

Reducing Regional Disparity in Java: A Spatial Econometrics Approach

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Received: June 2022 | Revised: September 2022 | Accepted: June 2023

Abstract

Regional disparity is one of the challenges faced by the government of developing Indonesia. Indonesian government focus on increasing equitable development by increasing physical and non-physical connectivity through the National Medium-Term Development Plan III (RPJMN III) in 2015-2019. However, the allocation of capital or investment between regions can trigger or reduce regional disparity. This study aims to determine the role of technology, transportation infrastructure, and investment spatially in reducing regional disparity in Java. The study utilizing data of 6 provinces in Java Island in 2015 – 2019. The method used in this study was spatial econometric analysis. The spatial model used is Moran's I, Lagrange Multiplier Test, and Spatial Error Model (SEM) using Geoda 1.20 software. The results of Moran's I showed that there is a negative spatial dependence on regional disparity with a Moran index of -0.021. Based on the result of LM Test, the spatial model used is SEM. The estimation results of SEM model showed that technology has spatially a negative and significant impact on regional disparity in Java, while transportation infrastructure and investment has spatially a positive and significant effect on regional disparity in Java.

Keywords: Regional Disparity, Spatial Dependence, Spatial Error Model.

JEL Codes: O18, O21, O33, R11, R58

How to Cite: Yunitasari D., Fauzan A., Prianto F. W. (2023). Reducing Regional Disparity in Java: A Spatial Econometrics Approach, 24(1), 129-140. doi:<https://doi.org/10.23917/jep.v24i1.18532>

DOI: <https://doi.org/10.23917/jep.v24i1.18532>

1. Introduction

In the spatial context, economic growth is not considered as the appropriate indicator to describe the distribution of regional development and economic welfare. High economic growth can only be enjoyed by some individuals or regions, for example Special Region of Yogyakarta had high economic growth about 141,4 trillion in 2019 but at the same time its gini ratio was about 0.428. Development does not always produce equality for every region (Sakti & maudita, 2022). So that development which only targets high economic growth will potentially cause inequality. Development disparity between one region and another can lead to an imbalance of economic activity which has an impact on regional disparity (Yunitasari & Firmansyah,

2019). Therefore, the purpose of development must be focused not only on increasing economic growth but also regional development equality.

In the process of implementing regional development, there exist some main problems resulting in economic disparity between regions, due to the differences in region's ability to improve the quality of development process (Wiratama et al., 2018). The implementation of development in Indonesia has been going on for quite a long time starting from the old order era to the reform era, and one of the challenges faced was regional disparity (Oktavia et al., 2021). Sukwika's study (2018) empirically showed that economic disparity between provinces in Indonesia in 2011 – 2015 is quite large with a Williamson index of 0.7. The

result of Mahardiki and Santoso's study (2013) also showed that disparity of GRDP per capita between provinces in Indonesia is large with a Williamson index of 0.79. Vu and Mukhopadhaya (2011) also stated that a decrease in inequality would make low-income regions grow faster than high and medium income regions. This implication provides a strong incentive for low-income regions to further aim at eliminating poverty, and income distribution gaps.

The distribution of Indonesia's GDP in 2019 was still centralized and unequal. Java becomes Indonesia's growth pole with the largest contribution to the national GDP of 59 percent in 2019 (BPS, 2020). Karim et al (2022) also stated that the real GDP of Java was always higher than outside Java even though Java only consists of 6 provinces while outside Java consists of 28 provinces. Unfortunately, according to the study conducted by Alsya *et al* (2020) showed that all provinces in Java have income inequality above 0.35, meaning that disparity in Java is at moderate level, indicating that Java is the center of the economy but its welfare has not been equally distributed.

There are several factors that potentially determine regional economic growth, such as technology, infrastructure, and investment. According to Romer (1986) technology is a factor that can determine the velocity of regional economic growth. The lower technological development will slow down regional economic growth while the rapid technological development can increase and accelerate regional economic growth. The result of Tajerin's study (2007) empirically showed that the level of technology has positive influence on economic convergence in the eastern region of Indonesia where technology can accelerate economic growth in developing region compared to developed region and will ultimately reduce disparity between developing and developed regions. On the other hand, Fong's study (2009) showed that technology described by the number of internet user, mobile phone, personal computer, and telephone has a positive influence on the disparity between rural and urban areas in China. Kim (2012) in his research stated that there are two versions of the Technological Kuznets Curve (TKC), namely TKC version I as an inverted U-shaped and TKC version II as a U-shaped. Therefore, technological developments can have a

positive or negative effect on regional disparity so that technology can be the cause of an increase in regional disparity or a solution in reducing the level of regional disparity.

