Journal of Rural Development, Vol. 38 No. (2) pp. 296-321
NIRDPR, Hyderabad.

EFFICIENCY VS. EQUITY OF STATE ELECTRICITY DISTRIBUTION: EVIDENCE FROM AN INDONESIA VILLAGE

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ABSTRACT

The purpose of this paper is to analyse the determinants of household access on State electricity at the village level in Indonesia. Access to State electricity differs significantly between provinces in Indonesia, as well as between rural and urban areas. This study utilises data at the village level known as Potensi Desa or PODES, for the time period between 2005 and 2011. Panel data regression is performed to estimate the impact of village's remoteness as well as economy and social heterogeneity among communities in villages. By controlling village's characteristics, this study finds that the number of households utilising State electricity are lower in villages where: (i) they have low population density, (2) are located in remotes areas, and inhabitants have limited access to economy-generating activities. Access to State electricity is significantly better in the region where potential economic activities are mostly non-agricultural. As compared to a previous study that focuses on ethnic heterogeneity, this study found that in villages where the community comprises of more than two ethnicities and more than two difference religions, households access on State electricity is higher than the villages where there is no social heterogeneity. This study concludes that State electricity distribution meets efficiency principle, but not equity or universal distribution.

Keywords: Access to Electricity, Ethnic Heterogeneity, Indonesia.

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Introduction

Electricity is an essential energy source for supporting daily activities of household, businesses, and industries. Domestic activities such as cooking, water pumping, washing and ironing will be easier if households utilise electricity and have sufficient wattage for supporting the appliances. Even though electricity access is important for daily activities, communities in rural areas of developing countries such as Indonesia still cannot enjoy access to electricity, universally. Access to State electricity differs significantly among provinces. Gap in electricity access is also large between urban and rural areas. On an average, electrification ratio in Jawa and Sumatera islands is up to 95 per cent, while in other provinces the ratio is about 80 per cent, but in East Nusa Tenggara and Papua the ratio is still below 30 per cent (BPS, 2014).

In Indonesia, differences in access to electrification are also related with different rules in local institutions. Usually, it is organised by traditional '*adat*' or civil law (Pal and Wahhaj, 2012). In regions where *adat* rule is dominant, average electricity consumption is lower than the regions where the pertaining rule is civil law. Electricity distribution not only varies by regions, but also by the level of economic activities. West Papua and Central Kalimantan provinces are richer in natural resources, but at the district level, these provinces still experience gaps in access to electricity. Communities in urban areas enjoy almost 90 per cent electricity, while in rural areas, household access to electricity is below 40 per cent (DettmanandPepinsky, 2014). In geographically disadvantaged province like East Nusa Tenggara, percentage of rural household with State electricity access is only about 28 per cent.

Official Statistic data shows that the access to State electricity is concentrated in Jawa and Sumatera. On an average, number of villages in Jawa, Aceh and North Sumatera have almost three to four times higher access to PLN than villages in other regions or islands (BPS, 2012; 2014). Demographic indicators show that total size of areas in Jawa and Sumatera are approximately 32 per cent of Indonesia, but the number of villages in these two islands is about 63 per cent of the total villages in Indonesia. In terms of regional per capita GDP, provinces in Jawa and Sumatera have relatively higher per capita GDP as compared to other provinces in the eastern part of Indonesia (BPS 2012, 2015). In this case, larger share of households with electricity access in Jawa and Sumatera might be related to higher potential demand and cost efficient for electricity grid distribution.

There are a growing numbers of studies that investigate determinants of access to basic infrastructure in developing countries, especially access to electricity in rural areas. Empirical studies consider various factors that might influence electricity distribution. Some studies consider geographical barriers, while other studies consider economic and social diversity, demand and supply sides or human capital and government funding. Studies that focus on geographical barriers in general conclude that there is a negative link between access to electricity with the degree of village's remoteness. Villages with mountainous or hilly landscapes, separated by river, lake or sea require higher cost of installation (Bazilian et al., 2012; Cook, 2013a, 2013b; Foster and Caramanis, 2013; Javadi, et al., 2013; Lahimer et al., 2013; Zvoleff, Kocaman, Huh, and Modi, 2009).

In terms of the supply side, economic and social diversity are considered as an obstacle to governments in providing infrastructure and access to public goods like electricity. Social diversity can influence preference of individual and the community on consuming types of public goods. On the demand side, economic inequality can reduce the potential demand for electricity, as this is related to price affordability from low income consumer. Studies that focus on diversity reported that both economic and social diversity have negative association with infrastructure and access to public goods distribution, including electricity (Alesina, Baqir and Easterly, 1999; Alesina and Ferrara, 2004; Banerjee, Iyer and Somanathan, 2008; Banerjee and Somantahan, 2004; Banerjee., Iyer and Somanathan, 2005). Access on electricity distribution is negatively related with the role of institution, the quality of regulation and the availability of technician for maintaining the electricity network. In some developing countries, power loss becomes another issue in-line with bad institutions and low gridline maintenance (Agbemabiese, Nkomo and Sokona, 2012; Chaurey, Krithika, Palit, Rakesh and Sovacool, 2012; Javadi, Saidur and Kamalisarvestani, 2013; Karekezi and Kimani, 2004; Yadoo and Cruickshank, 2010).

The focus of this study is electricity distribution in Indonesia. Geographically, Indonesia is an archipelago country. Indonesia has thousands of islands, varying with bigger and smaller ones. Majority of the island's landscape in Indonesia consists of beaches as well as mountainous areas. Geographical and landscape barriers prove to be a little expensive for the Government of Indonesia or private firms to build electricity grid for supplying energy to all areas. On the other hand, Indonesia is well-known for having rich natural resources as well as social identity like ethnicity and religiosity. There also exists a regional difference in economic opportunities. Some islands have better opportunities due to natural resources endowment, while other islands depend only on agricultural sector.

