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Impact of Information and Communication Technology (ICT) Infrastructure on Economic Growth and Income Inequality in Indonesia

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ABSTRACT

Information and Communication Technology (ICT) plays an important role in supporting economic growth and overcoming income inequality. ICT infrastructure functions to facilitate the use of ICT by economic actors through ICT devices. Previous research used more data between countries or between districts/cities while Indonesia consisted of provinces with different social and economic characteristics. Therefore, the purpose of this study is to analyze the impact of ICT infrastructure on economic growth and income inequality in Indonesia using provincial panel data for the period 2011-2016. The results of the analysis of simultaneous equation models using the Two Stages Least Square (TSLS) method state that ICT infrastructure indicators consisting of cellular telephone ownership, internet accessibility, and the number of Base Transceiver Station (BTS) significantly has a positive impact on economic growth. In addition, these ICT infrastructure variables indirectly have an impact on income inequality through economic growth. Other results obtained are that government spending on ICTs do not significantly impact economic growth and income inequality in Indonesia. The conclusion is that ICT infrastructure has a direct impact on economic growth and an indirect impact on income inequality.

Keywords : Economic Growth, ICT, Income Inequality, Infrastructure, Simultaneous Equations

I. INTRODUCTION

Development is a multidimensional process that includes various fundamental changes to the social structure, attitudes of society, and national institutions, while continuing to pursue accelerated economic growth, overcoming income inequality, and alleviating poverty (Todaro and Smith, 2004). The three main components of economic growth are accumulation of capital goods, population growth, and technological progress. One technology that is developing very fast is Information and Communication Technology (ICT). In the era of globalization and information, ICTs have an important role in supporting economic actors to increase output. World Bank (1994) in its study concluded that every one percent increase in infrastructure stock would increase Gross Domestic Product (GDP) by one percent. Availability of adequate infrastructure will increase productivity and reduce production costs. Alleman et al. (2004) explain that modern telecommunications infrastructure is a prerequisite for attracting new investments. Most infrastructure investments have a positive effect on the economy in three ways, namely reducing production costs, increasing income, and increasing employment both directly and indirectly.

Indicators of economic development besides economic growth are income inequality. Income

inequality occurs when a large portion of the population of a region receives a small portion of income. Inter-regional connectivity through ICT is an important element in supporting economic growth and income distribution in Indonesia. Calderon and Serven (2004) explained that the quantity and quality of infrastructure had a positive effect on economic growth and negatively affected income inequality. However, research by Prasetyo (2013) concluded that infrastructure variables are instrument variables that significantly increase income inequality.

Macroeconomic indicators to measure a country's economic growth, namely Gross Domestic Product (GDP). GDP at the provincial and district/city level is called Gross Regional Domestic Product (GRDP). The macroeconomic indicators to measure income inequality in a region are using the Gini Coefficient (Gini Ratio).

The role of ICTs in supporting economic growth and income distribution makes ICT a technology that needs to be improved evenly and sustainably. Increasing the use of ICT by economic actors must be supported by ICT infrastructure that serves to facilitate the use of ICT by economic actors through ICT tools. The level of ICT infrastructure development in an area can be seen from the number of Base Transceiver Station (BTS) and government ICT capital expenditure. The study by Tamara (2011) concluded that telecommunications infrastructure, as measured by the number of BTSs, had a positive effect on economic growth in Indonesia. Another study by Ngatono (2016) provides a conclusion that telecommunications infrastructure, as measured by the number of BTS, has a positive effect on economic growth in Banten Province.