Figure 1 showed that Java's Information and Communication Technology Development Index (ICTDI) in 2019 tends to be unequal between provinces. Jakarta ICTDI is the highest compared to other provinces so that Jakarta has more opportunities to utilize technology in its economic activities. Although ICTDI in other provinces is above the national ICTDI, it is still much smaller than Jakarta ICTDI. Therefore, the gap of technological progress between provinces in Java needs to be a concern so that each region has the same facilities in its economic activities in order that regional disparity can be reduced.

Spatial concentration that causes regional disparity is dynamic, as the geographical economic signal that reveals the government's role in these dynamics through spatial planning and infrastructure development (Prianto, 2011). Banister and Berechman (2000) in the theory of transportation investment explained that regional economic growth is largely determined by the region ability to increase its production while production is influenced by the availability of capital and labor as production factors. The availability of production factors is largely determined by the ease of accessibility and marginal transportation costs so that it becomes a consideration for the selection of industrial and company locations. Jose (2019) pointed out in his study that infrastructure disparity contributes to the existing regional disparity in India. Rosmeli's study (2011) found that connectivity infrastructure, measured by roads, has a positive influence on the reduction of regional disparity in Indonesia because connectivity infrastructure is the main factor of goods and services mobility between regions. On the other hand, Makmuri's study (2017) showed that roads and telecommunications have negative influence on reducing regional disparity in Indonesia. It is in line with the theory of New Economic Geography (Krugman, 1991) that production and labor activities will tend to be concentrated in areas with low levels of transportation costs so that these areas will become the centers of growth.

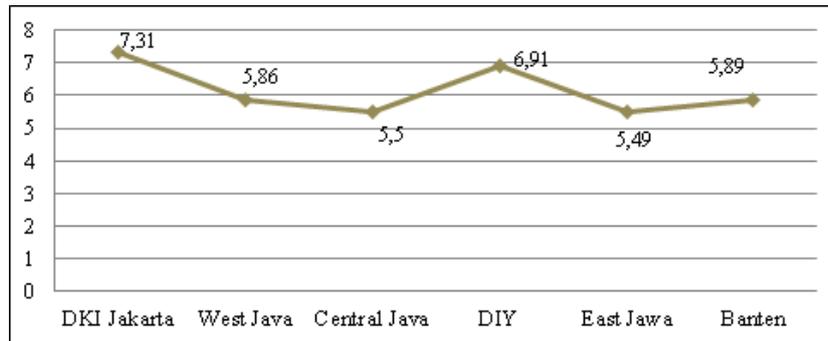


Figure 1 Information and Communication Technology Development Index (ICTDI) distribution in Java in 2019 (Ratio).

Source: Statistics Indonesia (BPS), 2020.

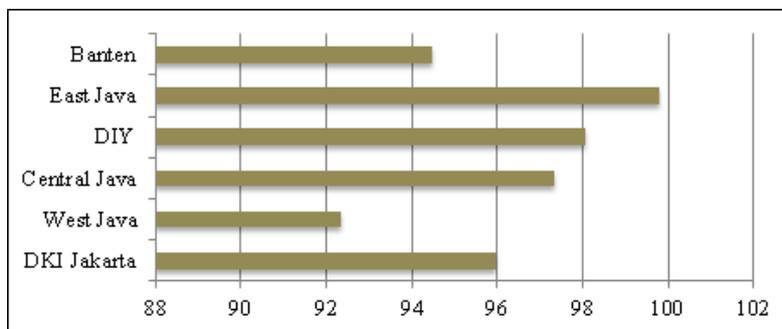


Figure 2 Java's national road qualities in 2019 (Percent).

Source: Ministry of Public Works and Housing, 2020.

