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## Article

# Does electrification affect rural poverty and households' non-food spending? Empirical evidence from western Indonesia

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## DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

# Does electrification affect rural poverty and households' non-food spending? Empirical evidence from western Indonesia

Ikhsan Ikhsan<sup>1\*</sup> and Khairul Amri<sup>2</sup>

**Abstract:** The study aims to determine the effect of electrification on rural poverty and households' non-food spending (NFS). Using a cross-province dataset of western Indonesia from 2007 through 2017, an econometric model was used to analyze the causal relationship between the variables. The econometric model is a panel cointegration test, panel VECM, and Granger causality tests. The study pointed out three main findings. Firstly, there is a long-run equilibrium relationship between rural poverty and households' NFS and electrification. In the long run, the electrification program has a negative and significant on households' NFS. Secondly, in the short run, electrification significantly reduces poverty and increases households' NFS. Thirdly, the Granger causality test pointed out that there is one-way causality from electrification to rural poverty and households' NFS. The rural poverty reduction and the raising households' NFS are positive impacts of the electrification program. Therefore, the local governments in western Indonesia should be electrification programs as one of the strategic options for rural poverty reduction in the region.

**Subjects:** Development Policy; Rural Development; Macroeconomics

**Keywords:** electrification; rural poverty; household's non-food spending; panel vector error correction model; Granger causality test

**JEL Classification:** I32; I38; D1

### ABOUT THE AUTHORS

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### PUBLIC INTEREST STATEMENT

Poverty alleviation has become a major issue in the economic development programs of Indonesia. Given that most of the poor live in rural areas, the Indonesian government has designed various development programs to reduce the rural poverty rate. One of the rural infrastructure development programs is related to the provision of electrical energy resources. Using cross-provinces data from Western Indonesia, the study proved that electrification significantly reduces rural poverty, and increases the share of household spending on non-food goods. In other words, decreasing poverty reduction and increase in household non-food spending are the real impacts of the electrification program.

## 1. Introduction

So far, several social-economic researchers have found empirical evidence regarding the economic impact of rural electrification. Electrification has a significant effect on changes in the socio-economic circumstances of society. In particular, for the rural region, electrification improves the better social-economic lives of the community. The socio-economic improvement of electrification is related to three categories pertains to education, health, and the increase in potential income (Peters & Sievert, 2015). Besides improving communities' welfare, rural electrification also affects the household's spending. In particular, for the higher-income community, electrification affects the household's consumption pattern. From the macroeconomic perspective, rural area electrification may drive employment and reduce the poverty rate. Therefore, in most developing countries, the government implements an electrification program to be a competitive strategy for poverty eradication. The provision of this energy source is the main infrastructural development program for poverty eradication (Bah & Azam, 2017; Ding et al., 2018; Vernet et al., 2019).

The role of electrification in poverty reduction and its impact on the pattern of household expenditure has been a focus of social and economic researchers. However, the results of their study were still confusing and have not been providing fixed conclusions yet. Electrification not only has a positive impact on household expenditure but can also drive rural poverty reduction (Cook, 2011). Previously, Haanyika's (2008) study also pointed out that electricity effectively increases the activities of communities. In rural areas with most of the population working in the agricultural sector, electricity makes agricultural activities easeful. The irrigating of agricultural land and the processing of agricultural commodities will be extremely easy to do by farmers because of the availability of electricity. Electricity is beneficial for rural communities (Thomas & Urpelainen, 2018).

In contrast to these researchers, several research studies prove that electricity does not contribute to increasing income and reducing poverty. Electrification does not seem to have a significant impact on the growth of income-generating activities (Wamukonya & Davis, 2001). Electricity can encourage increased use of electronic devices, but it cannot increase income and reduce poverty (Bensch et al., 2011). An empirical study conducted by Lenz et al. (2017), for the case of OECD countries, found that electricity facilitates people's life, but there is weak evidence for effects on social-economic indicators such as health, education, and income.

In the Indonesian economy, the government's efforts to improve people's welfare have been implemented through developing electricity infrastructure. Although the rural electrification program has long been carried out by the government, the availability of this energy source has not been enjoyed by all groups of society. In western Indonesia, for example, until 2017, on average, electrified households were only 92 percent of the total household. This means that there are still many rural households that have not received electricity services. Indonesian Central Bureau of Statistics (2018) documents that the poverty rate and rural household expenditure in western Indonesia also differ from one province to another. The highest-poverty provinces, namely Aceh (15.92%), Bengkulu (15.59%), and Lampung (13.04%). On contrary, for the same period, the lowest-poverty provinces are West Sumatra (6.75%), Riau (7.41%), and Jambi (7.9%). Regarding the structure of household spending, statistical information classifies the spending into two categories that are food spending and non-food spending. Household expenditure on food needs is higher than non-food needs. Although non-food expenditure is a smaller portion compared to food expenditure, the allocation of total household income for providing non-food goods also differs between provinces.

A phenomenon of poverty and household spending in western Indonesia can be related to the accessibility of the community to sources of electrical energy. It is very reasonable because the development of rural electricity infrastructure aims to improve community welfare. Considering the study of the economic impact of electrification on rural communities in the region has never been disclosed in an empirical study, the current research investigates the existence of this energy source in reducing poverty and affecting household spending. The research findings regarding the relationship between electricity and these two variables still provide confusing conclusions and

show contradictory results. Therefore, it is important to re-examine the impact of electricity on poverty and household spending in western Indonesia. In contrast to previous studies, our study analyzes the long and short-run effects of electricity on poverty reduction and household non-food spending. By employing a panel granger causality test econometric model, our research also reveals the direction of causality between the variables.