Social identity in the community is very diverse in Indonesia. Official Statistics data indicates Indonesia has more than 515 ethnics, and these ethnicities still exist in 34 provinces of Indonesia (BPS, 2014). The distribution of ethnics among the islands in Indonesia are: about 50 ethnicities in Sumatera, 18 in Jawa, 61 in Bali and Nusa Tenggara, 127 in Kalimantan, 94 in Sulawesi and Maluku, and 115 ethnics in Papua. This data implies that diversity in ethnicity is larger in the eastern part as compared to the western part of Indonesia (Jawa and Sumatera). Empirical studies reported that higher the variety in group characteristics, lower will be the probability of that group to get public goods allocation (Banerjee et al., 2008; Esteban and Ray, 1999). This finding is supported by many studies such as Alesina, Baqir, and Easterly (1999), Banerjee (2004), Banerjee and Somanathan (2007), Baldwin and Huber (2010) and Habyarimana et al., (2007).

The issue to be addressed in this study is estimating the determinant of electricity access at village level in Indonesia. Following previous empirical studies which investigate the role of geographic and diversity as determinant of electricity distribution, this study focus on testing two points. Firstly, does geography or social diversity undermine the State electricity distribution in rural areas of Indonesia? Secondly, can villages with better access of electricity generate a variety of small household business? This study will utilise micro data at village level, known as *Potensi Desa* (*PODES*) for the data surveys in 2005 and 2011. PODES is a nationwide survey; therefore, utilising this data will benefit in terms of national coverage. As far as the authors are concerned, among different studies referred in this study, only the study of Oda and Tsujita (2010) apply village level data for the case in India. The authors believe that by applying micro data at village level, deeper empirical evidence can be presented as compared to investigate data at macro level.

The rest of the paper is organised as follows: The next session will present brief literature review and hypothesis. This session is followed by presenting model and data, and subsequently followed by results and discussion. The last two sessions are policy recommendations and conclusion.

Brief Literature and Hypothesis

Empirical Studies of Electricity Access

United Nations Development Program (UNDP) report in 2010 determined multi-dimensional measures of poverty. According to this report, one indicator of living in poor condition is if individuals or households have limited or no access to electricity (OECD, IEA, UNDP and UNIDO, 2010; UNDP, 2010). Limited access to electricity means households have a significant longer time for doing physical household activities. Longer time for domestic activities means that the households have shorter time duration for work concerning wages and limited income. Furthermore, household with limited electricity mean that children cannot learn with proper light at night. Further, limited electricity wattage means no refrigerator for storing food. As a result, germs and viruses grow quickly on food material if not stored well, without utilising any electronic appliances. In all, limited income, shorter studying time and low quality of food intake will deteriorate human capital investment in the long run. This condition would further result in poor condition/s that will be carried into the next generation, and in aggregate, this condition results in low income and output. Based on these considerations, access on electricity becomes one of the main points for achieving Sustainable Development Goals (SDGs), especially for reducing poverty rate (Attigah andTasch, 2013).

Empirical studies report positive impact of electrification access on education, health, fertility rate, income and productivity. An improvement of rural areas for access on electricity has significant positive impact on educational outcomes (Brodman, 1982; Dasso, Fernandez and Nopo, 2015; Squires, 2015). It was reported that fertility rate suffered a significant dip in villages with better access on electricity (Grimm, Sparrow and Tasciotti, 2015; Herrin, 1979). Higher productivity, better wage rate and increase in female labour participation rate reportedly had a positive impact of rural electrification (Baliscalan, 2001; Brodman, 1982; Cook, 2013b; Songco, 2002; Spencer, 1988; Torero, 2014; Wilcox et al., 2015). Other studies find that crime rate has changed in specific regions where street lighting is supported by access from State electricity (Clarke, 2008; Wright et al., 1974).

The study of Brodman (1982) focuses on rural electrification and its impact on rural commercialism regions in Klaten, Central Jawa and other rural areas in Jawa, Indonesia. This study investigates 320 villages, which consist of 170 electrified villages and the rest without any electricity. The study found that villages with State electricity access have higher chance for establishing small business, accessing credit as well as market. Dasso et al. (2015) analysed panel data at individual and household level in rural areas of Peru. The authors combine three-year panel data at the household level and five-year panel data at the individual level. Taking electrification effect by gender, Daso et al., (2015) noted as follows: The study found not enough evidence saying electrification programme has effect on overall educational outcome. In electrified villages, girls enrollment is much higher than boys, but in villages without electricity, there is an imbalance in the enrollment ratio between boys and girls. Comparing score test for math and reading, this study also finds no significant difference between threated and non-threated villages. However, among the threated villages, reading test score for girl is higher when compare to boys, but the opposite is true for math test score. Squires (2015) applies longitudinal data (1991, 1993, 2001, and 2005) to investigate the impact of electrification programme on education in Honduras. In general, this study concludes that there is no significant impact of electrification on children school enrollment, school attendance and potential dropouts. Surprisingly, this study reported that there is a negative impact of rural electrification on school enrollment, attendance and risk of dropouts in a village. The author argues that this finding might reflect on short run adjustment. Access on electricity was responded by higher participation in labour market. Household wife can substitute their domestic time into labour market, but consequently, the first son or daughter have to sacrifice their schooling for looking after their younger siblings. Therefore, the impact of electricity on school attendance is not significant, but it is transmitted in female participation in labour market.

