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The Effect of Spatial Dependence and Population Density on the Economic Development in Banten Region Before and During the Covid-19 Pandemic

Dewiana Novitasari[1], Shofwatun Hasna[2], Tias Pramono[3], Sukriyah[4], Albertus Maria Setyastanto[5]
[1,2,3,4] Universitas Insan Pembangunan Indonesia, Indonesia
[5] Universitas Indraprasta PGRI, Indonesia

**Corresponding email: dhewiediosa@yahoo.co.id*

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Abstract

This study aims to analyze the effect of spatial linkages and population density on economic development in Banten Province in 2016-2021. The data used is panel data with a spatial econometric approach. The selected model is a spatial panel model with fixed effects. This study builds two models, namely, the first model does not include the pandemic period and the second model includes the pandemic period. The results of the analysis of the first model show that before the COVID-19 pandemic occurred, spatial linkages and population density were proven to have a significant positive effect on Banten's per capita income. Population density is the main factor that strongly influences the per capita income of the Banten region. Meanwhile, in the second regression model, spatial correlation is proven to have a significant positive effect on Banten's per capita income, but population density has a negative effect. High population density actually lowers GDP per capita, because there is a lot of unemployment during the pandemic.

Keywords: *Economic development, population density, spatial dependence.*

Introduction

Information is likened to the blood that flows in the body of an organization. Just as humans need blood flowing in their bodies, organizations also need this information. An organization that lacks or is not informed will not succeed. The source of information is data. Data is the plural form of the singular data-item. Data is a fact that describes an event and a real entity. Events are things that happen at a certain time. In the business world, events that often occur are changes in a value called a transaction. For example, a sale is a transaction that changes the value of goods into the value of money or the value of accounts receivable. So it can be concluded that information is data that is processed into a form that is more useful and more meaningful for its users. Data is a form that is still raw, can not tell much so that it needs to be processed further. The data is processed through a model to produce information. Data can be in the form of symbols such as letters or the alphabet, numbers, sound forms, signals, pictures. Processed data alone is not enough to be said as an information. To become an information, the processed data must be useful for the user. To be useful, information must be supported by three pillars, namely right to the person or relevant, timely, and the right value or accurate.

Research Method

The method used in this research is descriptive qualitative method. Data collection is done by listening to the material from the module and then reading with observations, the next technique is data collection by conducting a literature study from various articles so that it can be analyzed according to data classification which Spatial model is a model built to see and bring up spatial dependence in an econometric model. Spatial economics takes into account the geographical condition/location of a region in determining the influence of another region variable. Tobler's first law of geography (1979) states, "Everything is related to everything else but near things are more related than distant things," (in Purri, 2005). In general, two areas that are located close to each other have more intensive interactions than areas that are far apart. Geographical factor / location is something real and very clearly a determinant in economic life. The location factor of a region determines the neighboring regions. Regions surrounded by rich neighboring regions will grow faster than regions surrounded by poor neighbors. The influence of the income level of neighboring regions on regional growth can be caused by the relationship between the two (the effect of externalities).

Banten region consists of four districts and four cities. The land area of each district/city is based on the Regulation of the Minister of Home Affairs no. 6 of 2008, namely: Pandeglang Regency (2,746.89 km2), Lebak Regency (3,426.56 km2), Tangerang Regency (1,011.86 km2), Serang Regency (1,734.28 km2), Tangerang City (153.93 km2) , Cilegon City (175.50 km2), Serang City (266.71 km2), and South Tangerang City (147.19 km2), (BPS, 2021).

Banten is an industrial area where this sector is able to contribute 49.75% of GDP. This industrial sector is also the largest sector in the absorption of labor in Banten, although the ability to absorb labor is still relatively low, only around 23.11%. Banten has 8 regencies/cities with uneven population density. This is because there are several areas with a very large number of industries, namely Tangerang Regency and Tangerang City. The existence of a large number of industries causes population density in the area concerned. Economic concentration becomes concentrated in areas with a high industrial sector. Sjafrizal (2012) states that regional economic growth will tend to be faster in areas where there is a large concentration of economic activity. These conditions will encourage the process of regional development through increasing the provision of employment and income levels of the community. The occurrence of a fairly high concentration of economic activity in certain areas will affect the inequality of economic development.

This study tries to include spatial relationships in the research model, because it is proven that industrially rich areas will have an influence on the economic development of their closest neighbors. This evidence can be seen from the data on the number of industries and GRDP of Banten per region from 2017 to 2019 below,

Table 1.1 Number of Large and Medium Industrial Companies

City/Districts	2017	2018	2019
Pandeglang District	10.00	9.00	10.00
Lebak District	27.00	26.00	29.00
Tangerang District	1137.00	1131.00	1353.00
Serang District	245.00	236.00	309.00
Tangerang City	776.00	731.00	941.00
Cilegon City	95.00	86.00	103.00
Serang City	40.00	31.00	37.00
South Tangerang City	185.00	180.00	145.00

Source: BPS Banten.

Table 1.2 GRDP on the basis of current prices per Regency City

City/Districts	2017	2018	2019
Pandeglang District	24182302.53	26183539.56	27931123.75
Lebak District	24485545.33	26602743.20	28725281.30
Tangerang District	118994083.85	129825980.84	140089287.58
Serang District	65905439.09	71521738.86	76906395.06
Tangerang City	149005544.80	161359628.33	171732446.27
Cilegon City	88871488.82	96909883.39	103931063.56
Serang City	26452445.40	28980866.42	31602577.25
South Tangerang City	67980904.36	75043782.35	82769481.67
Total	565877754.18	616428162.94	663687656.44

Source: BPS Banten.