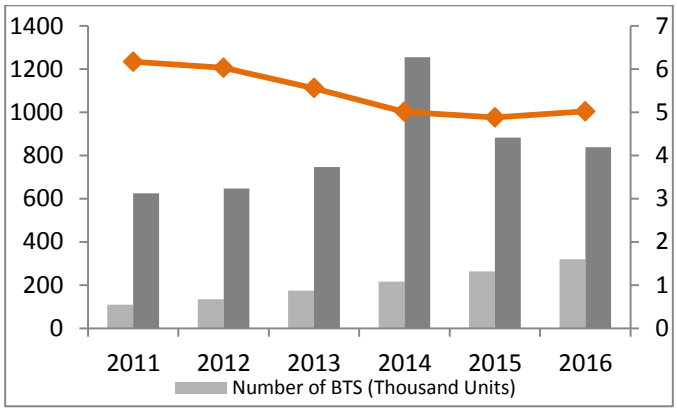

Figure 1: Number of BTS, Government ICT Capital Expenditures, and Economic Growth (National GDP), 2011–2016

Data from the Ministry of Communication and Information (2018) states that the number of BTS in Indonesia has always increased during the period 2011-2016. Capital expenditure in the ICT sector of the provincial government in Indonesia also increased during the period 2011-2016. However, the rate of economic growth (National GDP) slowed up to 2015 (Figure 1). Besides that, the Gini coefficient shows the level of income inequality that fluctuated during 2011–2016. However, the income inequality in 2016, with the Gini Coefficient of 0.394, is higher than in 2011, with the Gini Coefficient of 0.388 (Figure 2).

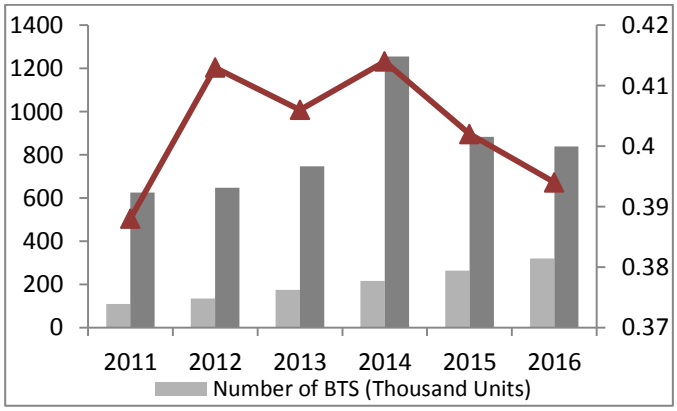

Figure 2: Number of BTS, Government ICT Capital Expenditures, and Gini Coefficient, 2011–2016

The gap between theories supported by the results of previous research with empirical data indicates the need for research to analyze the impact of ICT infrastructure on economic growth and income

inequality in Indonesia. Previous research used more data between countries in a particular regional area, as well as district/city data in a province. Indonesia is an archipelago with different social and economic characteristics. Therefore, research is needed to analyze the impact of ICT infrastructure on economic growth and income inequality in Indonesia, using provincial panel data for the period 2011-2016.

Based on the background and formulation of the problems described above, the objectives of this study are:

1. Analyzing the impact of ICT infrastructure on the economic growth of provinces in Indonesia
2. Analyzing the impact of ICT infrastructure on income inequality of provinces in Indonesia

II. METHODS AND MATERIAL

2.1 Data Source and Text Mining

This study uses secondary data from BPS Statistics Indonesia and the Ministry of Communication and Information (Kemenkominfo) Indonesia. The data period used is annual from each province studied from 2011 to 2016. North Kalimantan province is included in the East Kalimantan due to limited data availability.

The variables used in the study consisted of GDP at constant 2010 prices as an indicator of economic growth and the Gini Coefficient/Gini Ratio as an indicator of income inequality. Variables of ICT infrastructure are represented by ownership of cellular telephones, internet accessibility, number of BTS, and government ICT expenditure.