This paper is systematically arranged into five sections. The first section is the background of the study. The second section is a literature review containing related studies regarding the relationship between the variables studied. The third section deals with research methods containing information on data sources and econometric methods used to analyze the relationship between variables. Furthermore, the fourth section is the results and discussion. The final section highlights practical conclusions and recommendations for policymakers.

## **2. Literature review**

### **2.1. The links between electrification and poverty**

Most researchers have evidence that electricity has a positive impact on people's lives. The energy sources not just affect the economic dimension but also affect the social and cultural sectors. For instance, a research study conducted by Riva et al. (2018) suggests that electricity use has a direct causal relation with people's live dimensions. For instance, the change in income-generating activities and the improvement of the socio-economic effect of electrification is the real impact of electricity. The electric program could affect the production capacity of the enterprise, household economy, technology development, child educational methods, social networks, and other variables. Several research studies address the role of electrification programs as the strategic program of the government to increase economic growth and reduce the poverty rate (Pueyo & Maestre, 2019). For a rural community, the availability of electricity can encourage economic and social development by increasing productivity, creating jobs, and reducing the workload of families. Even rural electrification will reduce household spending on energy, in particular for the p of communities, and it will improve the productivity of income-generating activities. Electrified households can work longer and allow them to generate more income (Kim, 2015).

Studies on the relationship between electrification and poverty have been a focus by economic researchers (Wamukonya & Davis, 2001). Empirical research conducted by Tegene et al. (2015) in Ethiopia discovered that the impact of electricity on poverty reduction is positive and significant. Previously, Yang's (2003) study for the case of Hebei and Henan provinces, China, also proved the positive impact of electricity on poverty reduction. That shows that access to energy sources significantly affects poverty reduction. The accessibility to electric energy leads to an increase in the economic activities of a community. Also, it can encourage entrepreneurial activities and expand employment opportunities and income (Ghosh, 2009). Communities living in the electrified area have better welfare rather than those living in unelectrified areas (Vernet et al., 2019).

### **2.2. The links between electrification and household consumption**

Electricity has direct and indirect effects on the social and economic aspects of rural society. Even over the past century, rural electrification has been the key determinant of economic development and the social progress of rural areas (Lee et al., 2019). Electrification programs reaching more poor households significantly affects the prosperity of the rural poor . The direct impact of the program is economically reflected in increased income, employment opportunities, and patterns of household consumption expenditure (Barkat et al., 2002).

The existence of causal relations between electrification and household consumption spending has been clear in previous research findings. For instance, empirical research conducted by Tegene et al. (2015) for the case of northern Ethiopia concluded that most electrified households noted that electric energy sources significantly improve the quality of their life, in particular, regarding consumption. Previously, an economic survey programmed by the Asian Development Bank (ADB)

(2010) for the case of central and western Bhutan showed that electrified households enjoy a better quality of life. The empirical result of the economic survey also noted that most of the economic, social, and environmental outcomes of electrified households are better than unelectrified households.

Access to electricity has a significant impact on household consumption patterns. The results of the study of Barkat et al. (2002) for the case of Bangladesh found that electrification has acted as a driver for improving the consumption of rural households. A research study conducted by Costello (2018) concerning the causal relations between consumer behavior and the electrification program also pointed out that access to electricity encourages households to make requests for electronic devices. This thing explicitly shows that the demand for non-food goods is also increasing. The impact of electrification on household consumption was also supported by the study of Zhang et al. (2017), which concluded that there is a causal relationship between electricity and household consumption.

### **2.3. The links between poverty and household consumption**

The effort to improve the standard of living is a fundamental requirement of the people (Hussein & Filho, 2012). However, some community groups have lower ability for their daily primary needs. They are people living in the poverty circle. Poverty is defined as inadequate access to fundamental aspects of life's primary needs, such as food, clothing, sanitation, shelter, health care, education, and so on. This thing is reflected as people suffering from insufficient circumstances. Poverty harms various aspects of community life (Amri et al., 2019; Muliadi & Amri, 2019). The negative impact of poverty directly affects consumption (Lee et al., 2019). The poverty experienced by rural communities makes their quality of life worse.

Studies on the relationship between consumption and poverty have been carried out by previous researchers. Research findings of Balaji et al. (2017) for the case of Tamil Nadu communities, India, found that household income affected consumption patterns. The rising income affects the household's consumption spending. In line with the findings of Balaji et al., empirical research conducted by Da Silveira Bezerra et al. (2017) also pointed out that there is a difference between the quality of consumer goods between the poor and the rich.

### **3. Data and methods**

This research study uses a panel data set, that is the combination of annual time-series data from 2007 to 2017 and cross-section data of 8 provinces in western Indonesia. All the data was sourced from the Indonesian Central Bureau of Statistics. The study operates three variables, namely rural poverty, electrification, and household non-food spending. The poverty rate is proxies by the annual poverty rate, which is that a poor people to total population ratio measured by percent. Electrification is proxies by an electrified household to total household ratio. This variable also is measured by percent. Further, the household's non-food spending is the proportion of household expenditure allocated to non-food spending that is also measured by percent. Three secondary data then were transformed into the logarithmic form. The transformed process does so that the estimation coefficient of an exogenous variable on other endogenous variables enable interpreted as the elasticity of those.

