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CAUSALITY RELATIONSHIP BETWEEN ELECTRICITY CONSUMPTION, ECONOMIC GROWTH, INEQUALITY AND POVERTY IN INDONESIA 1971–2019

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Abstract

This study investigates the long-run relationship and causality between electricity consumption, economic growth, poverty and inequality in Indonesia from 1971 to 2019. This study employs Cointegration Test and Granger Causality Test. The cointegration test revealed a long-run relationship between variables at a 5% level in Indonesia. The Granger causality test showed that there is no causal relationship between electricity consumption and economic growth. The granger causality test also revealed a one-way relationship between electricity consumption and poverty and a one-way relationship between electricity consumption and inequality, not vice versa. This research can be used as a reference in determining electricity subsidy policies and the use of renewable energy.

Keywords: electricity consumption, granger causality, economic growth, poverty, inequality

1. Introduction

1.1 Introduce the Problem

Energy is one of the most important factors in our environment. Electrical energy is very influential in everyday life, especially in this era where much-supporting equipment needs based on electricity or using electrical energy in operation have been used. In increasing economic growth, a country needs to have adequate energy availability to encourage or support the activities of various sectors, especially the industrial sector. According to the Ministry of Industry, the industrial sector is still Indonesia's mainstay in its contribution to Gross Domestic Product (GDP) until the second quarter of 2020, 19.87 per cent. If the industrial sector activities are not run well, it will affect the economic growth. Therefore, energy becomes a very influential factor in increasing economic growth.

Economic growth and consumption of electrical energy have a causal relationship. Economic activities generate a great demand for electrical power from electricity consumption. According to Thaker (2019), there is a causal relationship between energy and GDP, which shows that economic activity highly relies on energy because energy is one of the drivers for economic

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growth. If energy poverty occurs, it will have a negative impact on economic growth or economic activity.

On the other hand, the increasing economic growth was not followed by a significant reduction in poverty and inequality. Even though the electrification ratio in Indonesia has reached 99 per cent, there are still 5 million people who still do not have access to electricity. There are significant differences in income inequality in urban and rural areas and electricity consumption in various provinces in Indonesia. The areas with a high inequality rate tend to have a low level of electricity consumption as in the Special Region of Yogyakarta (DIY), Southeast Sulawesi, Gorontalo, West Sulawesi, West Papua, Papua, North Sulawesi and West Nusa Tenggara, which have a Gini ratio above 0.25. These areas have electricity consumption levels below 2000 GWh, as revealed by figure 1

