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# Analysis of Spatial Autocorrelation and Causality GRDP and Income Inequality in Java

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***Abstract***

*Research on the relationship between GRDP and income inequality shows that there is a spatial autocorrelation, however, empirical data shows that there is still income inequality that differs between regions, so it is necessary to re-examine the relationship. The island of Java is the main pillar of Indonesia's economic cycle, but the income inequality between the provinces is still high. This study aims to identify the magnitude of income inequality in Java. Identify the autocorrelation of GRDP and income inequality spatially, and in clusters and identify the causal relationship between GRDP and income inequality in Java. The analysis method uses the Williamson Index, Moran Index, Local Indicator of Spatial Autocorrelation (LISA) using the LISA Clustermap, and Granger Quality. This study is on the level of income inequality in each province in Java based on the Williamson Index value in the category of high inequality, having a negative autocorrelation value (the pattern tends to spread) and there is no spatial autocorrelation. Autocorrelation based on LISA Clustermap there is a pattern of cluster linkages (clustering and influencing each other) which has a High-Spot value so that there are areas that can be used as areas of cooperation for development.*

**Keywords:** ***GRDP, Income Inequality, Local Indicator of Spatial Autocorrelation, Granger Causality***

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## INTRODUCTION

Economic growth is one of the indicators that assess the success of a country's economic development. The essence of economic development is the existence of economic growth (Hakim, 2002). Pratiwi & Kuncoro (2016) and Murdiah & Bowo (2020) state that development is not only shown by the achievements of economic

growth achieved but beyond that because development has a broad perspective. High economic growth and low disparity are benchmarks for the success of a region's development. The development has the goal to create community welfare in the long term (Todaro & Smith, 2006).

The welfare of the community can be seen from the increase in economic growth and the even distribution of income (Arsyad, 2010:11). Inequality in an area is a common aspect that occurs in every country with various problems/inequality through different measures. Panzera & Postiglione (2021) found that regional income inequality is a determinant of economic growth. Kuznets stated that high inequality is an unequal distribution of income (Kuncoro, 2004).

The unequal distribution of income that results in inequality will have an impact on economic development. Every country is closely related to various economic activities, and Indonesia is no exception. According to the Central Statistics Agency/BPS (2020) recorded that 59 percent of the Indonesian economy is still centered on the island of Java. One thing that is most striking in Java is the problem of income inequality between provinces and districts/cities. Putri & Erita (2019) state that in fact inequality often occurs in the province itself. The economic growth of a region can be measured by looking at the GDP and its growth rate based on constant prices (Masli, 2008).

On the island of Java, the development of the global and domestic economy is quite in good condition, especially in the GRDP growth rate which is quite fast from year to year. It is in Figure 1.1 that the position of the GRDP growth rate has increased which is quite volatile for five consecutive years, it can be proven that the average economic growth of each province in Java is above the national average growth of 5.06 percent.

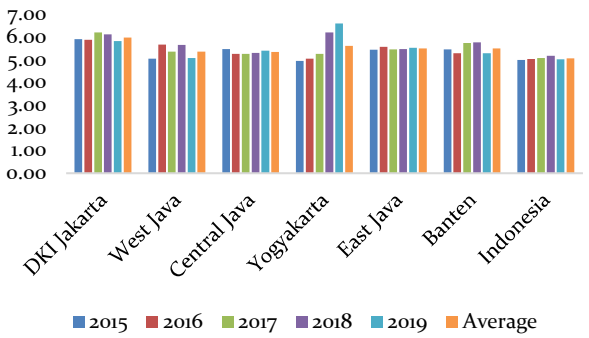


**Figure 1.** Constant Price GRDP Growth Rate by Province in Java Island (Percent)
Source: BPS Indonesia, 2020

This condition was supported by positive performance from various sources, apart from trade, manufacturing, and consumption factors as well as price stability at a low and controlled level. However, ironically, there are still economic problems in each region, namely the unequal distribution of income shown by GRDP per capita. The economic inequality between regions can also be seen in regional differences in GRDP per capita which is measured based on the range between regions with the highest and lowest GRDP per capita.

