

Infrastructure and inequality: An empirical evidence from Indonesia

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Abstract

This research is an attempt to study the empirical relationship between infrastructure and income inequality in Indonesia. It uses panel data covering 32 provinces. The model is estimated by simple pooled OLS, fixed-effect and random-effect models. We find that road and telecommunication quantities tend to boost income inequality, while electricity quantity, airport quantity, and airport quality have a favorable impact on the distribution of income and help to alleviate income inequality. Whereas, when these different categories of infrastructure are formed as synthetic indices, the relation between these indices and income inequality lends support to the idea that infrastructure increases income inequality.

Abstrak

Penelitian ini bertujuan untuk mengetahui apakah terdapat hubungan empiris antara infrastruktur dan kesenjangan pendapatan di Indonesia. Data yang digunakan adalah data panel dari 32 propinsi. Model analisis menggunakan teknik regresi panel data dengan model pooled OLS, fixed-effect dan random-effect. Hasil yang diperoleh menunjukkan bahwa kuantitas jalan dan telekomunikasi cenderung meningkatkan kesenjangan pendapatan, sementara itu untuk kuantitas listrik, kuantitas bandara, dan kualitas bandara menunjukkan pengaruh yang sebaliknya yaitu mengurangi kesenjangan pendapatan. Akan tetapi, ketika beberapa indikator infrastruktur ini dihitung sebagai indeks, maka hubungan antara indeks infrastruktur dengan kesenjangan pendapatan adalah positif yang artinya infrastruktur memperlebar kesenjangan pendapatan.

Introduction

Indonesia has experienced a tremendous economic growth in the past few years. During the period of 2007-2013 the economy has grown steadily at around 6%. However, it seems that these impressive economic growth was not distributed equally to all people because the Gini coefficient as a proxy of income inequality has been increasing during the same period. In 2007 Gini coefficient was 0,364 and it decreased slightly to 0,35 in 2008 and then increased gradually to 0,41 in 2011 before rose steadily to 0,413 in 2013 (Central Bureau of Statistic). This is the highest recorded level in the past two decades. Even though by international standard this level of inequality is moderate, it is climbing faster than in most of East Asian countries. The Gini coefficient increase in Indonesia from 1990's to 2000's is one of the highest in the region (The World Bank, 2015).

On sub-national level, the same pattern of income inequality can also be easily observed. Among 33 provinces in Indonesia, only 5 of them show decreasing trend in income inequality, while the other provinces show increasing trend. A recent study by Yusuf, Sumner, & Rum (2013) confirms this recent increase in inequality in Indonesia. Moreover, the level of income disparity among provinces is still severe (Resosudarmo & Vidyattama, 2006) and there is some evidence of increasing regional disparity (Sakamoto, 2013).

Income inequality at national level could lead the government to an inappropriate judgement about economic situation at the sub-national levels, i.e. regions and provinces. Farole (2013) stated that even though the average inequality seems acceptable at national level, this national indicator may not capture the economic stagnation and rising poverty at the sub-national levels. Furthermore, these regions which are left behind are at risk to fall into "the low growth trap" which can drag the overall national growth potentials (Farole, Rodriguez-Pose & Storper, 2011).

Considering the consequences of inequality both at national and sub-national level, it becomes important to understand the driving forces behind lower income inequality. The literature points to various set of strategies through which the objective of reduced income inequality can be achieved, for example progressive tax, cash transfer, decentralization, etc. Infrastructure is seen as another particularly important strategy for distributing income across members of the society (Chatterjee & Turnovsky, 2012).

Concerning on how infrastructure and inequality are interrelated, previous studies reported different results regarding their relationship. The empirical evidence on the infrastructure investment-inequality relationship is mixed and quite conflicting (Chatterjee & Turnovsky, 2012). On the one hand, several studies found that public investment has promoted growth and contributed towards the alleviation of inequality. Examples of such studies are Ferranti et al. (2004), Fan & Zhang (2002), Calderón & Servén (2004, 2008, and 2014), Seneviratne & Sun (2013), and Raychaudhuri & De (2010). On the other hand, studies conducted by Brakman, Garretsen, & vanMarrewijk (2002) found that government spending on infrastructure has increased regional disparities within Europe, and Artadi & Sala-i-Martin (2003) pointed to excessive public investment as a contributing factor to rising income inequality in Africa. In addition, Bajar & Rajeev (2015) found that infrastructure (power and roads) tend to increase inequality in India.

