Spatial Autocorrelation and Convergence of GDRP Per Capita in Java and Kalimatan Island

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Abstract. This research aims to analyze the spatial autocorrelation of GRDP per capita between provinces in Java and Kalimantan. The second objective is to analyze whether there is Absolute Beta Convergence and Conditional Beta GRDP per capita between provinces on Sumatra Island and Kalimantan Island. The analytical tool used is the Moran Index to determine the occurrence of spatial relationships and panel data regression to estimate the determinants of per capita GRDP. The estimation results showthere is no spatial relationship of GRDP per capita in the provinces of Java and Kalimantan. The second finding is that there is no Absolute Beta and Conditional Beta Convergence in Java and Kalimantan. The variables of Road Infrastructure, Communication Technology, and Human Development Index (IPM) have a positive and significant effect on GRDP per capita in Java and Kalimantan. Meanwhile, Foreign Direct Investment (FDI) has a positive but not significant effect on GRDP per capita in the two regions.

Keywords: spatial autocorrelation · convergence · GRDP per capita

1 Introduction

Convergence is the process of economic growth in different countries or regions in such a way as to reduce the gap in income, productivity, wage levels and various other economic indicators [1]. Regional integration is a sign of successful regional development. Barro and Sala-i-Martin (1995) propose that there are two concepts of income convergence: convergent sigma and convergent beta. Sigma Convergent measures income dispersion. As income inequality decreases, regional disparities tend to shrink, in other words, income convergence is progressing [2]. To determine if sigma convergence is occurring, we can calculate the spread of GRDP, measured as the coefficient of variation or standard deviation of the logarithm. Convergence beta aims to determine the influence of factors putative to determine the level of convergence [3].

Beta convergence explains that economies in poor regions tend to grow faster than rich countries, and conditional convergence is analyzed by adding other explanatory variables. Convergence is divided into two areas: absolute convergence and conditional convergence [4]. Absolute Gross Domestic Product (GDP) per capita is one measure of

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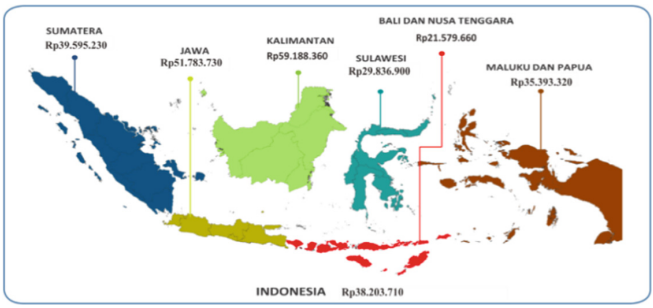

Fig. 1. Average GRDP per capita of Indonesia per island in 2015–2020 (Source: Central Bureau of Statistics 2021

Table 1. Comparison of Grdp Per Capita of Provinces In Java and Kalimantan in Year 2015–2020 (In Rupiah)

GRDP per capita Province in Java and Kalimantan 2015–2020 (Rupiah)			
Provinces in Java		**Province of Kalimantan Island**	
159,747,735	DKI Jakarta	West Kalimantan	25,398,280
28,214,486	West Java	Central Kalimantan	34,523,200
26,404,638	Central Java	South Kalimantan	29,721,290
24,990,721	DIYogyakarta	East Kalimantan	127,236,400
38,246,568	East Java	North Kalimantan	79,062,600
33,098,206	Banten		
51,783,726	Average	Average	59,188,360

Source: Central Bureau of Statistics, 2021 (processed)Ease of Use

a country's economic growth. Traditionally, development has meant a steady increase in Gross Domestic Product (GDP) per capita, or her per capita Gross Domestic Product (GDP). Although not a good indicator, GDP per capita can be used as an indicator of economic growth because it reflects the well-being of a population better than GDP alone [5]. The chart below shows his GRDP (Gross Regional Domestic Product) levels per her capita by island in Indonesia from 2015 to 2020:

Based on Fig. 1, it is Rp. 38,203,710. Meanwhile, Kalimantan Island has the largest GRDP per capita, which is Rp. 59,188,360, followed by Java Island at Rp. 51,783,730 and Sumatra Island at Rp. 39,595,230. Meanwhile, the islands of Bali and Nusa Tenggara had the smallest GRDP per capita, amounting to Rp. 21,579,660, followed by Sulawesi Island at Rp. 29,836,900 and Maluku and Papua Island at Rp. 35,393,320 From the data in the picture above, Java Island and Kalimantan Island are areas that have GRDP per capita above the average GRDP per capita in Indonesia. So it has a large enough potential to develop and advance beyond the progress achieved by other islands in Indonesia.