Data processing is statistically conducted through several steps. The first step is to conduct a data stationary test. This test is to detect whether each data has been free of unit root symptoms. The method used for unit root tests comprises LLC, IPS, ADF-Fisher, and PP-Fisher. Implementation of this method to test data stationery has also been carried out by several previous researchers (Ehigiamusoe et al., 2018; Hayakawa, 2016; Wang et al., 2018). The second step in the data analysis is to test the co-integrating sign of the variables studied. The concept of cointegration is most relevant to determining the long-run relationship between the variables (Granger, 1969). A basic idea that underpins cointegration is conceptually simple. If the difference "between two non-stationary series" is stationary, showing that the two series are cointegrated. If

two or more series are cointegrated, it is possible to interpret the variables in these series as being in a long-run equilibrium relationship (Engel & Granger, 1987). The absence of cointegration statistically shows that the variables have no long-run relationship. In this respect, the cointegration test refers to Pedroni's (1999) cointegration test and Kao's (1999) cointegration test.

Further, the third step, followed by the analysis model employed to investigate the relationship between variables. In this respect, the dynamic model of the econometrics, i.e. the panel vector error correction model (PVECM) is then used to analyze the relationship between rural poverty, household non-food spending, and electrification. The econometric model combines the traditional VAR approach, putting all the variables in the system as endogenous (Grossmann et al., 2014; Kumar Mandal & Madheswaran, 2010; Yasar et al., 2006). One of the three variables can be positioned as endogenous variables alternately, and the others as exogenous. Before applying the PVECM as a data analysis approach, we first determine the optimal lag length by using the Akaike information criterion (AIC). Econometrical, the PVECM model application to examine the causality relationship between the three variables is planned as follows:

$$\Delta \log \text{POV}_{it} = \alpha_0 + \sum_{j=1}^n \beta_{1j} \Delta \log \text{POV}_{i,t-j} + \sum_{j=1}^n \beta_{2j} \Delta \log \text{NFS}_{i,t-j} + \sum_{j=1}^n \beta_{3j} \Delta \log \text{EL}_{i,t-j} + \gamma e_{i,t-1} + \mu_{it}$$

$$\Delta \log \text{NFS}_{it} = \alpha_0 + \sum_{j=1}^n \beta_{1j} \Delta \log \text{POV}_{i,t-j} + \sum_{j=1}^n \beta_{2j} \Delta \log \text{NFS}_{i,t-j} + \sum_{j=1}^n \beta_{3j} \Delta \log \text{EL}_{i,t-j} + \gamma e_{i,t-1} + \epsilon_{it}$$

$$\Delta \log \text{EL}_{it} = \alpha_0 + \sum_{j=1}^n \beta_{1j} \Delta \log \text{POV}_{i,t-j} + \sum_{j=1}^n \beta_{2j} \Delta \log \text{NFS}_{i,t-j} + \sum_{j=1}^n \beta_{3j} \Delta \log \text{EL}_{i,t-j} + \gamma e_{i,t-1} + \epsilon_{it}$$

Where  $\Delta$  denotes the first difference operators,  $\log \text{Pov}$  is the logarithmic value of rural poverty,  $\log \text{NFS}$  is the logarithmic value of household's non-food spending and,  $\log \text{EL}$  is the logarithmic value of electrification,  $i$  stand for the province of  $i$ ,  $t$  represents the period of  $t$ , and  $j$  represents the optimal lag length of the dynamic model.  $\alpha$  and  $\beta$  are constants to be estimated, as well as,  $\mu$ ,  $\epsilon$ , and  $\epsilon$  denotes a stochastic error term of the equation, respectively.

The model above can avoid the loss of short-run information. The short-run deviations towards long-term equilibrium are directly adjusted to long-run equilibrium. Therefore, the error term allows the imbalance proportion of the next period can be corrected (Nazamuddin & Amri, 2020). The term of error correction model (ECM) is represented by the coefficient of  $\gamma$  if the variables are cointegrated with one another.

To determine the causal relations among the variables then be analyzed by the Granger causality test. The test enables the identification of the direction of the causal relations, thus can be known whether electrification cause poverty and non-food spending or if poverty and non-food spending are a cause of electrification. To find the statistical evidence to answers the questions, we apply a Chi-square (Wald) test to evaluate the significant influences of a certain endogenous variable on the exogenous variable (Adnan & Amri, 2021). If the result of the test provides statistical information on the reciprocal and significant effects of the two variables, then that thing explains that a bidirectional causality exists between the two variables (Adnan & Amri, 2021; Hasyim et al., 2019).

## 4. Result and discussion

### 4.1. The result of descriptive statistics

As previously explained, the variables operationalized in this study comprised electrification, rural poverty, and household non-food spending. Electrification in a particular province is proxies by the electrified households to total household ratio, which is then measured by



a percent. Rural poverty is proxies by the poor to total population ratio, which is also expressed by percent. Likewise, non-food spending is the percentage of total household expenditure allocated for non-food purchasing.