Short and long run impacts of electrification programme on fertility rate are reported by Herrin (1979) and Grimm et al., (2015). The study of Herrin (1979) was conducted in Misamis province, Northern part of Mindanao Island, Philippines. This study investigated 43,725 villages in Misamis, for the period 1970-1975. Based on the empirical investigations, the authors conclude that relatively in short run from 1970 to 1975, the fertility rate in Misamis decreased significantly. The authors interpreted this result carefully due to mixed and indirect evidences regarding impact of electricity access on fertility rate. Combinations of follow-up programmes for rural electricity were recorded, which includes agricultural, support for small business, road improvement as well as family planning programme. This study found business and labour market confidence increased and it was followed by higher participation in female labour. This finding implies that bringing up a child becomes expensive, and as result significant decline in fertility rate. The study of Grim et al., (2015) focuses on Indonesia. This study utilises a combination of four sources of micro data, including: annual Indonesian National Socio-economic Household Survey (SUSENAS), longitudinal data of villages survey (*PODES*), Indonesian Demographic and Health Surveys (DHS), and data electrification ratio from State Electricity Company (*PLN*) for the period of 1993–2010. Similarly, with the study of Herrin (1979), Grimm et al., (2015) concludes that there are indirect and mixed effects of electricity on the long run decline in fertility rate in Indonesia.

As far as studies in this area are concerned, there are still limited studies investigating why electricity access is limited in rural areas by applying micro level data pertaining to village or sub districts level. Therefore, this study will investigate the number of households with access to State electricity at the village level in Indonesia. Quite few studies concerning the determinants of electricity consumption at village level have been done with focus on universal access indicator. As an archipelago country, Indonesia consists of thousands of islands, and it is separated by the sea. This geographical condition might lower the ability of the government to provide electricity grid universally, as it will be subject to higher cost of installation. Power sources for electricity generator have been established only in Sumatera and Jawa Islands. On the other hand, the gap might result in differences in economic opportunities such as potential of exploring natural resources, and the ability of local government attracting private sector to participate for installing electricity grid. Private participation is expected to improve efficient provision of electricity.

Some studies consider geographic barriers or remoteness as one of major obstacles for the government delivering electricity grid universally. Landlocked countries such as Bhutan, Nepal or small islands in Pacific region face geographical barriers when compared to other countries which are not separated by mountains, rivers, beaches and sea (Alex, Kimber and Komp, 2006; Chen, Kuo and Chen, 2006; Davidson and Mwakasonda, 2002; Dean, 2010, 2011; Yadooand Cruickshank, 2010; Zvoleff et al., 2009).While most of studies focus on single country, other studies compare several countries, either in similar regions or compare countries with different stages of development. Among the influential cross-country studies are the studies of Esfahani and Ramirez (2002); Yoo (2006); Chen et al., (2006); Oda and Tsujita (2010); Bruce (2010); Eggoh, Bangaké and Rault (2011); Desmetand Henderson (2014); and Vaona and Magnani(2014). The effect of diversity on economic, social identity and geographic aspects of electricity access and consumption has become a growing concern recently (Glennerster, Miguel and Rothenberg, 2010; Habyarimana et al., 2007; and McQuoid, 2011).

Hypothesis

Hypothesis to be tested in this study will be related to the characteristics of Indonesia villages. Based on Indonesia Statistical data, 2011, number of villages located in lowland and beach areas are 11,884, while villages locate in non-beach areas such as valley, hillsides and riversides area accounted for 78,609 (BPS, 2014). The data implies that geographically, majority of villages in Indonesia are located in disadvantage areas. Indonesia is an archipelago country which consists of thousands of mountainous islands. There are about 160 mountains in Jawa, 45 mountains in Sulawesi and 39 mountains in Sumatera.

There is high diversity among Indonesia's villages, both in terms of economic resources and social identity. In terms of economy, majority of villages depend on agricultural economy, but some villages are also rich with mineral resources. In terms of social identity, Indonesian community consists of 1,115 ethnics and there are five religions officially recorded. According to Alesina et al., (2003) Ethnic fractionalisation Index in Indonesia is 0.735 and Religious Fractionalisation Index is 0.234. An index close to zero indicates (perfect) homogeneity, while index close to one mean (a perfect) heterogeneity. Based on Alesina et al. (2003), Indonesia has moderately high index of ethnic fractionalisation and moderately low religious fractionalisation.

Three hypotheses will be tested in this study. The first two hypotheses are regarding the determinant of electricity access. This study hypothesises that electricity access is: (1) negatively related with geography remoteness and (2) negatively related with ethnic and religious diversity. The first hypothesis follows the study of Torero (2014) and the study of Alex et al., (2006). Remote areas have difficult topography and typically low population density. Low population means low economic activities and consumption. On the other hand, empirically, it is also reported that there exists a negative relationship between high ethnic and religious diversities with access to public goods, including electricity (Alesina, Baqir and Easterly, 1997; Alesina and Ferrara, 2004; Baldwin and Huber, 2010; Banerjee, 2004; Banerjee. et al., 2005). Higher Fractionalisation Index of ethnic and religion associates with lower access of public goods in the society. The third hypothesis is related with the impact of electricity access on village development process. Access to electricity can encourage business activity and increase the probability for running home industries. This study hypothesises positive correlation between number of households with electricity access with probability of establishing home industries.

Data and Methodology

Data

This study will utilise village level data, collected from survey in Indonesia Central Statistics, i.e., *Potensi Desa* (*PODES*) in the time period from 2005 to 2011. Majority of the data in *PODES* survey are stated in nominal scale. In this study, data is mostly expressed in binary variables, whether it is available or not in the villages. Instead of this data insufficiency, as *PODES* survey has national coverage, this study can be benefited in terms of sample size and coverage. There were differences in sample size during 2005 to 2011. Therefore, to analyse the data in panel data regression, only matching villages both in 2005 and 2011 were included in the analysis.

Methodology

This study estimates linier regression for panel data. Firstly, regarding the first two hypotheses, the determinant of electricity access, by considering location and diversity at village's level will be estimated. The determinant of State electricity access is formulated as follows:

(1) $$Y_{ij} = \alpha_0 + \beta_k X + \gamma_k W + \delta_k Z + \varepsilon_j +$$

Notations in equation (1) are as follows: ***Y*** is number of household utilising State electricity access in a village; ***X*** is vector that describes demography characteristics; ***W*** is vector for set variables in a location and access of transportation; ***Z*** is a vector for set of variables describing diversity; ε_{ij} is the random error component, and a_i is village fixed effect. Index *i* represents village 1,2,..,n; index *j* represents year 2005 and 2011; and index *k* represents subscript of parameters, and k=1,2,…,n.

