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Spatial analysis of regency city minimum wage, labor force, regional original income and investment affecting gross regional domestic product in central Java province in 2022

Darwin Kasidi*), Husnul Fitri
Urban Studies, School of Strategic and Global Studies, Universitas Indonesia, Jl. Salemba Raya, Jakarta, Indonesia

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ABSTRACT

Economic growth in Central Java Province is influenced by various regional economic factors, such as the Regency/City Minimum Wage (UMK), labour force, Regional Original Revenue (PAD), and investment, which play an important role in increasing Gross Regional Domestic Product (GRDP). However, economic disparities between regions in the province require in-depth analysis to understand how these factors interact with each other and affect GRDP, as well as to formulate more equitable and sustainable development policies. This study aims to analyze the influence of the variables of Regency/City Minimum Wage (UMK), Total Labor Force (Work), Regional Original Income (PAD), Investment (Foreign Investment and Domestic Capital Investment) on Gross Regional Domestic Product (GRDP) per capita in Central Java Province in 2022 and spatial analysis of these factors in 35 Regency / City in Central Java Province. The analysis is quantitative descriptive using regression analysis techniques and spatial analysis with statistical tests on the GeoDa program. The results show that all four variables, namely MSEs, labour force, PAD, and investment, have a significant influence on GRDP with probability values less than 0.05, indicating that these factors directly contribute to economic growth in Central Java. The pattern of economic concentration found mainly around urban areas, such as Semarang City, suggests an economic spillover effect that drives growth in the surrounding areas. These findings reinforce the important role of investment, PAD management, as well as job creation and MSE adjustment in supporting more equitable and sustainable economic development across the province. This study provides strategic insights for more equitable and sustainable economic development planning in Central Java Province.

Corresponding Author:

Darwin Kasidi,
Universitas Indonesia
Email: darwinkasidisianipar@gmail.com

Introduction

Regional economic development is a process of managing community resources by local governments by forming a partnership pattern between the private sector to create new jobs and stimulate the development of economic activity (economic growth) in the region (Malizia et al., 2021); (Christenson, 2019) . The economic development of a region basically aims to achieve community welfare (Surya et al., 2021). Community welfare is closely related to economic growth because of its role as a tool to maintain community welfare (Cheng et al.,

2020). The achievement of economic growth is one of the important indicators of the success of a country's development (McClelland, 2019). Economic growth can also be used as a benchmark to assess the progress of a country or region (Budihardjo et al., 2021); (Todaro & Smith, 2020).

Economic growt is the process of increasing output per capita in the long term (Simon, 2019). (Appiah et al., 2019) states that economic growth shows the extent to which economic activity will generate additional public income in a certain period. According to (Urbano et al., 2019), economic growth is defined as an increase in Gross Domestic Product or Gross National Income regardless of whether the increase is greater or less than the population growth rate or whether changes in economic structure occur or not. Economic growth is defined as the development of activities in the economy that cause the goods and services produced in society to increase and the prosperity of society to increase (Yuliana et al., 2019). Regional economic growth is the increase in community income that occurs in a region, namely the increase in all added value that occurs in the region (Syahza & Asmit, 2019). The success of development will be seen in significant economic growth in society, namely through the level of economic growth.

Economic growth also provides an increase in community income that occurs in a region, namely the increase in all added value that occurs in the region (Sukmawati & Maryanti, 2022). The increase in income is measured in real value, meaning that it is expressed in constant prices (Haig, 2020). Economic growth is measured based on the value of the Gross Regional Domestic Product (GRDP) which is the gross value added arising from all economic sectors of a region (Runtunuwu, 2020). Gross value added here includes the components of factor income, depreciation and net indirect taxes. By calculating the gross value added of each sector and summing the gross value added of all sectors, the Gross Regional Domestic Product will be obtained (Erokhin et al., 2023).

One of the interesting regional economic growths to be analyzed is economic growth in the Regency / City in Central Java Province. The development of economic growth by district / city in Central Java Province in 2020 - 2022 can be seen in table 1. Based on the Official Gazette of the Central Java Provincial Statistics Agency No. 14/02/33/TH XVII dated February 6, 2023, the Quarterly Gross Regional Domestic Product (GRDP) Economic Growth Rate had dropped to -5.93% in Q2 2020 below the National GRDP growth rate of -5.32%. However, in Q4 of 2022, Central Java Province's GRDP growth increased to 5.24% and was able to outperform the National GRDP of 5.01%. GRDP at constant prices by Regency/City in Central Java Province continues to increase every year, namely in 2021 by 3.50 percent then increased in 2022 to 5.40 percent. However, the increase in economic growth is uneven in each district/city. It can be seen in Figure 1 that Semarang City has the highest economic growth and even far exceeds the regencies/cities in Central Java province.

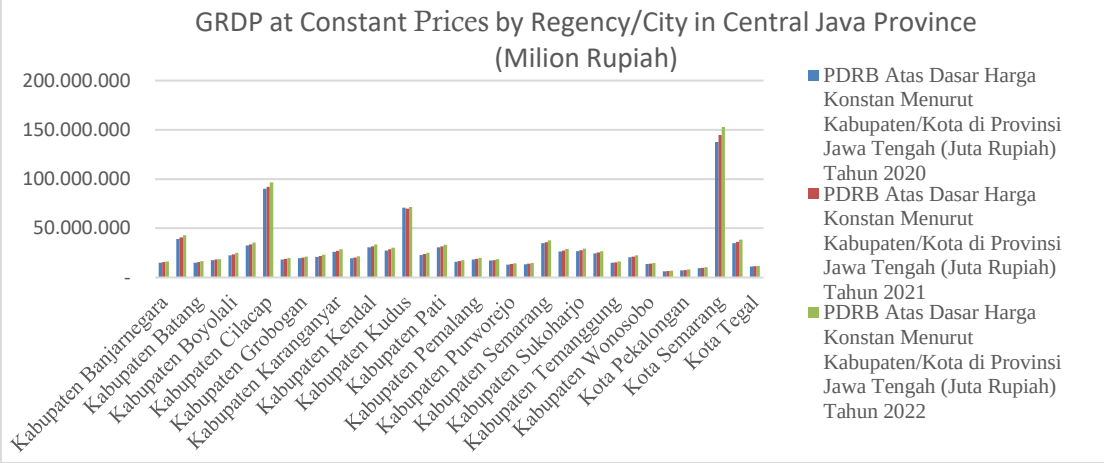

Figure 1. Development of Economic Growth by Regency/City in Central Java Province 2020 - 2022
Source: Researcher's Process