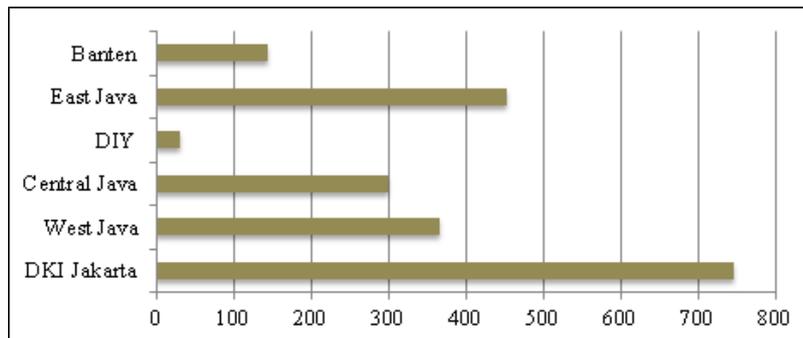


Figure 3 gross fixed capital formation distributions in Java in 2019 (Trillion Rupiah).

Source: Statistics Indonesia (BPS), 2020.

Figure 2 showed that national road quality in East Java is higher than other provinces, which is about 99.8% so that the mobility of goods and services in East Java will be easier than other provinces. In addition, some provinces still have a low national road quality, such as West Java with national road quality of

92.3%. The lower quality of road infrastructure as a supporting facility in the mobility of goods and services, can affect the ability of its region to increase economic growth. Therefore, the gap of national road quality between regions needs to be considered in carrying out national development so that each region has the same

supporting facilities, especially national road quality in carrying out economic activities.

In addition to connectivity factors, the allocation of capital or investment between regions can also trigger regional disparity. Investment can be from the private sector and the government. In the context of National Medium-Term Development Plan III (RPJMN III), government investment described by gross fixed capital formation, is strategy in increasing equitable development between regions.

According to Harrod-Domar (1947) investment has a role in increasing production by increasing the capital stock in a region. The increase of production will certainly encourage regional development process through the expansion of employment opportunities and an increase in per capita income. According to Romer (1986) the availability of capital can increase regional economic growth through increased production. However, according to Myrdal (1957) the allocation of capital or investment has potentially increased income in developed region because developed region has more modern industries or sectors (Arysad, 2010). The result of Hartini's study (2017) showed that investment has negative and significant effect on disparity between regions in Special Region of Yogyakarta. However, the result of Siagian's study (2019) showed that investment has a positive and significant effect on disparities in Jambi City.

Figure 3 showed that the government investment, especially gross fixed capital formation is centered in Jakarta, which is about 747.26 T. If the investment mobility between regions is centralized, then economic activity will be concentrated in certain region such Jakarta so that it will widen regional disparity in Java. The allocation of government investment to developing region must also be increased in order to develop its economy and increase GRDP, as well as GRDP per capita. Thus, regional disparity in Java will decrease because developing regions can compete with developed regions in the long term.

Based on some phenomena, theoretical gap, and empirical gap above, it is very important to know the role of technology, transportation infrastructure, and investment spatially in reducing regional disparity so that further formulating strategies in

solving regional disparity problems in Indonesia, especially in Java. Good coordination between regions in implementing spatial development policies, will produce spatial interactions so that all regions can advance together and reduce regional disparity.

The study objectives to be achieved are to analyze the spatial dependence of regional disparity in Java, and the role of technology, infrastructure transportation, and investment spatially on reducing regional disparity in Java. The limitation of this study is that only analyzing 6 provinces of Java Island in the implementation of National Medium-Term Development Plan III (RPJMN III) because it has a vision to realize equitable development with the main development focus, namely transportation infrastructure and information and communication technology (ICT) so that regional demand chains can develop (Ministry of National Development Planning, 2014).

2. Research Method

The type of this study is explanatory. The data analysis method used in this study is spatial econometric analysis which aims to determine the influence between regions that are neighboring each other on the level of disparity between regions using Geoda 1.20 software. The data used in this study is panel data consisting of cross section data from 6 provinces in Java ($n = 6$) and time series data in 2015 – 2019 ($t = 5$). The type of data in this study is secondary data obtained from Statistics Indonesia (BPS), Ministry of Public Works and Public Housing (PUPR), and other related agencies, consisting of ICTDI, the length of total national road, the length of the national road with good category, gross fixed capital formation, total population of each province and district, and GRDP for each province and district.