TABLE I
VARIABLES AND RESEARCH DATA SOURCE

Variable	Description	Unit	Source
Economic growth	GDP on the basis of constant prices in 2010	Rupiah	BPS
Income inequality	Gini Coefficient/Gini Ratio	-	BPS
Cellular phone ownership	The percentage of households that have cell phones	Percent	BPS
Internet accessibility	Percentage of households accessing the internet	Percent	BPS
Number of BTS	Number of BTS units	Unit	Kemenkominfo
Government ICT expenditure	Government ICT capital expenditure	Rupiah	BPS
Road infrastructure	Ratio of road length to population	Km/ 1,000 people	BPS
Electricity Infrastructure	Percentage of households that access electricity	Percent	BPS
Dummy poor area	Dummy Value 1 if poor and 0 if not poor	-	BPS
Labor	Number of labor	People	BPS
Human Capital 1	Mean year school	Year	BPS
Human Capital 2	The ratio of the number of doctors to population	Doctor / 100,000 people	BPS

The other variables used were the variable road infrastructure, electricity infrastructure, dummy poor areas, labor, the average length of school as an indicator of human capital 1, and the ratio of the

number of doctors to the population as indicators of human capital 2. These variables are presented in Table 1. Road infrastructure variables are obtained by dividing the length of the road to the population, while the variable human capital 2 is obtained by calculating the number of doctors to the population.

2.2 Panel Data Analysis with Simultaneous Equation Model

The analytical method used is descriptive analysis method and quantitative analysis method. The quantitative analysis used is panel data regression analysis with a simultaneous equation model consisting of two structural equations. The simultaneous equation model is as follows:

$$LNGRDP_{it} = \alpha_i + \beta_1 CELL_{it} + \beta_2 NET_{it} + \beta_3 LNBTS_{it} + \beta_4 LNGOV_{it} + \beta_5 ROAD_{it} + \beta_6 ELEC_{it} + \beta_7 DPOOR_{it} + \beta_8 GINI_{it} + u_{it} \quad (1)$$

$$GINI_{it} = \sigma_i + \beta_9 LNLF_{it} + \beta_{10} HK1_{it} + \beta_{11} HK2_{it} + \beta_{12} LNGRDP_{it} + v_{it} \quad (2)$$

where GRDP= GRDP on the basis of constant prices in 2010 (rupiah); CELL= percentage of households that have cellular phones (percent); NET= percentage of households accessing the internet (percent); BTS= number of BTS (units); GOV= government ICT expenditure (rupiah); ROAD= ratio of road length to population (km/1,000 people); ELEC= percentage of households that access electricity (percent); DPOOR = dummy variable, worth 1 if poor and 0 if not poor; GINI= Gini Coefficient; LF= number of labor (people); HK1= mean year school (year); HK2= ratio of the number of doctors to population (doctor/100,000 people); α, σ= intercept constant; β1-β12= expected parameter; u, v= error term; i= province with i= 1,2,3, ..., 33; t= year with t= 1,2,3, ..., 6.

The simultaneous equation model with two structural equations consists of two endogenous variables and ten exogenous variables. The relationship between variables is described in Figure 3. The first structural equation is called the economic growth equation while the second structural equation is called the income inequality equation.

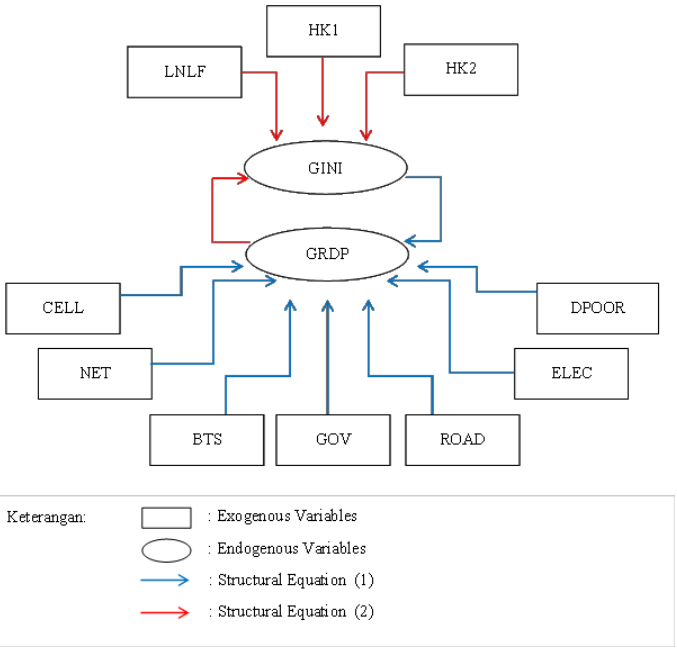

Figure 3: The Relationship between Variables

III.RESULTS AND DISCUSSION

3.1 ICT Infrastructure and Economic Growth

The general description of the relationship between ICT infrastructure and economic growth is explained using scatter diagrams which divide the provinces in Indonesia into four quadrants (Figure 4). In order to accommodate the linkages with poverty, each province was included in the category of poor or not poor provinces. Poor provinces are defined as provinces with per capita income below the median per capita income.