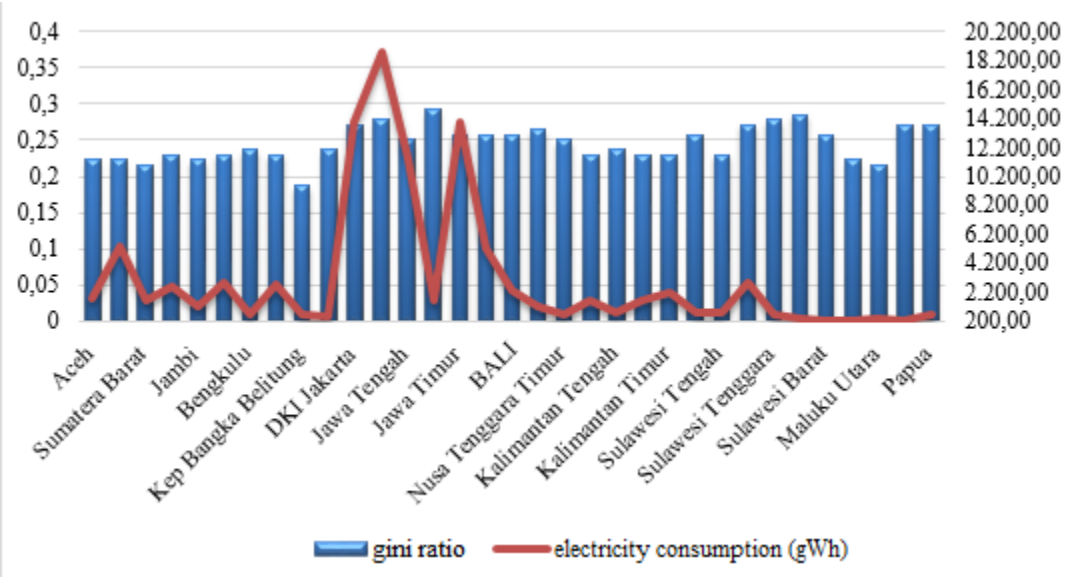

Figure 1. Gini Ratio and Household Electricity Consumption in 2019

The low consumption of electricity is one of a determinant of the high poverty rate. According to Pachauri et al. (2004), a high poverty rate can be a pattern of the quality of individual energy consumption. Given the low income of the poor, they are forced to save on the utilization of electrical energy or traditional, unreliable, and unclean (polluting) energy sources. These kinds of energy sources can affect their health and will increase the level of poverty. In Indonesia, areas that have a high percentage of poverty have a low level of electricity consumption. Areas with high poverty rates and low electricity consumption include Papua, West Papua, East Nusa Tenggara, Maluku, and Aceh. These areas have poverty rates above 15 per cent, with electricity consumption rates below 2000 GWh. See figure 2.

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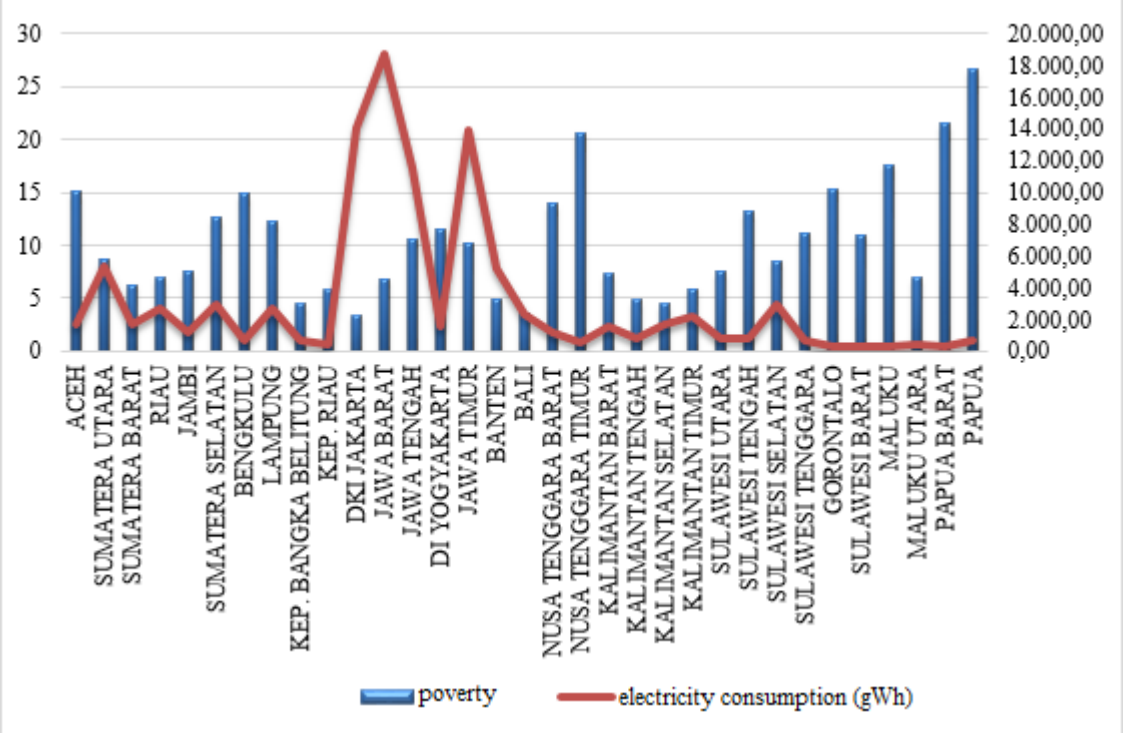