Tangerang City and Tangerang Regency are the two regions in Banten with the highest number of industries and GRDP. This has an influence on its closest neighbors, namely South Tangerang City and Serang Regency. Meanwhile, areas far from Tangeran City and Tangerang Regency with limited number of industries, such as Serang, Lebak and Pandeglang cities have low GRDP. The effect of the proximity of neighbors needs to be included in the research model, because if not, the consequences of the relationship obtained will be biassed, inconsistent, and inefficient (Florax 2000: 27 in Purri 2005).

Elhorst (2003) in his writing entitled "Specification and Estimation of Spatial Panel Data Models" states that, two problems arise when panel data is included in the location component, namely, 1) spatial relationships may arise between objects of observation in each time period. 2) Parameters are not homogeneous but vary in different locations. The problem with traditional panel regression is that there is no spatial effect in the model, even though it is clear that the model is in the location component, and within the location there must be a spatial relationship between regions. It is this connection that the traditional panel model does not provide. As is the case with cross-sectional regression, the traditional panel data technique captures only the mean or representative of individual responses. Panel regressions have a constant slope in the mean effect of the spatial units, even if looking at different intercepts, will not show differences between spatial units. One or more relevant variables have been omitted from the model or captured in an incorrect functional form.

Based on the background described previously, the following framework can be drawn up:

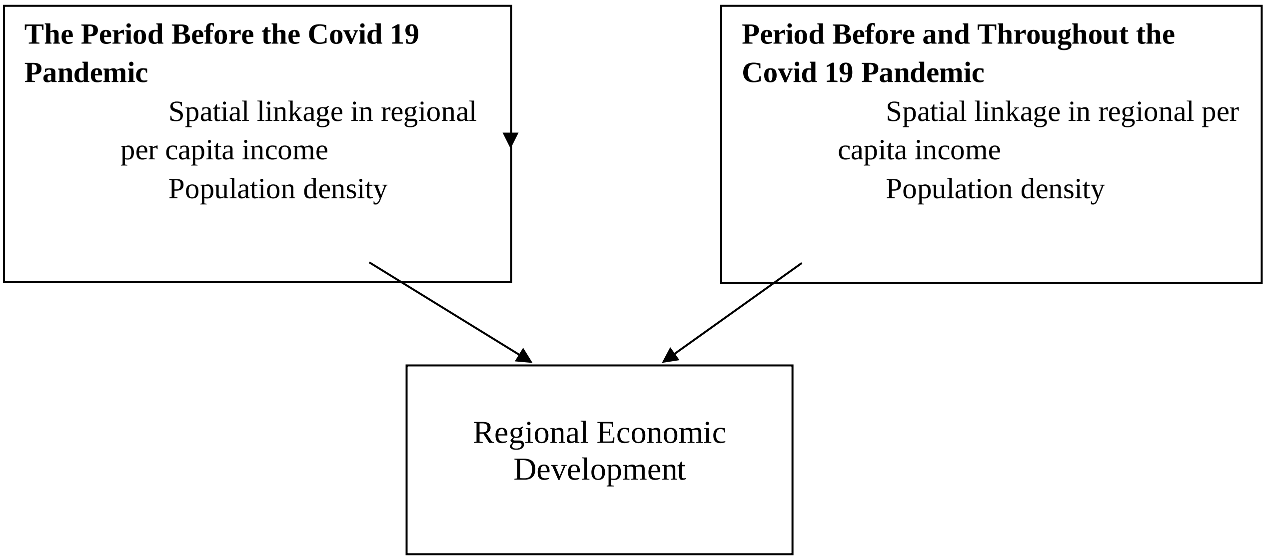


Figure 1.1 Framework

Economic development analysis needs to pay attention to the spatial interrelationships between regencies/cities in order to obtain an appropriate model and the right conclusions. Therefore, based on the background of the problem, this study will incorporate spatial dependence into the model with the following research objectives:

1. analyze the influence of spatial and population density on the economic development of Banten Province for the 2016-2018 period, namely in the period before covid-19
2. analyze the effect of spatial and population density on economic development in Banten Province for the 2016-2021 period, namely before and during the COVID-19 pandemic

This study is expected to be a reference for policy makers in making development decisions in the next period.

1. THEORY FRAMEWORK AND HYPOTHESES DEVELOPMENT

1.1 Spatial Analysis

Linear regression models on panel data where there is an interaction between spatial units will have a dependent variable spatial lag or spatial processing of errors which are usually called spatial lag models and spatial error models (Elhorst, 2003). Spatial error determines the correlation between spaces in the error value, while spatial lag indicates the influence of independent variables in space, named i and j, on the dependent variable in space i.

a. Spatial Lag Model (SAR)
   This model is composed of the spatial lag dependent variable (WY) which acts as the independent variable. The spatial lag model is expressed in the following equation:

$$y_{it} = \rho \sum_{j=1}^{N} w_{ij} y_{it} + x_{it}\beta + \mu_i + \varepsilon_{it}$$

   where ρ is the autoregressive spatial coefficient (spatial lag parameter), and W is the spatial weighting/weighting matrix with the diagonal elements equal to zero.
b. Spatial Error Model (SEM)
   This model describes the spatial relationship that occurs in the random error, therefore it is arranged (Wε) as the independent variable. The spatial error model is expressed in the following equation:

$y_{it} = x_{it}\beta + \mu_i + \varphi_{it}$

$$\phi_{it} = \lambda\sum_{j=1}^{N} w_{ij}\phi_{it} + \varepsilon_{it}$$

where u is the spatial autocorrelation on the error and is the spatial autocorrelation coefficient.