Empirical data relating to these three variables shows that electrification, rural poverty, and household non-food spending differ by region. The differences are because of many factors such as economic, social, and cultural aspects of the community. Regarding electrification, the result of descriptive statistics shows a maximum and minimum value amount of 98.32 percent and 77.34 percent, respectively. On average, the electrified household amount to 92.56 percent of the total household. With the poverty rate, the maximum and minimum values are 29.87 percent and 6.57 percent, respectively. On average, the poverty rate during this period was 13.97 percent. For more details regarding the result of descriptive statistics, as shown in [Table 1](#).

The proportion of household expenditures for non-food spending also differs by province. As in [Table 1](#) above, the maximum and minimum value of the non-food spending is 46.68 percent and 32.99 percent, respectively. On average, the proportion of household expenditure for non-food needs is 40.11 percent. This respect indicates that most household expenditures meet food needs. Meanwhile, non-food spending is a small proportion of household total spending.

[Table 1](#) above also shows the direction of the relationship between variables. Electrification has a relatively weak negative relation with poverty shown with a correlation coefficient of  $-0.192$ . Likewise, non-food spending with a correlation coefficient of  $-0.129$ . The relationship between poverty and non-food spending is relatively strong negative with a correlation coefficient of  $-0.318$ . These statistical number indicates that a significant increase in poverty has an impact on reducing non-food consumption. In other words, there is an inverse relationship between poverty rates on the one hand and non-food spending on the other.

#### 4.2. The result of the panel unit root test

Considering that the data operationalized in this study is panel data, which is a combination of cross-section data and time-series data, the stationarity test uses two methods consisting of the Levine-Lin-Chu (LLC) method and Im-Pesaran-Shin (IPS) method (Im et al., 2003). Besides being useful for testing data stationarity, the LLC method checks for heterogeneity of intercepts across members of the panel, while the IPS detects heterogeneity in intercepts and slope coefficients. Both tests were

**Table 1. The result of descriptive statistics and correlation matrix**

	Household's Non-Food Spending (%)	Poverty Rate (%)	Electricitified Household (% of total household)
<b>Descriptive Statistics</b>			
Mean	40.109	13.969	92.563
Median	40.140	13.578	94.375
Maximum	46.680	29.870	98.320
Minimum	32.990	6.670	77.340
Observations	88	88	88
<b>Correlation Matrix</b>			
Household's non-food spending (%)	1.000		
Poverty Rate (%)	$-0.318$	1.000	
Electrified household (% of total household)	$-0.129$	$-0.192$	1.000

Source: Author's Computation using E-views 9.0.



applied by intermediate ADF and Phillips-Perron (PP) cross-section unit tests (Cerrato & Sarantis, 2007; Herwartz et al., 2014; Kyophilavong et al., 2019; Maddala & Wu, 1999). Eventually, the unit root test in this study used four methods consisting of LLC, IPS, ADF-Fisher, and PP-Fisher. The initial hypothesis was that there were no unit root symptoms. The hypothesis testing refers to the p-value generated by the econometrical testing with the provision is that if the  $p\text{-value} > 0.05$ , the initial hypothesis is rejected. This statistics result reflects the symptom of a unit root. An opposite interpretation will appear if only the  $p\text{-value} < 0.05$ . In other words, the hypothesis is accepted and indicates that there are no unit root symptoms. In other words, the data stationarity condition had been fulfilled. The results of the unit root test panel are shown in Table 2.

Table 2 above shows that at the level data, there are several statistical tests with a  $p\text{-value} > 0.05$ . That informs that more of the data have unit root symptoms or are not stationary at the data level. Then the unit root test was carried out on the first difference data. At this stage, all data has a  $p\text{-value} < 0.05$ . This thing indicates that all variables enabled stated to be stationary in the first difference.

#### 4.3. The result of the cointegration test

Because the data is stationary in the first difference, the next process and part of the data processing step is to detect whether a long-term relationship exists between poverty, non-food spending, and electrification. Given the operational data is panel data, the test uses three statistical approaches of Pedroni's cointegration test, Kao's, and Johansen-Fisher's cointegration test. The third approach utilizes to determine the number of cointegrating equations.

Pedroni (1999) suggests seven statistical tests to determine panel cointegration. The statistical methods are divided into two groups. The first group comprises panel v-statistic, panel rho-statistic, panel PP-statistic, and panel ADF-statistics. All the statistical test is termed "within-dimension" (Panel test). The second group of tests comprises group rho-statistic, group PP-statistic and group ADF-statistic, which is termed "between-dimension" (group test). The null hypothesis proposes no cointegration relationship between electrification, poverty, and non-food spending. Further, the alternative is that there is a cointegration relationship between the three variables. Acceptance of one of the two hypothesis statements based on the p-value resulted through E-view's output with the provision is that the  $p\text{-value} < 0.05$ , the alternative hypothesis is accepted, and the null hypothesis is not supported. The alternative is not accepted, and the null hypothesis is supported when the  $p\text{-value}$  is  $> 0.05$ . The result of Pedroni's and Kao's cointegration test such as shown in Table 3.

Table 3 shows the results of Pedroni's (1999) panel cointegration tests provide  $p\text{-values} < 0.05$ . Furthermore, Kao's cointegration test also points out a  $p\text{-value} < 0.05$ . These two tests lead to the interpretation of the strong evidence of the empirical existence of long-run cointegration relationships between the three variables. This finding is in line with Ghosh's (2009) research on the case of the Indian economy which concludes that there is a long-run relationship between electricity and communities' welfare.