The inequality of GRDP that occurs in each region in Central Java is influenced by various factors. Some of them consist of the Regency / City Minimum Wage, Labour, Regional Original Income, and Investment. The District/Municipal Minimum Wage (UMK) plays an important role in driving the regional economy (Iswara & Astuti, 2024), especially through increasing people's purchasing power which directly affects household consumption (Jahang et al., 2024). Higher minimum wage allow workers to earn a more adequate income, thus fulfilling their living needs and improving their welfare standards (Kurniawan, 2019). This encourages increased demand for goods and services in the local market, which in turn spurs economic growth at the regional level

and contributes to GRDP (Gross Regional Domestic Product) (Winarni et al., 2023). The labour force has a central role in driving regional economic growth, as a productive workforce contributes to increased output and economic efficiency as reflected in Gross Regional Domestic Product (GRDP) growth (Dumais et al., 2022). The high number of labour force can be a valuable asset for a region, assuming that the labour force has skills that match market needs, so that it can support productive sectors and create significant added value (Nurpalah, 2022). However, if the labour force is dominated by individuals with low skills or less suited to industry needs, then this can hamper productivity and economic growth (Laia & Ashar, 2023). Therefore, improving the quality of the labour force through education, skills training and capacity building is crucial to ensure the positive contribution of the labour force to the regional economy (Puspasari, 2019).

Local own-source revenue (PAD) is one of the main sources of finance that enables local governments to finance sustainable development and improve people's welfare (Butar-Butar et al., 2023). With strong own-source revenues, regions have sufficient funds to strengthen various vital sectors, such as infrastructure, health, education and other public services (Azizah et al., 2022). Good infrastructure, for example, facilitates access to and distribution of goods and services, thereby improving regional productivity and competitiveness. Investments in the health sector ensure a healthier and more productive workforce, while quality education improves people's skills and creates superior human resources. All of these contribute to increased local economic activity that is ultimately reflected in an increase in Gross Regional Domestic Product (GRDP) (Jasman & Hwihanus, 2023). Therefore, PAD is not only a financing tool but also a key driver in achieving stronger and more sustainable regional economic growth (Arifin et al., 2023).

Investment acts as the main driving force in regional economic development as it can directly drive the growth and progress of various sectors of the local economy (Alfaro & Chauvin, 2020); (Li et al., 2021). Investment flows, both domestic and foreign, bring much-needed capital to build infrastructure, such as roads, health facilities, and education, which in turn improves access to and efficiency of production in the area (Makhathini et al., 2020); (Nwokolo et al., 2023). Investment also creates new jobs, lowers the unemployment rate, and increases people's income, which in turn boosts purchasing power and economic activity in the area (Bartik, 2020); (Siregar, 2019). With investment, economic sectors, such as trade, industry, and services, are encouraged to develop and innovate, increase regional productivity, and contribute positively to Gross Regional Domestic Product (GRDP) (Kusuma & Suryaningrum, 2021); (Yuliadi, 2020).

Economic disparities between regions in Central Java show significant variations in Gross Regional Domestic Product (GRDP) achievements between districts and cities. Spatial analysis is important to understand these patterns, as this approach allows the identification of local differences and factors that contribute to GRDP in each region. Therefore, it is necessary to conduct a study to see the economic structure of Central Java Province to find out the sectors that affect economic growth. Knowledge of the influential sectors can be an input for economic development policies in the Central Java region as one of the provinces with the largest economic value in Indonesia. The economic structure of a region can be seen from the contribution of each economic sector to GRDP. In addition to showing the dominant sectors in the economy through this structure can also be seen the direction of economic growth that occurs in a region.

This study analyzes the influence of the Regency/Municipality Minimum Wage (UMK) sector, Total Labor Force, Regional Original Revenue (PAD), and Investment (Foreign Investment and Domestic Investment) in relation to the GRDP of Central Java Province. On the other hand, this study also analyzes the spatial influence on GRDP growth so that it can provide appropriate policy recommendations in the context of economic equality in the Central Java region.

Method

The research method used in this study is spatial analysis with a quantitative approach. This research aims to identify and analyse the influence of macroeconomic factors on Gross Regional Domestic Product (GRDP) in Central Java Province using secondary data from BPS Central Java in 2022. The data used includes variables such as Gross Regional Domestic Product (GRDP) per capita, Regency/City Minimum Wage (MSE), Total Labor Force (Work), Regional Original Income (PAD) and Investment (FDI & PMDN) in 35 Regencies and Cities in Central Java Province. Quantitative design was chosen in this study because it is able to provide a comprehensive picture of the relationship between macroeconomic variables and Gross Regional Domestic Product (GRDP) through systematic numerical analysis.

This method is appropriate because the data used is large-scale secondary data from various regions in Central Java, which requires a statistical approach to identify spatial patterns and trends. Although classical regression with the addition of spatial analysis has the advantage of identifying the influence of macroeconomic variables in various locations, this approach does have limitations, especially related to the assumption of spatial

data independence that can cause estimation bias. To address this shortcoming, the study used diagnostic tests such as Moran's I to identify spatial autocorrelation, as well as considering correction with spatial regression to deal with potential bias. Alternative methods such as panel data regression or more complex econometric models, such as Generalised Method of Moments (GMM), were considered, but these approaches were less appropriate given the study's primary focus on spatial patterns between regions rather than time dynamics.

This study uses clear definitions and measurement methods for each variable to ensure transparency and validity of the results. For the District Minimum Wage (UMK) variable, the data includes the prevailing UMK value at the end of the observation period, thus indicating the current minimum wage that impacted local economic conditions in that year. Investment data includes new investments that entered the region during the observation period, so the focus is on new capital growth as an indicator of dynamic economic activity, without including old or pre-existing investments. As for local own-source revenue (PAD), the data is presented in nominal form and is not adjusted for inflation, given the different inflation rates in each district/city that will be addressed through spatial analysis. This detailed explanation is presented to strengthen the accuracy of measurement and interpretation of variables in the context of analysing macroeconomic factors on GRDP in Central Java.