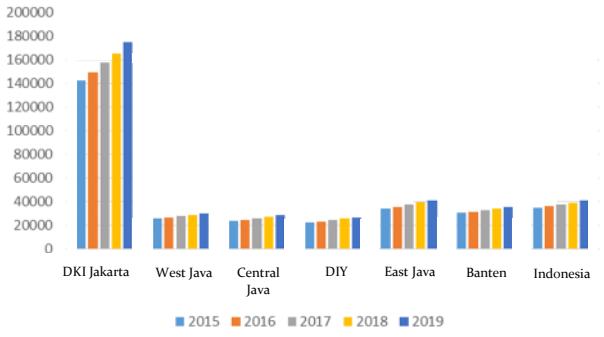


**Figure 2.** BPS Indonesia, 2020
Source: GRDP Per Capita Province in Java Island 2015-2019 (IDR Thousand)

Figure 2 shows that the divergence of GRDP per capita between provinces in Java is very obvious. This condition shows that there is a significant divergence in the value of GRDP per capita between the highest and lowest GRDP per capita in Java. These differences show a picture related to the different conditions of economic development between provinces on the island of Java so is found that the tendency of disparity in Java is very high. The spatial effects are an important part of regional growth (Vidyattama, 2014).

Spatial autocorrelation of the economic conditions of each region is the main element of growth in the development of a region. Interactions between regions often occur and cannot be avoided, because it is one of the elements of spatial or space which is one of the causes that must be considered in determining the state of a region. Kuznets (1995) shows that there is a negative relationship between economic growth (GRDP) and inequality in income distribution. If growth is higher, inequality will decrease. Based on the description above, identification is needed to measure the level of inequality and spatial autocorrelation of GRDP in Java.

## RESEARCH METHODS

This study uses quantitative descriptive data and uses secondary data sources. The secondary data used is panel data from 2015 – 2019 and 6 provinces. In this study, data were collected from publications from the Central Statistics Agency (BPS) of Indonesia, DKI Jakarta Province, Banten Province, Central Java Province, East Java Province, West Java Province, Yogyakarta DIY Province, as well as other related agencies in this study. The data used in the research on the value of GRDP (Gross Regional Domestic Product) Constant Prices in 2010 according to the business field of each province on the island of Java in 2015-2019, the total population of each province on the island of Java and in the province of Java in 2015-2019 years, and spatial data in the form of administrative maps of the island of Java in shapefile format obtained through the Global Administrative Area.

The analytical tool used is the Williamson Index to see the magnitude of inequality and the Moran Index and Local Spatial Autocorrelation Index (LISA) in calculating the spatial relationship to see spatial relationships or adjacent areas. Detection of spatial autocorrelation is believed to be stronger and more relevant in detecting spatial interactions (Lee & Wong, 2010:78). If you find a spatial autocorrelation, it will also ensure that there is an interaction of economic activity between regions (Rey & Montouri, 1999). Using the Granger causality analysis tool to identify the strength of the relationship between variables and show the direction of the causal relationship.

## RESULTS AND DISCUSSION

The level of inequality in Java tends to increase in the 2015-2019 period but does not occur every year.

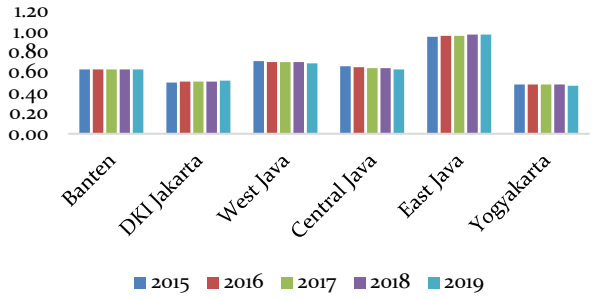


**Figure 3.** Williamson Index in Java Island 2015-2019

Source: BPS Indonesia, 2022

Inequality between provinces in Java is seen based on figure 3. The Williamson Index for the 2015-2019 period is included in the high category because it is in the IW close to 1. Even though in the 2017-2019 period it tends to decrease. Inequality in Java is caused by the existence of a center of economic activity and population density.

Economic activities that only focus on a few provinces on the island of Java, the increase in the population of an area in Java is not accompanied by the development of the quality of human resources which causes competition in obtaining jobs to become more stringent, causing unemployment and the greater the level of income inequality and the level of welfare that is higher decrease.

