption.

6. References

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