Following the above discussions, this paper aims at examining single primary objective: to find out if infrastructure development in the country might have effects on income inequality in Indonesia. The rest of the paper is organised as follows. Following the introduction in Chapter 1 is Chapter 2 that outlines the methodology, the econometric specification of equation to be tested, and the data. Chapter 3 discusses the regression results and Chapter 4 concludes several interesting results from the findings of this paper.

Research Method

There are two main problems concerning the methodology; the measurement of infrastructure and the identification of endogeneity. Thus, we will evaluate several previous studies to find solutions to deal with these problems. Meanwhile, most of the data are obtained from the Central Bureau of Statistics, the Central Bank, the State Electricity Company, the Ministry of Health and the missing years are further gap-filled with data from various sources.

Many researches with different approaches have been performed by many scholars to test the impact of infrastructure on income inequality. The first group of researchers uses single indicator as infrastructure proxy. For example, Fan & Zhang (2002) used indicator of road density to measure the effects of infrastructure on inequality in India. One reason behind this single-approach is the fact that it is difficult to accurately capture the various indicator of infrastructures in a proper way.

Whereas, the second group of researchers uses several indicators to proxy for infrastructure. For instance, Bajar & Rajeev (2015) used several sector such as roads, railway, electricity, and telecommunication as proxy of infrastructure to investigate the relationship between infrastructure and inequality in India. In addition, Prasetyo, Priyarsono & Mulatsih (2013) employed various economic and social infrastructure such as road, public high school, health facilities, and household sanitation to assess the relationship between infrastructure and inequality in Indonesia. One special note should be considered when using several infrastructure indicators as proxy that is sometimes the correlation found among these indicators of different kind of infrastructure is high.

Therefore, there is the third group those uses several indicators and construct indices to proxy for infrastructure to overcome the high correlation that often found among various infrastructure indicators. First and foremost is Calderón & Servén (2004, 2008, and 2014) who examine the effects of various infrastructure indicators such as roads, telecommunication and electricity on income inequality. They employ principal components analysis to constructs synthetic indices that summarize the quantity and quality of these various infrastructure. One reason why Calderón & Servén (2004, 2008, and 2014) construct these synthetic indices is that while these indices are able to combine information of various infrastructure sectors, these indices also help address the problem of high collinearity among their individual indicators. The other researchers who follow Calderón & Servén (2004, 2008, and 2014) by constructing synthetic indices are Raychaudhuri & De (2010), Majumder (2012), and Seneviratne & Sun (2013).

To sum up, in this study we will follow the approach used by Calderón & Servén (2004, 2008, and 2014) by constructing indices to measure the multi-dimensional concept of infrastructure. However, we will also analyse the impact of these various sector of infrastructure individually to obtain a comprehensive examination about the impact of different categories of infrastructure on income inequality.

Measuring the quantity and quality of infrastructure

We adopt a similar strategy used by Calderón & Servén (2004, 2008, and 2014) to construct quantitative indices of infrastructure quality and quantity. Both indices are intended to capture information in various basic infrastructure sectors. To build these indices, we take the same approach pioneered by Calderón & Servén (2004, 2008, and 2014) who follow Alesina & Perotti (1996) and Sanchez-Robles (1998) and apply principal component analysis to disaggregate infrastructure indicators. The synthetic indices are given by the first principal component of these various infrastructure variables.

In order to construct the aggregate index of infrastructure quantity, we use data from three sectors: road sector (road density in km of road per km² of land area), telecommunication sector (the percentage of households which connected to telephone lines, percentage of households which own cellular phone, and percentage of households with internet access), and electricity sector (electricity distributed per capita in MWh). The first principal component of these three infrastructure quantity variables accounts for 77% of their overall variance. All three infrastructure quantities enter the first principal component with almost similar weights:

$$P(Z)_{it} = 0.6048 \times \ln(Z_1)_{it} + 0.473 \times \ln(Z_2)_{it} + 0.6404 \times \ln(Z_3)_{it} \quad (1)$$

where $P(Z)_{it}$ is infrastructure quantity index, Z_1 is road density in km of road per km² of land area, Z_2 is the percentage of households which connected to telephone lines, percentage of households which own cellular phone, and percentage of households with internet access, and Z_3 is electricity distributed per capita in MWh.