This result is in line with the inequality theory put forward by Jeffrey G. Williamson in Sjafrizal (1997) which says that if Williamson's inequality index number is getting closer to zero, it indicates a smaller inequality and if the index number shows that it is getting further from zero, it indicates greater inequality getting wider. In this study, the index number obtained is in the Williamson Index close to 1 or away from 0 with the conclusion that the level of inequality is still high. Although in 2017-2019 there was a decline, the decline was not far from the category of high inequality.

Based on the results of research from 2015-2019 it can be concluded that the level of inequality in Java Island from 2015 to 2016 inequality is at its peak with an average index value of 0.66 and inequality slowly decreases from 2017-2019 to an average value index of 0.65. Economic growth raises various problems, one of which is inequality according to the assumptions of Aghion (1997:155), assuming that economic growth that increases periodically has not been able to fully address the problems of regional disparities, unemployment, and poverty.

This result is in line with the Ministry of National Development Planning/National Development Planning Agency (PPN/Bappenas) stating that the island of Java is still the mainstay of the economy for the government. Even so, the island of Java is still not free from the issue of inequality.

This result is also in line with the income disparity theory from Tambunan (2014) which states that the concentration of economic activity in a particular area directly has an impact on income inequality between regions, to create conditions where the area which is the center of concentration of economic activity will be better able to provide higher income to the people. Thus, a relatively more prosperous society was born. But on the other hand, regions that are not centers of economic activity are only able to provide low income which results in relatively low prosperity for the people.

Provinces in Java Island based on the administrative map are divided into six provinces, so the weighting of the spatial matrix is 6x6, using the Queen Contiguity spatial weight method. With this, it can show the neighborliness between provinces on the island of java by racing the sides of the corners that intersect, to be able to explain that each province on the island of Java which is directly adjacent is the closest area. The following results of the Queen Contiguity method's spatial weighting with GeoDa 1.20 software can be seen in figure 4.

Figure 4 shows the areas of the Province of Java Island which are connected or directly adjacent to each other using the Queen Contiguity calculation where Banten Province has 2 neighbors which are directly adjacent to the Province of DKI Jakarta and West Java. For the

DKI Jakarta Province, there are only 2 neighbors that directly border each other, namely Banten Province and West Java Province. In West Java Province, it is wider because it has 3 directly adjacent neighbors, namely DKI Jakarta Province, Banten Province, and Central Java Province. It is also owned by the Province of Central Java with 3 neighbors that are directly adjacent to each other, namely West Java Province, East Java Province, and Yogyakarta DIY Province.


**Figure 4.** Map of Neighborhoods of Java Island with Queen Contiguity Method
Source: GeoDa 1.20 processed, 2022

Meanwhile, East Java Province and Yogyakarta DIY Province only have 1 neighbor with the same neighbor, namely Central Java Province. In this case, it can be concluded which areas are directly adjacent to the provinces in Java. If combined with the theory of spatial autocorrelation according to Lyon, (2006), the research results are aligned or directly proportional, where spatial autocorrelation is a correlation between variables and themselves based on space (distance, time and region).

In this case, the correlation between Constant Price GRDP variables in Java is based on space. This research is in line with Kosfeld, (2006) in Saputro et al., (2018) who say that location information is known from the source of neighboring relationships, where neighboring relationships of spatial units are formed based on maps.

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This result is related to the theory of the interregional model which states that the theory of the interregional model includes the impact of neighboring regions of Tarigan (2005). The discussion of this study looks at the impact of neighboring regions between provinces on Java Island.

**Table 1.** Moran Index Value Linked to GRDP Constant Price 2015-2019

| Year | Constant Price GRDP | |
|---|---|---|
| | I | Z(I) |
| 2015 | -0.1673 | 0.0994 |
| 2016 | -0.6173 | 0.0994 |
| 2017 | -0.1672 | 0.0998 |
| 2018 | -0.1669 | 0.1005 |
| 2019 | -0.1645 | 0.3009 |
| Average | -0.25664 | 0.14 |

Source: Data Processed, 2022

Spatial autocorrelation is a picture that explains the economic relationship between an area and the surrounding area (Kuncoro, 2002). This result is in accordance with the theory of the Polarization Effect, which states that when a certain area experiences an increase in GRDP, neighboring regions also experience an increase

in the GRDP. The results of the Moran GRDP Index can be seen in table 1.

