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ANALYSIS OF THE EFFECT OF PUBLIC INFRASTRUCTURE ON INCOME INEQUALITY IN INDONESIA

Ysma Soleha[1*], Hady Sutjipto[2] & Agus Salim[3]

Master of Economics Program, Universitas Sultan Ageng Tirtayasa

Corresponding Author: Ysma Soleha

Master of Economics Program, Universitas Sultan Ageng Tirtayasa

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Abstract: This study aims to analyze the effect of public infrastructure on income inequality in Indonesia. The public infrastructure variables employed in this study include road infrastructure, electricity infrastructure, bridges, and information and communication technology (ICT), while income inequality is measured using the Gini Ratio. This research applies a quantitative approach using panel data regression analysis. The data used are secondary data obtained from the Central Bureau of Statistics (BPS) and related institutions covering 34 provinces in Indonesia. The analysis includes stationarity testing, multicollinearity testing, Common Effect Model (OLS), Fixed Effect Model (FEM), and Random Effect Model (REM). The findings reveal that the ICT variable has a negative and significant effect on income inequality, indicating that improved access to information and communication technology contributes to reducing the Gini Ratio. Meanwhile, the electricity variable demonstrates a positive and significant effect in the OLS and REM models, suggesting that the expansion of electricity infrastructure has not been fully accompanied by an equitable distribution of economic benefits and therefore tends to increase income inequality. In contrast, road and bridge infrastructure variables do not show a significant effect on income inequality in Indonesia. Overall, the results confirm that public infrastructure development has not yet fully generated equitable income distribution. Therefore, more inclusive and regionally balanced infrastructure development policies are required, particularly in the information and communication technology sector.

Keywords: *Public infrastructure, income inequality, Gini Ratio, ICT, panel data regression.*

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Introduction

Income inequality remains one of the major challenges in Indonesia's economic development, as it reflects the uneven distribution of welfare across regions and among communities. High levels of inequality may negatively affect social stability and hinder the equitable distribution of economic development outcomes (Todaro & Smith, 2015). Therefore, income inequality has become an important issue in national development policy.

One of the factors influencing income inequality is public infrastructure. Public infrastructure such as roads, electricity, bridges, and information and communication technology (ICT) plays a significant role in supporting economic activities, improving regional connectivity, and facilitating the distribution of goods and services (Inna & Andrii, 2019). Adequate infrastructure can enhance public access to economic opportunities and encourage more balanced regional development.

According to endogenous growth theory, infrastructure development constitutes a form of public capital capable of increasing economic productivity and regional growth (Barro, 1990). Road and bridge infrastructure contribute to improving economic mobility and expanding interregional access. Electricity infrastructure supports production activities and industrial development, while the advancement of ICT accelerates access to information, broadens market access, and supports digital economic transformation (Rogers, 2003).

Several previous studies have demonstrated that public infrastructure affects income inequality, although the findings remain inconclusive. Bajar and Rajeev (2016) found that infrastructure development influences income distribution depending on the level of regional development. Meanwhile, Hulu and Wahyuni (2020) showed that several types of public infrastructure in Indonesia have not yet exerted a significant effect on income inequality.

Indonesia continues to face disparities in infrastructure development across regions, leading to differences in welfare levels among provinces and communities. Therefore, this study aims to analyze the effect of public infrastructure on income inequality in Indonesia by employing variables of road infrastructure, electricity infrastructure, bridge infrastructure, and information and communication technology (ICT).

Literature Review

Income Inequality

Income inequality refers to the unequal distribution of income among individuals or groups within a region. Inequality is commonly measured using the Gini Ratio, where values closer to one indicate higher levels of inequality. According to the Kuznets hypothesis, inequality tends to increase during the early stages of

economic development due to the concentration of economic activities in certain regions, and subsequently declines as economic development becomes more evenly distributed (Todaro & Smith, 2011).

Public Infrastructure

Public infrastructure refers to facilities and public services provided by the government to support social and economic activities, including roads, bridges, electricity, and information technology. Infrastructure plays a crucial role in enhancing economic productivity, facilitating the distribution of goods and services, and expanding public access to economic opportunities across regions (Arsyad, 1999).