Figure 2. The poverty rate and household electricity consumption 2019

There have been many studies that discuss economic growth associated with electricity consumption, such as research conducted by Ozturk and Eventvci (2010), Thaker et al. (2019), Tang et al. (2016), Shahbaz et al. (2014), Ouedraogo (2010). According to Toman & Jenelkova (2003), most energy and economic development research discuss the effect of economic development on energy consumption, not the other way around. Many researchers regard economic growth as the main stimulus for energy demand. In addition, there are still few studies that discuss the effect of electricity consumption on inequality and poverty, especially in Indonesia. Previous research mostly only linked overall energy consumption (not electricity consumption) and access to electricity (not consumption) with income inequality and energy poverty with household energy consumption. Poverty and inequality are two interesting things to be associated with electricity consumption. Electricity has an essential role in alleviating poverty. In addition, electricity is also important for providing information, communication and education technology which plays a very important role in reducing inequality (Nerini et al.: 2018). When a country has a high electricity consumption, it can reduce the level of poverty and inequality. Therefore, based on the background described above, this research will fill the gap in the previous literature.

1.2 Literature Review

Research on electricity consumption and economic growth has been widely conducted by using data from many countries. Shahbaz et al. (2017) utilize electricity consumption, oil prices and GDP. The research found a causality relationship between electricity consumption and economic

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growth, where electricity consumption affects economic growth and vice versa in countries with upper middle income and high income: East Asia & Pacific, Europe & Southeast Asia.

Furthermore, research on electricity consumption and economic growth is also conducted by Tang et al. (2016), utilizing GDP, per capita energy consumption and foreign investment. The findings from the research showed that there is a long-run relationship between economic growth and energy consumption. Energy consumption has a positive influence on economic growth in Vietnam. A similar study was also conducted by Ouedraogo (2010), where the research utilized electricity consumption, economic growth and investment. The research revealed an insignificant relationship between electricity consumption and investment and a long-term two-way relationship between electricity consumption and economic growth.

Research by Thaker et al. (2019) utilizes economic growth and electricity consumption. The findings showed that electricity consumption has a positive and significant impact on economic growth and that electricity consumption and the economy are in long-term equilibrium. In addition, there is Granger causality in the direction of electricity consumption to real GDP but not vice versa. A similar study was also conducted by Yemane & Rufael (2014), in which the variables of economic growth and electricity consumption were used in their research. The research findings show a one-way relationship between electricity consumption and economic growth in Belarus and Bulgaria. Moreover, there is a one-way relationship from economic growth to electricity consumption in the Czech Republic, Latvia, Lithuania and Russia.

Research on electricity consumption and poverty has also been conducted, not as much as electricity consumption and economic growth. Research by Okwanya and Abah (2018) utilizes the variables of the poverty level, energy consumption per capita, GDP, capital stock and political stability. The findings of the Granger causality test show that there is a short-run unidirectional causality ranging from energy consumption to poverty. This finding clearly shows that an increase in energy consumption leads to a decrease in the poverty rate.

Islam and Ghani (2016) also researched electricity consumption and poverty by using energy consumption variables, carbon dioxide emissions, economic growth, population, poverty and forest area. The findings show that the poverty variable negatively affects energy consumption in Malaysia, the Philippines and Brunei. It shows that a 1% increase in the poverty rate will decrease the energy consumption of 61,877kg, 6,663kg, and 754,700kg in Malaysia, the Philippines, and Brunei. Furthermore, it was also found that there is a positive relationship between poverty levels and energy consumption in Singapore.