There are several stages or procedures for testing the spatial model in this study which is showed in Figure 4. This study used Queen Contiguity in determining the spatial weight matrix which is giving weight to the area that has a side or angle intersection with the area of the interest of $W_{ij} = 1$ while the area that does not have side or angle intersection with the area of the interest is given weight of $W_{ij} = 0$.

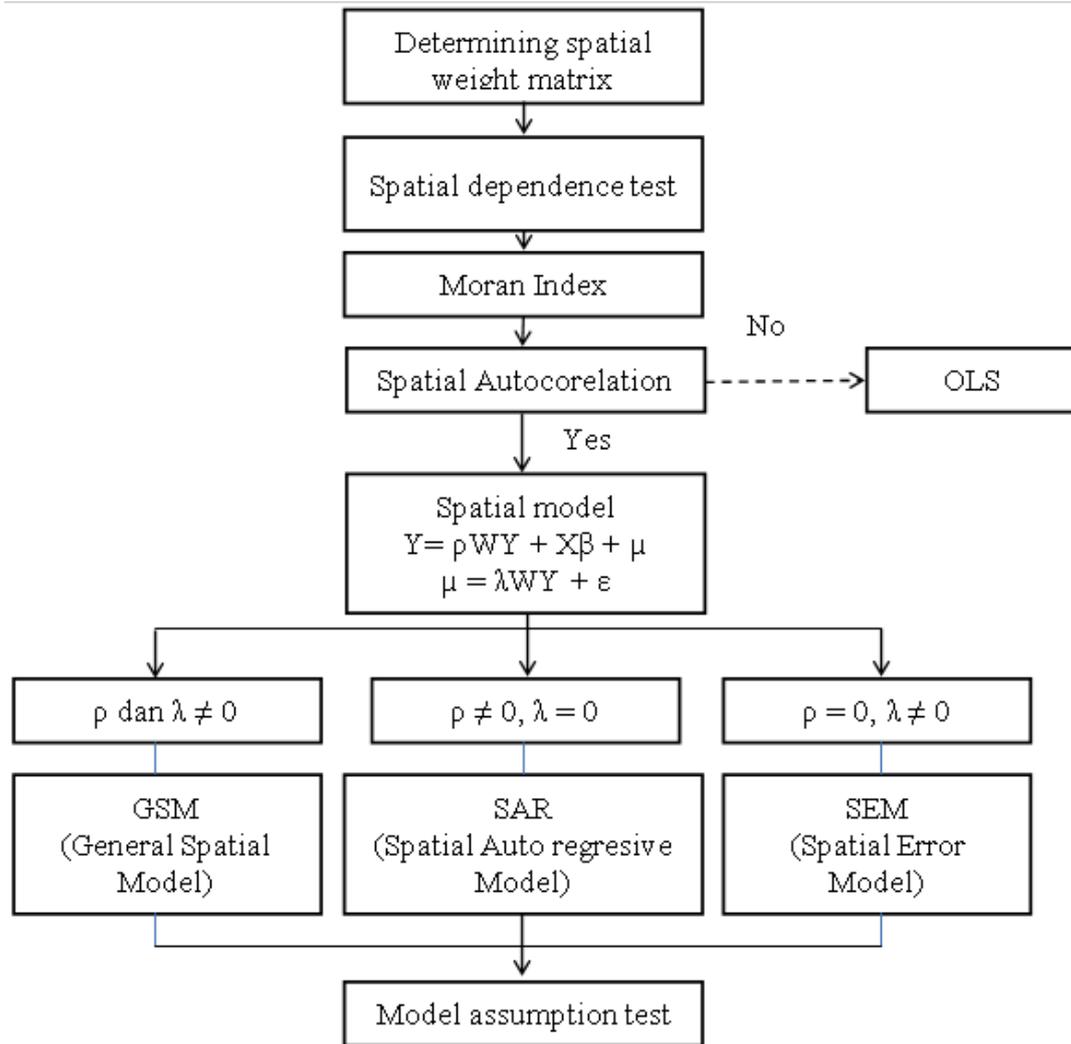


Figure 4 Procedures for testing spatial model

Source: Yunitasari & Firdaus (2022)