Demography Characteristics (X) includes population density, existence of village's legislative body, known as *Badan Permusyawaratan Desa* (BPD), dummy location for Jawa and Sumatra island and dummy year. Village's location and access of transportation (W) include: village's location; main transportation access to the village;

village's road quality; flow of transportation along the year and distance between the village and city. Village's heterogeneity (Z) include: heterogeneity in source of income and social identity. Village's source of income is again classified into agriculture and non-agriculture. Diversity of village in social identity has heterogeneity in ethnicity and religion.

Estimation Result

Table 1 presents description of data utilised in this paper. On an average, the number of household with electricity access has increased in 2011 when compared to access in 2005. As is presented in Table 1, majority of the data are nominal scale data, and only few data are presented as ratio scale data. In general, data indicate that the number of household having electricity access have increased for the survey in 2011 when compared to the figures in 2005. Furthermore, the number of home industries has also increased significantly.

The figure in Table 1 indicates that the average number of households with State electricity access have increased significantly. On an average, 575 households per village enjoy State electricity in 2005; and the number has increased to 735 by 2011. In terms of geography and access of transportation, it seems that the villages with remote conditions have decreased by 2011 as access to transportation to the villages got better. The average distance to the villages from *Kecamatan* (sub district) on the other hand is getting farther. This might relate to many bridges which connect two villages or become less functioning, therefore commuting and trip must be done through traditional road, and it takes longer time and distance.

Regarding heterogeneity of economic and social identity in villages, data in Table 1 indicates that there is no change in the number of villages with majority of the community work in agricultural sector. However, by the same time, more villages are found exploring mineral type 'C' resources. This condition might be relevant with the introduction of Law Number 28/2009, which encourages local government up to village level to explore mineral type C resources, as basis for revenue generating unit. Regarding heterogeneity in ethnic and religion, the data in Table 1 indicates that communities in the villages slowly get mixed in ethnicity, but do not in terms of religion.

Table 2 represents the estimation results of determinant of electricity access regarding access of transportation to the village. All models are estimated with Fixed Effect Model (FEModel or FEM) and Random Effect model (REModel or REM). Choices for FEM or REM estimations follow the null hypothesis that the FEM and REM estimators do not differ substantially. Statistically, it is determined by Haussman test. Rejecting null hypothesis indicates FEM is preferable than REM (Gujarati and Porter, 2009:604; Wooldridge, 2013: 495). Gujarati and Porter (2009) suggest that if samples of cross section is large, while the

Table 1: Data Description

S. No.	Data Description	Survey 2005 Mean and Standard Deviation	Survey 2005 Min. Value	Survey 2005 Max. Value	Survey 2011 Mean and Standard Deviation	Survey 2011 Min. Value	Survey 2011 Max. Value
1.	Access for electricity. Defined as the number of households that have access State electricity in the village	574.98 (929,99)	0.00	17,587	735.19	0.00	29,528
2.	Population size; total population in the village (person)	3,366.81 (4,241.69)	10.00	78,985	3,627.58 (5,201.2)	13.00	160,222
3.	Village size; total area of the village, calculated in KM^2	4,671.76 (4,419.56)	9.00	359,360	4,700.46 (4,449.2)	9.00	359,360
4.	Village's location; dummy 1= village located inside the forest, 0 = otherwise	0.03 (0.18)	0.00	1.00	0.02 (0.15)	0.00	1.00
5.	Geography; dummy 1=village located in top of mountain or in hilly region, 0=otherwise	0.88 (0.32)	0.00	1.00	0.23 (0.41)	0.00	1.00
6.	What is main mode of transportation; dummy 1=water; 0= road and water	0.33 (0.17)	0.00	1.00	0.02 (0.13)	0.00	1.00
7.	How is the road quality; dummy 1=no asphalt, 0=covered by stone or aspal	0.12 (0.32)	0.00	1.00	0.07 (0.25)	0.00	1.00
8.	Is the road in good condition all over the year, dummy 1=yes, 0=no	0.08 (0.27)	0.00	1.00	0.06 (0.24)	0.00	1.00
9.	Distance from *Kecamatan* (sub distric), States in KM	7.68 (11.98)	0.00	99.8	8.52 (33.91)	0.00	185

contd...

Table-1 contd.,

10.	What is main source of income for majority of the villagers? Dummy 1=agriculture, 0 = non agriculture	0.87 (0.34)	0.00	1.00	0.86 (0.35)	0.00	1.00
11.	Does the village have C mineral resources?; dummy 1=no, it has not; 0=yes, it has	0.21 (0.41)	0.00	1.00	0.26 (0.44)	0.00	1.00
12.	Is the village occupied by more than two ethnicities;1=yes, it does and0=no, it does not	0.62 (0.47)	0.00	1.00	0.76 (0.43)	0.00	1.00
13.	Does the community in the village follow more than two religious affiliation,1= yes, it does, 0=no, it does not	0.56 (0.50)	0.00	1.00	0.56 (0.50)	0.00	1.00

Source: BPS, *Potensi Desa* 2005, 2011.