The Global Moran Index test for the Constant Price GRDP variable in Java is negative, with an average of -0.25664. The Constant Price GRDP in Java Island has various values in locations adjacent to the pattern that tends to spread. The global significance test of the Moran Index was carried out using the Z normality test approach.

The results of the normality test with = 5 percent resulted in Z0.95 = 1.654 and -Z0.95 was -1.654. Based on the results of the normality test, in 2015-2019 the Z(I) GRDP Constant Price value in Java is 0.14 which indicates that the Z(I) GRDP Constant Price value < 1.654 then accepts Ho. It was concluded that the GRDP of Constant Price in Java did not have a spatial autocorrelation of GRDP between regions. In seeing the pattern of distribution and grouping between locations on variables, Moran ScatterPlot analysis can be used. According to Lee (2001), the Moran ScatterPlot shows the relationship between the observed values at the location under study and the average observed values from neighboring locations with that location. The Moran ScatterPlot of Constant Price GRDP starting point and ending point on Java Island can be seen in figure 5.

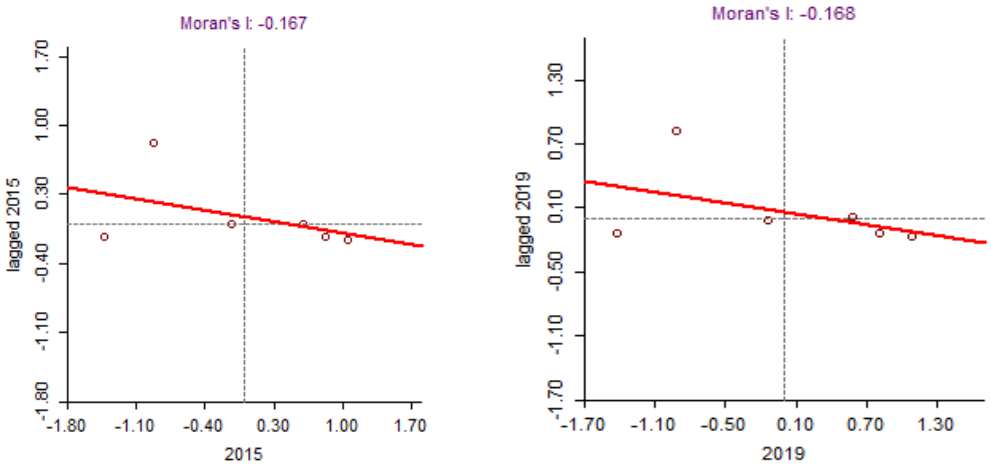



**Figure 5.** Moran ScatterPlot of Constant Price GRDP in 2015 and 2019
Source: Data Processed, 2022

The Moran Scatterplot of Constant Price GRDP in 2015 and 2019 illustrates how the distribution of the GRDP in Java is different at the start and end points of the study. The plot is divided into four quadrants to allow a qualitative assessment of associations by type: High-High and Low-Low (relative to the mean) as positive correlations which are often referred to as spatial clusters, and High-Low and Low-High as negative correlations or spatial outliers. Wong (2001) mentions that Moran's Scatterplot is one way to interpret Moran index statistics.

Moran's I interpretation can be seen through the regression line which describes the linear relationship between observations and the spatial lag of the value of the observations themselves. Scatter plots can also show outliers. Outliers are extreme data that may result from abnormal situations. The categories of each quadrant in the 2015 and 2019 Moran Scatter Plot

of GRDP can be seen in appendix 1 and appendix 2. Moran Scatterplot of GRDP in 2015 and 2019 as a whole, the distribution of the data is spread in the positions of quadrants II, III, and IV. This means that the island of Java at the starting point of 2015 and the end of 2019 has a GRDP rate that tends to spread and with a weak correlation.

**Table 2.** Moran's Index Value of Income Inequality in 2015-2019

| Year | Williamson Index | |
|---|---|---|
| | I | Z(I) |
| 2015 | -0.005 | -0.8296 |
| 2016 | -0.387 | -0.5781 |
| 2017 | -0.385 | -0.6823 |
| 2018 | -0.439 | -0.9367 |
| 2019 | -0.514 | -0.9793 |
| Average | -0.346 | -0.8012 |

Source: Data Processed, 2022

This condition is in line with the theory according to the GIS (Geographic Information System) dictionary made by ESRI, which states that spatial autocorrelation refers to the relationship of spatial data within the scope of space that forms a spreading pattern. In this case, according to the results of the research, the Constant Price GRDP variable forms a spreading pattern because the distribution of points is in each quadrant excluding quadrant I.