Table 1 shows indications of inequality in GRDP per capita between provinces in Java and Kalimantan. DKI Jakarta Province is the area with the highest GRDP per capita on the island of Java with an average GRDP per capita of 159,747,735 rupiah. Meanwhile, DI Yogyakarta province is the region with the lowest GRDP per capita with an average GRDP per capita of 24,990,721 rupiah. If viewed from the aspect of neighbourhood, DKI Jakarta Province is directly adjacent to the provinces of Banten and West Java, DKI Jakarta province is the center of the economy on the island of Java. This makes DKI Jakarta a magnet for its neighboring areas which attracts a lot of people's interest to work in the area so that every day there is mobility of workers from neighboring areas. On the other hand, neighboring areas play an important role as supporting areas for distribution [6].

Spatial autocorrelation in conditional convergence analysis according to a regional perspective, each region cannot be treated as a stand-alone unit. Regional development is strongly influenced by the development of neighboring areas, mainly due to the production factors of the surrounding area. This influence or neighbor effect is called spatial autocorrelation. Spatial autocorrelation is a relationship due to regional interaction so that the value of observations in region i depends on the value of neighboring observations, namely region j where i j. Interactions that occur between regions can be in the form of interactions in the economic field such as the flow of goods and services, labor migration, and income flows [7].

The purpose of this study is to analyze convergence, so the involvement of spatial effects is needed to realize the process of convergence between regions. The importance of the neighboring effect on the growth of a region cannot be ignored because interactions between regions must occur, one of which is the entry of production factors from the surrounding area [8]. Two or more cities that are close together, although previously separate and independent cities, can benefit from synergies from interactive urban growth. The spatial relationship of economic growth basically describes the economic relationship between a region and the surrounding environment. This relationship can occur because it is influenced by several aspects, namely [9].

The difference between this research and previous research is in the area study and the spatial weighing matrix used. The spatial weighing matrix used in this study is Queen contiquity. This research examines spatial autocorrelation of GRDP per capita between provinces on the island of Java and the island of Kalimantan. Another purpose of this study is to analyze whether there is an absolute convergence of GRDP per capita between provinces in Java and Kalimantan. The final objective of this study is to analyze whether there is conditional convergence by adding other variables that affect GRDP per capita such as investment, infrastructure, technology and HDI in Java and Kalimantan.

2 Methodology and Data

The data used in this research is secondary data and is in the form of panel data, which is a combination of time series and cross section data [10]. Where the cross section data is for the provinces of Java and Kalimantan, while the time series data is 2015 to 2020. The spatial autocorrelation analysis is carried out separately between Java and Kalimantan islands. Meanwhile, the calculation of Absolute Beta Convergence and Conditional Beta

is done by merging data between the two islands, this is done because the number of cross-section data on the island of Kalimantan (5 Provinces) is less than the number of variables to be tested, which is 1 independent variable (Y). And 5 dependent variables (Yit, INV, INF, TEK, and IPM) so that in testing the Random Effect Model an error occurred in the Eviews10 application.

2.1 Tool of Analysis

1) Spatial Analysis

Spatial analysis is also used in this study. Spatial analysis is a process involving the evaluation of a series of calculations and mathematical logics influenced by the position of the object being analyzed. Spatial regression is a method or analytical tool that examines the relationship or correlation between one variable and another by including spatial elements at multiple locations that are observed or observed. Spatial analysis has two spatial effects: spatial dependence and spatial heterogeneity [9]. To check the spatial autocorrelation, there are several steps that can be taken. There are the following stages:

a) Determination of Spatial Weight W (Location)

Spatial weights are often symbolized by W. To determine these weights, two approaches are used, namely the intersection of regional boundaries and distances [11]. Spatial weights can be shaped as a matrix, in this study the matrix formed from the existing area is of the order 10x10. The matrix formed is based on the neighboring region tau method. This is because the areas on the island of Sumatra are neighbors to each other. The following is a table of the division of the province on the island of Sumatera.

b) Global Moran Index

Spatial autocorrelation measurement using global Moran Index [12]:

$$I = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} wij(xi - \overline{x})(xj - \overline{x})}{S_0 \sum_{i=1}^{n} (xi - \overline{x})}$$

where:

I: Moran Index.
n: Numbers of place.
xi: Value in i Location.
xj: Value in j Location.
x: Average of total of variables or value.
wij: Unstandardized element between i and j location.

C) Local Indicator of Spatial Associations (LISA)

LISA When analysis aimed specifically at determining regional connectivity is used, [9] states that there are two requirements for LISA analysis.