The aggregate index of infrastructure quality uses information from one sector: air transportation sector (the ratio of the regional aggregate tonnage to the total tonnage recorded in the year). The first principal component of this indicator of infrastructure quality captures approximately 100% of their total variation. The infrastructure quality index can be expressed as:

$$P(qz)_{it} = 1.00(Q_1)_{it} \quad (2)$$

where $P(qz)_{it}$ represents infrastructure quality index, and Q_1 represents the ratio of the regional aggregate tonnage to the total tonnage recorded in the year.

Econometric specifications

The second problem that hinders those who study the relationship between infrastructure and income inequality is the identification of endogeneity. Infrastructure and income inequality may have two-way causality. Income inequality could prevent the poor from accessing infrastructure services, while at the same time inadequate infrastructure may worsen income inequality.

Calderón & Servén (2004, 2008, and 2014) and Raychaudhuri & De (2010) applied some kind of instrumental variable approach internally as well as externally to overcome this endogeneity problem. At first, they primarily relied on internal instruments as described by Arellano & Bond (1991) and use GMM-IV difference estimator technique. These internal instruments are suitable lags of the variables. Since lags of the variables can be weak instruments for the regression equation in differences especially when the regressors are persistent over time, they turn to GMM-IV system estimators which combines the regressions in differences and in levels. The instrument for the regression in differences are suitable lags of the variables, while the instruments for the regression in levels are the lagged differences of the corresponding variables. They also employed demographic variable as external instruments for the infrastructure indicators such as population density, labor force, and urban population.

Seneviratne & Sun (2013) used different and simpler estimation technique to deal with the endogeneity. They used pooled-OLS with fixed country effects and lagged variable. Thus, in their estimates both infrastructure indices entered the regressions with one year lag. Whereas, Prasetyo, Priyarsono & Mulsatih (2013) used two stage least square (2SLS) estimate in their study to assess the impact of infrastructure on economic growth and inequality in Indonesia. At the first stage, they regressed economic and social infrastructure such as road, number of public high school, number of health facilities, electricity, and households sanitation on economic growth. Subsequently, at the second stage they regressed the results from the first stage on Gini coefficient.

In this study we use fixed-effects (FE) estimate method over pooled-OLS and random-effects (RE) since we assume that specific characteristics within province may impact or bias the predictor or outcome

variables. For example, some provinces may be more connected to a larger input and output markets or may have higher people and capital mobility to improve their income levels over time because they have adequate infrastructure. If this assumption is held true, then it would automatically result to income inequality among provinces. For selecting the appropriate model we perform Breusch-Pagan Langrange multiplier (LM) test for deciding between pooled-OLS and RE model and Hausman test to confirm whether FE model is the more suitable method than RE model. Eventually, the result of Breusch-Pagan Langrange multiplier (LM) test lends support to RE model over pooled-OLS and Hausman test lends support to the FE model instead to the RE model, then our assumption is true and FE model is the more reliable method. In addition, we also perform Wald test for heteroskedasticity and Breusch-Pagan LM test of independence for cross-sectional dependence/contemporaneous correlation. The result of Wald test and Breusch-Pagan LM test reveal that our data has heteroskedasticity and autocorrelation problems. To overcome the heteroskedasticity problem, we use robust standard errors to control heteroskedasticity as suggested by Hoechle (2007). While, for the contemporaneous correlation problem, according to Baltagi (2008), it is a problem in macro panels with long time series (over 20-3- years). This is not much a problem in micro panels such as this study since we use few years and large number of cases.