The results of the Moran Index of inequality using the results of the Williamson Index that the Moran Index of global linkages in the Province of Java Island 2015-2019 is related to negative economic conditions. Global Moran Index test in Java Island Province was overall negative, with an average of -0.346.

The level of income inequality has various values in locations adjacent to the pattern that tends to spread so that there is no spatial autocorrelation relationship in Java. The results of the normality test with = 5 percent then the resulting Z0.95 = is 1.654 and -Z0.95 is -1.654. Based on the results of the normality test, in 2015-2019 the value of Z(I) income inequality in Java is -0.8012 which shows that the value of Z(I) income inequality is < 1.654, thus accepting Ho. The Moran ScatterPlot of income inequality starting point (2015) and endpoint (2019) in Java can be seen in figure 6.

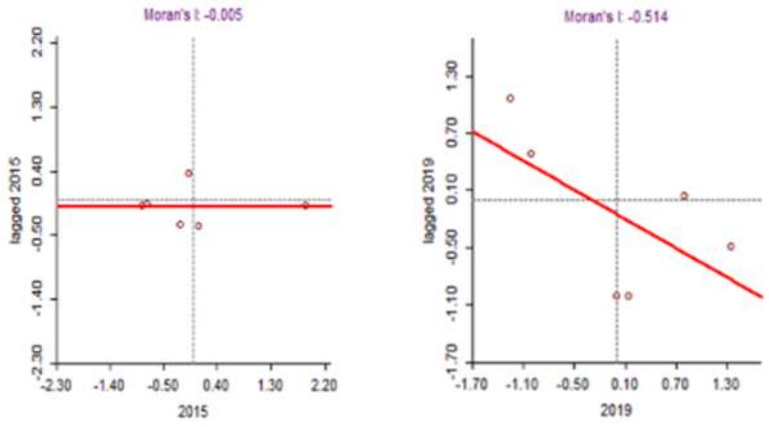
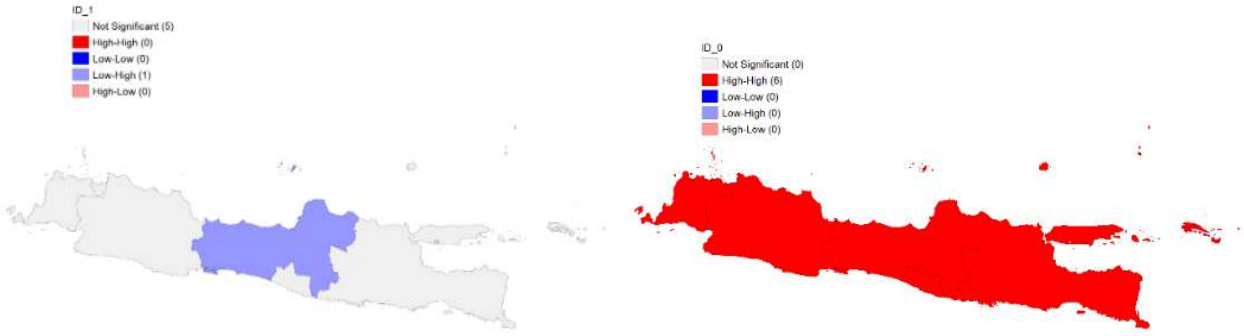



**Figure 6.** Moran ScatterPlot Income Inequality 2015 and 2019
Source: Data Processed, 2022

The plots are divided into four quadrants to allow a qualitative assessment of associations by type. Where the category of each quadrant on the Moran ScatterPlot can be seen in appendix 3 and appendix 4. Analysis of spatial patterns to detect local groupings of GRDP and inequality in Java is by analyzing the distribution pattern of the thematic map output processed with Geoda 1.20, namely LISA ClusterMap.

Based on the LISA Cluster Map in figure 7, it can be concluded that in the GRDP variable between the provinces of Java, there is no relationship or correlation between provinces. There is even a light blue spatial pattern of outliers in the Central Java Province. Where the area which means Low-High is an area with different characteristics.