2.1 Moran Index

$$I = \frac{n \sum_i \sum_j w_{i,j} (X_i - \bar{X})(X_j - \bar{X})}{(\sum_i \sum_j w_{i,j}) \sum (X_i - \bar{X})^2}$$

Positive or negative Moran Index means that there is a spatial dependence between neighboring areas while Moran Index with coefficient $I = 0$ means that there is no spatial dependence between neighboring area. To determine the distribution of spatial effect of the Moran Index, it used Moran Scatterplot which is divided into four quadrants in Figure 5.

Quadrant II (Low-High)	Quadrant I (High-High)
Quadrant III (Low-Low)	Quadrant IV (High-Low)

Figure 5 moran scatterplot

Quadrant I illustrates that region that has high observation value is surrounded by region with high observation value as well. Quadrant II illustrates that region with low observation value is surrounded by region with high observation value. Quadrant III illustrates that region with low observation value is surrounded by region with low observation value. Quadrant IV illustrates that region with high observation value

is surrounded by region with low observation value (Zhukov, 2010).

LM test is used to test the type of spatial dependence between areas, and also whether to use SAR, SEM, or, SARMA model in the estimation.

Lagrange Multiplier Lag (SAR) test is to select the spatial lag model that is used to determine the WY coefficient value. The hypothesis in the LM lag test is $H_0 : \rho = 0$, spatial error model is better to use than spatial lag model while $H_1 : \rho \neq 0$, spatial lag model model is better to use than spatial error model. Lagrange Multiplier Lag (SAR) test can be calculated by the following equation:

$$LM\ lag = \frac{\left(\frac{e'Wy}{\sigma^2}\right)^2}{\frac{(wx\beta)'Mwx\beta}{\sigma^2} + trace[(W' + W)W]}$$

Lagrange Multiplier Error (SEM) test is to select the spatial error model that is used to determine the value of the $W\epsilon$ coefficient. The hypothesis of LM error test is $H_0: \rho \neq 0$, spatial lag model is better to use than spatial error model while $H_1: \rho = 0$, spatial error model is better to use than spatial lag model. LM error statistical test is as follows:

$$LM\ error = \frac{\left(\frac{e'Wy}{\sigma^2}\right)^2}{trace[(W' + W)W]}$$

Spatial regression is the development of classical regression by including spatial or regional aspects of the study object.

The spatial lag model or often called spatial autoregressive (SAR) is a model that describes the influence of the independent variable in region j on the dependent variable in region i (Hasna, 2013). The SAR model is a model that combines a simple regression model with spatial lag on the dependent variable (Anselin, 1988). The SAR model is composed of the dependent variable spatial lag and (WY) acts as the independent variable, with the following equation:

$$Y_{it} = \rho \sum_{j=1}^N W_{ij} Y_{jt} + X_{it} \beta + \mu_i + \epsilon_{it}$$

Where ρ is a spatial autoregressive coefficient and W is spatial weight matrix coefficient that describes the spatial arrangement of the units in the sample (Elhorst, 2009). SAR model in this study is as follows:

$$Williamson\ Index_{it} = \rho W\ Williamson\ index_{it} + \beta_1\ Information\ and\ Communication\ Technology_{it} + \beta_2\ Road\ Quality_{it} + \beta_3\ Gross\ Fixed\ Capital\ Formation_{it} + \mu_i + \epsilon_{it}$$

Spatial error model (SEM) is spatial model used to describe the spatial relationship or correlation that occurs in the error. Lesage and Pace (2008) in S et al (2017) introduced spatial error model with equation as follows:

$$Y_{it} = X_{it} \beta + \mu_i + \phi_{it}$$

$$\phi_{it} = \rho + \epsilon_{it}$$

Where ϕ is the autocorrelated spatial error term and ρ is the spatial autocorrelation coefficient (Elhorst, 2009). SEM model in this study is as follows:

$$Williamson\ Index_{it} = \beta_1\ Information\ and\ Communication\ Technology_{it} + \beta_2\ Road\ Quality_{it} + \beta_3\ Gross\ Fixed\ Capital\ Formation_{it} + \phi_{it}$$

$$\phi_{it} = \rho \sum_{j=1}^N W_{ij} \phi_{jt} + \epsilon_{it}$$

4. Results and Discussion

The result of spatial weight matrix using queen contiguity method in Java is as follows:

Table 1. Java Neighborhood Using Queen Contiguity

Province	Quantity	Neighboring Province
Banten	2	Jakarta, West Java
DIY	1	West Java
Jakarta	2	Banten, West Java
West Java	3	Jakarta, Banten, West Java
Central Java	3	West Java, DIY, East Java
East Java	1	Central Java

The result of dependent variable Moran Index in this study showed that its Moran Index is -0.021 while the expected value of Moran Index is -0.2 . These results indicate that the value of the Moran Index is greater than the expected value of Moran Index ($I > I_0 = -0.021 > -0.2$), it means that there is autocorrelation or spatial dependency of regional disparity, measured by Williamson Index, between provinces in Java.

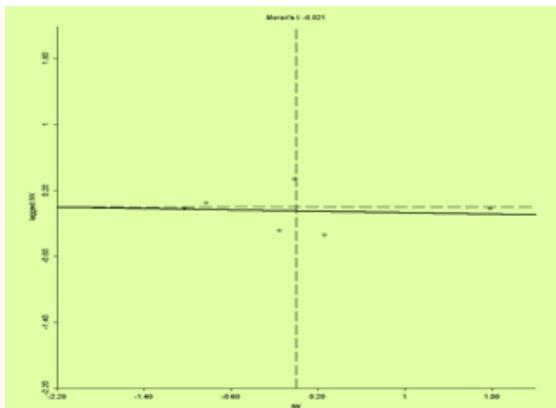


Figure 5. Moran's scatterplot

Figure 5 showed negative spatial dependence which indicates that dependent variable data (Y) tends to cluster in quadrants

II (Low-High) and IV (High-Low) so that regions with low Williamson Index are neighboring areas with a high Williamson Index, and otherwise region with high Williamson Index is neighboring area with a low Williamson Index. It indicates that Indonesia's regional development policy, decentralization, has not yet been effective to overcome disparity. Chen and Zheng (2008) also stated in their study that China's regional development policies have contributed greatly to regional inequality because the development only happen in the coast region rather than the interior region.

Figure 6 showed the distribution of regional disparity in Java during 2015 – 2019 which is divided into 4 categories, province with darker color indicates that it has higher Williamson Index than others. Province with the highest williamson index is East Java, it means that regional disparity in East Java is higher than other provinces in Java. While region with lighter color indicates that it has lower Williamson Index than others. Province with the lowest williamson index is Special Region of Yogyakarta, meaning that regional disparity in Special Region of Yogyakarta is better solved than other provinces in Java.

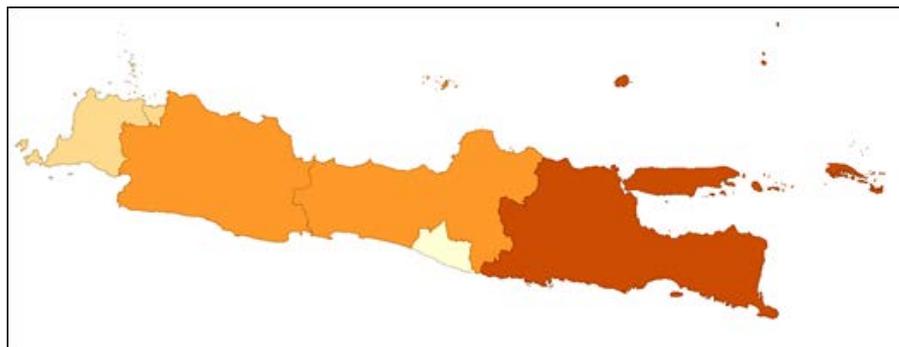


Figure 6 the distribution of regional disparity in Java

Table 2. Result of LM test

Test	Value	P-value
<i>LM (Lag)</i>	0,2553	0.61337
<i>Robust LM (Lag)</i>	5.1990	0.02260
<i>LM (Error)</i>	2.8754	0.08995
<i>Robust LM (Error)</i>	7.8191	0.00517