Quadrant I is not poor provinces with a level of economic growth above Indonesian level, consist of Sumatera Utara, Jambi, Sumatera Selatan, Kepulauan Riau, DKI Jakarta, Jawa Timur, Banten, Bali, Kalimantan Tengah, Kalimantan Timur, Sulawesi

Utara, Sulawesi Selatan, and Sulawesi Tenggara. Quadrant II is a poor province with a level of economic growth above Indonesian level, consist of Sumatera Barat, Bengkulu, Lampung, Jawa Barat, Sulawesi Tengah, Gorontalo, Sulawesi Barat, Maluku, and Maluku Utara. Quadrant III is a poor province with a level of economic growth below Indonesian level, consist of Aceh, Jawa Tengah, Yogyakarta, NTB, NTT, Kalimantan Barat, and Kalimantan Selatan. Quadrant IV is a not poor province with a rate of economic growth below Indonesian level, consist of Riau, Kepulauan Bangka Belitung, Papua Barat, and Papua.

Provinces with a high level of ICT infrastructure are defined as provinces with ICT infrastructure levels above the Indonesian level for the 2011-2016 average, and represented by colored dots. ICT infrastructure represented by ownership of cellular phone (Figure 4a), internet accessibility (4b), number of BTS per capita (Figure 4c), and ratio of government ICT expenditure (Figure 4d).

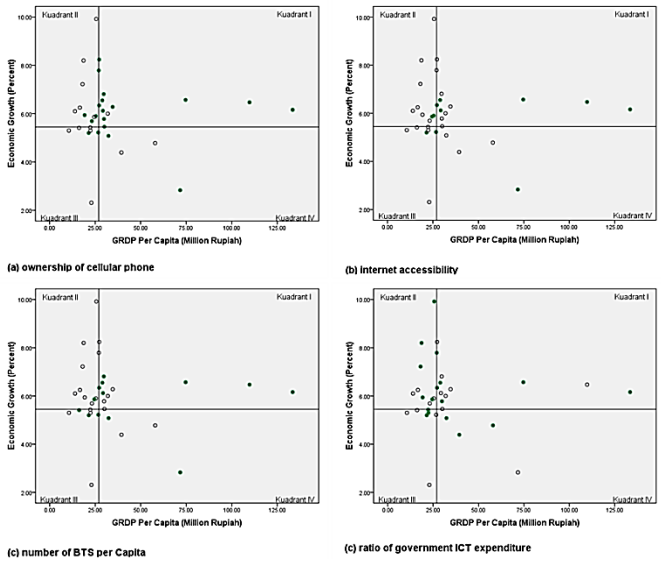

Figure 4: Distribution of Provinces according to Economic Growth, GRDP Per Capita, and ICT Infrastructure for Average in 2011-2016

In general, provinces with a high level of ICT infrastructure tend to have a high level of economic growth, which is above Indonesian level, both in the poor and not poor categories.