In general, all provinces on the island of Java do not have a GRDP linkage, while on the map of the pattern of income inequality linkages between provinces in Java, there is a positive spatial pattern, this happens because the pattern tends to cluster, and influence the surrounding areas, namely the Hot-Spot area which is marked in dark red. Regions in quadrant I or Hot-Spot positions consist of provinces with high characteristics. Where Java Island has a high value of income inequality.




a b

**Figure 7.** LISA Cluster Map (a) GRDP and (b) Income Inequality in Java Island 2015-2019
Source: Author, 2022

Granger Causality test to find out which of the variables GRDP growth and income inequality affect other variables with a confidence level of 0.05 percent. Granger causality is very sensitive to the amount of lag data used, so it is important to determine the optimum lag before testing the relationship between the two variables.

Determination of lag can be used with several approaches, including Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), and Schwarz Information Criterion (SC). This study uses lag 3, which is by the conditions for determining the optimum lag. The results of the Lag Order Selection Criteria can be seen in appendix 5.

Based on appendix 5, shows that lag 3 is included in all the criteria for determining the optimum lag, so this study uses lag 3 to be used as an estimate of the parameters in this study.

The results of the Granger causality using the Pairwise Granger Causality Test are shown in table 4.

**Table 4.** Granger Causality Tests

Pairwise Granger Causality Tests
Date: 05/28/22 Time: 09:26
Sample: 2015 2019
Lags: 3

| Null Hypothesis: | Obs | F-Statistics | Prob. |
|---|---|---|---|
| GDP does not Granger Cause IW | 12 | 6.73708 | 0.0330 |
| IW does not Granger Cause GDP | | 0.05997 | 0.9787 |

Source: Data Processed, 2022

Based on table 4, it is explained that the probability value of GRDP to inequality is 0.0330. This value is smaller than the probability level (0.1696 <0.05), then rejects Ho, i.e. there is a causal relationship between GRDP and IW, which means that GRDP causes income inequality, while income inequality has a probability value greater than the probability level (0.9787)> (0.05).

Therefore, the results accept Ho, that is, there is no causal relationship between the two IW variables on GRDP. In other words, income inequality does not cause GRDP in Java. On the other hand, there is a causal relationship between GRDP and income inequality in Java. This shows that the GRDP that has occurred has provided an answer to the income inequality that has occurred because the center of Indonesia's growth is concentrated on the island of Java.

This is because, in the early stages of development, economic actors tend to invest in relatively developed areas. After all, the infrastructure is complete, the trained workforce is abundant, and there are business opportunities. Differences in asset ownership by a region owned will be able to create inequality between regions.

This result is also by the Neo-Classical hypothesis of Sjafrizal (2008) which says that at the beginning of the development process of a region, development inequality between regions tends to increase. After that, if the development process continues, regional development inequality will gradually decrease. It can be seen in figure 3 that the level of inequality in Java in 2015-2017 has increased, and in 2018-2019 there has been a decrease in income inequality in Java. The increase in the value of GRDP that has not been evenly distributed has led to various problems, one of which is inequality.

According to the assumptions of Aghion, (1997:155) assuming that the GRDP that increases periodically has not been able to fully. Economic activities that only focus on a few provinces on the island of Java will directly have an impact on income inequality between provinces to create conditions in which the province which is the center of concentration of economic activity will be in a position to earn higher incomes than other provinces.

Where this is also in line with the income disparity theory from Tambunan, (2014) which states that the concentration of economic activity in a particular area directly has an impact on income inequality between regions, to create conditions where the area which is the center of concentration of economic activity will be better able to provide higher income, high to the people.

Thus, a relatively more prosperous society was born. But on the other hand, regions that are not centers of economic activity are only able to provide low income which results in relatively low prosperity for the people.

This shows that the Kuznets hypothesis can be said to be in line with this research and in line with Sutarno & Kuncoro (2003) using the Williamson Index to measure inequality and see its relationship to GRDP growth and research by Purnama et al., (2021) which states that Kuznets hypothesis applies, which shows an inverted U shape on inequality in economic areas, where in the initial growth inequality worsens and in later stages inequality decreases, but at one time there will be an increase in inequality again and eventually, it will decrease again so that it can be said that the event is like repeated.