Table 1. Data on Dependent Variables and Independent Variables

		Dependent Variable	Independent Variable			
No	**Regency**	**GDP Per Capita (Million Rupiah)**	**City/Regency Minimum Wage (Rupiah)**	**Number of Labor Force (Working)**	**Regional Original Revenue (Million Rupiah)**	**Investment (Million Rupiah)**
1	Kabupaten Banjamegara	15.75	1,819,835.00	487714.00	289,405.83	536.111.93
2	Kabupaten Banyumas	23.85	1,983,261.00	817989.00	854,988.93	871,408.73
3	Kabupaten Batang	20.53	2,135,535.00	426004.00	305,962.27	5,878,821.93
4	Kabupaten Blora	20.95	1,904,196.00	500373.00	291.111.18	74,842.97
5	Kabupaten Boyolali	23.09	2,010,299.00	562948.00	391.068,38	2,298,473.48
6	Kabupaten Brebes	17.61	1,885,019.00	826023.00	434,991.36	1,637,411.13
7	Kabupaten Cilacap	48.61	2,230,731.00	788513.00	742,049.55	770,096.75
8	Kabupaten Demak	16.22	2,513,005.00	571566.00	451,605.08	3,097,623.47
9	Kabupaten Grobogan	14.50	1,894,032.00	744832.00	349.216.21	771,534.68
10	Kabupaten Jepara	19.49	2,108,403.00	671473.00	490,005.62	9,585,326.50
11	Kabupaten Karanganyar	30.20	2,064,313.00	476875.00	377,807.95	1.121.054,76
12	Kabupaten Kebumen	15.56	1,911,850.00	619368.00	407,718.60	135,572.30
13	Kabupaten Kendal	32.35	2,340,312.00	524396.00	565,639.02	5,195,484.18
14	Kabupaten Klaten	23.68	2,015,623.00	623119.00	274,489.70	1,492,928.83
15	Kabupaten Kudus	83.40	2,293,058.00	485048.00	382.613.58	691.718,11
16	Kabupaten Magelang	19.01	2,081,807.00	781195.00	367,058.06	903.117.84
17	Kabupaten Pati	24.87	1,968,339.00	692477.00	362,814.60	1,648,799.12
18	Kabupaten Pekalongan	17.70	2,094,646.00	467510.00	439,706.81	205,170.20
19	Kabupaten Pemalang	13.26	1,940,890.00	642038.00	300.394,96	928,168.65
20	Kabupaten Purbalingga	18.33	1,996,814.00	510319.00	285.220,90	340.215.58
21	Kabupaten Purworejo	18.38	1,906,781.00	393775.00	444,922.92	71,239.86
22	Kabupaten Rembang	22.59	1.874.322,00	375614.00	373,771.13	956,762.01
23	Kabupaten Semarang	35.43	2,311,254.00	619227.00	549,652.63	3,094,542.30

		Dependent Variable	Independent Variable			
No	Regency	GDP Per Capita (Million Rupiah)	City/Regency Minimum Wage (Rupiah)	Number of Labor Force (Working)	Regional Original Revenue (Million Rupiah)	Investment (Million Rupiah)
24	Kabupaten Sragen	29.16	1,839,429.00	470456.00	352,767.66	844,334.86
25	Kabupaten Sukoharjo	31.84	1,998,153.00	475594.00	357,999.60	1,903,201.48
26	Kabupaten Tegal	16.45	1,968,446.00	643030.00	458,043.75	1,501,384.09
27	Kabupaten Temanggung	20.24	1,887,832.00	460765.00	296,358.64	480.252.77
28	Kabupaten Wonogiri	21.24	1,839,043.00	578089.00	251,871.85	297.232,79
29	Kabupaten Wonosobo	16.48	1,931,285.00	431010.00	230.186,77	152,407.22
30	Kota Magelang	56.62	1,935,913.00	62347.00	220,306.78	121,095.96
31	Kota Pekalongan	25.96	2.156.213,00	161470.00	223.246,98	482,768.04
32	Kota Salatiga	53.14	2,128,523.00	108396.00	245,944.33	390,305.98
33	Kota Semarang	92.17	2,835,021.00	994091.00	2,853,408.00	9,873,989.12
34	Kota Surakarta	73.57	2,035,720.00	271928.00	736.097,87	69,263,591.65
35	Kota Tegal	42.66	2,005,930.00	124887.00	374.211.81	141,882.30

Source: Researcher Process *(Badan Pusat Statistik, 2022)*

Analysis Method

This research uses descriptive quantitative methods which are analyzed using multiple linear regression methods. In general, this relationship can be expressed as the following equation:

$$Y=\beta 0+\beta 1X1+\cdots+\beta pXp+\varepsilon$$

With Y Dependent variable, X Independent variable, $\beta 0,\beta 1,\ldots\beta p$ is the parameter that must be estimated, and ε is the regression error value. This multiple linear analysis will use the Geoda application. Geoda is a free software program intended to provide a user-friendly and graphical introduction to spatial analysis for geographic information systems (GIS) professionals. The program includes functionality ranging from simple mapping to exploratory data analysis, visualization of global and local spatial autocorrelation, and spatial regression. The main feature of GeoDa is an interactive environment that combines maps with statistical graphics, using dynamically connected window technology. A brief overview of the software design is provided, as well as several illustrative examples that highlight distinctive features of these programs in applications related to public health, economic development, real estate analysis, and criminology (Anselin, 2005).

This research uses secondary data from Statistics Indonesia (BPS), which is known as an official data source with a high level of validity and reliability in the context of national statistics. However, to ensure the reliability and accuracy of the data used, this study undertook several additional steps. Firstly, data selection is done carefully by prioritising macroeconomic variables that are relevant and significant in influencing GRDP, such as Regency/City Minimum Wage (MSE), Total Labor Force (Work), Regional Original Income (PAD) and Investment (FDI & PMDN) in each district/city in Central Java. Secondly, a filtering process is performed to identify and address outliers or inconsistencies in the dataset, which may affect the analysis results. The use of outlier detection methods as well as other diagnostic tests are also applied to ensure that the selected data is truly representative and consistent, so that the research results are reliable and accurately describe the economic conditions in the entire Central Java region.

Spatial Weighting Matrix

A close relationship (neighboring) between locations is expressed in a weighting matrix W. The elements of this matrix are INij which shows the size of the relationship between the and j locations. The spatial matrix weights (W) are obtained from information on the distance between one region and another region. The elements of the matrix Ware (LeSage, 1999) explains that there are several ways to determine the Wij value, namely: (1) Linier Contiguity: W_{ij} = 1 for areas on the edge or edges (*edge*) either left or right of another region. (2) Rook Contiguity:

W_{ij} = 1 for the region next to (*side*) other regions. (3) Bishop Contiguity: W_{ij} = 1 for regions whose corner points are (*vertex*) meet other regions. (4) Queen Contiguity: W_{ij} = 1 for areas that are on the side or corner of another area.

In this study, GeoDa was used to conduct spatial analysis by constructing a spatial weighting matrix that maps the relationships between regions in Central Java. The matrix chosen was Queen contiguity, which considers the spatial relationship between regions that share a point or line boundary. The choice of this matrix is based on the need to reflect broader geographical interactions among districts/municipalities, given that macroeconomic factors in one region are likely to affect neighbouring regions directly and indirectly. This matrix is considered more appropriate than Rook contiguity, which only takes into account directly adjacent areas, as this study aims to capture broader regional economic linkages. However, to reduce the potential bias of this matrix choice, sensitivity tests were conducted with several alternative matrix types, so that the analysis could evaluate whether the results remained consistent.

Classical Regression

In this study, the initial regression is in the form of a classical model regression which is carried out by determining the dependent and independent variables. At this stage, we see that the R-squared results are close to 100% and the Prob (F-statistic) is below 5% and we check the probability of each variable with a limit of <5% (significant data).