The number of research on electricity consumption and inequality are still very low compared to research on electricity consumption and economic growth. Research conducted by Medeiros and Ribeiro (2020) utilize the variables of income inequality, electricity consumption, customer satisfaction index and GDP per capita. The findings show that electricity consumption per capita has a negative and significant effect on income inequality, where the estimation results of the GMM-System model show that a 1% increase in electricity consumption per capita reduces income inequality by 0.195%. A similar study was also conducted by Dong and Hao (2018) by utilizing the rural-urban income difference and per capita electricity consumption. The research shows that the effect of urban-rural income inequality on electricity consumption depends on

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income level. Income inequality has a negative and significant effect on electricity consumption per capita.

Research on electricity consumption and inequality was also conducted by Sarkodie and Adams (2020) by utilizing income level variables, inequality in income distribution, corruption control in access to electricity. The findings show that income inequality has a positive impact on access to electricity. In other words, inequality in income distribution does not block access to electricity in South Africa. A similar study was also conducted by Bajar and Rajeev (2015) using the variables of electricity consumption, road length and income inequality. The results of his research indicate that the variable of electricity consumption has a positive and insignificant effect on income inequality. Makmuri (2017) studied infrastructure and inequality in Indonesia. The research found that the quantity of electricity has a negative relationship with inequality where it shows that the quantity of electricity can reduce income inequality.

2. Method

2.1 Variable Specification and Data Sources

This study aims to determine the causal relationship between electricity consumption, economic growth, poverty and inequality. This study utilizes secondary time series data for forty-nine years from 1971 to 2019 obtained from the World Bank and the Indonesian Central Statistics Agency. The data include electricity consumption per capita (LELEC) in kWh units, the percentage of the poor (POV), the Gini ratio (GINI) and the rate of Indonesia's Gross Domestic Product (GROWTH) 1971 - 2019.

2.2 Estimation

An econometric framework consisting of a unit root test, cointegration test, and Granger causality test are employed to analyze the relationship between variables in the study. The first stage of the unit root test was executed by employing the Augmented Dickey-Fuller test method. The unit root test was executed to avoid spurious regression. If the variable is found to have a unit root at the level, it is necessary to test it at the first difference level so that the data used in the study is stationary.

In the second stage, to determine the long-term relationship between variables in the model, it is necessary to employ a cointegration test. The Johansen test method is employed as a cointegration test in this study. The test is executed at three confidence levels, namely 1%, 5% and 10%, by comparing the trace statistic value with the critical value. Furthermore, at the last stage to determine the relationship between variables, Granger causality testing is executed, which can be shown by the equation below:

$$X_t = \sum_{i=1}^{m} a_i X_{t-1} + \sum_{j=1}^{n} b_j Y_{t-1} + \mu_t$$

$$Y_t = \sum_{i=1}^{r} c_i X_{t-1} + \sum_{j=1}^{s} d_j Y_{t-1} + v_t$$

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Where X, Y are variable, whereas μ, ν is *Error Term.* Below are several hypotheses in the Granger causality test:

- If $\sum_{j=1}^{n} b_j \neq 0$ and $\sum_{j=1}^{s} d_j = 0$, then there is a one-way causality from Y to X.
- If $\sum_{j=1}^{n} b_j = 0$ and $\sum_{j=1}^{s} b_j \neq 0$, then there is a one-way causality from X to Y.
- If $\sum_{j=1}^{n} b_j \neq 0$ and $\sum_{j=1}^{s} b_j \neq 0$ then the variables Y and X, there is no causality between one another.
- If $\sum_{j=1}^{n} b_j = 0$ and $\sum_{j=1}^{s} d_j = 0$, there is bidirectional causality between Y and X.

3. Results

3.1 Unit Root Test

It is important to do a unit root test before executing the Granger causality test to determine the stationarity of the data. If the unit root test is not executed, it will result in an inaccurate regression. In this study, the unit root test was performed using the Augmented Dickey-Fuller method.