## CONCLUSION

Based on the value of the Williamson Index, there was an inequality of GRDP per capita in the Province of Java Island in 2015-2019 although it decreased in 2017-2019 the decline was still relatively small so it was included in the category of high inequality. This is due to the difference in income between people or areas that are developed and areas that are lagging. This can not be avoided because of the effect of seepage down from the output completely.

High income is only enjoyed by a handful of minority groups, it is also caused by part of the production factors in an area originating from other regions or abroad, and vice versa the production factors owned by residents of the area participate in the production process in other areas or outside the country. This is what causes the value of GRDP in an area to be different from the income received by residents of that area.

In addition, the existence of high economic activity is only concentrated in a few areas. On the other hand, Java Island has the largest population density in Indonesia, thus creating conditions in which areas that are the center of concentration of economic activity will be able to provide higher incomes to its people.

The Moran index indicates that there is no spatial autocorrelation of all locations in Java and each province, both to GRDP and income inequality, where the autocorrelation value shows a negative value (the pattern tends to spread). Spatial autocorrelation based on LISA Cluster Map GRDP shows no spatial cluster linkage pattern (clustering and influencing each other). Adjacent areas are still minimal in terms of interconnection to influence and are only local or in each province. However, income inequality in Java Island 2015-2019.

Based on the LISA Cluster Map, there is a pattern of spatial linkage of clusters (clustering and influencing each other) which is of High-High (hot-spot) value and is significant, so that there are areas that can be used as areas of concentration for cooperation for the development of economic growth and there are areas for cooperation to minimize inequality inter-regional income. Because the adjacent provinces have an influence on one another. There is a causal relationship between GRDP to income inequality. In other words, when GRDP increases, the position of income inequality also increases.

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**Appendix 1.** Moran ScatterPlot of Constant Price GRDP in Java Island Province 2015

| Quadrant | Category and Location |
|---|---|
| I | High-High (HH) indicates Quadrant I (High-High) indicates a province that has a high Constant Price GRDP value and is surrounded by areas with a high Constant Price GRDP value. On the island of Java, there are no provinces in quadrant I. |
| II | Low-High (LH) provinces that have low Constant Price GRDP values but are surrounded by areas with high Constant Price GRDP values, namely Central Java and Banten. In this quadrant, there are no inter-provincial linkages between provinces. As is the case with Central Java Province, and Banten is a province that has a low Constant Price Grdp when compared to surrounding provinces such as East Java, West Java, DKI Jakarta. This is caused by the lack of sources of sustainable economic growth, the low quality of human resources, the high dependence on the processing industry, and the limited mobility of people's savings (Bappenas, 2018). |
| III | Low-Low (LL) in this quadrant, between provinces provide linkages to the surrounding provinces. Provinces that have low Constant Price GRDP GRDP values are surrounded by provinces that have low Constant Price GRDP values, namely Yogyakarta Special Region. This is due to the growth rate of GRDP ADHK DIY Yogyakarta in 2015 of 4.95 percent, which is the lowest in Java and below the national economic growth of 4.99 percent. This happened in terms of production, a decrease in seasonal effects on the agricultural, forestry and fisheries business fields, especially the food crops sub category, which grew negative 34 percent. The low growth was also due to the large negative growth in business fields that have a large contribution to GRDP, namely wholesale and retail trade, and car repair, as well as the provision of accommodation and food and drink (BPS Yogyakarta Province). |
| IV | High-Low (HL) is a province that has a high Constant Price GRDP value, surrounded by provinces that have a low GRDP value, namely DKI Jakarta, East Java, and West Java. The three provinces are in the top three in contributing to the Constant Price GRDP of Java Island in 2015. Especially the biggest contribution to DKI Jakarta, occurs because it is the center of the economy and the center of government in Indonesia. |

Source: Data Processed, 2022

**Appendix 2.** Moran ScatterPlot of Constant Price GRDP in Java Island Province 2019

| Quadrant | Category and Location |
|---|---|
| I | High-High (HH) indicates Quadrant I (High-High) indicates a province that has a high Constant Price GRDP value and is surrounded by areas with a high Constant Price GRDP value, namely West Java. In this quadrant, provinces provide interrelationships, so that the observed areas and neighboring areas are correlated with each other. |
| II | Low-High (LH) provinces that have low Constant Price GRDP values but are surrounded by areas with high Constant Price GRDP values, namely Banten. In this quadrant, there are no inter-provincial linkages between |