To overcome the endogeneity problem, we will adopt the similar strategy used by Seneviratne & Sun (2013) in which the infrastructure quantity and quality indices enter the regression with one-year lag. The model to be estimated is as follows:

$$y_{it} = \alpha + \phi' K_{it} + \gamma' Z_{it} + \varepsilon_{it} \quad (3)$$

where:

y = a suitable inequality indicator (Gini coefficient)

K = a set of standard inequality determinants: per capita GRDP and its square, education, health, financial depth, macroeconomic stability, and the size of modern sector

Z = a vector of infrastructure-related measures

Income inequality

As our main variable of income inequality, we use the Gini coefficient measuring the concentration of incomes between the extremes of 0 (absolute equality) and 1 (maximum inequality). Data are primarily taken from the Central Bureau of Statistics (BPS). Gini coefficient is calculated by the Central Bureau of Statistics using expenditure approach based on the National Socio Economic Survey (Susenas).

Infrastructure

As our main independent variable, the infrastructure data are taken mainly from the Central Bureau of Statistics (BPS). Firstly, this study utilize the roads length data published by the Central Bureau of Statistics (BPS) to quantify the road quantity and quality. Road length are disaggregated according to the materials used to build the road, which are asphalt, gravel and soil. While road quantity is defined as the ratio between total length of road, regardless of the materials used, and the surface area, road quality is measured by percentage of the asphalted road to total roads.

Secondly, the data to calculate the seaport quantity and quality are extracted from the Transportation Statistics book published annually by the Central Bureau of Statistics (BPS). Seaport quantity is defined as the ratio of total passengers per region to the total passenger traffic recorded for all ports both for embarkation and disembarkation. Seaport quality is measured by the ratio of the regional aggregate cargo to the total cargo recorded in the year. Zhang et al. (2003) stated that cargo throughput is the suitable indicator to measure the quality of port since it computes the transactions and processes carried out by the port at a specific time. Moreover, this indicator can portray the economic situation and the level of development of the regions where the port is located.

Similar to the data that are used to calculate seaport quantity and quality, the data to measure airport quantity and quality also summarized from the Transportation Statistics book. Airport quantity is defined as the ratio of total passengers per region to the total passenger traffic recorded for all ports both for embarkation and disembarkation. Airport quality is measured by the ratio of the regional aggregate cargo to the total cargo recorded in the year. The rationale behind the proxy choice of airport quality is similar to that of seaport quality.

Next, the data to calculate electricity quantity and quality are gathered from PLN Electricity Statistics annual books. Electricity quantity is proxied by the electricity distributed per capita, while electricity quality will be proxied by the percentage of distribution loss. Due to data limitation, the electricity quality will not further use in the regressions.

Finally, the data to measure telecommunication quantity and quality are obtained from the Telecommunication Statistics of Indonesia published annually by the Central Bureau of Statistics (BPS). Telecommunication quantity will be represented by the percentage of households which connected to telephone lines, percentage of households which own cellular phone, and percentage of households which access internet. However, we find that there is no suitable proxy for telecommunication quality. Thus we will not employ this variable in our regressions.

Other covariates

Although infrastructure is our main concern in this paper, it is necessary to include several control variables stressed by previous empirical studies such as Milanovic (2000) and Calderón & Servén (2004, 2008, and 2014).

First of all, we include the (log) level of regional GDP per capita and its square to test for non-linear effects in the spirit of the conventional Kuznets curve effect. The data are obtained from the Central Bureau of Statistics (BPS).

In addition we include two variables of human capital: the average years of secondary schooling attained by population 15+ years as suggested by Barro & Lee (2001) as a proxy of education and the number of doctors per 1.000 people as a proxy of health development. The education data are taken from the Human Development Index report published yearly by the Central Bureau of Statistics (BPS), while the latter are compiled from the annual Indonesian Health Profile issued by the Ministry of Health.

The next variable control that we use is the ratio of credit to the private sector to regional GDP as suggested by Beck, Demirguc-Kunt & Levine (2000) as a proxy of financial depth. The data of credit are mainly obtained from the Indonesian Banking Statistics book published yearly by the Central Bank.

The other control variable is macroeconomic instability which is proxied by the CPI inflation rate. The data of CPI inflation rate are mainly compiled from the Central Bureau of Statistics (BPS) and the missing years are further gap-filled with data from various sources. Lastly, the control variable that we used is the size of the modern sector which is calculated as the share of industry in the economy's total value added (Milanovic, 2000). The data of industry's value added are calculated from the Annual Manufacturing Survey done by the Central Bureau of Statistics (BPS).