LM-Leg and LM-Error checking

After running the data using the classic regression model, the next check refers to the LM-Leg and LM Error values. LM-Leg and LM-Error become significant when the value is below 5%.

Spatial Effect Check

The spatial effect is a description of the influence on the areas around the observation. The flow of the determination process in the Spatial Lag Model and Spatial Lag Error analysis, including: (1) When the value of LM-Leg and LM Error, then the flow of the process stops until the result of OLS. (2) If the LM Leg value is significant the process continues using the Spatial Lag Model and if the LM error value is significant then the process continues using the Spatial Error Model. (3) If the LM Leg and LM Error values are significant then the next check is to look at the Robust LM Error and Robust LM Lag values. If the Robust LM Error value is more significant than the next process uses the Spatial Error Model and if the Robust LM Lag value is significant then the process continues using the Spatial Lag Model.

Local Indicators Of Spatial Association (LISA)

The formula and table explanation in the previous point is for calculating. Global Moran Index. One more tool is needed to detect Local Indicators Of Spatial Association (LISA). The tool used is the Local Moran Index. There are two requirements for LISA analysis, namely: (1) The LISA for each observation indicates a significant spatial clustering around the observation area. (2) The sum of the LISA for all observations is proportional to the global spatial linkage indicator (Anselin, 1995). The purpose of LISA is to identify clustering and spatial outliers.

Moran Scatterplot

In addition to LISA, a tool called Moran Scatterplot is used. Moran Scatterplot is a tool used to see the relationship between the standardized value of an observation and the standardized average value of its neighbors.

Quadrant IV or HL (*High-Low*)	Quadrant I or HH (*High-High*)
Quadrant III or LL (*Low-Low*)	Quadrant II or LH (*Low-High*)

Figure 2. *Moran Scatterplot* (Triastuti, 2014)

According to Zhukov (2010) the quadrants in the Moran Scatterplot are as follows: (1) In quadrant I, HH (High-High) indicates that areas that have high observation values are surrounded by areas that have high observation values. (2) In quadrant II, LH (Low-High) indicates that areas that have low observation values are surrounded by areas that have high observation values. (3) In quadrant III, LL (Low-low) indicates that areas that have low observation values are surrounded by areas that have low observation values. (4) In quadrant IV, HL (High-Low) indicates that areas that have high observation values are surrounded by areas that have low observation values.

Results and Discussions

In spatial analysis to determine the presence of spatial autocorrelation, the main component required is a location map. The map is used to determine the proximity relationship between districts in Central Java province. It will thus be easier to weight each location or district (Figure 3). `

Figure 3. Location Map of Regency/City Administrative Areas of Central Java Province
Source: Results of Data Processed Data using QGIS Program (2023)

From the map of Central Java province, it is known that there are 35 districts / cities so that the spatial weighting matrix will be 35 x 35. The matrix weighting method used is Queen contiguity how to obtain a spatial weighting matrix based on the standardize contiguity matrix W (standardized weighting matrix). Standardize contiguity matrix W (standardized weighting matrix) is obtained by giving equal value or weight to the nearest neighboring location and other locations are given zero weight. Based on the spatial weighting matrix, the number of neighboring locations owned by each district can be determined. In the Geoda program, the number of neighbors is a graph that explains the number of district locations that are directly adjacent according to the queen contiguity provisions with the observed district. The graph of the number of neighbors for each district is illustrated in Figure 4.

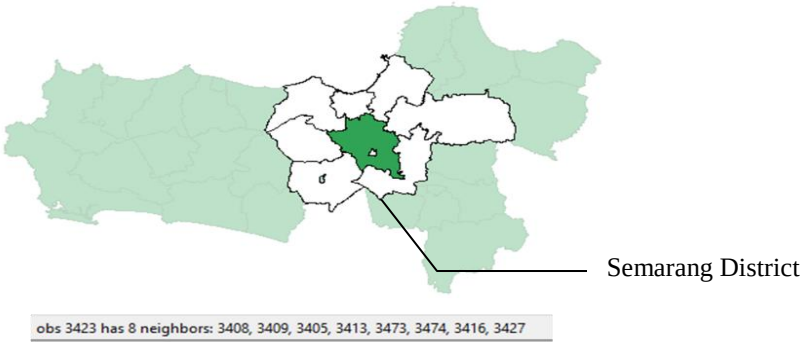

Figure 4. Map of districts with the most boundaries (neighbors)

In Figure 4, it can be seen that the district that has the most location boundaries (neighbors) is the district that is colored solid green and has a total of 8 neighbors, namely Semarang district.

Regression Model

Classical Model Regression

Classical regression modeling is carried out to determine the parameters that significantly affect Gross Regional Domestic Product (GRDP) in Central Java Province. The test carried out is the coefficient of determination (R^2) test to determine how much the ability of the independent variables to explain the dependent variable through the magnitude of the R^2 value.

Table 2. Results of The Coefficient of Determination Test (R^2) on The Classical Regression Model

Summary Model			
R	**R Square**	**Adjusted R Square**	**Standard Error**
0,7915	0,6265	0,5767	12,8515

Source: Processed by Researchers (Geoda Output)

Based on the results of the regression analysis, the overall model suitability is obtained, Table 2 shows that the R value is 0.7915 which shows a strong positive correlation between the independent variable and the dependent variable. Meanwhile, the coefficient of determination R^2 is 0.6265. This indicates that 62.65% of the variation in the dependent variable is explained by the independent variables. This is a pretty good level of explanation. As for Adjusted R^2 of 0.5767, it takes into account the number of independent variables and is considered a more reliable measure of fit. This still indicates a fairly good explanatory power.

F Test

The F test was conducted to see the effect of the independent variables on the dependent variable together.

Table 3. F Test Results on Classical Regression Models

ANOVA					
	Sum of Squares (SS)	**df**	**Mean Square (MS)**	**F**	**Significance F**
Regression	8311,571713	4	2077,892928	12,58104497	$3{,}99082^{-06}$
Residual	4954,817984	30	165,1605995		
Total	13266,3897	34			

Source: Processed by Researchers (Geoda Output)

In Table 3, it can be seen that the F statistical value is 12.581 with a significance of F equal to 3.99082^{-06} shows that the model is statistically significant at the 1% level (smaller than 0.10). This means that the independent variables together have a significant impact on the dependent variable.

P Test - Value

Partial test is carried out to determine the magnitude of the influence of the independent variable on the dependent variable partially.