Table 1. Unit Root Test Conclusion

Variable	Level	First difference
Lelec	-2.313057	-5.057923***
Growth	-4.849988***	-7.626803***
Pov	-3.470471**	-8.970967***
Gini	-5.434512***	-9.173721***
Critical value		
1% critical value***		-3.581152
5% critical value**		-2.926622
10% critical value*		-2.601424

The unit root test results show that there is one variable that is not stationary at the level. Therefore, it is continued at the first difference level, and the result is that all variables are stationary at the first difference level.

3.2 Cointeg

ration Test

Before the cointegration test is executed, the optimum lag selection test needs to be carried out so that the resulting residuals avoid autocorrelation and heteroscedasticity problems. The

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optimum lag selection test looks at the AIC (Akaike Information Criterion) and SC (Schwarz Criterion) criteria. In this study, the optimum lag was found to be lag 8.

After finding the optimum lag, a cointegration test can be performed to determine whether there is a long-run relationship between variables in the model. If cointegration is found, it can be concluded that there is a stable relationship between variables in the long term. In this study, the cointegration test was performed by employing the Johansen test method. The Johansen test method compares the value of the trace statistic with the max-eigen statistic at the critical value significance level.

Table 2. Cointegration Test

Hypothesized No. Of CE(s)	Eigenvalue	Trace Statistic	0,05 Critical Value	Prob.**
None *	0.885656	199.5793	63.87610	0.0000
At most 1 *	0.731068	110.6691	42.91525	0.0000
At most 2 *	0.629257	56.82390	25.87211	0.0000
At most 3 *	0.325446	16.14182	12.51798	0.0118
Hypothesized No. Of CE(s)	Eigenvalue	Max-Eigen Statistic	0,05 Critical Value	Prob.**
None *	0.885656	88.91016	32.11832	0.0000
At most 1 *	0.731068	53.84522	25.82321	0.0000
At most 2 *	0.629257	40.68207	19.38704	0.0000
At most 3 *	0.325446	16.14182	12.51798	0.0118

The cointegration test results show that the trace and max eigen statistics are greater than the critical values. Thus, it can be concluded that there is a long-term relationship between variables in the model.

3.3 Granger Causality Test

The Granger causality test was performed to determine the direction of the relationship between variables in the study. The test results can be known by reading the hypothesis in the test results table. If the value of f statistic > f table, the null hypothesis is rejected, or there is a relationship between variables. If the value of f statistic < f table, the null hypothesis is accepted, or there is no relationship between variables. The f table in this study is 2.858796

Table 3. Granger Causality

Null Hypothesis :	Obs	F-Statistic	Prob.
Growth does not Granger Cause Lelec	41	0.58773	0.7781
Lelec does not Granger Cause Growth		0.47511	0.8616
Pov does not Granger Cause Lelec	41	1.32571	0.2784
Lelec does not Granger Cause Pov		8.55080	2.1305
Gini does not Granger Cause Lelec	41	1.60158	0.1767
Lelec does not Granger Cause Gini		4.63147	0.0016

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The results of the Granger causality test show that there is no causal relationship between economic growth and electricity consumption. In addition, there is a one-way relationship between electricity consumption per capita and poverty which is not significant but not vice versa. Also, there is a one-way relationship between electricity consumption and inequality significantly and not vice versa.

4. Discussion

The unit root test revealed that all variables are stationary at the first difference level in the Augmented Dickey-Fuller test. Then the cointegration test results on the variables in the study: electricity consumption (LELEC), economic growth (GROWTH), poverty (POV) and inequality (GINI) have a long-run equilibrium relationship where the results are in line with the hypothesis in this study.