Results and Discussion

We turn to the evaluation of the impact of infrastructure quantity and quality on income inequality. We first examine the effects of different categories of infrastructure as a quantitative index and then its effects before these different categories of infrastructure are aggregated as a quantitative index. By doing so, we would like to obtain a comprehensive analysis about the impact of infrastructure indices as well as the impact of different categories of infrastructure on income inequality.

The impact of infrastructure quantity and quality indices

Table 1 below summarizes regression results using fixed-effects model. The first two columns include separately the infrastructure quantity and quality indices constructed in the regressions and the third columns include the two indices together. The coefficient of both infrastructure indices are contradictory. Infrastructure quantity index is positive, while infrastructure quality index is negative. However, of these two indices, both are statistically significant. The significantly positive sign of quantity index indicates that infrastructure quantity is positively correlated with income inequality. A 1% increase in the aggregate index of infrastructure quantity, *ceteris paribus*, will raise the gini coefficient by 0.065%. This finding contradicts with the empirical result from Calderón & Servén (2004, 2008, and 2014) and Seneviratne & Sun (2013) and the theoretical result of Chatterjee & Turnovsky (2012) which suggest that better infrastructure quantity reduced income inequality. However, this finding confirms the empirical result from Brakman et al. (2002) and Artadi & Sala-i-Martin (2003) which point out that better infrastructure has increased income disparity in Europe and Africa respectively.

Table 1. Estimation results of the impact of infrastructure quantity and quality indices on income inequality using fixed-effects (FE) model

	Gini	Gini	Gini
Infrastructure quantity	0.047 (1.39)	-	0.069 (2.04)**
Infrastructure quality	-	-0.045 (2.52)**	-0.053 (2.93)***
Cons	-1.658 (3.26)***	-2.170 (3.38)***	-2.137 (3.07)***
R2	0.61	0.62	0.63
N	198	198	198
Hausman test (prob>chi2)			0.000

* p < 0.10; ** p < 0.05; *** p < 0.01

The impact of different categories of infrastructure quantity

In Table 2 below we present the regression results of different categories of infrastructure quantities: road, telecommunication, electricity, airport, and seaport, individually or jointly. In columns 1-5 of Table 2 we use one infrastructure quantity indicator at one time, while in column 6 we use all infrastructure quantity indicators jointly. We want to see the impact of road, electricity, telecommunication, airport, and seaport quantity on income inequality. Firstly, from the Table 2 we can see that two out of five infrastructure quantities have positive and significant effects, namely road and telecommunication quantities. Secondly, the other two infrastructure quantities have significantly negative effects, to be precise electricity and airport quantities. Finally, the seaport quantity shows negative and not significant effect. While the magnitude of the coefficient estimates of these variables change, the pattern of signs and significances do not.

Table 2. Estimation results of the impact of different categories of infrastructure quantity on income inequality using fixed-effects (FE) model

	Gini	Gini	Gini	Gini	Gini	Gini
Road quantity	0.101 (2.65)***	-	-	-	-	0.088 (1.98)**
Electricity quantity	-	-0.112 (1.70)*	-	-	-	-0.131 (1.90)*
Telecommunication quantity	-	-	0.108 (2.24)**	-	-	0.092 (1.67)*
Airport quantity	-	-	-	-0.069 (2.64)***	-	-0.068 (2.50)**
Seaport quantity	-	-	-	-	0.004 (0.61)	-0.001 (0.19)
Cons	-1.813 (3.94)***	-1.687 (3.17)***	-0.858 (1.27)	-2.536 (4.35)***	-1.811 (3.36)***	-1.477 (1.87)*
R2	0.62	0.61	0.61	0.62	0.6	0.65
N	192	192	192	186	186	180
Hausman test (prob>chi2)						0.000