Table 2: Access on State Electricity and Village's Remoteness

Dependent variable is number of household with State electricity	Village's characteristics		Village's remoteness	
	FE Model	RE Model	FE Model	RE Model
Constant/Intercept	682.4***	837.7***	721.8***	483.8***
	(2.100)	(16.34)	(7.341)	(24.14)
Village's characteristics				
Population density			3.671***	4.429***
			(0.101)	(0.0977)
Village has BPD (1=yes)			-173.4***	-204.7***
			(8.045)	(7.976)
Dummy Sumatera (1=Sumatera)			-	93.66***
				(34.91)
Dummy Jawa (1=Jawa)			-	877.5***
				(30.78)
Dummy year (1=2011)			167.9***	169.8***
			(3.531)	(3.547)
Village's remoteness				
Village's Location	-85.45***	-91.85***	-74.22***	-80.78***
(1=inside forest area)	(12.68)	(12.66)	(12.46)	(12.47)
Main transportation	-180.4***	-200.2***	-115.6***	-125.3***
(1=through water only)	(16.46)	(16.37)	(16.23)	(16.15)
Quality of the road	-102.1***	-110.7***	-59.85***	-64.38***
(1=no asphalt and muddy)	(8.016)	(8.005)	(7.927)	(7.935)
Can cars pass through all over	-71.67***	-80.04***	-66.61***	-72.38***
the year (1=no, it can not)	(8.900)	(8.887)	(8.744)	(8.752)
Distance from village to	-0.762***	-0.808***	-0.792***	-0.803***
City centre (sub district)	(0.0830)	(0.0829)	(0.0816)	(0.0818)
Goodness of Fit Model				
Haussman Test		500,59***		1,723.***
Observation	110,290	110,290	110,290	110,290
R-squared	0,005	0,0053	0,040	0,0398

Source: Author's calculations.

Note : Figure in the bracket is standard errors. Level of signification *** p<0.01, ** p<0.05, * p<0.1.

number of time series is small, FEM estimation is appropriate. Wooldridge (2013) argues that FEM estimation is preferable in terms of model for policy analysis. Null hypothesis for Haussman test are rejected at one per cent significant level. Following rule from Gujarati and Porter (2009), Haussman test indicated that FEM estimation is preferable.

By controlling the village characteristic, Table 2 indicates less assessability or remote location of a village and lower number of households utilising State electricity. Remoteness is indicated by villages located inside the forest, only assesses through water transportation, no asphalt road, no regular transportation and further away from city centre. Combining village's characteristics and village's heterogeneity does not change the sign of coefficient of village's remoteness, even though the magnitude gets lower.

Table 3 presents estimation results of association between village's characteristics and heterogeneity. Heterogeneity in social identity is specified as heterogeneity in ethnicity and religion. Village inhabited by more than two different ethnicities and inhabitants pertains to more than two different religions. The estimation result indicate heterogeneity in economic, i.e., village inhabitant depend on agricultural activity and village has mineral 'C' resources and significantly lower electricity utilisation. The coefficient indicates that about 411-472 less households in agricultural areas can afford State electricity when compared to the non-agricultural one. If the estimation is combined with village's characteristics, the signs of estimation remain negative even as the magnitude decrease. Villages inhabited by heterogenic people in terms of ethnicity and religion are estimated to have more access on State electricity. Like estimation regarding economic heterogeneity, the sign of coefficient remains negative, but the magnitude gets lower as the control variable i.e., village's characteristics is relaxed.

Majority of rural households in Indonesia rely on agricultural activity and a few of the rural areas have rivers as source of mineral type 'C'. These rivers contain stone and sand which can be explored and traded for building materials. Agriculture activity is characterised by relatively low productivity, when compared to other sectors. Lag time between planting and harvesting periods will influence flow of farmer's income. Some farmers have land up to 0.25 ha, while others only depend on providing labour work to the landlords (BPS, 2014). Landless and relatively low productivity make farmers have low income. Mineral type 'C' such as sand and stone are valuable material for construction of buildings. However, these materials are non-renewable and they are common resources. These materials are mostly available temporarily and soon become exhausted because of the ongoing rush for exploring it. Therefore, even though a village has mineral type 'C', the probability that village's inhabitants remain poor is considerably high.

Table 3: Access to State Electricity and Village's Heterogeneity

Dependent variable is number of household with State electricity	**Village's characteristics**		**Village's heterogeneity**	
	FE Model	RE Model	FE Model	RE Model
Constant/Intercept	926.7***	1,098***	911.6***	663.7***
	(9.213)	(15.64)	(11.13)	(23.04)
Village characteristics				
Population density			3.306***	4.053***
			(0.0993)	(0.0957)
Village has BPD (1=yes)			-123.6***	-147.1***
			(7.936)	(7.882)
Dummy Sumatera (1=Sumatera)			-	110.2***
				(30.52)
Dummy Jawa (1=Jawa)			-	890.6***
				(26.88)
Dummy year (1=2011)			160.4***	161.0***
			(3.497)	(3.524)
Village's heterogeneity				
Main source of income	-411.5***	-472.8***	-382.7***	-432.5***
(1=agriculture)	(7.645)	(7.613)	(7.579)	(7.537)
Does village has mineral C	-42.38***	-37.17***	-36.52***	-33.01***
resources (1=yes)	(4.705)	(4.737)	(4.642)	(4.660)
There are more than 2	62.10***	63.18***	26.39***	32.95***
ethnics in village (1=yes)	(4.623)	(4.651)	(4.630)	(4.645)
There are more than 2	169.2***	178.2***	167.4***	177.5***
religions (1=yes)	(5.183)	(5.186)	(5.113)	(5.097)
Goodness of Fit Model				
Chi Square-Haussman test		3.904***		240.06***
Observation	110,290	110,290	110,290	110,290
R-Squared	0.046	0.047	0.075	0.074
Source: Author's calculation.				
Note : Figure in the bracket is standard errors. Level of signification *** p<0.01, ** p<0.05, * p<0.1.				

Regarding heterogeneity in social identity, this study found different findings as compared to the study of Alesina, Baqir and Easterly (1999), Alesina and Ferrara (2004) and Banerjee, Iyer and Somanathan (2008). These studies indicate that heterogeneity in social identity is negatively associated with access to public goods including electricity.These studies argue that in heterogeneous communities, individual preference varies with their social identity. Heterogeneous preference will result in disequilibrium regarding type of public goods to be provided. All previous studies utilise ethnic and religious fractionalisation index for measuring social heterogeneity. Due to data unavailability at the village level, this study is only able to utilise dummy data. Data in terms of number of people or households that belong to particular ethnic and religion is not available in PODES survey; therefore we were unable to calculate ethnic fractionalisation.