3.2 ICT Infrastructure and Income Inequality

The general description of the relationship between ICT infrastructure and income inequality is explained using scatter diagrams which divide the provinces in Indonesia into four quadrants (Figure 5). Quadrant I is not poor provinces with a level of income inequality above Indonesian level, consist of DKI Jakarta, Bali, Sulawesi Selatan, Papua Barat, and Papua. Quadrant II is a poor province with a level of income inequality above Indonesian level, consist of Jawa Barat, Yogyakarta, and Gorontalo. Quadrant III is a poor province with a level of income inequality under Indonesian level, consist of Aceh, Sumatera Barat, Bengkulu, Lampung, Jawa Tengah, NTB, NTT, Kalimantan Barat, Kalimantan Selatan, Sulawesi Tengah, Sulawesi Barat, Maluku, and Maluku Utara. Quadrant IV is a non-poor province with a level of income inequality under Indonesian level, consist of Sumatera Utara, Riau, Jambi, Sumatera Selatan, Kepulauan Bangka Belitung, Kepulauan Riau, Jawa Timur, Banten, Kalimantan Tengah, Kalimantan Timur, anf Sulawesi Tenggara.

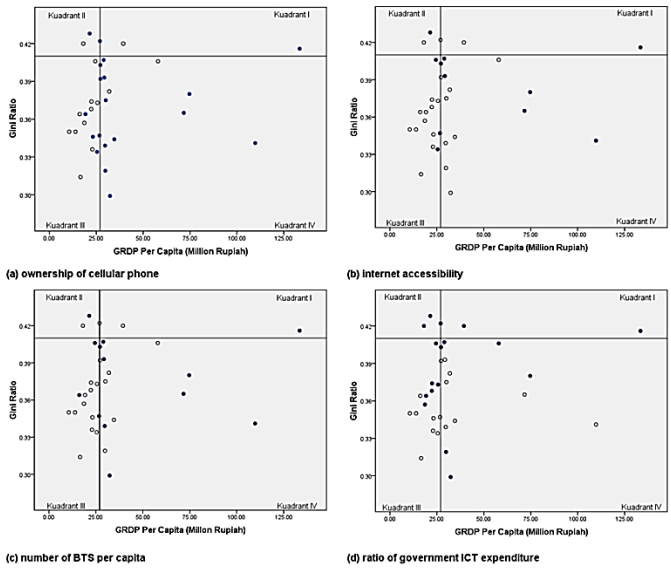

Figure 5: Distribution of Provinces according to Gini Ratio, GRDP Per Capita, and ICT Infrastructure for Average in 2011-2016

Provinces with a high level of ICT infrastructure are defined as provinces with ICT infrastructure levels above the Indonesian level for the 2011-2016 average, and represented by colored dots. ICT infrastructure represented by ownership of cellular phone (Figure 5a), internet accessibility (5b), number of BTS per capita (Figure 5c), and ratio of government ICT expenditure (Figure 5d).

In general, provinces with a high level of ICT infrastructure tend to have a low level of Gini Ratio, which is below Indonesian level, both in the poor and not poor categories.

3.3 Simultaneous Equation Parameter Estimation

Parameter estimation is done after going through the model identification, simultaneity test, model suitability test, econometric criteria test and statistical criteria test. Through a series of tests, a fixed effect model was obtained with the Two Stages Least Square (TSLS) method as the best model. The results of parameter estimation of simultaneous equations consist of two structural equations, namely the economic growth equation and the income inequality equation.

1. Economic Growth Equation

The estimation of economic growth equations, as the first structural equation, used in estimating the impact of ICT infrastructure on economic growth and income inequality in Indonesia is as follows:

LNGRDP = 31.1068 + 0.0042 CELL + 0.0080 NET + 0.0586 LNBTS - 0.0038 LNGOV - 0.5308 ROAD + 0.0025 ELEC - 0.0362 DPOOR + 0.3884 GINI

The estimation results show that the ICT infrastructure variables which include the percentage of households that have cellular phones, the percentage of households accessing the internet, and the significant number of BTS have a positive impact on economic growth at a real level of five percent. Conversely, the variable government ICT expenditure and the Gini Coefficient does not significantly impact economic growth. Other variables that also have a significant impact are the percentage of households that access electricity which have a positive impact while the dummy variable in poor areas has a negative impact. In the initial conditions, there were significant differences between the economic growth of poor provinces and not poor provinces, where the growth of poor provinces was lower than the non-poor provinces.