- Each observation indicates that there are significant clusters or spatial groups in the observed region.
- The overall LISA for all observation areas is proportional to the global scale. LISA aims to identify local groups that are spatial outliers.

Moran scatterplots are used to identify spatial effects. The types of spatial autocorrelation can be seen in the Fig 1. [12]:

2) Absolute Convergence Beta Analysis

To analyze the absolute beta convergence, according to Barro and Sala-I Martin (1996) can use the equation [2]:

$$\mathbf{ln\ Y = \alpha + \beta 0 lnYit + uit.}$$

where:Y = GRDP per capita.
$Y_{it\ -1}$ = GRDP per capita (previous period).
ln = Natural Logaritm.
u = *Error term.*
i = Province.
t = year.

3) Conditional Beta Convergence Analysis

Conditional convergence explains how the economy of poor regions has a tendency to grow faster than rich regions, namely by looking at GRDP growth, as well as using other factors other than GRDP. To perform conditional convergence analysis, it is necessary to add variables that affect the steady state so that the equation used becomes [4]:

$$\mathbf{ln\ Y = \alpha + \beta 0 lnYit\text{-}1 + \beta 1 lnINV + \beta 2 lnINF + \beta 3 lnTECH + \beta 4 lnHDI + uit}$$

where: Y = GRDP per capita.
Yit-1 = GRDP per capita (previous period).
INV = Investment.
INF = Infrastructure.
TECH = Technology.
HDI = human capital.
ln = Natural logarithm.
i = Province.
t = year.
uit = Error Term.

3 Result and Discussion

Based on Table 2, the calculated value of Moran's I in Java every year is obtained by the value of Moran's I (-0.1244) > E(I) (-0.21003). This indicates that there is a positive autocorrelation and there is a clustered pattern of regions with the same characteristics even though the strength is low.

Table 2. Moran Scatterplot is used to identify spatial effects

Kuadran IV	Kuadran I
Consists of areas with high multidimensional poverty surrounded by areas with low multidimensional poverty (High-Low)	Consists of areas with high multidimensional poverty surrounded by areas with high multidimensional poverty (High-High).
Kuadran III Consists of areas with low multidimensional poverty surrounded by areas with low multidimensional poverty (Low-Low)	Kuadran IV Consists of areas with low multidimensional poverty surrounded by areas with high multidimensional poverty (Low-High)

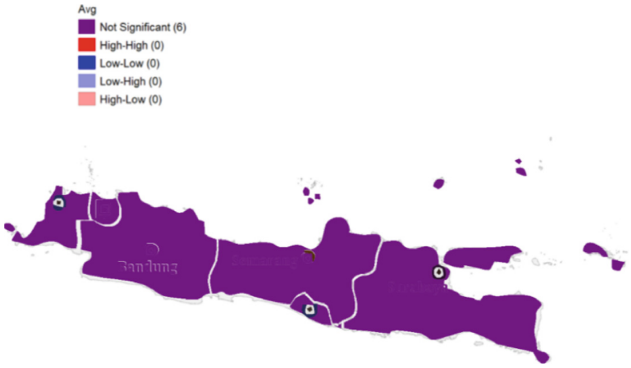

Fig. 2. Results of the LISA Cluster Map on average GRDP per capita in Java in 2015–2020

Figure 2 shows that there is no spatial autocorrelation (clustering and influencing each other) which has a high-high (hotspot) value and is significant. The results of the Moran index test statistically show that there is no spatial autocorrelation between regions, but when viewed from the facts on the ground, it shows that there is a reciprocal relationship between neighboring provinces on the island of Java. For example, DKI Jakarta Province which is directly adjacent to the provinces of Banten and West Java. DKI Jakarta Province is a growth center on the island of Java which makes DKI Jakarta the center of government economic activity, trade and service industries.

Table 3 shows the calculated value of Moran's I on the island of Kalimantan each year, where the value of Moran's I (-0.1592) > E(I) (-0,2500). This indicates that there is a positive autocorrelation and there is a clustered pattern of regions with the same characteristics even though the strength is low Fig. 3.

Figure 2 shows the results of the LISA GRDP Cluster Map per capita on the island of Kalimantan which shows that there is no spatial autocorrelation (clustering and influencing each other) which has a high-high (hotspot) value and is significant.