This study uses a spatial lag model where the author in this study wants to show the influence of the independent variables in space i and j on the dependent variable in space i.

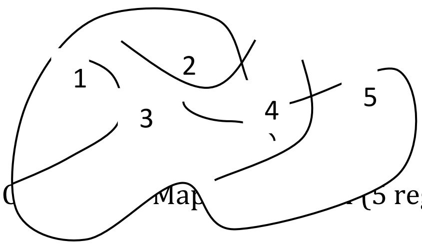
2.2 Spatial Weighting Matrix

Spatial weighting/weighting matrix (W) can be obtained based on distance information from the neighborhood , or in other words from the distance between one region and another. Several methods for defining the contiguity relationship between regions according to LeSage (1999) are as follows:

a) *Linear Contiguity.* Edge intersection defines *wij=1* for regions that are on the left and right edges of the region of concern, *wij=0* for other regions.
b) Rook Contiguity. The side intersection defines *wij=1* for the common side with the region of concern, *wij=0* for the other region.
c) Bishop Contiguity (Angle intersection). Angle intersection defines *wij=1* for the region whose vertex (common vertex) meets the corner of the region of concern, *wij=0* for other regions.
d) *Double Linear Contiguity.* The intersection of the two edges defines *wij=1* for the two entities that are on the left and right edges of the region of concern, *wij=0* for the other regions.
e) *Double Rook Contiguity*. The two-sided intersection defines *wij=1* for the two entities on the left, right, north and south of the region of concern, *wij=0* for the other regions.

f) *Queen Contiguity.* The side-angle intersection defines *wij=1* for the entity whose side (common side) or vertex (common vertex) meets the region of concern, *wij=0* for other regions.

The method used in this research is Rook Contiguity. For example, consider Figure 1.2 which is an illustration of 5 regions that appear on the map.



Map (5 region)

(Spatial Weighting Matrix) W =

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} 0 & 0{,}3 & 0{,}3 & 0 & 0 \\ 0{,}5 & 0 & 0{,}3 & 0{,}3 & 0 \\ 0{,}5 & 0{,}3 & 0 & 0{,}3 & 0{,}5 \\ 0 & 0{,}3 & 0{,}3 & 0 & 0{,}5 \\ 0 & 0 & 0 & 0{,}3 & 0 \end{pmatrix}$$

2.3 Population Density

2.4 Economic Development

Economic development in this study was measured by the per capita income of Banten Province from 2016 to 2021 before and during the COVID-19 pandemic. Per capita income is obtained from the total income of an area (GDP at constant prices) divided by the total population of the area for the same year, (Tarigan, 2009:21). Tambunan (2003) describes that GRDP per capita can be used as an indicator in analyzing a region's standard of living, in addition to per capita household consumption, human development index, sectoral contribution to GRDP, poverty level and fiscal structure. Hypothetically it can be said that the better the development in an area, the higher the GRDP per capita of the area.

2.5 Factors Affecting Regional Economic Development

Shumpeter, in Putong (2010) explains that economic growth is an increase in output (national income) caused by a natural increase in the rate of population growth and the rate of savings. Meanwhile, according to some development economists, economic growth is a term for developed countries to refer to the success of their development, while for developing countries the term economic development is used. Murni (2009) explains that the factors that support economic growth include: natural resources (R), human resources (L), capital resources (K), technology and innovation (T), expertise in the form of management and entrepreneurship (S), as well as information (Inf). All of these factors greatly affect the growth of a country's GNP. The relationship between national product and economic growth factors can be expressed in the form of a function Q = f (R, L, K, T, S, Inf).

Mankiw (2005) states that if it is assumed that there is labor growth (due to population growth), in the short term, output growth will slow down due to diminishing returns and the economy will converge towards a constant steady-state growth rate (no economic growth per capita). So, the Solow model predicts that population growth will affect a country's standard of living which is reflected in GDP per capita. Countries with high population growth will have a low level of GDP per capita, and vice versa.

1) Based on the related theory, it can be formulated in the form of a statement that connects several variables as follows:
2) It is assumed that the per capita income of district / city j has a positive effect on the per capita income of district / city i.
3) It is suspected that population density has a negative effect on per capita income.

2. RESEARCH METHOD

The type of data used in this study is secondary data taken from official documents issued by the Central Statistics Agency of Banten Province, which is taken from the Banten in Figures book. The secondary data used is panel data, which is a combination of cross section data of 8 districts/cities in Banten and time series data from 2016-2021. Secondary data obtained from statistical data were analyzed using panel data analysis techniques. Data processing in this study was carried out with Eviews6 software so that the data processing process was faster and more accurate.