* p < 0.10; ** p < 0.05; *** p < 0.01

Our first variable of interest, road quantity, has a positive and statistically significant effect on income inequality at 5 percent level. It shows that 1 percent increasing road density will lead to increasing inequality by 0.088 percent, ceteris paribus. The reasonable explanation for this finding would be that better roads network has limited distributional impact on household income. This finding matches with the result of study done by Khandker & Koolwal (2007) that access to better road in rural Bangladesh enhances income only for households with higher income. In Indonesian context, this better road network has promoted private car and motorcycle ownership of higher and middle income households. The increasing private car ownership can be observed through the automobile sales volume in Indonesia. According to the data obtained from Gaikindo (The Association of Indonesia Automotive Industries), the private car

sales figure has increased sharply from 433,341 units in 2007 to 1,229,901 units in 2013. In addition, the data of motorcycle obtained from BPS (Central Bureau of Statistics) shows that the motorcycle ownership has also increased drastically from 41,955,128 units in 2007 to 76,381,183 units in 2012. The ownership of these better transportations will lead to a better access to productive opportunities. It does not mean that lower income households do not get benefit from better roads network. They do also have chance to access productive opportunities, but their returns of accessing better roads may not as large as the returns acquired by higher and middle income households. It can be argued that the benefits from accessing better roads network have accumulated better by the already rich households than the poorer households relatively, since better investment opportunities lead to even higher returns, which eventually leads to even more unequal income gain (Bajar & Rajeev, 2015).

The other variable of interest which has positive and statistically significant effect on income inequality is telecommunication quantity. The relation is significant at 10 percent level which suggest that 1 percent increase in telecommunication quantity will lead to 0.09 percent increase in income inequality. This finding is similar to the result of study done by Bandyopadhyay (2012). Possible explanation for this is the nature of technological bias possessed by information and telecommunication technology. Technological bias can partially have impact across the society i.e. positively affects one group of society more than others. For instance, technological bias can excessively increase the demand for skilled labor over unskilled labor by elevating the level of skill required to keep several type of jobs (Card & DiNardo, 2002). Thus, there will be jobs elimination for those who do not possess the skill demanded to attain those jobs.

The next two variable of interests that will be discussed have significantly negative effects on income inequality namely electricity quantity and airport quantity. The electricity quantity is significant at 10 percent level and airport quantity is significant at 5 percent level. These suggest that increase in electricity and airport quantity will lead to a decrease in income inequality.

The impact of electricity quantity on income inequality can be explained as follows: by accessing to electricity lower income households and small businesses which are owned by or employ the poor can improve their productivity that eventually lead to increases in income and employment of the poor households (Brenneman & Kerf, 2002). In this case, access to electricity enables these small businesses to use machines and telecommunication devices that require electricity. By allowing these small businesses owned by or that employ the poor households to use more reliable machinery and telecommunication technology can help increase productivity, hence, improve incomes. In addition, Brenneman & Kerf (2002) summarise that electricity is positively correlated with income, therefore, the presence of electricity means that lower income households can earn enough money to send their children to school. The increase of school attendance and the amount of time that children can spend on education will lead to a better job opportunities and income prospects.

Meanwhile, the plausible explanation of the negative relation between airport quantity and income inequality is that the presence of infrastructure such as airport enhances the access of the lower income households to potential income sources (Calderón & Servén, 2008). Moreover, Fan & Zhang (2002) add that regions with better airport hubs have comparative advantage for trade than regions with lesser airport hubs, and therefore may enable their population to have better access to market. Additionally, Brenneman & Kerf (2002) also argue that adequate transport infrastructure including airport facilitates the increasing productivity of businesses which employ the poor households. Usually, businesses have tendency to not locate in regions which are poor in transport infrastructure since this condition will create problem for them namely the difficulty to be accessed by consumers, employees and suppliers. Thus, businesses that locate in transportation-poor regions tend to be less productive consequently pay their workers with lower wages. Therefore, improving transportation infrastructure such as airport can significantly not only attract more businesses but also contribute to the productivity of the established businesses and the income of their workers. In the context of Indonesia, it is true that during the period of 2007-2013, the presence of airports grows considerably indicated by the increase of passengers. During this period, the number of passengers grows at rate of 15.4 % per year. In 2008, the number of passengers is 43.4 million people and this figure doubles to 88.8 million people in 2013.

The only variable of interest that does not have statistically significant impact on income inequality is seaport quantity. Although Indonesia is an archipelagic nation which comprises more than 17,000 islands and vast ocean as its connector, the development of seaport is still left behind. According to the Global Competitiveness Report 2013-2014, the seaport infrastructure in Indonesia only scores 3.9 and it is certainly far below the other ASEAN countries such as Singapore, Malaysia and Thailand which have score

6.8, 5.4, and 4.5 respectively. This seaport infrastructure condition makes people shift their ferriage preference from sea to air transport. As a result, the number of passengers using sea transport declines by 0.81% per year. In 2008 the number of passengers using sea transport is 20.1 million people, but in 2013 this figure drops to 19.3 million people.