Road Infrastructure

Road infrastructure functions to improve regional connectivity and facilitate the mobility of goods and services. According to Samuelson's public goods theory, roads are classified as public facilities that can be jointly utilized by society. Adequate road infrastructure can reduce distribution costs and expand economic access, thereby contributing to the reduction of interregional income inequality (Samuelson, 1954).

Electricity Infrastructure

Electricity is a fundamental infrastructure that supports production activities and overall economic performance. Hirschman's Unbalanced Growth Theory (1958) explains that electricity infrastructure development can stimulate economic growth through intersectoral linkages. However, uneven electricity development may concentrate economic benefits in certain regions, thereby increasing income inequality.

Bridge Infrastructure

Bridges play an important role in strengthening connectivity between regions separated by geographical barriers. Bridge infrastructure facilitates community mobility and economic distribution, thereby opening economic access for remote areas. In addition, bridge development generates spillover effects that contribute to the economic growth of surrounding regions (Yilmaz et al., 2002).

Information and Communication Technology (ICT) Infrastructure

Information and communication technology (ICT) plays a vital role in improving economic efficiency, expanding access to information, and supporting digital economic transformation. According to the Diffusion of Innovation Theory, the widespread dissemination of technology can accelerate innovation adoption and broaden economic opportunities for society (Rogers, 2003). Equitable ICT infrastructure development can therefore help reduce economic disparities across regions.

Methodology

Research Scope

This study employs a quantitative approach using panel data econometric methods to analyze the effect of public infrastructure on income inequality in Indonesia. The variables used in this study include road infrastructure (Road), electricity infrastructure (Electric), bridge infrastructure (Bridge), and information and communication technology (ICT) on income inequality measured by the Gini Ratio.

Data and Data Sources

The data used in this study are secondary data obtained from the Central Bureau of Statistics (BPS) and related institutions covering 34 provinces in Indonesia. The research variables consist of the Gini Ratio as the dependent variable, while Road, Electric, Bridge, and ICT are used as independent variables. Data processing and analysis were conducted using Stata, EViews, and Microsoft Excel software.

Data Analysis Technique

Panel Data Regression Model

Panel data regression analysis was employed to examine the effect of road infrastructure, electricity infrastructure, bridge infrastructure, and ICT on income inequality in Indonesia. The panel data method was selected because it is capable of combining time series and cross-sectional data while accommodating differences in regional characteristics (Gujarati, 2003).

The panel regression model used in this study is formulated as follows:

$$Gini_{it} = \beta_0 + \beta_1 Road_{it} + \beta_2 Electric_{it} + \beta_3 Bridge_{it} + \beta_4 ICT_{it} + \varepsilon_{it}$$

Classical Assumption Tests

Classical assumption testing was conducted through stationarity testing using the Fisher Augmented Dickey-Fuller (ADF) test and multicollinearity testing using the Variance Inflation Factor (VIF) to ensure that the data fulfilled the requirements for panel data regression analysis.

Panel Data Model Selection

Model selection was performed using the Common Effect Model (OLS), Fixed Effect Model (FEM), and Random Effect Model (REM). Furthermore, the Lagrange Multiplier (LM) test was conducted to determine the most appropriate estimation model.