A. Absolute Beta Convergence Analysis

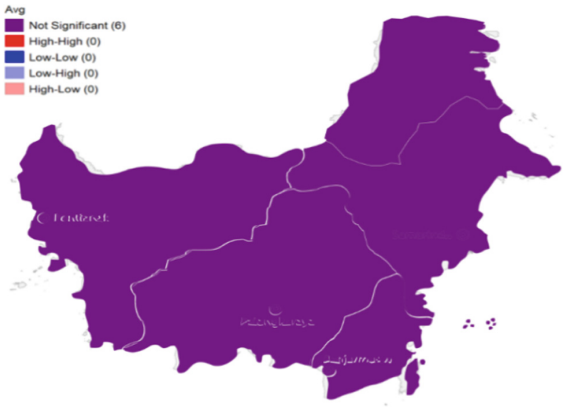

Fig. 3. The Results of the LISA Cluster Map on average GRDP per capita on the island of Kalimantan Period 2015–2020

Table 3. The Results of The Calculation of the Moran Index of Java Island

Year	***Moran's I***	***E(I)***	***z-value***
2015	-0,1338	-0,2000	0,4948
2016	-0,1371	-0,2000	0,4732
2017	-0,1398	-0,2103	0,4555
2018	-0,1425	-0,2103	0,4378
2019	-0,1470	-0,2000	0,4088
2020	-0,1513	-0,2000	0,4152
Average	**-0,1424**	**-0.21003**	**0,4393**

Source: data processed, 2022 Open Geoda Attachment Description: Z $\alpha/2 = 1{,}960$

Based on the panel data model selection, the best model chosen to estimate absolute beta convergence is the fixed effect model. Absolute convergence occurs when regions with low incomes grow faster than regions with high incomes so that the result is that the income levels of the two regions will be the same. This can be done by estimating the absolute convergence model in which GRDP per capita in the previous year is the only explanatory variable for GRDP per capita. The following are the results of the absolute convergence regression of the provinces in Java and Kalimantan:

Based on the regression estimation results, it is known that the coefficient of GRDP per capita in the previous year showed a positive value, this indicates that there is no absolute beta convergence between provinces in Java and Kalimantan in 2015–2020. This means that there is no Cath-up Effect or that a province with a low GRDP per capita is unable to catch up with a province with a much higher GRDP per capita.

B. Conditional Beta Convergence Analysis

Table 4. The Results of The Calculation of the Moran Index of Kalimantan Island

Year	***Moran's I***	***E(I)***	***z-value***
2015	-0,1716	-0,2500	0,3399
2016	-0,1657	-0,2500	0,3639
2017	-0,1570	-0,2500	0,3990
2018	-0,1540	-0,2500	0,4110
2019	-0,1528	-0,2500	0,4156
2020	-0,1537	-0,2500	0,4117
Average	**-0,1592**	**-0,2500**	**0,3902**

Source: data processed, 2022, Open Geoda Attachment
Description: Z α/2 = 1,960

Table 5. Absolute Convergence Ordinary Least Square (Ols) Estimation Results

Independent Variable	**Coefficient**	**t-statistic**	**Probability**
Constanta	2.869592	5.669796	0,0000
GRDP per capita previos period	0.732643	15.41860	0,0960

Source: Data processed, 2022

Table 6. Estimation Results of Ordinary Least Square (Ols) Conditional Convergence

Independent Variable	**Coefficient**	**t-statistic**	**Probability**
Constanta	-0.927531	-0.48854	0.6273
LnYit	0.289913	3.24553	0.0021
LnINV	0.003489	0.54206	0.5902
LnINF	0.061305	3.03150	0.0038
LnTech	0.387352	2.11111	0.0398
LnIPM	1.481839	2.196520	0.0327

Source: Data processed, 2022

Based on the panel data model selection, the best model chosen to estimate conditional beta convergence is the fixed effect model [13]. Conditional Beta Convergence can be seen whether low-income areas can grow faster than high-income areas if other variables are held constant. This concept states that convergence depends on the structure or characteristics of each region and these structural differences lead to differences in the stability of the economy of each region.

Based on the estimation results of conditional convergence, the previous year's GRDP shows the coefficient of the previous year's GRDP per capita is positive, this

indicates that there is no conditional beta convergence between provinces in Java and Kalimantan in 2015–2020. This shows that provinces with low GRDP per capita are unable to catch up with provinces with higher GRDP per capita. The estimation results also show that there are variables that affect the per capita GRDP variable, namely the previous year's GRDP per capita, Infrastructure, Technology and HDI Tables 5 and 6.

GRDP per capita in the previous year has a positive and significant effect, if the GRDP per capita in the previous year has increased by 1 percent, then GRDP per capita has increased by 0.289913 percent with the assumption of ceteris paribus. Infrastructure has a positive and significant effect on = 5 percent with a coefficient value of 0.061305. If the infrastructure increases by 1 percent, it will cause GRDP per capita to increase by 0.061305 percent with the assumption of ceteris paribus. Infrastructure plays an important role as one of the driving wheels of economic growth. This is what causes infrastructure development to become the foundation of sustainable economic development.