The impact of different categories of infrastructure quality

In Table 3 below we present the regression results of different categories of infrastructure quality namely road, airport, and seaport, individually or jointly. These 3 infrastructure quality indicators show different relation to income inequality. Among these 3, airport quality is the only indicator which shows statistically significant effect, while road and seaport qualities do not have statistically significant impact on income inequality.

Table 3. Estimation results of the impact of different categories of infrastructure quality on income inequality using fixed-effects (FE) model

	Gini	Gini	Gini	Gini
Road quality	0.000 (0.00)	-	-	-0.016 (0.55)
Airport quality	-	0.049 (2.21)**	-	-0.052 (2.25)**
Seaport quality	-	-	-0.004 (0.42)	-0.003 (0.34)
Cons	-1.815 (3.41)**	-2.260 (4.05)**	-1.798 (3.34)**	-2.287 (3.98)**
R2	0.60	0.62	0.60	0.61
N	192	186	186	180
Hausman test (prob>chi2)				0.000

* p < 0.10; ** p < 0.05; *** p < 0.01

First of all, the airport quality has negative sign and statistically significant effect on income inequality at 5% level. This suggests that increase in airport quality will lead to a decrease in income inequality. This is somewhat analogous to the result of airport quantity. Airport quality also helps to alleviate income inequality by enhancing region's comparative advantage for trade and increasing the productivity of the established businesses and income of their workers. Meanwhile, the road quality shows a negative sign, similar to the sign of road quantity, however statistically insignificant. The plausible reason for this is the fact that road quantity and quality has strong correlation (Calderón & Servén, 2004). As a result it is reasonable that the effects of road quality may be mostly summed up by the quantity indicator.

Finally, the seaport quality shows similar pattern to seaport quantity, a statistically insignificant negative coefficient. It suggests that the seaport quality in Indonesia cannot contribute much in reducing income inequality. This result is corroborated by the low quality of seaport in Indonesia reflected by the very long dwelling time, between 9 and 10 days. At national level, this longer dwelling time cause higher logistic cost which is equal to 24.5% of Gross Domestic Product. Compared to other ASEAN countries, the Logistic Performance Index (LPI) in Indonesia is still lagging behind. In 2007, among 150 countries, Indonesian LPI was ranked 43rd, far below the neighboring countries such as Singapore, Malaysia, and Thailand which were ranked 1st, 27th, and 31st respectively. In 2013, the Indonesian LPI dropped to 59th and the gap to Singapore, Malaysia, and Thailand is widened.

Conclusions

There were interested results of this study in which we found different relation between five different categories of infrastructure and income inequality. The impact of different categories of infrastructure quantities on income inequality gave an insight that some components of infrastructure, namely road and telecommunication quantities, tend to boost income inequality. On the contrary, electricity and airport quantities had a favorable impact on the distribution of income and helped to alleviate income inequality. In addition, the infrastructure qualities that had impact on income inequality was airport quality. The airport quality also helped to decrease income inequality.

However, when these different categories of infrastructure were formed as synthetic indices, the relation between these indices and income inequality lent support to the idea that infrastructure increases income inequality. The finding of this paper corroborated the argument that infrastructure quantity tended to increase income inequality.

Taking everything into consideration, this study leaves much space for improvement. For instance, to deal with endogeneity problem, future study can utilize appropriate instrument variable and use more advanced estimate method. Furthermore this study does not consider the relation between reducing absolute poverty policies and income inequality. Thus, the future study could examine the impact of the goal of reducing absolute poverty through distribution policies such as distribution of infrastructure on income inequality. Finally, the results of this study do not recommend abandoning infrastructure development which positively correlate with income inequality such as road and telecommunication sectors. However, the road transportation and telecommunication projects need a complementary policy in order to benefit all groups of society. The government should put much effort such that infrastructure facilities are effectively utilized by all. This can be achieved through more informed and comprehensive planning and well-placed infrastructure project so that the lower income groups can take advantage of the facilities.

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