Because of three variables have a long-run equilibrium relationship, it is necessary to determine the number of cointegration equations. In this case, we employ the Johansen-Fisher panel cointegration test. The results of the test, as shown in Table 4.

Based on the Table 4 above, can conclude that at least there are two co-integration equations. Hence, we have to employ the panel vector error correction model (PVECM) as means of data analysis.

#### 4.4. The result of optimal lag length

The tests used were determined based on informational criteria—the Akaike information criterion (AIC), Hannan-Quinn (HQ), and Schwarz information criterion (SC), taking into consideration that if the number of lags is too small then the model does not capture all the information while if there are too many lags then the degree of freedom is wasted. Different information

**Table 2. The result of the panel unit root test**

Variables	Test for a unit root in	Include in test equation	Test Type			
			LLC	IPS	ADF-Fisher	PP-Fisher
Poverty Rates(logPOV)	Level	Intercept	[-4.528] (0.000)	[-1.727] (0.042)	[26.906] (0.042)	[54.157] (0.000)
		Intercept & trend	[-2.641] (0.004)	[0.099] (0.539)	[14.110] (0.590)	[23.239] (0.107)
	1 <sup>st</sup> difference	Intercept	[-3.799] (0.000)	[-1.675] (0.047)	[26.929] (0.042)	[-2.125] (0.017)
		Intercept & trend	[-3.757] (0.000)	[-0.112] (0.456)	[16.839] (0.396)	[-0.411] (0.341)
Non-Food Spending(logNFS)	Level	Intercept	[-6.632] (0.000)	[-3.244] (0.000)	[40.598] (0.000)	[31.397] (0.012)
		Intercept & trend	[-8.663] (0.000)	[-1.775] (0.038)	[36.488] (0.003)	[27.423] (0.037)
	1 <sup>st</sup> difference	Intercept	[-4.115] (0.000)	[-2.226] (0.013)	[31.107] (0.013)	[-2.760] (0.003)
		Intercept & trend	[-2.734] (0.003)	[-0.042] (0.483)	[15.700] (0.474)	[-0.413] (0.339)
Electrification(logEL)	Level	Intercept	[-6.838] (0.000)	[-2.341] (0.009)	[34.187] (0.005)	[75.260] (0.000)
		Intercept & trend	[-1.457] (0.073)	[1.284] (0.901)	[4.816] (0.997)	[23.839] (0.093)
	1 <sup>st</sup> difference	Intercept	[-8.602] (0.000)	[-5.269] (0.000)	[59.509] (0.000)	[-5.229] (0.000)
		Intercept & trend	[-8.618] (0.000)	[-2.442] (0.007)	[44.446] (0.000)	[-4.023] (0.000)

Source: Authors' Computation using E-views 9.0

Number in bracket [] are W-stat for both ADF-Fisher and PP-Fisher, and Z-stat for both ADF-Cho and PP-Cho; number in parentheses () are p-value; p-value < 0.1 indicate significant at 90 percent level; and p-value < 0.05 indicate significant at 95 percent level.

**Table 3. The result of Pedroni's and Kao's cointegration test**

**Test Methods**

Pedroni's Test	Panel Cointegration Statistics (Within-Dimension)				
	Test statistics	Trend assumption			
		No deterministic trend		Deterministic intercept and trend	
		t-statistics	p-value	t-statistics	p-value
	V-Statistic	-2.759	0.032	-3.497	0.044
Kao's Test	Rho-Statistic	-3.348	0.016	-2.689	0.032
	PP-Statistic	-2.322	0.043	-2.315	0.041
	ADF-Statistic	-2.429	0.037	-3.346	0.046
	Group Mean Panel Cointegration Statistics (Between-Dimension)				
	Rho-Statistic	-2.600	0.012	-2.378	0.021
	PP-Statistic	-1.429	0.076	-6.998	0.000
	ADF-Statistic	-4.309	0.002	-5.661	0.000
	Null Hypothesis	T-Statistic	P-value		
	No cointegration	-2.208	0.014		
	Residual Variance	0.003			
	HAC variance	0.002			

Source: Authors' Computation using E-views 9.0

Ho:no cointegration; p-value < 0.05 indicate the rejection of null hypothesis at 95% confidence interval.

**Table 4. Johansen-Fisher panel cointegration test**

Null Hypothesis	Alternative Hypothesis	Fisher Stat.* (from trace test)		Fisher Stat.* (from max-eigen test)	
		Trace test	P-value	Max-eigen test	P-value
Deterministic trend specification: linear trend in data; intercept no trend					
r = 0	r ≠ 0	73.68	0.000	73.68	0.000
r ≤ 1	r > 1	31.63	0.000	20.05	0.010
r ≤ 2	r > 2	29.46	0.000	29.46	0.000
Deterministic trend specification:: linear trend in data; intercept & trend					
r = 0	r ≠ 0	36.84	0.000	36.84	0.000
r ≤ 1	r > 1	526.8	0.000	36.84	0.000
r ≤ 2	r > 2	13.75	0.008	13.75	0.008

Source: Authors' Computation using E-views 9.0

\* Probabilities are computed using asymptotic Chi-square distribution

criteria suggest different optimal lag lengths for the VAR model, as shown in Table 5. The standard information criteria of Hannan-Quinn (HQ) and Akaike information criterion (AIC) shows an optimal lag length of 1, respectively. Information criteria of Schwarz information criterion show an optimal lag length of 1. In this respect, the information criteria are based on HQ and AIC.