An increase of one percent in households with cell phones will increase the provincial GDP by 0.42 percent. These results support previous empirical results conducted by Alleman et al. (2004) which states that GDP is positively related to telecommunications investment, which is represented by telephone penetration. The one percent increase in households accessing the internet will increase the provincial GDP by 0.80 percent. Research with similar results was carried out by Naym and Hossain (2016) which stated that the number of internet customers, as an approach to using ICT, had a significant positive effect on GDP. When the number of BTS increased by one percent, the provincial GRDP increased by 5.86 percent. The results of research conducted by Tamara (2011) and Ngatono (2016) similar to these results, stated that telecommunication infrastructure, represented by the number of BTS, had a positive and significant influence on economic growth.

Estimation results in economic growth equations generally support empirical results by Mefteh and Benhassen (2015) which state that there is a positive and significant relationship between ICT and economic growth in 43 countries. ICT variables are represented by new technology variables consisting of the number of fixed telephone customers, the number of fixed broadband customers, the number of individual internet users, the number of cellular

telephone customers, the number of households with computers, the number of fixed internet subscribers, and the number of fixed broadband internet customers.

Other research results supported are research by Vu (2011) which states that there is a very significant relationship between growth and penetration of ICTs (penetration of personal computers, cellular telephones, and internet users). Penetration of personal computers, cellular phones and internet users has a significant influence on growth. The results of the study support the hypothesis that ICT penetration has a positive influence on economic growth through three channels, namely encouraging the diffusion of technology and innovation; improve the quality of decision making by companies and households; and increase demand and reduce production costs. These three things together increase the level of output.

2. Income Inequality Equation

The estimation of income inequality equation, as the second structural equation, is used to estimate the impact of ICT infrastructure on economic growth and income inequality in Indonesia, namely:

GINI = 3.2929-0.0213 LNLF + 0.0156 HK1 + 0.0004 HK2 - 0.0849 LNGRDP

The estimation results show that the mean year school significantly impacts negatively on income inequality. When the average length of school increases by one year, the provincial Gini Coefficient rises by 0.0156 units. In other words, the longer the average year of schooling will further increase income inequality. The other results obtained were the ratio of the number of doctors to the population did not significantly impact income inequality at the real level of five percent. However, these variables have a positive impact on the real level of ten percent. Labor variable does not significantly affect income inequality.

Economic growth has a positive impact on overcoming income inequality at a real level of five percent. An increase in GRDP of 1 percent will reduce the Gini Coefficient by 0.00849 units. This indicates that the higher the income of a region will further reduce income inequality in the region. In other words, the ICT infrastructure variables include the percentage of households that have cell phones; the percentage of households accessing the internet; and the number of BTS, indirectly has an impact on income inequality in Indonesia.

These results corroborate the results of research by Calderon and Serven (2004) which state that the quantity and quality of infrastructure has a significant negative effect on income inequality, through economic growth. In addition, the results obtained are contrary to the results of another study by Prasetyo (2013) which concluded that economic infrastructure, including ownership of cellphones; indirectly affecting income inequality through economic growth.

IV.CONCLUSION

Provinces with a high level of ICT infrastructure tend to have relatively high levels of economic growth, both in the poor and not poor categories. The majority of provinces with high levels of ICT infrastructure have a level of income inequality below Indonesia, both in the poor and not poor categories.

Percentage of households that have cellular phones, the percentage of households accessing the internet, the number of BTS, and the percentage of households that access electricity have a positive impact while the dummy of poor regions has a negative impact on economic growth. In contrast, government ICT expenditure, the ratio of road length to population, and the Gini Coefficient have no significant impact on economic growth. ICT infrastructure which is represented by the ownership of cellular phones, accessibility to the internet, and the number of BTSs

directly have a significant positive impact on economic growth.

The average length of school has a negative impact while economic growth has a positive impact on income inequality. The labor force and the ratio of the number of doctors to the population do not significantly affect income inequality at the real level of five percent. In other words, ICT infrastructure, which includes ownership of cellular telephones, accessibility to the internet, and the number of BTS, indirectly has an impact on income inequality through economic growth.

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