Table 4. Partial Test Results

	Coefficients	**Standard Error**	**T Stat**	**P-Value**
Intercept	-11,6622621	29,8129813	-0,39118067	0,69842824
UMK (District/City Minimum Wage)	$2{,}46495^{-05}$	$1{,}49236^{-05}$	1,65171579	0,10902318
Total Labour Force (Employed)	$-4{,}18806^{-05}$	$1{,}26337^{-05}$	-3,31500400	0,00240343*
PAD (Million Rupiah)	$2{,}55318^{-05}$	$8{,}22426^{-06}$	3,104456357	0,00413724*
Total PMA & PMDN Investment (Million Rupiah)	$3{,}54633^{-07}$	$2{,}0342^{-07}$	1,743356582	0,09151326

Source: Processed by Researchers (Geoda Output)

Table 4 shows that the variable District Minimum Wage (UMK) is not statistically significant (P-value = 0.109), the positive coefficient indicates a weak increase in the dependent variable with a higher minimum wage. For the variable. This could be because MSEs only reflect the minimum wage standard in each region, which generally affects the welfare of individual workers rather than directly affecting total regional economic output. In addition, other factors such as investment, labour productivity, and industrial and service sector activities have a more dominant influence on GRDP growth. The insignificant effect of MSEs may also be due to the unevenness of the formal and informal sectors in different regions; for example, regions with larger informal sectors may be less affected by MSE policies as the majority of their workers are not bound to the minimum wage. Thus, while MSEs are an important instrument for worker welfare, their impact on regional economic aggregates in the form of GRDP is not significant.

Total Labor Force (Employed) is statistically significant (P-value = 0.002), but with a negative regression coefficient direction. This shows that an increase in the number of workers is actually associated with a decrease in GRDP. This phenomenon can occur due to an imbalance between the number of workers and their productivity; an increase in the number of workers is not always followed by an adequate increase in productivity. Factors such as education quality, skills, and labour efficiency also play an important role in determining economic output. In some regions, high employment rates may be more prevalent in low productivity sectors or the informal sector, which contributes less to GRDP. In addition, high labour absorption in low value-added sectors may lead to slow economic growth, so that even though many workers are employed, the positive impact on GRDP is not felt.

For Regional Original Revenue (PAD) is statistically significant (P-value = 0.004), a positive coefficient indicates an increase in the dependent variable with higher regional budget allocations. Regional Original Revenue (PAD) has a positive and significant influence on Gross Regional Domestic Product (GRDP) in Central Java Province, indicating that an increase in PAD contributes directly to regional economic growth. This is because PAD is a source of financing collected by the regions from various sectors, such as local taxes, levies, and the results of the management of separated regional assets. An increase in own-source revenue allows local governments to allocate more funds into infrastructure development, public service improvement, and investment in productive sectors, which in turn strengthens local economic competitiveness. As PAD increases, local governments have more flexibility in funding development projects that support local economic activity,

thereby boosting GRDP growth. This positive effect suggests that strengthening PAD not only improves local fiscal independence, but also strengthens the local economic base, resulting in an overall increase in GRDP.

While Total Investment (PMA & PMDN) is not statistically significant (P-value = 0.092), further investigation may be required to understand the relationship between investment and the dependent variable. The analysis shows that investment has a positive but insignificant influence on Gross Regional Domestic Product (GRDP) in Central Java Province. This means that although an increase in investment tends to be expected to boost GRDP growth, its impact at the regional scale is not large enough to show a significant relationship. Several factors may explain this result. First, the distribution of investment may be uneven or more concentrated in a few regions, so that the benefits are not widespread throughout the province. In addition, incoming investments may be mostly directed at sectors with low contributions to GRDP or at long-term projects that take time to deliver visible economic impacts. Other factors such as supporting infrastructure and the availability of qualified labour could also be constraints, so that investment has not optimally boosted economic output. These results indicate that investment needs to be optimized and aligned with productive sectors that have high leverage to strengthen its influence on regional economic growth.

Classical Model Regression using Geoda software

Overall Model Fit shows that the coefficient of determination (R^2) test is 0.6265 indicating a fairly strong relationship between the independent variables and the dependent variable (GRDP). However, it should be noted that the corrected R^2 is 0.5767 showing a more reliable measure after accounting for the number of variables, indicating a slightly weaker fit. While the F-statistic is 12.581 with a P-value of 3.99-06 indicating the model is statistically significant at the 1% level, meaning the independent variables jointly explain most of the variation in the dependent variable.

Table 5. Test Results of the Coefficient of Determination (R^2), F and P-value on the classical regression model using Geoda software

Model Summary			
R Square	**Adjusted R Square**	**F-statistik**	**P-value**
0.6265	0.5767	12,581	$3,99^{-06}$

Source : Researcher process (Output Geoda)

Table 6 shows that the coefficient of the individual variable Kabupaten/Kota Minimum Wage (UMK) is 2.46-05 with a P-value of 0.1090, meaning it is not statistically significant. The coefficient of the individual variable Total Labor Force (Employment) is -4.19-05 with a P-value of 0.0024, which is statistically significant because it is below 5% and shows a negative association with GRDP. The coefficient of the Individual Variable of Local Revenue is 2.55-05 with a P-value of 0.0041, which is statistically significant because it is still below 5%, and shows a positive association with GRDP. The coefficient of the Individual Variable Total Investment is 3.55-07 with a P-value of 0.0915, meaning it is not statistically significant.

Table 6. Individual Variable Coefficient Test Results using Geoda software

	Coefficient	**Standard Error**	**T Statistic**	**P-Value**
Constant	-11,6623	29,813	-0,391181	0,69843
UMK (District/City Minimum Wage)	$2,46495^{-05}$	$1,49236^{-05}$	1,65172	0,10902
Total Labour Force (Employed)	$-4,18806^{-05}$	$1,26337^{-05}$	-3,315	0,0024*
PAD (Million Rupiah)	$2,55318^{-05}$	$8,22426^{-06}$	3,10446	0,00414*
Total PMA & PMDN Investment (Million Rupiah)	$3,54633^{-07}$	$2,0342^{-07}$	1,74336	0,09151

*: significant at 5 percent alpha

Source : Researcher process (Output Geoda)

Furthermore, the spatial dependence test is conducted, namely the Lagrange Multiplier test to determine the effect of spatial dependence. Based on the test, the results show that: (1) All spatial dependence tests (Moran's I, Lagrange Multiplier, Robust LM) fail to reject the null hypothesis (p-value > 0.05), implying the model adequately accounts for spatial autocorrelation in the data. (2) Spatial dependence: Robust LM (Lag) probability 0.00482 while Robust LM (Error) probability 0.016 so it was decided to make the spatial lag model the model of choice because the Robust LM is close to Zero or very small below alpha 5% which indicates there is still a possibility of spatial dependence even though the Lagrange Multiplier (lag) probability is above (p-value > 0.05).