The estimation result in Table 3 indicates that both diversity in ethnicity and religion do not determine access on electricity. Villages where inhabitants belong to difference ethnics and religions do have more households utilising State electricity, as compared to villages with homogeneous inhabitants. Indonesia is inhabited by 1200 different ethnics and the State declares formally five religions in Indonesia, namely: Islam, Catholicism, Protestantism, Hinduism and Buddhism. Development and cultural assimilation result in heterogeneity of inhabitant in each village. Data description in Table 1 indicates that in about 62 per cent of the villages in 2005 and about 72 per cent of villages in 2011, they have two or more ethnicities co-existing in the same village. No changes were recorded for religious diversity between 2005 and 2011.

The first two hypotheses to be tested are related with Table 2 and Table 3. The first null hypothesis states that there is no association between remoteness and access of transportation to the number of households utilising State electricity. The second null hypothesis points that there is no association between heterogeneity conditions in the village with the number of households utilising State electricity. Regarding the first hypothesis, estimation results indicate that villages located in or near the forest, only can be reached through water transportation. Village roads are not covered by asphalt and the further roads from villages to sub-district cities have lower households that utilise State electricity. The sign of coefficients estimation for geography and remoteness have not changed, even with slight depression in the magnitude when relaxing the control variable i.e., characteristics of the village such as population density.

Regarding estimation for the second hypotheses, this study finds different results as compared to the previous study by Alesina et al.(1999), Alesina and Ferrara (2004), Banerjee and Somantahan (2004), Baldwin and Huber (2010) and Balasubramaniam, Chatterjee and Mustard (2014). These studies claim that the higher the index of fractionalization for ethnicity, lower the distribution of public

Table 4: Summary Determinants of Access on State Electricity

Dependent variable is number of household with State electricity	Model	
	FEModel	REModel
Constant/ intercept	925.9***	694.6***
	(11.17)	(23.12)
Village's characteristic		
Population density	3.299***	4.043***
	(0.0992)	(0.0956)
Village has BPD (1=yes)	-121.6***	-145.1***
	(7.934)	(7.879)
Dummy Sumatera (1=Sumatera)	-	96.10***
		(30.50)
Dummy Jawa (1=Jawa)	-	864.3***
		(26.92)
Dummy year (1=2011)	156.5***	156.6***
	(3.524)	(3.550)
Village's remoteness		
Village's location	-64.90***	-71.21***
(1=inside forest area)	(12.22)	(12.26)
Main transportation	-80.33***	-88.53***
(1=through water only)	(15.93)	(15.86)
Quality of the road	-46.92***	-50.71***
(1=no asphalt and muddy)	(7.779)	(7.805)
Can cars pass through all over	-48.12***	-52.45***
the year (1=no, it cannot)	(8.587)	(8.615)
Distance from village to	-0.585***	-0.580***
city centre (sub-district)	(0.0801)	(0.0805)
Village's heterogeneity		
Main source of income	-382.7***	-432.5***
(1=agriculture)	(7.579)	(7.537)
Does village has mineral C	-36.52***	-33.01***
resources (1=yes)	(4.642)	(4.660)
There are more than 2	26.39***	32.95***
ethnics in village (1=yes)	(4.630)	(4.645)

There are more than 2	167.4***	177.5***
religions (1=yes)	(5.113)	(5.097)
Goodness of Fit Model		
Chi Square Haussman Test		-437,60
Observations	110,290	110,290
R-squared	0.077	0.0764

Source : Author's calculations.
Note : figure in the bracket is standard errors.
Level of signification *** p<0.01, ** p<0.05, * p<0.1.

goods. The study of Alesina et al. (1999) focuses on America, while Alesina and Ferrara (2004) conducted cross-countries study. The two studies found that ethnic fractionalisation do undermine the effectiveness of public spending and further lowering access to public goods such as health facilities, school infrastructure, electricity, water and sanitation among various States in America.

The study of Banerjee and Somanathan(2004) and Balasubramaniam et al., (2014) investigate the distribution of public goods such as water for irrigation, schooling and health infrastructure among rural villages in India. Even though majority of the community in India believes in Hinduism, there is a high social division according to the caste status. These studies found that ethnic fragmentation does not associate with lower access to public goods, but it relates with difference in caste status. Access to public goods is significantly higher in areas where Brahman caste is dominated as compared to areas that are not. The study of Baldwin and Huber (2010) updates the study of Alesina and Ferrara (2004) by combining new data from Comparative Study of Electoral Systems (CSES) and World Value Survey (WVS). Combination of CES and WVS data can generate Between-Group Income Inequality (BGI), Ethno Linguistic Fractionalisation (ELF) and Cultural Fractionalisation (CF). The authors conclude that higher BGI score associates with lower public goods provision in 46 countries, but this association is not robust for ELF and CF indicators.

Diversity in social identity is measured by dummy variables. The estimation result in Table 2 indicates that access of State electricity is not lower in villages that have social heterogeneity in terms of ethnicity and religion as compared to the villages that have not. Numbers of households that have access to State electricity is indeed lower in villages where majority of the community work in related to agricultural or the villages have no mineral resources such as mineral 'C' as an alternative sources of income, compared to the counterpart villages. This means that in villages where source of income are limited, effective demand for electricity is lower. In Indonesia, majority of farmers are landless and on an average, each agricultural household owned less than 20m^2(BPS, 2014). This condition might explain why farmers belong to the lowest income group in Indonesia. Limited income influences farmer's affordability for consuming State electricity.