This research model uses the dependent variable of GRDP per capita and the independent variable of population density by inserting a spatial weighting matrix of GRDP per capita into the model to consider the spatial relationship between existing regencies/cities. The hypothesis that will be investigated in this study is that there is a spatial dependence on GRDP per capita between districts/cities in Banten. If this is proven and spatial dependence is not included in the regression, then spatial dependence will only be recorded in the error term. In other words, the equation cannot explain in detail what phenomena actually occur, so the regression model becomes unreliable. In general, spatial dependence can be interpreted as a functional relationship between what happens at one point in space and what happens in another place. Researchers in this case build 2 Spatial Panel Models as follows:

The First Model (The Period Before the Covid-19 Pandemic)

$$ln\ PDRB_{it} = \delta W\ ln\ PDRB_{it} + \beta_1\ ln\ KEPDTN_{it} + \mu_i + \varepsilon_{it}$$

The Second Model (The Period Before and During the Covid-19 Pandemic)

$ln\ PDRB_{it} = \delta W\ ln\ PDRB_{it} + \beta_1\ ln\ KEPDTN_{it} + \mu_i + \varepsilon_{it}$

where,

$PDRB_{it}$: GRDP per capita of the ith district/city period t

δ : *spatial autoregressive* Coefficient

W : Spatial weighting matrix

$KEPDTN_{it}$: Population density of the district/city period t

3.1 Data Analysis Panel

Ariefanto (2012: 150) explains that there are two types of panel data modeling, namely the Fixed Effect Model and the Random Effect Model. This modeling is based on the assumption whether the residual character is constant or random.

3.1.1 Fixed Effect Model

$$y_{it} = \alpha_0 + \sum_{j=1}^{k} \alpha_j X_{j,it} + u_{it}$$

(3.1)

where

$$u_{it} = e + \sum_{i=1}^{N} D_i^c v_i + \sum_{t=1}^{T-1} D_t^\tau w_t$$

(3.2)

Where D_i^C dan D_t^T is a dummy variable as much as N-1 and T-1 to identify the specific residual cross section and time series which is constant. By plugging (2.2) into (2.1) we get:

$$y_{it} = \alpha_0 + \sum \alpha_j X_{j,it} + \sum_{i=1}^{N-1} D_i^c v_i + \sum_{t=1}^{T-1} D_t^\tau w_t + e$$

(3.3)

3.1.2 Random Effect Model

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + a_i + u_{it}$$

(3.4)

The random effects model in Ariefanto (2012:151-152) is used when the unobserved effect αi can be assumed to be uncorrelated with one or more independent variables. Model (3.1) can be modeled using the composite error term,

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + v_{it}$$

(3.5)

Because α_i always exists in the composite error term in every time period, so v_{it} experiencing serial correlation. It can be shown that:

$$Corr(v_{it}, v_{is}) = \frac{\sigma_\alpha^2}{\sigma_\alpha^2 + \sigma_u^2}; t \neq s$$

(3.6)

Then correct the presence of serial correlation with the GLS procedure. However, for this procedure to be effective, the data must have N greater than T. With GLS, each regressor and dependent variable is transformed through a coefficient. λ, where

$$\lambda = 1 - \left(\frac{\sigma_u^2}{\sigma_\alpha^2 + T\sigma_a^2}\right)^{1/2}$$

(3.7)

This estimator is then used to transform equation 3.1 into

$$y_{it} - \hat{\lambda} y_i = \beta_0(1 - \hat{\lambda}) + \beta_1(x_{it1} - \hat{\lambda} x_{i1}) + \ldots + \beta_k(x_{itk} - \lambda x_{ik}) + (v_{it} - \lambda \bar{v}_i$$

(3.8)

3.2 **Pemilihan Model Terbaik**

Juanda (2012: 183) explains that the selection of the model between pooled or panel is the Chow Test or Likelihood Test Ratio, namely by looking at the significance of the calculated F. The Chow test looks at the consistency of the estimation with the fixed effect to choose between fixed or pooled effects.

H_0: *Probability value* > α (*pooled* is preferred)

H_1: *Probability value* < α (*fixed effect* is preferred).

The selection of the panel model between fixed effects or random effects in this study is based on the Hausman test. Tested hypothesis shown:

H_0 : *random effect* (individual effect uncorrelated). Reject H_0 if p-value < α.

H_1 : *fixed effecet*. Reject H_1 if p-value > α.

1. The operational definitions of the variables from the design model are as follows:
2. Economic development (between regions) in this case is represented by GRDP per capita on the basis of constant prices for each district/city.
3. Population density is the ratio between the total population and the area in each district/city.

3. RESULT AND DISCUSSION

3.1 The Best Model Selection Test Results

The selection of the best panel model between the fixed effect model and Pooled least square (PLS) was carried out by the Chow test. The results of the Chow test concluded that the fixed effect model was better than PLS because the significance for chi-square < α = 0.05. Consider Table 1.3 below,

1.3 Chow Test

Before Covid-19 Pandemic in the Period of 2016-2018

Effects Test	Statistic	d.f.	Prob.
Cross-section F	1.755.941.905	-7,14	0.0000

Before and During Covid-19 Pandemic in the Period 2016-2021

Effects Test	Statistic	d.f.	Prob.
Cross-section F	150.052.420	-7,38	0.0000
Cross-section Chi-square	161.032.679	7	0.0000

Source: Processed Data.
Description: *significant at α = 0,05

Meanwhile, the selection of the best model between the fixed effect model and the random effect model was carried out by the Hausman test which concluded that the fixed effect was better than the random effect because of the significance for chi-square < α = 0.05. Consider the following Table 1.4,