As previously explained, the three variables achieved stationarity after first differencing. In addition, these variables are also co-integrated with each other in a long-term equilibrium relationship. Furthermore, the statistical optimal lag test results show an optimal lag length of 3. Finally, we use the lag length of 3 to analyze the short-term and long-term relationships between variables. The co-integrating equation and error correction model represent the long and short-term relationship, as seen in Table 6.

**Table 5. The optimal lag length**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	222.6583	NA	2.19e-10	-13.72864	-13.59123*	-13.68310
1	225.6588	5.250891	3.20e-10	-13.35368	-12.80402	-13.17148
2	238.3244	19.78999	2.59e-10	-13.58278	-12.62089	-13.26394
<b>3</b>	<b>257.6144</b>	<b>26.52380*</b>	<b>1.42e-10*</b>	<b>-14.22590*</b>	<b>-12.85178</b>	<b>-13.77042*</b>
4	266.1831	10.17529	1.59e-10	-14.19894	-12.41258	-13.60681
5	273.2899	7.106768	2.07e-10	-14.08062	-11.88201	-13.35184
6	276.8516	2.893917	3.70e-10	-13.74073	-11.12988	-12.87531

\* indicates lag order selected by the criterion; LR: sequentially modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

#### 4.5. The result of panel vector error correlation model

As explained earlier, three variables have a long-run equilibrium relationship, as shown in the results of the cointegration test in Table 4 earlier. Referring to the statistical information, we then apply the vector error correction model to explore the dynamic relationship between variables. This econometric model allows us to obtain statistical information regarding the long-run and short-run relationships of the three variables (Amri, 2018; Amri et al., 2019; Ikhsan et al., 2020). Besides, the econometric model also provides information in terms of the short-run causality effects of the related variables. The long-run relationship is econometrically reflected in the cointegrating equation. Then, the information regarding the short-run relationships is shown at the error correction section.

The result of the Johansen Fisher panel co-integration test shows that there are at least two co-integration equations related to the functional relationship between electrification, rural poverty rate and household non-food spending. Based on the PVECM results, the two equations are as in Table 6.

The first co-integration equation represents the long-run equilibrium relationship between the poverty rate and electrification. Electrification positively affects the poverty rate, but the effect is insignificant. This thing is statistically shown by the estimated coefficient of 0.668 (t-stat of 0.888). In the long term, the electrification program could not lead to poverty reduction in western Indonesia. A negative and significant impact of the program on the poverty rate exists in the short run. In statistics, that is as shown by the error correction coefficient of -1.005 (t-stat of -3.652). This finding is surprisingly and not in line with the findings of Okwanya and Abah (2018) for the case of African countries that have discovered the opposite result, where the significant impact of electricity programs on poverty reduction has been empirical facts for the long term. Meanwhile, in the short run, the program does not have a significant effect on poverty.

The second equation represents a long-run relationship between electrification and household non-food spending. In the long run, there is a negative relationship between the two variables. The better the energy programs caused to decrease in the poverty rate. The estimated coefficient of -0.558 (t-stat = -2.031) is statistical evidence of the negative relationship. The direction of the

**Table 6. The co-integrating equation and error correction**

	Co-integrating Equation	Error Correction
CointEq1	$\Delta LPOV = -0.028 + (0.698)\Delta LEL_{t-1}$ [0.888]	(-1.005)[-3.652]**
CointEq2	$\Delta LNFS = 0.020 - (0.558)\Delta LEL_{t-1}$ [-2.031]*	(-3.189)[-5.344]**

Estimated coefficient in (); t-statistics in []; \* indicates the significant at 95% level; and \*\* indicates the significant at 97.5% level.

relations indicates that the availability of electricity sources in rural areas does not lead to changes in the household's spending patterns. In general, rural communities still encounter to fulfill their basic needs, in particular food needs. The presence of electricity as a source of lighting encourages improvements in the quality of their consumption. Although the availability of energy sources impacts a household's demand for electronic goods, for example, this does not mean a contraction in food demand. So that electricity does not create a trade-off between food and non-food spending among rural households.

In the short term, the relationship between electrification and non-food spending is negative. The indications as shown by the coefficient estimate of the error correction section of  $-3.189$  ( $t\text{-stat} = -5.344$ ). When the household non-food spending lies above the long-run equilibrium, then the electrification will decrease significantly in the next period. This thing is because the electrification program is related to the rural electricity installation program. The program is not a routine activity, and the installation of electricity does not occur repeatedly. Areas with households already electrified for a certain period will no longer be re-installed in the next period. In other words, the electricity program will not take place in the same settlement for different periods. The electrified household has had non-food items such as electronics, for example, in the early stages of electrical installation. That is, at this stage, they make requests for non-food goods which are generally durable. On the other hand, the electrification program is no longer in that area. This thing explains the negative relationship between NFS and electrification in the short term.

#### **4.6. The short-run effect between the variables**

The PVECM results show that electrification has a negative effect on the poverty rate for the 2-period horizon. Electrification in the period of  $t$  significantly reduces the poverty rate for two periods later ( $t + 2$ ). This finding explains that the poverty reduction impact of the rural electrification program exists after the second period. In the early period, the availability of electrical energy in rural areas could not be used by the community to increase productive economic activities. But this energy source is useful for consumptive activities only. The negative poverty-electrification nexus is consistent with the error correction value previously explains that, in the short run, there is a negative and significant relationship between electricity and poverty.