| | |
|---|---|
| | provinces. As is the case with Banten, which is a province that has a low Constant Price GRDP when compared to surrounding provinces such as East Java, West Java, DKI Jakarta, and Central Java. This is due to the expenditure side, namely the increase in household consumption and government consumption (Bappenas, 2018). |
| III | Low-Low (LL) in this quadrant, between provinces provide linkages to the surrounding provinces. Provinces with low Constant Price GRDP values are surrounded by provinces with low Constant Price GRDP values, namely Yogyakarta Special Region and Central Java. Occurs due to global uncertainty that continues to weaken export demand. The decline in the performance of the processing industry also has an impact on the trading business field, the limited trade in industrial goods has caused trade growth to weaken (Bappenas, 2020). |
| IV | High-Low (HL) is a province that has a high Constant Price GRDP value, surrounded by provinces that have a low GRDP value, namely DKI Jakarta and East Java. The three provinces are in the top three in contributing to the GRDP of Constant Price in Java in 2019. Especially the biggest contribution to DKI Jakarta this happens because it is the center of the economy and the center of government in Indonesia. |

Source: Data Processed, 2022

**Appendix 3.** Moran ScatterPlot Income Inequality in Java Island 2015

| Category | Category and Location |
|---|---|
| I (HH) | On the island of Java, there are no provinces in quadrant I. |
| II (LH) | Regions with low inequality are surrounded by regions with high inequality, namely Central Java. In this quadrant, there are no inter-provincial linkages between provinces. Supported by the growth of leading sectors, namely the agriculture and processing industry (BPS Central Java Province). |
| III (LL) | Regions with low inequality are surrounded by regions with low inequality, namely Banten, DKI Jakarta, and Yogyakarta Special Region. In this quadrant, between provinces provide linkages to the surrounding provinces. This happened because in 2015 in the three provinces there was an increase in wages for agricultural workers by 1.21 percent and wages for construction workers by 1.05 percent (BPS Indonesia). |
| IV (HL) | High-Low (HL) shows areas with high inequality surrounded by areas with low inequality, namely East Java and West Java. Occurs by income differences between people in an urban and suburban areas. High income is only enjoyed by a few minority groups. |

Source: Author, 2022

**Appendix 4.** Moran ScatterPlot Income Inequality in Java Island Province 2019

| Category | Category and Location |
|---|---|
| I (HH) | Regions with high inequality values are surrounded by regions with high inequality values, namely Banten. In this quadrant, provinces provide interconnectedness to the surrounding area. This occurs because the average high economic growth of |

| | |
|---|---|
| | Banten Province is enjoyed by only a handful of parties. Development is not evenly distributed at all levels of society. |
| II (LH) | Areas with low inequality are surrounded by regions with high inequality, namely Central Java and DKI Jakarta. In this quadrant, there are no inter-provincial linkages between provinces. |
| III (LL) | On the island of Java in 2019, there are no provinces in quadrant III. |
| IV (HL) | High-Low (HL) shows areas with high inequality surrounded by areas with low inequality, namely East Java, West Java, and Yogyakarta Special Region. This is because some of the production factors in an area come from other regions or abroad, and vice versa, the production factors owned by the residents of the area participate in the production process in other areas or abroad. To be causes the value of domestic products that arise in an area is not the same as the income received by the residents of that area. |

Source: Author, 2022

**Appendix 5.** Optimum Lag

VAR Lag Order Selection Criteria
Endogenous variables: GRDP IW
Exogenous variables: C
Date: 05/27/22 Time: 14:57
Sample: 2015 2019
Included observations: 12

| lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -170.6286 | NA | 1.07e+10 | 28.77144 | 28.85226 | 28.74152 |
| 1 | -73.14010 | 146.2328* | 1874,156 | 13.19002 | 13.43247 | 13.10025 |
| 2 | -69.34453 | 4.428160 | 2113,867 | 13.22409 | 13.62818 | 13.07448 |
| 3 | -61.28288 | 6.718042 | 1350,272* | 12,54715* | 13.11287* | 12.33770* |

* Indicates lag order selected by the criterion
LR: *sequential modified LR test statistics (each test a 5% level)*
FPE: *Final prediction error*
AIC: *Akaike information criterion*
SC: *Schwarz information criterion*
HQ: *Hannan-Quinn information criterion*

Source: Data Processed, 2022