Table 1.4 Hausman Test

Before Covid-19 Pandemic in the Period of 2016-2018

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	27.131.176	2	0.0000

Before and During COvid-19 Pandemic in the Period of 2016-2021

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	8.166.188	2	0.0169

Source: Processed Data.
Description: *significant at α = 0,05

The next test is the Goodness of Fit test through R square. This test informs whether or not the estimated regression model is good. R square on the spatial fixed effect panel model is 99%, which means that the model is able to explain well the influence of spatial linkages and population density on the economic development of the Banten region. Consider at Table 1.5 below,

1.5 *Goodness of Fit (R^2) Test*

Before Covid-19 Pandemic in the Period of 2016-2018

R-squared	0.999252
Adjusted R-squared	0.998772

Before and During Covid-19 Pandemic in the Period of 2016-2018

R-squared	0.995738
Adjusted R-squared	0.994729

Source: Processed Data

3.2 The Effect of Spatial Dependence and Population Density on the Economic Development of Banten Province Before the Covid-19 Pandemic

The regression results before the covid-19 pandemic explain the characteristics of the inequality of economic development between districts/cities which are reflected in the intercept values of each district/city as follows:

Table 1.6 Intercept Value Before Covid-19 Pandemic in the Period of 2016-2018

	Intercept
_PANDEGLANGDISTRICT—C	0.933256
_LEBAKDISTRICT—C	1.027123
_TANGERANGDISTRICT—C	-0.481646
_SERANGDISTRICT—C	0.747630
_TANGERANGCITY--C	-1.316.605
_CILEGONCITY—C	0.547023
_SERANGCITY—C	-0.162727
TANGSELCITY—C	-1.294.053

source: Data Processed.

It can be seen that there are variations in the intercept of each district/city. The areas dominated by positive intercepts are Pandeglang Regency, Lebak Regency, Serang Regency and Cilegon City. Prior to the pandemic, these areas were not much affected by spatial factors and population density. The highest intercept value before the pandemic occurred was Lebak Regency. Lebak's intercept value of 1.027123 means that if there is no influence from spatial dependence and population density, then the value of Lebak's GRDP per capita is still positive at Rp. 1,027,123.00.

Before the pandemic, Lebak was the region that had the lowest GRDP per capita. Lebak's low per capita GRDP does not depend much on economic transfers from its closest neighbours, namely Serang Regency and Pandeglang Regency. This is because Lebak Regency is surrounded by 2 regions that both have low GRDP per capita which can be seen from Table 1.7 below,

Tabel 1.7 GRDP Per Capita Banten Region Before the Covid-19 Pandemic

	2016	2017	2018
Pandeglang District	14040.36	14824.00	15561.00
Lebak District	13807.43	14505.00	15231.00
Tangerang District	23632.99	24259.00	24917.00
Serang District	31468.59	32910.00	34468.00
Tangerang City	45686.75	47327.00	48636.00
Cilegon City	150418.67	156302.00	163462.00
Serang City	28908.96	30233.00	31694.00
South Tangerang City	30463.43	31673.00	33012.00

Total	31921.59	32947.60	34183.75

Source: BPS Banten.

Meanwhile, the areas with negative intercept values are Tangerang Regency, Tangerang City, Serang City and South Tangerang City. The negative intercept in these areas means that the GRDP per capita of these areas is strongly influenced by spatial factors and population density. The lowest intercept value is Serang City of -6782.020 which means that if there is no influence from spatial dependence and population density, the GRDP per capita value of Serang City is negative at -Rp. 6,782,020.00.

After passing through 3 stages of selecting the best model, then the hypothesis and significance tests were carried out for the selected model. The results of the model estimation are shown in the following Table 1.6,

Table 1.8 Spatial Fixed Effect Estimation Before the Covid-19 Pandemic

Intercept	-1,745770*
W_GRDP	0,069040*
Density	1,789455*

Source: Data Processed.

Description:
*significant at α = 0,05

Spatial *fixed effect* Model is defined as follows,

$GRDP_{it}$ = -1,745770 + 0,069040 W_PDRB + 1,789455 Kepadtn

The estimation results of the spatial fixed effect model show that the spatial relationship and population density significantly have a positive effect on Banten's per capita income before the COVID-19 pandemic occurred. The constant of -1.745770 means that the relationship between region and population density before the pandemic is a very dominant factor affecting Banten's GRDP per capita, it is proven that if both are assumed to be 0 then the constant is negative. The population density coefficient value is greater than the spatial relationship, indicating that before the pandemic occurred, population density had a stronger effect on the formation of Banten's per capita GRDP than spatial relationships. Population density is very large in influencing the increase in GRDP per capita in the Banten region. The population density that occurs in Tangerang Regency is because this region has the highest industry and the GRDP per capita of Tangerang Regency is highly dependent on this industrial sector.

3.3 The Effect of Spatial Dependence and Population Density on the Economic Development of Banten Province *Before and During the Covid-19 Pandemic*

The results of the model regression by including the covid-19 pandemic period explain the characteristics of the inequality of economic development between districts/cities which are reflected in the intercept values of each district/city as follows,

Tabel 1.9Intercept Value Before and During Covid-19 Pandemic in the Period of 2016-2021

Nama Kabupaten	Intercept
_PANDEGLANGDISTRICT—C	-23216.25
_LEBAKDISTRICT—C	-6782.020
_TANGERANGDISTRICT—C	-5283.080
_SERANGDISTRICT—C	5174.465
_TANGERANGCITY--C	70317.88
_CILEGONCITY—C	-22863.95
_SERANGCITY—C	8213.806

Source: Data Processed

It can be seen that there are variations in the intercept of each district/city. The areas dominated by positive intercepts are Tangerang City, Cilegon City, and South Tangerang City. These areas were not much affected by spatial factors and population density during the pandemic. The highest intercept value is Cilegon City of 70317.88, which means that if there is no influence from spatial dependence and population density, then the value of Cilegon's GRDP per capita is Rp. 70,317,880.00.