This finding confirms the results of Yang's (2003) study on China's economy that reveals that the supply of electricity has a significant impact on poverty reduction. This energy source increases labor participation in productive economic activities for both men and women further may drive poverty alleviation. The empirical result of this study supports the research finding of Khandker et al. (2012) pointed out that rural electrification increases the labor supply of the rural community, which the rural poverty decreases. For more detail, the relationship between the poverty rate, non-food spending, and electrification is given in Table 7.

The effect of the electrification on the household's non-food spending is positive and significant at the lag of 1. But it is positive and insignificant at the lag of 2. This respective shows that the availability of electricity in rural areas can significantly increase the non-food consumption of rural communities. Rural electricity lead to a change of the consumption patterns of the people. The portion of rural households' expenditure on non-food goods is a positive response from the community to the electricity supply in rural areas. The logic underlying this reasoning is that the availability of electricity affects the emergence of the need for a better life, so rural households want to own several non-food items.

These empirical findings support the empirical findings of Wamukonya and Davis (2001) studies for the case of Namibians pointed out that electrification has improved household welfare. Most electrified households note that electrification has resulted in positive changes in their life. The positive change among others, such as the shifting of consumption spending from food needs to non-food needs. Ownership of air conditioners, freezers, fans, refrigerators, and television, for example, reflects people's response to the availability of electrical energy sources (Sakah et al.,

Table 7. The summary of PVECM

Exogenous Variable	Endogenous Variable									
	$\Delta(\Delta\log\text{POV})$				$\Delta(\Delta\log\text{NFS})$				$\Delta(\Delta\log\text{EL})$	
	Estimate Coeff	Stand errors	t-stat		Estimate Coeff	Stand errors	t-stat		Estimate Coeff	Stand errors
$\Delta(\Delta\log\text{POV}(-1))$	0.008	0.244	0.034		-0.248	0.257	-0.966		0.133	0.085
$\Delta(\Delta\log\text{POV}(-2))$	-0.033	0.214	-0.154		-0.409	0.225	-1.822		0.172	0.074
$\Delta(\Delta\log\text{POV}(-3))$	-0.136	0.161	-0.847		-0.236	0.169	-1.395		0.037	0.056
$\Delta(\Delta\log\text{NFS}(-1))$	0.229	0.439	0.520		1.724	0.462	3.728		-0.243	0.153
$\Delta(\Delta\log\text{NFS}(-2))$	0.175	0.339	0.516		0.928	0.356	2.610		-0.186	0.117
$\Delta(\Delta\log\text{NFS}(-3))$	0.105	0.191	0.547		0.328	0.201	1.632		-0.103	0.066
$\Delta(\Delta\log\text{EL}(-1))$	-0.779	0.525	-1.486		1.393	0.551	2.526		-1.281	0.182
$\Delta(\Delta\log\text{EL}(-2))$	-1.045	0.487	-2.145		0.123	0.512	0.240		-0.942	0.168
$\Delta(\Delta\log\text{EL}(-3))$	-0.798	0.414	-1.930		0.008	0.435	0.018		-0.396	0.144
C	-0.014	0.015	-1.153		-0.019	0.013	-1.572		-0.009	0.004
	R <sup>2</sup> Adj. R <sup>2</sup> F-statistic Akaike AIC Schwarz SC		: 0.654 : 0.548 : 6.182 : -2.841 : -2.373		R <sup>2</sup> Adj. R <sup>2</sup> F-statistic Akaike IC Schwarz SC		: 0.717 : 0.630 : 8.283 : -2.742 : -2.274		R <sup>2</sup> Adj. R <sup>2</sup> F-statistic Akaike AIC Schwarz SC	: 0.682 : 0.584 : 7.008 : -4.958 : -4.490
	Akaike information criterion				Schwarz criterion					

Source: Author's computation by E-views 9.

2018). Thus, electrification has acted as a factor affecting the consumption pattern of the rural people having electricity in their households (Barkat et al., 2002). These findings are also consistent with Adnan and Amri (2021) empirical studies for the case of the Indian economies pointed out that electrification has a positive impact on household expenditures, adult household activities, and ownership and usage of appliances.

When inserting rural electrification as an endogenous variable, the statistical information as seen in the table above shows that poverty has a positive and significant effect on rural electrification at the lag of 2. This respectively implicitly informs that electrification programs by local governments are more focused on poor areas. Electrification is a strategic program of the government to increase community economic activities and reduce poverty levels. When an area is in high-poverty rate areas, for the next two periods, the government encourages the electricity program in the region. The number of electrified households increases. That causes the positive influence of poverty on electrification. This finding confirms the results of Kemmler's (2007) research for the Indian economy case that proves that household characteristics showed by poverty encourage the government to increase electricity supply to the area. The electrification program is the most profitable strategic policy for rural poverty alleviation.

#### 4.7. The result of the granger causality test

To determine the causality relationship of the three variables, we applied the Granger causality test. The result of the test provides statistical evidence pointing out the direction of the causality. Unidirectional causality exists from electrification to rural poverty (see table 8). The supply of electric energy sources for rural areas causes a change in the poverty rate. Poverty is a response to rural electrification. As explained in the result of PVECM earlier, the program has a negative and significant impact on poverty at the 2-period horizon. These findings are in line with Phiri's (2017) studies for the case of the Zambian economy discovered that rural electrification significantly reduces the poverty rate. Electricity affects employment creation, which then affects income and reduces the poverty rate (Ghosh, 2009). These findings also confirm the view of Pueyo and Maestre (2019) that access to electricity is a key determinant of economic growth and poverty reduction in developing countries. Electricity can drive economic and social development by increasing productivity, enabling new job-creating enterprises, and reducing household workloads, hence most beneficial for the quality of people's lives.