Table 7. Lagrange Multiplier and Robust LM Test Results

Test	MI/DF	Value	Prob.
Moran's I (Error)	- 0,0315	0,0616	0,95089
Lagrange Multiplier (Lag)	1	2,3014	0,12926
Robust LM *(Lag)*	1	7,9449	0,00482*
Lagrange Multiplier (Error)	1	0,0642	0,80003
Robust LM *(Error)*	1	5,7077	0,01689
Lagrange Multiplier (SARMA)	2	8,0090	0,01823

*: significant at 5 percent alpha
Source : Researcher process (Output Geoda)

Based on the test results, it can be concluded that there are two variables that have a significant effect on the dependent variable (GRDP) because the independent variable has a p-value < α (0.05). These variables are the Total Labour Force (Work) and Local Revenue (PAD). While spatial dependence in all spatial dependence tests (Moran's I, Lagrange Multiplier, Robust LM) fails to reject the null hypothesis because it has a p-value > α (0.05), but it does not rule out the possibility that there is still spatial dependence if we look at the Robust LM (Lag) which is a p-value of 0.00482 (p-value > 0.05) to make sure then we need to do testing using the Spatial Lag Model.

Spatial Lag Model Regression using Geoda Program
After knowing the selected model, then estimate the spatial lag model. The Geoda output results obtained are the R-squared (R^2) value of 0.684035 indicating that approximately 68.4% of the variation in the dependent variable (GRDP) can be explained by the independent variables used in the Spatial Lag model. This indicates a relatively good level of model fit in explaining variations in the data.

Table 8. Estimation Results of Spatial Model Lag

Model Summary	
Lag Coeff. (Rho)	**R Square**
-0,504049	0.684035

Source : Researcher process (Output Geoda)

Table 9 shows that the Variable Coefficient:

P - GRDP
Probability 0.01267 indicates that there is spatial dependence in the model, which means that the value of GRDP in a region is influenced by the value of GRDP in the surrounding area. This spatial dependence suggests that economic development in a region can stimulate growth in surrounding areas through economic interactions, labour mobility, and the flow of goods and services, making it important for governments to consider inter-regional relations in formulating economic policies.

MSES
Probability 0.00343 Probability that MSEs have a significant positive influence on GRDP. This means that an increase in MSEs in a region contributes significantly to an increase in the economic output of that region. The positive effect of MSEs on GRDP can be explained through an increase in the purchasing power of local workers; when MSEs increase, workers' income also increases, which in turn encourages the consumption of goods and services in the local economy. This effect can spur aggregate demand, potentially leading to increased production and other economic activities in sectors that support GRDP. Thus, the policy of increasing MSEs not only benefits workers' welfare, but also directly supports regional economic growth, as long as the balance between the increase in MSEs and productivity can be maintained.

Total Labor Force
Probability -0.00111 indicates that Juml has a significant negative effect on GRDP. This indicates that an increase in the number of employed labour is actually associated with a decrease in GRDP. One explanation for this result is the mismatch between the number of workers and their productivity. The high number of labour, especially in the informal sector or those with low education, may not be accompanied by high productivity, resulting in a less than optimal contribution to GRDP. Policies that focus on improving the quality of labour, such as skills training and education, will be more effective in improving productivity and ultimately increasing GRDP.

Local Revenue
Probability 0.00664 indicates that PAD has a significant positive effect on GRDP. This means that an increase in local own-source revenue (PAD) has a direct impact on regional economic growth, as revenues obtained from local taxes and levies can be used to fund infrastructure development, public services, and other economic

development programmes. A strong PAD provides flexibility for local governments to make productive investments that can encourage sustainable economic growth, so an increase in PAD should continue to be encouraged to increase GRDP.

Total Investment

Probability 0.00336 indicates that PAD has a significant positive effect on GRDP. This indicates that the influx of investment, both domestic and foreign, has a direct impact on increasing GRDP. Investment directed to productive sectors is able to boost economic activity through job creation, increased production capacity, and technology transfer. Thus, policies that support a conducive investment climate and strengthen investment attractiveness in strategic areas can further optimise the contribution of investment to GRDP growth in Central Java.

Table 9. Results of Estimation of Spatial Model Variables Lag

Variable	Coefficient	Standard Error	T Statistic	P-Value
W - GRDP	-0,504049	0,202186	-2,49299	0,01267
Constant	-29,5449	25,7667	-1,14663	0,25153
UMK (District/City Minimum Wage)	$3{,}95709^{-05}$	$1{,}35237^{-05}$	2,92605	0,00343*
Total Labour Force (Employed)	$-3{,}54893^{-05}$	$1{,}0885^{-05}$	-3,26037	0,00111*
PAD (Million Rupiah)	$1{,}93259^{-05}$	$7{,}11964^{-06}$	2,71445	0,00664*
Total PMA & PMDN Investment (Million Rupiah)	$3{,}7235^{-07}$	$1{,}75235^{-07}$	2,12486	0,03360*

*: significant at 5 percent alpha
Source: Researcher's Process (Geoda Output)

Spatial Dependence Diagnostic: The Likelihood Ratio test was used to test the spatial lag dependence of the GRDP matrix. The test results show that there is a significant spatial lag dependency, indicating that the value of GRDP in a region is influenced by the value of GRDP in the surrounding region.

Tabel 10. Uji Likelihood Ratio

Test	DF	Value	Prob.
Likelihood Ratio	1	3,9120	0,04794

Source : Researcher process (Output Geoda)

Spatial Test Results

Moran's Test Results

The data that I use as a sample is data on GRDP, Inflation, Minimum Wage, Labor Force, district / city in Central Java Province in 2022:

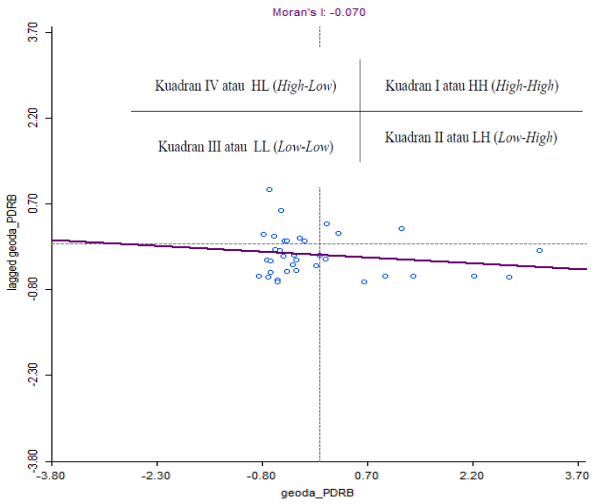

Figure 5. Moran's Output of GRDP in Central Java Province in 2022
Source: Data processed with Geoda program

The Moran's value of the GRDP variable in 2022 is negative -0.070> 0, indicating that the data pattern forms a cluster, which can be seen in the GRDP distribution map below:

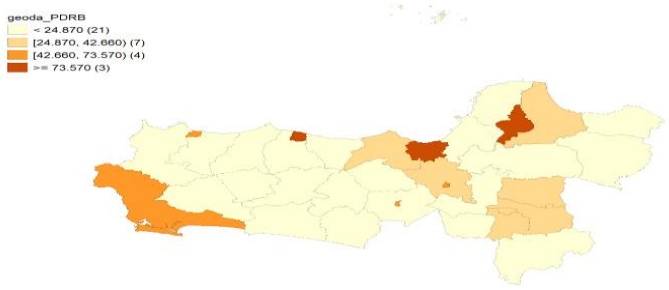

Figure 6. Distribution of Regency / City GRDP Data in Central Java in 2022
Source: Data processed with Geoda program

The value of the distribution of GRDP per capita on the map above is divided into four, namely, the value of GRDP per capita is very high, GRDP per capita is high, GRDP per capita is medium, and GRDP per capita is low with the following regional division: (1) Very high per capita GRDP value is above Rp. 73,570,000,000.00 which consists of areas: Semarang City, Pekalongan City, Kudus Regency; (2) High per capita GRDP value between Rp.42,660,000,000.00 - Rp. 73,570,000,000.00, namely the regions of : Cilacap Regency, Magelang City, Salatiga City, and Tegal City; (3) Medium GRDP per capita value between Rp.24,870,000,000.00 - Rp. 42,660,000,000.00 includes the regions of : Surakarta City, Sukoharjo Regency, Sragen Regency, Semarang Regency, Pati Regency, Kendal Regency, Karanganyar Regency; (4) Low GRDP per capita value below Rp. 24,870,000,000.00, covering the regions of: Banjarnegara Regency, Banyumas Regency, Batang Regency, Blora Regency, Brebes Regency, Demak Regency, Grobogan Regency, Jepara Regency, Boyolali Regency, Kebumen Regency, Klaten Regency, Magelang Regency, Pekalongan Regency, Pemalang Regency, Purbalingga Regency, Purworejo Regency, Rembang Regency, Tegal Regency, Temanggung Regency, Wonogiri Regency, Wonosobo Regency.

Based on the output of Moran's I Scatter Plot, regional groupings based on GRDP per capita are formed into four quadrants: (1) Quadrant 1 is an area with high GRDP per capita surrounded by areas with high GRDP per capita. It consists of Kota: Salatiga, Kendali District, Semarang District. (2) Quadrant 2: Areas with low GRDP per capita surrounded by areas with high GRDP per capita. Quadrant 2 consists of Cilacap Regency, Magelang City, Pekalongan City, Semarang City, Tegal City, and Kudus Regency, Sukoharjo Regency and Karanganyar Regency. (3) Quadrant 3, is an area with low GRDP per capita surrounded by areas with low GRDP per capita. Quadrant 3 consists of Banjarnegara Regency, Banyumas Regency, Blora Regency, Boyolali Regency, Klaten Regency, Magelang Regency, Pekalongan Regency, Pamalang Regency, Purbalingga Regency, Purworejo Regency, Rembang Regency, Sragen Regency, Tegal Regency, Temanggung Regency, Kebumen Regency and Wonosobo Regency; (4) Quadrant 4 is an area with high GRDP per capita surrounded by areas with low GRDP per capita. Quadrant 4 consists of Surakarta City, Pati Regency, Batang Regency, Brebes Regency, Demak Regency, Grobogan Regency, Jepara Regency, and Wonogiri Regency.

LISA Cluster Map

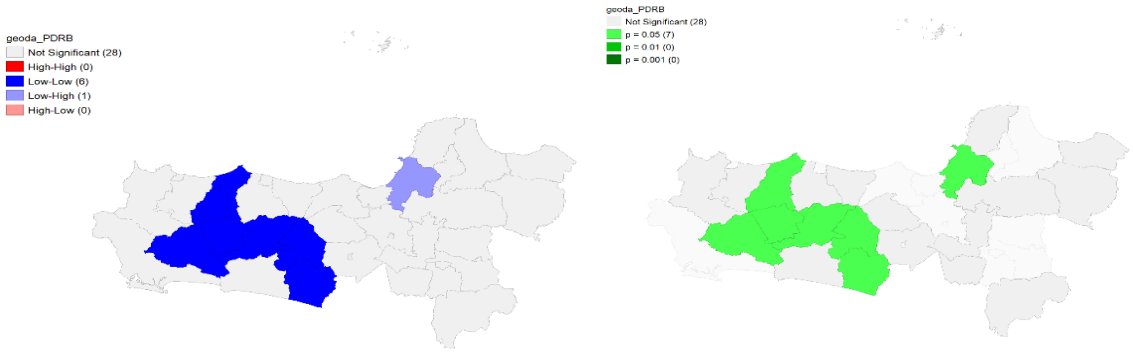

Figure 7. *Local Indicator of Spatial Association* (LISA) Regency/City GRDP in Central Java in 2022
Source: Data processed with the Geoda program

If seen from the LISA Cluster Map, there is spatial concentration (*Low-low*) which means low GDP per capita surrounded by low GDP per capita, including in the districts of Banjarnegara, Pemalang, Purbalingga, Purworejo, Wonosobo and Banyumas. For category *Low-high* which means low GDP per capita surrounded by high GDP per capita, namely Demak district, while for category *High - High* and

High – Low not found in this analysis. Meanwhile, other regions did not show significant results, namely 28 city districts in Central Java Province, which means they did not have a significant influence. For p = 0.05 in the cluster map there are seven districts, namely Wonosobo, Purworejo, Purbalingga, Pemalang, Demak, Banyumas, and Banjarnegara, which means they have a significant influence.

This spatial clustering pattern reveals notable economic disparities across Central Java, with distinct clusters of low GDP per capita districts, particularly in Banjarnegara, Pemalang, Purbalingga, Purworejo, Wonosobo, and Banyumas, forming a concentrated area of lower economic output. The presence of a "Low-High" cluster in Demak suggests a unique regional dynamic, where a lower GDP per capita district is surrounded by higher GDP per capita areas, potentially indicating economic spillover or dependency relationships with neighboring, more economically developed regions. The absence of "High-High" and "High-Low" clusters indicates that high GDP per capita areas do not cluster in the same way, suggesting either a more isolated distribution of wealthier regions or less interdependence in high economic output areas. Additionally, with a significance level of p = 0.05, the identified clusters namely Wonosobo, Purworejo, Purbalingga, Pemalang, Demak, Banyumas, and Banjarnegara show that these regions not only have lower GDP per capita but also hold significant spatial influence, potentially due to structural factors such as limited infrastructure, lower levels of industrialization, or workforce constraints. This spatial analysis highlights the need for targeted economic policies to address and bridge the economic disparities between these low-output districts and the rest of Central Java Province.