Cilegon is an area that has the largest GRDP per capita in the Banten region. Cilegon's high per capita income is because this city is an area rich in natural resources, namely steel. Steel production produced from this city is around 6 million tons annually, (Styaningrum, 2022). The positive intercept results indicate that both before and during the COVID-19 pandemic, Cilegon City was an area that was not much affected by spatial factors and population density.

Meanwhile, the areas with negative intercept values are Serang City, Serang Regency, Tangerang Regency and Pandeglang Regency, which means that the GRDP per capita of these areas is strongly influenced by spatial factors and population density. The lowest intercept value is Tangerang Regency of -6782,020 which means that if there is no influence from spatial dependence and population density, then the value of GRDP per capita is negative at -Rp 6,782,020.00. Consider at the following table,

Table 1.10 GRDP Per Capita Banten Region Throughout Covid-19

	2019	2020	2021
Pandeglang District	16119.00	15395.00	15623.00
Lebak District	16008.00	14916.00	15090.00
Tangerang District	26329.00	28902.00	29698.00
Serang District	36107.00	32818.00	33371.00
Tangerang City	50244.00	54362.00	55811.00
Cilegon City	170122.00	169727.00	174464.00
Serang City	33189.00	32685.00	33173.00
South Tangerang City	35852.00	44008.00	45665.00
Total	35913.90	37164.35	38199.27

Source: BPS Banten.

Tangerang Regency has 3 neighbors, Tangerang City, Serang Regency, and South Tangerang City. The three regions are included in the top 5 regions with high GRDP but low GRDP per capita due to the dense population. The negative intercept value means that the GRDP per capita of Tangerang Regency is very dependent on spatial factors and population density.

After passing through 3 stages of selecting the best model, then the hypothesis and significance tests were carried out for the selected model. The results of the model estimation are shown in the following table 1.6,

Tabel 1.11 Spatial Fixed Effect Estimation Before and During the Covid-19 Pandemic

Intercept	35,551*
W_PDRB	0,7749*
Density	-2,1792*

Source: Data Processed.

Description:
*significant at α = 0,05

Spatial *fixed effect* Model is defined as follows,

$GRDP_{it} = 35.551 + 0{,}7749\ W\_PDRB - 2{,}1792\ Kepadtn$

The estimation result of the spatial fixed effect model shows that spatial correlation has a positive effect on Banten's per capita income, while population density has a negative effect. The constant of 35,551 in the model that includes the pandemic period means that the relationship between region and population density is not the dominant factor affecting GRDP, it is proven that if both are assumed to be 0 then Banten's GRDP is still positive.

4. CONCLUSION

Before the Covid-19 pandemic occurred, regional linkages and population density were very dominant factors influencing the formation of Banten's GRDP. The spatial relationship and population density have been proven to have a significant positive effect on Banten's per capita income before the COVID-19 pandemic occurred. Whereas before and during the COVID-19 pandemic, spatial linkages were proven to have a significant positive effect on Banten's per capita income but population density had a negative effect.

The pandemic has made changes to Banten, where regional linkages and population density are not the dominant factors in the formation of Banten's per capita GRDP during a pandemic. When the pandemic period is included in the model, the direction of the influence of population density on Banten's per capita GRDP changes, where before the pandemic the effect was positive (directly proportional) to negative (inversely proportional). This is due to the large number of layoffs that occurred in many sectors, especially industry. Population density in industrially dense areas actually triggers a low GRDP per capita due to the increasing unemployment rate during the pandemic. Banten's per capita income data seems to be quite stable during the pandemic, which means that per capita GRDP during the pandemic is heavily influenced by spatial dependence and other factors outside this research model.

5. IMPLICATIONS AND LIMITATIONS

This research can provide insight for academics about the importance of incorporating spatial dependence into the regional economic panel research model. If spatial dependence is not included in the regression, then spatial dependence will only be recorded in the error term. The equation that is built cannot explain in detail what phenomena actually occur, so the regression model becomes unreliable. The limitation of this study is that the author only includes the independent variable for population density. Future researchers are expected to be able to develop this research by expanding the discussion, namely by raising other factors besides population density in influencing the economic development of the Banten region.

DAFTAR PUSTAKA

Ariefanto, Doddy. 2012. *Ekonometrika Esensi dan aplikasi dengan Menggunakan Eviews*. Jakarta: Erlangga.

BPS. 2019. *Provinsi Banten Dalam Angka 2019*. Banten: BPS.

BPS. 2020. *Provinsi Banten Dalam Angka 2020*. Banten: BPS.

BPS. 2021. *Provinsi Banten Dalam Angka 2021*. Banten: BPS.

Daryanto, Arief. 2012. Yundy Hafizrianda. *Model-Model Kuantitatif untuk Perencanaan Pembangunan Ekonomi Daerah*. Bogor: IPB Press.

Elhorst, J.P. 2003. *Specification and Estimation of Spatial Panel Data Models.* International Regional Science Review 26, 3: 244–268.