According to the study of Baldwin and Huber (2010), Between-Group Income Inequality or BGI in Indonesia is 0.32 and it is ranked 23 among 46 countries. On the other hand, the Ethno Linguistic Fractionalisation (ELF) is about 0.76, and Indonesia is ranked number 7 among 46 countries. Cultural Fractionalisation (CF) of Indonesia is quite high, close to 0.6. These figures indicate that social heterogeneity (ethnic, religion, language, and cultural) is quite high as compared to the index of income inequality. Figures 1, 2 and 3 present scatterplot that represent the association between average rural electrification with population density (figure 1), with dummy variable for ethnic heterogeneity (figure 2), electricity access with dummy for religion heterogeneity (figure 3) and number of home industries at village(figure 4), in 2011.

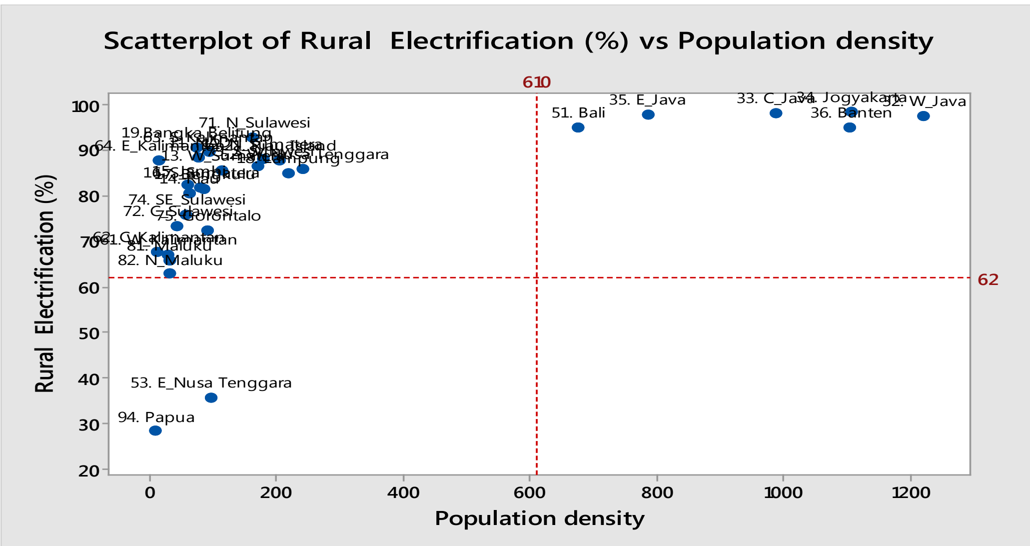

Figure 1: Scatter Plot of Percentage of Households with State Electricity Access and Population Density, Province-wise, 2011.

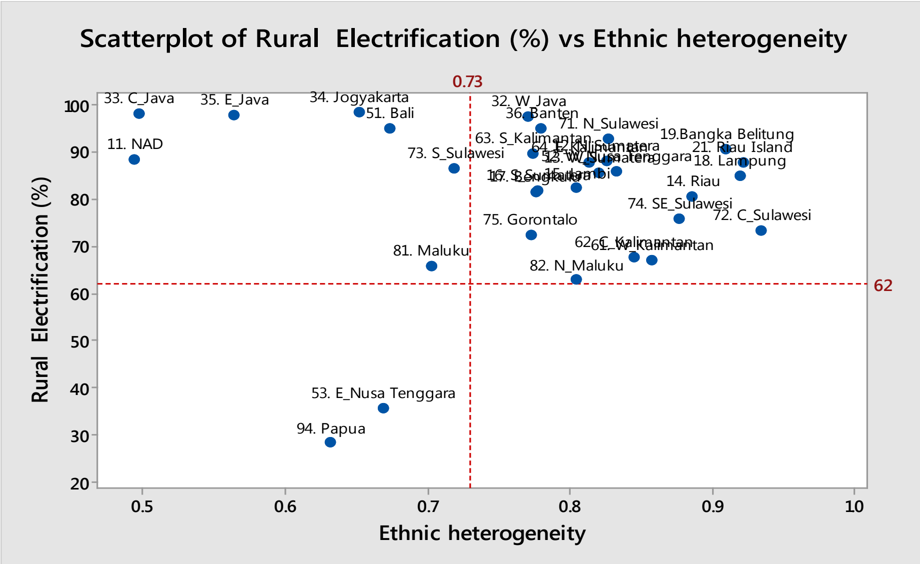

Figure 2: Scatterplot of Percentage of Rural Households having Access to State Electricity and Percentage of Villages with Heterogeneity in Ethnicity, Province-wise, 2011.

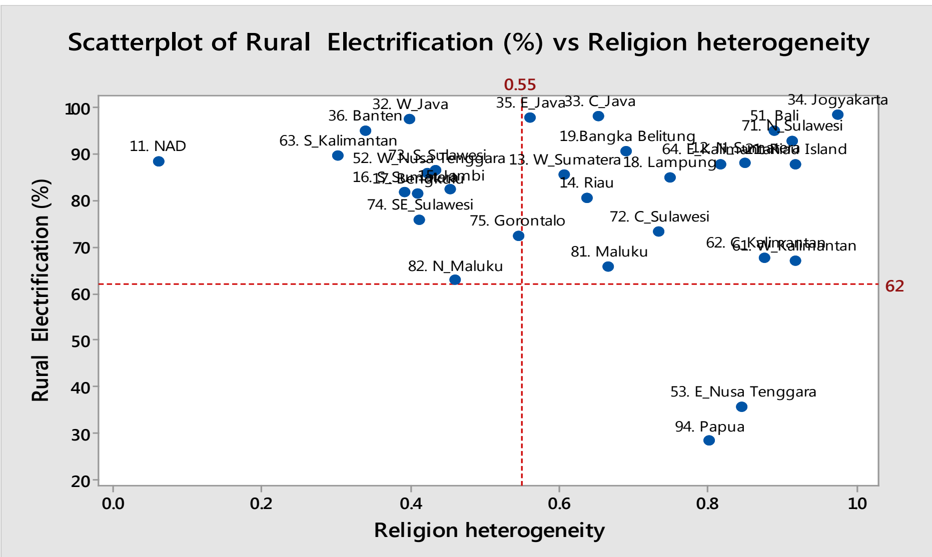

Figure 3: Scatter Plot Percentage of Rural Households having Access to State Electricity and Villages with Heterogeneity in Religion, Province-wise, 2011