LM test is carried out by including spatial weights into the Ordinary Least Square (OLS) method. Based on Table 5, p-value of LM lag in this study is 0.61337, greater than $\alpha = 0.05$ and $\alpha = 0.1$ so that H_0 is accepted, it means that there is no lag dependency. Therefore, Spatial Autoregressive Model (SAR) is not the best model to use in this study. While p-value of LM error in this study is 0.08995, it is greater than $\alpha = 0.05$ but smaller than $\alpha = 0.1$ so that H_0 is rejected at a significance level of 10%. Therefore, spatial error model (SEM) is the best model to use in this study because there is dependency of error.

Table 3. Result of SEM estimation of java

Variable	Coefficient	P-value
LAMBDA	-0.989544	0.00000
KONSTANTA	1.02502	0.01668
ICT	-0.216048	0.00000
Road Quality	0.00845094	0.04387
Gross Fixed Capital Formation	0.000488581	0.00000

Based on the results of Spatial Error Model (SEM) estimation in Table 3. Then the following model is obtained:

$$\text{Williamson Index}_{it} = 1.025 - 0.216 \text{ICT}_{it} + 0.008 \text{Road Quality}_{it} + 0.0004 \text{Gross Fixed Capital Formation}_{it} - 0.989 \sum_{j=1}^N \text{WijUit}$$

Based on the estimation results in Table 3, it showed that there is a spatial dependence on the error where probability of lambda is significant at the level of $\alpha = 0.05$ and $\alpha = 0.1$. However, a negative lambda value indicates that the dependency on the error is negative. It means that regional disparities among the neighboring regions have negative relationship.

Based on Table 3, technology (ICT) has spatially negative and significant effect on regional disparity between provinces in Java with a coefficient of -0.216 and probability of 0.000 , meaning that if the ICT level increases by 1 percent, it will reduce or reduce regional disparity between provinces in Java is 0.216 with the assumption that other independent variables

are considered constant and significant at the level of $\alpha = 0.5$ and $\alpha = 0.1$.

Technology as proxied by the sub-index of access and availability of technology in ICT has spatially negative and significant effect on regional disparity between provinces in Java. The alternative hypothesis is accepted because the increasing level of technology can reduce regional disparity between provinces in Java, so that the improvement of technology can spatially reduce regional disparity between provinces in Java. It is in line with Romer's (1986) theory which explained that technology can create economic divergence where technological progress will increase and accelerate regional economic growth and reduce regional disparity. Technology in Romer's theory (1986) is characterized by the creation of new ideas or innovations originating from the development of science and improving the quality of human capital (Arsyad, 2010:93).

The result of this study on the spatial effect of technology on regional disparity between provinces in Java is in line with the result of Tajerin (2007) study, technology has a positive influence on the convergence of economic growth between coastal areas in eastern Indonesia so that technological progress can reduce disparity between coastal areas in eastern Indonesia. The result of Otiam, et al (2018) study also showed that technology measured by access and infrastructure in ICT has spatially negative effect on disparity in Kigali Rwanda where technological progress tends to be concentrated in urban areas. The results of Kharlamova, et al (2018) study also showed that a country or region with continuous economic development due to technology, will decrease regional disparity.

Transportation infrastructure has spatially positive and significant effect on regional disparity between provinces in Java with coefficient of 0.008 and probability of 0.438 , meaning that an increase of national road quality by 1 percent will increase regional disparity between provinces in Java about 0.008 with the assumption that other independent variables are constant. This result is significant at the level of $\alpha = 0.5$ and $\alpha = 0.1$. The result of this study is in line with the theory of New Economic Geography (Krugman, 1991) that

capital and labor will tend to be concentrated in region with high level of transportation infrastructure, with the assumption that the higher quality of road will minimize the cost of transportation, so that its region will become growth pole. It needs to consider the aspects of equity in order that every region has equal road quality, and further capital and labor will spread equally in every region because every region has at least competitive production cost.