Florax, Raymond J.G.M. 2000. *Spatial Econometric An Introduction Dept. of Spasial Economics*. Master-point Free University De Boelelaan 1105 1081 HV Amsterdam The Netherlands, IAAE spatial Analysis Learning Workshop.

Juanda, Bambang dan Junaidi. 2012. *Ekonometrika Deret Waktu Teori dan Aplikasi*. Bogor: IPB Press.

Mankiw, Gregory N. 2003. *Teori Ekonomi Makro Terjemahan*. Jakarta: PT Gramedia Pustaka Utama.

Murni, Asfia. 2009. *Ekonomika Makro.* Bandung: PT Refika Aditama.

Oktavia, Putu. 2005. *Faktor-faktor yang Mempengaruhi Pendapatan Perkapita*. Jurnal Ekonomi, http://www.96147.com// diakses pada tanggal 16 Nopember 2010.

Putong, Iskandar. 2003. *Pengantar Ekonomi Mikro dan Makro*, Edisi 2. Jakarta: Ghalia Indonesia.

Sjafrizal. 2012. *Ekonomi Wilayah dan Perkotaan*. Jakarta: PT Raja Grafindo Persada.

Tambunan, Tulus. 2003. *Perekonomian Indonesia: Beberapa Masalah Penting*. Jakarta: Ghalia Indonesia.

Tarigan, Robinson. 2005. *Ekonomi Regional Teori dan Aplikasi*. Jakarta: Bumi Aksara.

Syaningrum, Puspasari. 2022. *Fakta Cilegon, Daerah Penghasil Baja Terbesar di Asia Tenggara yang Masuk Daftar Kota Terkaya di Indonesia*. Diakses pada tanggal 27 September 2022 pada https://regional.kompas.com/read/2022/02/23/145116578/fakta-cilegon-daerah-penghasil-baja-terbesar-di-asia-tenggara-yang-masuk?page=all.

APPENDIX

REGRESSION RESULTS BEFORE PANDEMIC (Fixed Effect)

Dependent Variable: PDRB?
Method: Pooled Least Squares
Date: 10/21/22 Time: 02:05
Sample: 2016 2018
Included observations: 3
Cross-sections included: 8
Total pool (balanced) observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
W_PDRB?	1.100654	0.107059	10.28087	0.0000
KEPDTN?	-0.036042	0.133350	-0.270279	0.7895

R-squared	0.216885	Mean dependent var	4.510601
Adjusted R-squared	0.181289	S.D. dependent var	0.313058
S.E. of regression	0.283263	Akaike info criterion	0.394773
Sum squared resid	1.765234	Schwarz criterion	0.492944

Log likelihood	-2.737280	Hannan-Quinn criter.	0.420818
Durbin-Watson stat	0.087190		

Dependent Variable: PDRB?
Method: Pooled Least Squares
Date: 10/21/22 Time: 00:17
Sample: 2016 2018
Included observations: 3
Cross-sections included: 8
Total pool (balanced) observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.745770	1.143250	-1.527024	0.1490
W_GRDP?	0.069040	0.048102	1.435298	0.1732
DENSITY?	1.789455	0.322914	5.541584	0.0001
Fixed Effects (Cross)				
_PANDEGLANGDISTRICT—C	0.933256			
_LEBAKDISTRICT—C	1.027123			
_TANGERANGDISTRICT—C	-0.481646			
_SERANGDISTRICT—C	0.747630			
_TANGERANGCITY--C	-1.316605			
_CILEGONCITY—C	0.547023			
_SERANGCITY—C	-0.162727			
_PANDEGLANGDISTRICT—C	-1.294053			

Effects Specification

Cross-section fixed (dummy variables)			
R-squared	0.999252	Mean dependent var	4.510601
Adjusted R-squared	0.998772	S.D. dependent var	0.313058
S.E. of regression	0.010973	Akaike info criterion	-5.892505
Sum squared resid	0.001686	Schwarz criterion	-5.401649
Log likelihood	80.71006	Hannan-Quinn criter.	-5.762281
F-statistic	2078.716	Durbin-Watson stat	1.594959
Prob(F-statistic)	0.000000		

The results of PLS (Pooled Least Squares) and FEM (Fixed Effect Model) were then tested with the likelihood ratio, the results

Redundant Fixed Effects Tests
Pool: POOL9SEBELUM
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	812.904794	(7,14)	0.0000
Cross-section Chi-square	144.238179	7	0.0000

The output of Eviews shows that neither the F test nor the Chi-square are significant (p-value 0.00 less than 5%), so the FEM model is better than PLS.

RANDOM EFFECT

Dependent Variable: PDRB?

Method: Pooled EGLS (Cross-section random effects)
Date: 10/21/22 Time: 02:09
Sample: 2016 2018
Included observations: 3
Cross-sections included: 8
Total pool (balanced) observations: 24
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.784554	0.450591	6.179779	0.0000
W_GRDP	0.034307	0.045060	0.761354	0.4549
DENSITY	0.474525	0.123850	3.831447	0.0010
Fixed Effects (Cross)				
_PANDEGLANGDISTRICT—C	0.005267			
_LEBAKDISTRICT—C	0.021022			
_TANGERANGDISTRICT—C	-0.213377			
_SERANGDISTRICT—C	0.209065			
_TANGERANGCITY--C	-0.236668			
_CILEGONCITY—C	0.636010			
_SERANGCITY—C	-0.069658			
_PANDEGLANGDISTRICT—C	-0.351661			