Figure 1 presents the scatter plot of percentage of rural electrification and population density, aggregated by provinces. Average percentage of rural electrification in Indonesia in the year 2011 is above 62 per cent, but in East Nusa Tenggara and Papua, rural electrification is just about 35 per cent. In this graph, it can be seen that East Nusa Tenggara and Papua belong to quadrant IV, which means low population density and low electricity access. Figure 2 and 3 indicates that rural electrification in these two provinces is the lowest among 31 provinces in Indonesia, but it is not associated with heterogeneity in ethnicity and religion. Percentage of villages having ethnic and religion heterogeneity in East Nusa Tenggara and Papua are subsequently about 65 per cent and 82 per cent. However, in other provinces, heterogeneity in ethnicity and religion are almost 95 per cent. The three figures imply that it is not social heterogeneity that explains low access of electricity in rural community in East Nusa Tenggara and Papua. Low electricity access in these provinces might be more related with population density and distance from Jawa as the centre of electricity distribution.

To justify the third hypothesis, simple linier regression, coefficient of correlation and scatter plot for number of villages having home industries and ratio of rural electrification, aggregated by provinces in 2011, are presented in figure 4. The figure indicates of a positive association between number of villages having home industries and rural electrification ratio, even when the magnitude of correlation coefficient is weak, i.e.r_{xy}=0.352. The coefficient correlation is significant at five per cent. Numbers of villages having home industries are high, more than 4,000 villages in some provinces, including Central Jawa, East Jawa, West Jawa and Nanggro Aceh Darusalam. In other three provinces, namely North Sumatera, South Sulawesi and East Nusa Tenggara; number of villages having home industries is between 100-4,000 villages. Number of home industries in Jakarta is below 100 units. This is because majority of economic activities in Jakarta are for supporting government sector, trade and business centres.

Regression equation for the third hypothesis is:

Number of villages having home industries = -1,040 + 34.60 rural electrification

The correlation coefficient, r_{yx} = 0.352, P-value=0.052

The estimation result indicates that there are small evidences showing the positive association between the number of operating business at the village level and household access on electricity. Electricity is a source of energy for supporting input of production either through machine or other utilities that promote labour productivity.

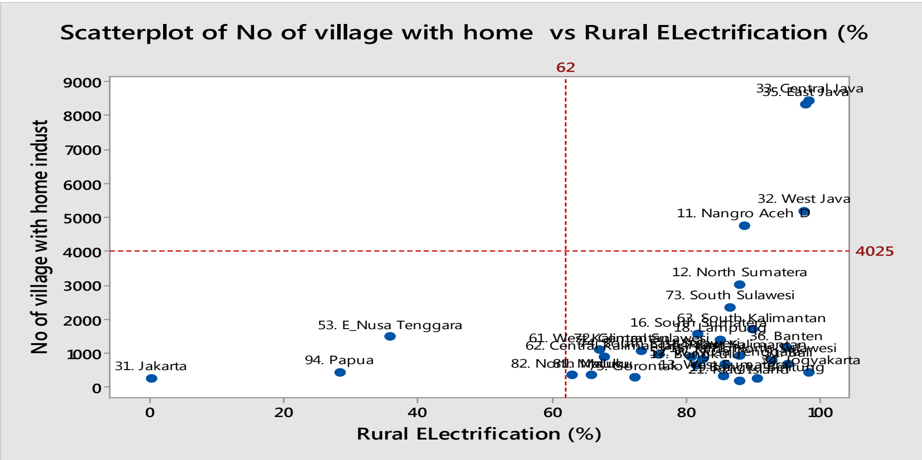

Figure 4 : Scatterplot of Percentage of Villages having Home Industries and Percentage of Rural Electrification, Province-wise, 2011.

Limitation of Analysis

Coverage of data in *PODES* survey is national wide, but data is mostly in nominal scale and presented in binary, regardless of the availability or unavailability of characteristics in the villages. Because most of the data are measured in nominal scale, it is not appropriate to analyse the data in causality analysis. Even though this study applies panel data regression, because explanatory variables are dummy variables, the interpretation cannot be indicated in causality, but only by association among explanatory or independent variables and dependent variable. Overall, this study finds that State electricity distribution is closely related with efficient distribution, but not with equity principle. Villages with higher density, mostly practicing non-agricultural activities and in non-remote areas are more efficient because grid installation is cost-effective and meets the potential demand. However, remote areas have limited means of income, hence grid installation cost is higher, but has low potential demand for electricity. According to the author, there is no specific programme designed by the government of Indonesia to improve electricity power generation, at least until the year 2011. This implies that recent condition is not far different with that in 2011 and 2005.

Policy Implication

The number of households utilising State electricity have significant positive correlation with number of home industries in villages. As electricity is an important input for economy-generation activities, government should improve the provision universally.

Inefficiency in scale of production can be eliminated by public private partnership, or by local government introducing small scale electricity grid by utilising natural power such as wind power, solar power or water generator. This alternative is eligible for East Nusa Tenggara and Papua, where electrification ratio is only about 35 per cent. This policy alternative is more efficient rather than using gridlines distribution from Java and Bali. Power loss along with the long distribution between islands can be eliminated. In the long run, more small or home businesses can be expanded as electricity is one primary input that should be provided sufficiently.

Conclussion

Electricity access is very important for supporting economic activities, not only for domestic use, but also for business productivity. Estimation in this study finds that villages where majority of the source of income is agriculture and those that have no mineral resources distribution of household with State electricity access is lower as compared to the non-agricultural villages or villages riches in natural resources. Number of households having access to State electricity is also relatively lower and villages have limited access to transportation facilities. This condition implies that there is a low provision by the government for State electrification access at village level due to potential demands as well as efficient cost for gridline distribution.

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