The absence of a causal relationship between electricity consumption and economic growth is not in line with the research hypothesis. However, these results align with Ozturk and Eventvci (2010) research regarding the relationship between carbon dioxide, energy consumption, and economic growth in Turkey. The results of the study indicate that there is no causal relationship between energy consumption and economic growth. In addition, these results are also in line with research conducted by Chontanawat, et al. (2008) regarding the effect of energy consumption on economic growth. The results revealed no causal relationship between energy consumption and economic growth in 51 of the 100 countries. These results indicate that the consumption of electrical energy is not the largest source of economic growth. In other words, the rate of economic growth does not depend on the level of electricity consumption. It happened because Indonesia is a developing country where the level of electricity consumption is still low. Based on data from PLN in 2016, electricity consumption per capita in Indonesia only reached 956 kWh per capita. This figure is still very far from developed countries such as the United States, which reached 12,820 kWh per capita, South Korea 10,620 kWh, Singapore 9,040 kWh, and Japan 7,970 kWh per capita.

The other results found a one-way relationship between electricity consumption and poverty and between electricity consumption and inequality. These results follow the hypothesis and are also in line with research conducted by Okwanya and Abah (2018) regarding the impact of energy consumption in reducing poverty in Africa. The results of his research show a one-way causal relationship between energy consumption and poverty in Africa. This shows that a high level of electricity consumption can reduce poverty and vice versa. The finding of a one-way relationship between electricity consumption and inequality is also following the research hypothesis. These results are also supported by Makmuri (2017) research on infrastructure and inequality in Indonesia. The research results show that the variable quantity of electricity has a negative influence on income inequality. Thus, it can be concluded that an increase or decrease in electricity consumption in Indonesia has a relationship with an increase or decrease in poverty and inequality in Indonesia.

This study aims to determine the relationship between electricity consumption and economic growth, poverty and inequality in Indonesia. Although many previous studies and relevant literature have found a relationship between electricity consumption and economic growth, this

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study cannot prove a relationship between electricity consumption and economic growth in Indonesia. However, this is supported by research conducted by Chontanawat et al. (2008). The research revealed that a causal relationship between energy consumption and economic growth was more common in developed countries than in developing countries. By analyzing whether or not there is a relationship between electricity consumption, economic growth, poverty and inequality, it can be seen that electricity consumption is not the biggest factor in increasing economic growth. Furthermore, it can be seen that electricity consumption can be a factor that can reduce poverty and inequality in Indonesia.

5. Conclusion and Recommendation

Based on the analysis of the cointegration test, it can be seen that the variables in the study, namely electricity consumption per capita, economic growth, poverty and inequality, have a long-term relationship. Granger causality test results show that the variable electricity consumption has no relationship with the variable economic growth, and the variable electricity consumption has a one-way relationship with the variables of poverty and inequality. This study's results follow the hypothesis except that there is no relationship between electricity consumption and economic growth. Moreover, the results of this study are supported by previous studies that have been described in the previous chapter.

This study recommends that the government encourage more and more efficient electricity consumption for both households and non-households. Thus, Indonesia's electricity consumption continues to increase so that it can increase economic growth. It should be noted that Indonesia's electricity consumption is still very low compared to developed countries, where electrical energy is an important factor in increasing economic growth. An adequate supply of electricity should also follow the encouragement to increase electricity consumption. It is hoped that electricity providers in Indonesia can assist the government in increasing the electricity consumption of the Indonesian people. In addition, the supply of electrical energy is expected to use renewable energy, such as nuclear energy, where the energy is cleaner and will minimize carbon emissions. In that way, the government's efforts and policies can be realized because of the support and contribution of electricity providers in Indonesia.

In addition, the government is expected to facilitate access to electricity in Indonesia. Ease of access includes adequate supply, affordable tariffs and increased electrification ratio. When the supply of electrical energy is adequate, the community does not lack access to electricity. Likewise, with affordable tariffs and increasing electrification ratios so that no more Indonesian people do not have access to electricity, people can have easy access to electricity. With the ease and even distribution of electricity access for the community, electricity consumption can continue to increase to reduce poverty and inequality in Indonesia.

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