Technology has a positive and significant effect on = 5 percent with a coefficient value of 0.387352. If technology increases 1 percent, it will cause GRDP per capita to increase by 0.387352 percent with the assumption of ceteris paribus. According to Romer's endogenous growth theory, the growth in the use of the Internet and information technology can increase the innovation capacity of the economy through knowledge exchange, new product development, and business models to promote growth. In addition, information and the adoption of new technologies are becoming easier to obtain [14]. HDI has a positive and significant effect on GRDP per capita, if the HDI has increased by 1 percent, it will cause GRDP per capita to increase by 1.481839 percent with the assumption of ceteris paribus. HDI is one of the important factors in stimulating regional economic growth which will later affect GRDP per capita. Solow stated that economic growth always comes from one or more of three factors increasing the quantity and quality of human (labor). The high life expectancy will have the potential to increase the workforce to be employed in available economic sectors [15].

4 Conclusion

There is no spatial autocorrelation of rural GDP per capita in Java and Kalimantan Islands. Based on the computational results during the study period, we find that there is no convergence of absolute and conditional betas in Java and Kalimantan. Based on the calculated results of road infrastructure, communication technology variables, HDI will have a positive and significant effect on her per capita gross domestic product of Java and Kalimantan. The investment has a positive effect on her per capita GDP in the two regions, but it is not significant..

References

1. Atmasari, "Konvergensi Pertumbuhan Ekonomi Kota dan Kabupaten Klaster Metropolitan Jawa Timur," e-Journal Ekon. Bisnis dan Akunt., vol. 7, no. 2, p. 91, 2020, doi: https://doi.org/10.19184/ejeba.v7i2.17867.

2. R. J. B. and X. Sala-i-Martin, “Convergence,” J. Chem. Inf. Model., vol. 53, no. 9, pp. 1689–1699, 1995.
3. L. Achmad, “Analisis Konvergensi dan Keterkaitan Spasial Pertumbuhan Ekonomi Kabupaten/Kota di Sulawesi Tengah,” e J. Katalogis, vol. 5, no. 1, pp. 153–164, 2017.
4. S. K. Mathur, “Absolute and Conditional Convergence : Its Speed for Selected Countries for 1961--2001,” pp. 1–39, 2002.
5. S. Sukirno, Pengantar Teori Mikroekonomi. 2003.
6. Badan Pusat Statistik, “PENDAPATAN NASIONAL (National Income of Indonesia),” Buku Publ. Stat., vol. 1, no. 1, pp. 1–186, 2020, [Online]. Available: https://www.bps.go.id/publication/2020/06/12/7fe8d749c43bad46b1601662/pendapatan-nasional-indonesia-2015-2019.html.
7. R. Adha and Wahyunadi, “Disparitas Dan Konvergensi Pertumbuhan Ekonomi Antar Kabupaten dan Kota di Provinsi Nusa Tenggara Barat,” Jurnal Sosial Ekonomi dan Humaniora, vol. 1, no. 1. pp. 13–23, 2015.
8. A. Fahmi, “Pengaruh Infrastruktur dan Keterkaitan Spasial Terhadap Konvergensi Beta di Indonesia,” J. Ekon. Pembang., vol. 13, p. 19, 2015.
9. L. Anselin, Spatial Econometrics: Methods and Models, vol. 110, no. 9. 1998.
10. Sugiyono, “Metode Penelitian Pendidikan pendekatan Kuantitatif, Kualitatif dan R&D.,” in METODE PENELITIAN ILMIAH, 2014.
11. L. Anselin, “Lagrange Multiplier Test Diagnostics for Spatial Dependence and Spatial Heterogeneity,” Geogr. Anal., 1988, doi: https://doi.org/10.1111/j.1538-4632.1988.tb00159.x.
12. L. Anselin, “Local Indicators of Spatial Association—LISA,” Geogr. Anal., 1995, doi: https://doi.org/10.1111/j.1538-4632.1995.tb00338.x.
13. D. Gujarati, Econometrics by Example. 2011.
14. P. M. Romer, “Endogenous technological change,” J. Polit. Econ., 1990, doi: https://doi.org/10.3386/w3210.
15. Asnidar, “Pengaruh Indeks Pembangunan Manusia (Ipm) Terhadap Pertumbuhan Ekonomi Di Kabupaten Wajo,” J. SAMUDRA Ekon., vol. 2, no. 1, p. 12, 2018.