Effects Specification	S.D.	Rho
Cross-section random	0.209593	0.9973
Idiosyncratic random	0.010973	0.0027

Weighted Statistics

R-squared	0.253082	Mean dependent var	0.136272
Adjusted R-squared	0.181947	S.D. dependent var	0.017981
S.E. of regression	0.016263	Sum squared resid	0.005554
F-statistic	3.557777	Durbin-Watson stat	0.949254
Prob(F-statistic)	0.046705		

Unweighted Statistics

R-squared	0.093371	Mean dependent var	4.510601
Sum squared resid	2.043649	Durbin-Watson stat	0.002580

Correlated Random Effects - Hausman Test
Pool: POOL9SEBELUM
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	27.131176	2	0.0000

Then the Hausman test was carried out to produce a probability value of 0.00 which is lower than the 5% chi-square significance degree, so it can be concluded that the fixed effect model is better than the random effect.

Regression Results Before and Throughout the Pandemic - PLS (Pooled Least Squares)

Dependent Variable: PDRB?
Method: Pooled Least Squares
Date: 09/23/22 Time: 11:19
Sample: 2016 2021
Included observations: 6
Cross-sections included: 8
Total pool (balanced) observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
W_GRDP	1.897918	0.092738	20.46528	0.0000

DENSITY	-1.929180	0.539655	-3.574838	0.0008

R-squared	0.850357	Mean dependent var	46606.71
Adjusted R-squared	0.847104	S.D. dependent var	46359.19
S.E. of regression	18127.34	Akaike info criterion	22.48900
Sum squared resid	1.51E+10	Schwarz criterion	22.56697
Log likelihood	-537.7361	Hannan-Quinn criter.	22.51847
Durbin-Watson stat	0.076031		

The data is then regressed into a fixed effect on the district/city, the results are

Dependent Variable: PDRB?
Method: Pooled Least Squares
Date: 09/23/22 Time: 11:18
Sample: 2016 2021
Included observations: 6
Cross-sections included: 8
Total pool (balanced) observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	35551.11	8293.882	4.286426	0.0001
W_GRDP?	0.774874	0.195122	3.971222	0.0003
DENSITY?	-2.179265	1.106075	-1.970270	0.0561
Fixed Effects (Cross)				
_PANDEGLANGDISTRICT—C	-23216.25			
_LEBAKDISTRICT—C	-25560.84			
_TANGERANGDISTRICT—C	-6782.020			

_SERANGDISTRICT—C	-5283.080
_TANGERANGCITY--C	5174.465
_CILEGONCITY—C	70317.88
_SERANGCITY—C	-22863.95
_PANDEGLANGDISTRICT—C	8213.806

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.995738	Mean dependent var	46606.71
Adjusted R-squared	0.994729	S.D. dependent var	46359.19
S.E. of regression	3365.766	Akaike info criterion	19.26375
Sum squared resid	4.30E+08	Schwarz criterion	19.65358
Log likelihood	-452.3300	Hannan-Quinn criter.	19.41107
F-statistic	986.5170	Durbin-Watson stat	0.773969
Prob(F-statistic)	0.000000		

The results of PLS (Pooled Least Squares) and FEM (fixed effect model) were then tested with the likelihood ratio, the results are

Redundant Fixed Effects Tests
Pool: POOL07
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	150.052420	(7,38)	0.0000

Cross-section Chi-square	161.032679	7	0.0000

The output of the Eviews shows that neither the F test nor the Chi-square are significant (p-value 0.00 less than 5%), so the FEM model is preferred over PLS.

The data is then regressed in a random effect in districts/cities, the result is

Dependent Variable: PDRB?
Method: Pooled EGLS (Cross-section random effects)
Date: 09/23/22 Time: 11:17
Sample: 2016 2021
Included observations: 6
Cross-sections included: 8
Total pool (balanced) observations: 48
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	24163.01	9073.121	2.663142	0.0107
W_GRDP?	1.090345	0.151147	7.213831	0.0000
DENSITY?	-1.462356	0.850574	-1.719259	0.0924
Fixed Effects (Cross)				
_PANDEGLANGDISTRICT—C	-13670.68			
_LEBAKDISTRICT—C	-16723.25			
_TANGERANGDISTRICT—C	41.44824			
_SERANGDISTRICT—C	3335.443			
_TANGERANGCITY--C	-8944.454			
_CILEGONCITY—C	53796.21			
_SERANGCITY—C	-23175.15			
_PANDEGLANGDISTRICT—C	5340.424			

	Effects Specification		S.D.	Rho
Cross-section random			19559.87	0.9712
Idiosyncratic random			3365.766	0.0288

	Weighted Statistics		
R-squared	0.544592	Mean dependent var	3266.042
Adjusted R-squared	0.524351	S.D. dependent var	5203.864
S.E. of regression	3588.964	Sum squared resid	5.80E+08
F-statistic	26.90620	Durbin-Watson stat	0.765360
Prob(F-statistic)	0.000000		

	Unweighted Statistics		
R-squared	0.754458	Mean dependent var	46606.71
Sum squared resid	2.48E+10	Durbin-Watson stat	0.017886

HAUSMAN TEST

Correlated Random Effects - Hausman Test
Pool: POOL07
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	8.166188	2	0.0169

Then the Hausman test was carried out to produce a prob value. 0.0169 which is lower than the 5% chi-square significance degree, so it can be concluded that the fixed effect model is better than the random effect.