One-way causality occurs from electrification to non-food spending (NFS) as shown by the chi-square value of 25,284 and p-value of 0.001. This respectively suggests that household consumption is a response to electrification. This statistical evidence explicitly informs that the shift in household consumption patterns from food spending to non-food spending is a logical response to electrification. When a household has electricity, there is a need for various types of electronic equipment. As a result, household spending on the procurement of electronic devices increases to improve their welfare.

**Table 8. VAR granger causality tests**

Endogenous Variables	Exogenous Variables		
	$\Delta \log \text{POV}$	$\Delta \log \text{NFS}$	$\Delta \log \text{EL}$
$\Delta \log \text{POV}$	-	(1.975) [0.853]	(16.962) [0.004]*
$\Delta \log \text{NFS}$	(1.331) [0.932]	-	(25.284) [0.001]**
$\Delta \log \text{EL}$	(3.963) [0.555]	(1.538) [0.909]	-

Source: Author's computation by E-views 9.

the values in parentheses () are chi-square, the values in bracket [] are p-values. \* indicate the significance at 90% level, and \*\* indicates the significance at 95% level.



As shown in the PVECM explained earlier, EL had a positive and significant effect on NFS at the lag of 1 and had an insignificant and positive influence on the next period. This finding supports the result of a research study conducted by Narayan and Smyth (2005) in Australia pointed out that a unidirectional causality exists running from income to electricity consumption. Shahbaz et al. (2017) also confirmed the feedback effects of household income and electricity consumption. Previously, Hussein and Filho (2012) also discovered that household needs to improve their welfare and life satisfaction increase because of the availability of household energy sources. Electricity makes part of household expenditure allocated to finance non-food needs. For example, rural households are encouraged to buy electronic devices. The percentage of income allocated to buy food needs decreases and rural communities are encouraged to fulfill non-food needs. This respective is what causes a one-way causality from electrification to non-food spending. The existence of household consumption effects of rural electrification is in line with Van de Walle et al.'s (2013) studies for the case of the Indian economy pointed out that the household's consumption changes because of the electricity supply.

## 5. Conclusion and suggestions

The availability of electric energy should be able to improve people's welfare. So far, studies on the economic impact of electricity have been an interesting focus for many researchers. Most of them proved that access to electricity not only contributes to job creation and poverty reductions. But, it also affects household consumption patterns in rural areas. The effort of the economic development in the developing countries enacted electrification programs as a priority. For the case of western Indonesia, an empirical study on the economic impact of the electrification program has never been conducted yet. Our research study aims to analyze the effect of electrification on reducing poverty and rural households' non-food spending in the region. Using a cross-section of data from 8 provinces during the 2007–2017 period, the analysis model used is the cointegration test, vector error correction model, and Granger causality test.

The study found a long-run equilibrium relationship between electricity, poverty, and household non-food spending. That means that the respective variable responds to changes that occur in other variables. A variable will make adjustments to changes in other variables so that it leads to long-run equilibrium. However, in the long run, electricity does not significantly reduce rural poverty rates. The electricity could not be used optimally for the community for profitable economic activities. Utilization of these resources is more likely to be related to consumption activities. In the short run, electricity also does not encourage an increase in non-food consumption. There is even an opposite direction to the relationship between the two. Non-food goods are usually durable goods, so consumption expenditures to get these goods are not routine expenses. Thus, food spending has always been the most total household spending. This respective is what causes a negative relationship between electricity and non-food spending in the long term.

In contrast to the long-run relationship, in the short run, electricity negatively impacts the poverty rates. But it is positive and significant for non-food spending. In the early stages, the electricity in rural areas, which previously had no energy source, was beneficial for a minority of people to develop their productive economic activities. They are part of the rural communities who work outside the agricultural sector, such as entrepreneurship, especially in home industries, that are quantitatively just the smallest part of the total rural population. For them, electricity can increase their income so they can get out of poverty. That causes a negative impact on electricity in the short run. In terms of household non-food spending, in the early stages, electricity encouraged people's desire to buy non-food goods such as fans, televisions, refrigerators, and household kitchen utensils. So non-food spending increased significantly. This conclusion is in line with the results of the ganger causality test statistically pointing out that there is a one-way causality from electrification to poverty reduction and household non-food spending. In the short run, electrification leads to poverty reduction and an increase in non-food spending.

Referring to the conclusions described above, it can be that the electrification of the rural area does matter for rural poverty alleviation in western Indonesia. Electrification does not increase only work productivity and creates rural employment, but also affects household consumption spending. Therefore, the infrastructure development policy of the local government of the region should have become the rural electrification program as their main priority. The allocation of public budgets to realize the program is the right policy for achieving economic development goals in the regions. Most people in western Indonesia live in rural areas. However, the priority of the electrification program should consider the geographic and socio-economic conditions of rural communities. Make electrification programs sure do for rural areas that economically have greater potential in developing community economic activities. Thus, the program directly affects increasing welfare and reduces poverty.

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