Natural Breaks

Natural break is a manual data classification method that attempts to divide data into classes based on natural groups in the data distribution. The natural break map model will display data in the form of a map of the distribution of MSEs, Number of Labor Force (Employed), PAD and Investment (PMA & PMDN)

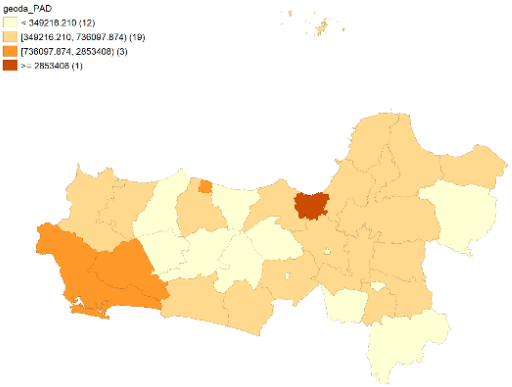

Figure 8. Distribution of PAD Data for Regencies/Cities in Central Java in 2022
Source: Data processed with the Geoda program

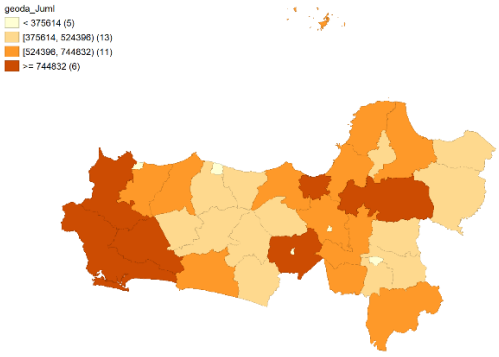

Figure 9. Distribution of Number of Labor Force (Employed) Data for Regencies/Cities in Central Java in 2022
Source: Data processed with the Geoda program

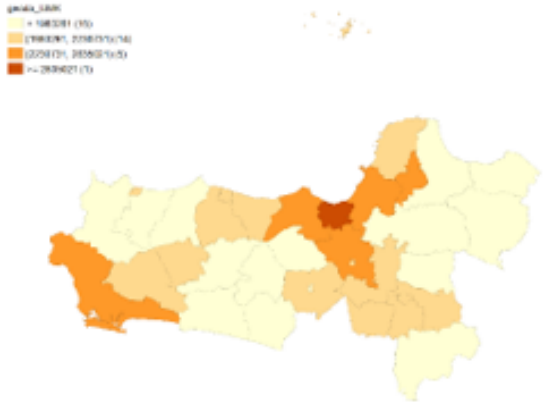

Figure 10. Distribution of Regency/City MSE Data in Central Java in 2022
Source: Data processed with the Geoda program

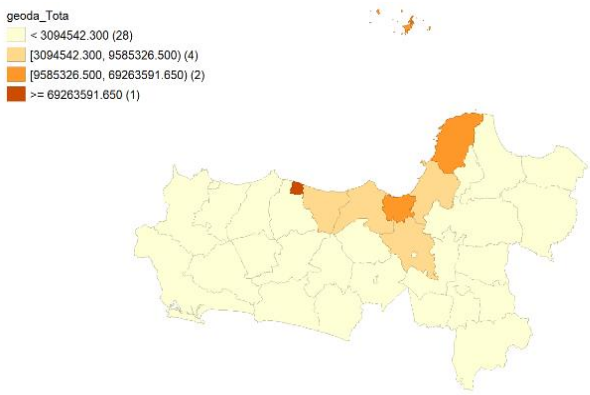

Figure 11. Distribution of Total Regency/City Investment Data in Central Java in 2022
Source: Data processed with the Geoda program

We can see that in Figure 8 the highest PAD in Central Java Province is in the City of Semarang which can influence neighboring areas that touch each other around it (Queen Contiguity) even though the influence is not significant, apart from that the City of Semarang also has a Regency Minimum Wage / City and the highest number of workers (employed) which also has quite a significant influence affecting neighboring areas that touch each other or are located around it (Queen contiguity) as well as investment which can be seen in Figure 11 even though it is in position 2 cities Semarang is still able to have a significant influence on neighboring regions that touch each other around it, resulting in an agglomeration forming on the northern side of Central Java Province, namely around the city of Semarang. In Figure 9, the number of labor force distribution patterns is greatest on the western side of Central Java Province, which is located in Semarang City, Grobokan Regency, and Magelang Regency. Meanwhile, for Regency/City Minimum Wages, we can see in Figure 10 that the highest values are on the southwest side and the north side around Semarang, the same as for the PDA. However, some districts, namely Wonogiri, Banjarnegara, and others whose PAD, investment, and workforce are still low, need more attention.

This pattern of economic concentration highlights how Semarang City serves as a regional economic hub, where high Local Revenue (PAD), significant employment rates, and substantial investment collectively stimulate economic growth in adjacent areas, albeit with varying levels of influence. The spatial contiguity shown in Figure 8 illustrates how neighboring regions can benefit from Semarang's economic activities, which foster an agglomeration effect on Central Java's northern side. As seen in Figure 9, the western region's high labor force concentration—especially in Semarang City, Grobogan Regency, and Magelang Regency—further complements this economic clustering by supplying a steady workforce to sustain the regional economy. In terms of Regency/City Minimum Wages, Figure 10 reveals that the highest levels are positioned similarly around Semarang, supporting higher living standards and potentially increasing consumer spending in these areas. Despite this, certain districts like Wonogiri and Banjarnegara remain on the economic periphery, with relatively low PAD, investment, and employment levels. This underscores a need for targeted policies to address disparities and enhance economic integration across Central Java, ensuring that underdeveloped regions are not left behind in the province's overall growth trajectory.

Conclusions

The conclusion of this study shows that economic factors such as District Minimum Wage (UMK), Total Labour Force, Regional Original Revenue (PAD), and Investment (both from Foreign Direct Investment and Domestic Direct Investment) have a significant influence on Gross Regional Domestic Product (GRDP) in Central Java Province. The spatial analysis conducted identifies that some regions, particularly Semarang City and its surrounding areas, exhibit agglomeration effects where high values of MSE, PAD, and the level of workers employed drive economic growth in neighbouring regions. This suggests that there is economic interdependence between regencies and cities that can strengthen economic activity in the region. This contiguity effect, which is evident from the LISA (Local Indicators of Spatial Association) results, underlines that differences in economic factors between regions create different clusters in the distribution of GRDP. In addition, this study also found that although investment has a positive influence on GRDP, not all regions feel the significant impact of investment, especially in less developed regions such as Wonogiri and Banjarnegara.

This indicates the existence of economic disparities that require policy intervention to improve regional economic integration and encourage more equitable investment. Local governments can consider policies that support PAD increase, job creation, and minimum wage adjustment in accordance with local economic capabilities to reduce inter-regional disparities. Thus, this study provides empirical evidence on the importance of spatial mapping as an analytical tool in planning for more equitable and sustainable economic development in Central Java Province. In future research, it is also necessary to examine the influence of other aspects such as the ease of doing business in the cities/districts that are still lagging behind in order to obtain a more comprehensive picture of the problem of investment in these areas.

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