Hypothesis Testing

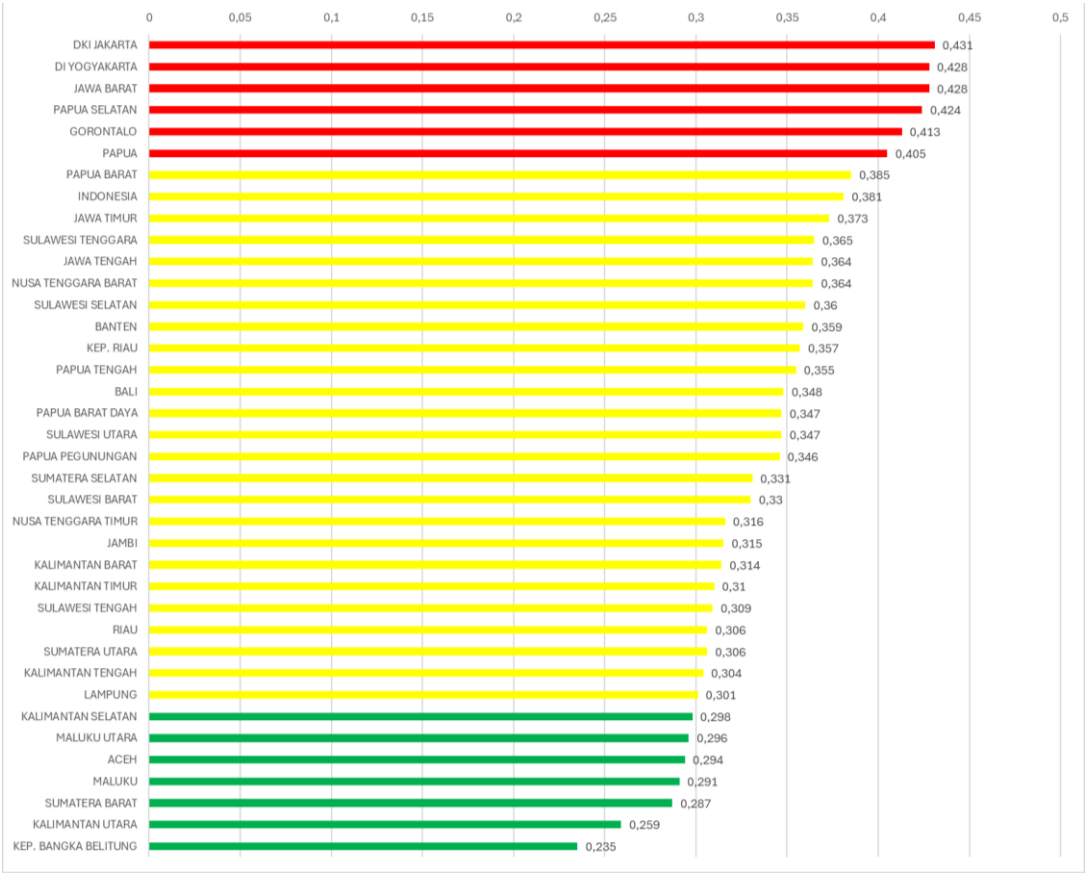
Hypothesis testing was conducted using partial tests (t-test) and simultaneous tests (F-test) at a 5% significance level to identify the effect of each independent variable on income inequality in Indonesia.

Results and Discussion

The findings of this study indicate variations in income inequality across provinces in Indonesia, which are influenced by differences in public infrastructure development in each region. Road infrastructure, electricity infrastructure, bridges, and information and communication technology (ICT) were analyzed to examine their effects on income inequality measured by the Gini Ratio.

The descriptive analysis demonstrates that income inequality in Indonesia fluctuated across several provinces during the observation period. Differences in infrastructure development levels have resulted in an uneven distribution of economic activities among regions. This condition is illustrated in Figure 1.

Figure 4.1 Income Inequality Level (Gini Ratio) in Indonesia, 2024



Source: Central Bureau of Statistics (BPS)

Based on Figure 4.1, income inequality among provinces in Indonesia in 2024 still shows considerable disparities. The province with the highest Gini Ratio was DKI Jakarta at 0.431, followed by DI Yogyakarta and West Java at 0.428, indicating relatively high levels of income inequality. Meanwhile, Bangka Belitung Islands recorded the lowest Gini Ratio at 0.235, followed by North Kalimantan at 0.259 and West Sumatra at 0.287, reflecting a more equitable income distribution. Nationally, Indonesia's Gini Ratio stood at 0.381, which falls within the category of moderate inequality. These disparities indicate that income distribution across regions in Indonesia remains uneven and is influenced by differences in economic activity, development, and infrastructure accessibility among provinces.

Furthermore, the stationarity test using Fisher ADF indicates that all research variables are stationary at the 5 percent significance level, allowing them to be used in panel data regression analysis.