A rational explanation for this finding is that better road connectivity has limited distributional impact on regional disparity. It has encouraged the concentration of economic activities in a certain area, such as in East Java Province, which is the province with the highest road quality in Java. The increase in the concentration of economic activity in East Java Province can be seen from the distribution of GRDP in Java, which tends to be concentrated in Sidoarjo and Surabaya with GRDP of 181,179 billion and 343,653 billion. It tends to encourage the mobility of production factors to industrial central areas such as Sidoarjo and Surabaya so that the level of Williamson index in East Java Province is higher than other provinces in Java.

The result of the study indicates that the better national road connectivity in one region has encouraged the concentration of economic activity in a certain area. This result is in line with the result of Makmuri (2017) study, showed that transportation infrastructure measured by the quantity of roads has positive effect on disparity so that the increasing of transportation infrastructure will tend to increase disparity. Increasing national road quality in certain developed areas will only enlarge the disparity with developing regions which have worse road quality. This condition cannot reduce regional disparities but widens regional disparity. Luo et al (2014) explained in his paper that poor transportation infrastructure distribution enlarges regional disparity and undermines the potential of economic prosperity.

Investment represented by Gross Fixed Capital Formation, has spatially positive and significant effect on regional disparities between provinces in Java with a coefficient of 0.0004 so

that an increase in gross fixed capital formation by 1 percent will increase regional disparities between provinces in Java by 0.0004 with the assumption that other independent variables are held constant, and significant at the level of $\alpha = 0.5$ and $\alpha = 0.1$. It is in line with Borts' theory (1960) in Capello (2015), capital or investment which is only concentrated in developed regions can widen regional disparity. According to Borts (1960) in Capello (2015) explained that capital movements tend to be directed towards developed regions because it has higher rate of return on capital than developing regions. The process of capital transfer that is concentrated in developed regions will create development imbalances that trigger regional disparity (Sjafrizal, 2018: 111).

The result of the study on the spatial effect of investment in reducing regional disparity between provinces in Java, is in line with the result of Siagian (2019) study which showed that investment has positive and significant effect on disparity in Jambi City. The result of Yosi, et al (2015) study also showed that investment has positive and significant effect on disparity between districts/cities in West Sumatra. Rahmawaty (2014) study result also showed that investment has positive and significant impact on regional disparity. Increasing investment only in certain regions will only enlarge regional disparity with other regions. The concentration of physical investment due to differences in the rate of return on investment has led to an imbalance in development which has triggered high regional disparity between provinces in Java. This is in line with the results of Gama's study (2009) which showed that gross fixed capital formation has positive and significant impact on disparity between regions because the allocation of physical investment tends to be concentrated in developed regions. The results of Rondinelli's study (1980) explained that the concentration of investment in Philippines widened the economic gap between the Manila metropolitan area and rural areas, and even villagers had almost no access to urbanized center in which productive resources, employment opportunities, public facilities and services are located.

4. Conclusion

The results showed that there was negative spatial dependence on regional disparities with Moran index of -0.021 . The model used is based on the results of the LM test, namely SEM. The estimation results of the SEM model showed that technology has spatially negative and significant effect on regional disparity in Java, while transportation infrastructure and investment has spatially positive and significant impact on regional disparity in Java.

In determining development strategy, government should include spatial aspect such as position, location, proximity, space, and distance, in order that there will be more spread effect in development. Besides, government does not only focus on the construction of national roads but also pays attention to the maintenance of the existing national roads so that the quality of roads is not unequal and can facilitate transportation mobility. In technology side, the focus of ICT development must also reach developing or remote regions so that there will be transformation of economic activity that leads to economic digitization and reduce regional disparity. Lastly, government should also increase gross fixed capital formation in potential developing regions so that developing regions can have greater capital in improving their economy.

This study has a limitation to only 5 years periods of development from 2015 – 2019, National Medium-Term Development Plan III (RPJMN III) which has a focus on objectives to increase the level of technology, region connectivity, and investment. Therefore, the future studies are recommended to analyze the spatial dependence of regional disparity in all periods of National Medium-Term Development Plan (RPJMN), RPJMN I to IV because RPJMN IV (2020-2024) is the last stage of National Long Term Development Plan (RPJPN) in order to find the result of National Long Term Development Plan (RPJPN) in reducing regional disparity.

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