Table 4.1 OLS Regression Results

Variable	Coefficient	P-value
Road	0.0000904	0.263
Electric	0.0001513	0.004
Bridge	0.0001928	0.070
ICT	-0.0005637	0.000
Prob > F = 0.0000		
R^2 = 0.0770		

Source: STATA Output

Based on Table 4.2, the OLS regression results indicate that the model is simultaneously significant, with a Prob > F value of 0.0000. The R^2 value of 0.0770 suggests that the independent variables explain approximately 7.7 percent of the variation in income inequality.

The Road variable has a positive coefficient value of 0.0000904 with a p-value of 0.263, indicating that road infrastructure does not have a significant effect on income inequality. The Electric variable has a positive and significant effect on the Gini Ratio, with a coefficient value of 0.0001513 and a p-value of 0.004. The Bridge variable has a positive coefficient value of 0.0001928 with a p-value of 0.070, indicating that bridge infrastructure does not significantly affect income inequality. Meanwhile, the ICT variable has a negative and significant effect on income inequality, with a coefficient value of -0.0005637 and a p-value of 0.000.

Table 4.2 Fixed Effect Model Results

Variable	Coefficient	P-value
Road	-0.0000776	0.481
Electric	0.0000478	0.527
Bridge	0.000094	0.456
ICT	-0.0011695	0.000

Source: STATA Output

Based on Table 4.1, the ICT variable shows a p-value of 0.000, indicating significance at the 5 percent level. Meanwhile, the Road, Electric, and Bridge variables exhibit relatively small

coefficient values. Overall, the test results confirm that the panel data are appropriate for regression analysis.

The multicollinearity test results reveal that all Variance Inflation Factor (VIF) values are below 10, namely Bridge at 1.28, Road at 1.23, ICT at 1.08, and Electric at 1.04, with a mean VIF of 1.16. These findings indicate the absence of multicollinearity among the independent variables in the regression model.

Table 4.3 Fixed Effect Model (FEM) Results

Variable	Result
Road	Not significant
Electric	Not significant
Bridge	Not significant
ICT	Negative and significant
Prob > F = 0.0000	

Source: STATA Output

Based on Table 4.3, the Fixed Effect Model (FEM) results indicate that the model is simultaneously significant, as reflected by the Prob > F value of 0.0000. The results show that the ICT variable has a negative and significant effect on income inequality, indicating that improvements in information and communication technology infrastructure contribute to reducing the Gini Ratio in Indonesia.

Meanwhile, the Road, Electric, and Bridge variables do not show statistically significant effects on income inequality after controlling for province-specific characteristics. These findings suggest that differences in regional characteristics across provinces may influence the relationship between public infrastructure and income inequality in Indonesia.

Table 4.4 Lagrange Multiplier (LM) Test Results

Test	Prob
Breusch-Pagan LM	0.0000

Source: STATA Output

Based on Table 4.5, the Lagrange Multiplier test result shows a Prob > chibar2 value of 0.0000, indicating that the Random Effect Model is more appropriate than the Common Effect Model (OLS).

Overall, the findings demonstrate that ICT is the most consistent variable affecting income inequality in Indonesia, with a negative relationship. This indicates that improved access to information and communication technology contributes to reducing income inequality. On the other hand, the Electric variable shows a positive effect on income inequality in both the OLS and REM models. Meanwhile, the Road and Bridge variables have not shown significant effects on income inequality in Indonesia.

Conclusion

The findings of this study demonstrate that public infrastructure exerts varying effects on income inequality in Indonesia. The ICT variable is found to have a negative and significant effect on the Gini Ratio, indicating that greater access to information and communication technology contributes to reducing income inequality. In contrast, the electricity variable shows a positive and significant effect in several estimation models, suggesting that the development of electricity infrastructure has not yet fully resulted in an equitable distribution of economic benefits across regions.

Meanwhile, road and bridge infrastructure variables do not exhibit a significant effect on income inequality in Indonesia. Overall, the results emphasize that public infrastructure development should be implemented in a more inclusive and equitable manner to ensure that the benefits of development are distributed across all segments of society. The government should expand equal access to information and communication technology while ensuring that the development of basic infrastructure is not concentrated only in specific regions, thereby contributing to the reduction of interregional income disparities.

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