

Spatial Econometric Model on Economic Growth in West Nusa Tenggara

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ABSTRACT

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Gross Regional Domestic Product (GRDP) is a reflection of a region's economic growth. West Nusa Tenggara (NTB) is one of the provinces that contributes to good GRDP for Indonesia. The purpose of this research is to modeling GRDP in NTB using spatial econometrics. The data used is the GRDP data of each district / city in NTB Province as a response variable and factors that affect the number of workers, capital value and electrification ratio as predictor variables. The results showed that there is a spatial dependence on the district / city GRDP in NTB Province on the error model so that the model formed is the Spatial Error Model (SEM) with a rho of 71.1% and an AIC value of 173.34.



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A. INTRODUCTION

Economic development is an indication of the development of a region in its efforts to achieve progress and the desired level of welfare (Syahza and Suarman 2013). Economic growth includes an increase in economic activity in producing goods and services from one period to the next. One measure of economic growth is national income. The national income of a country can show any overall economic activity. The concept of national income is the measure most often used as an indicator of economic growth. The concept of income is in the form of growth in the rate of Gross Regional Domestic Product (GDP) (Postiglione, Cartone, and Panzera 2020).

Capital formation is an important and strategic factor in the process of economic development. Capital formation is even the main factor leading to economic development (Rizky, Agustin, and Mukhlis 2016). This is supported by the statement of Robert Solow (1956) because the cause of high production output is capital. Another factor that affects is labor and technology. This is also in accordance with the theory of economic growth from Adam Smith.

Economic theory states that economic growth is faced with the case in terms of production, there is an intensity of activity in economic activities in producing goods and services, so that these factors ultimately lead to the supply of production goods consumed in a certain area. Another result is differences in the level of investment (in this case capital), labor absorption and the technology used in each region will also experience differences. (Sadhukhan et al. 2019).

Based on the problem of economic growth in various regions, it is not uncommon for spatial effects to be contained therein, where often observations in one location depend on observations in other nearby locations (neighboring). According to the law of geography proposed by Tobler (1979) "that everything is related to one another, but something closer will have more relationship than something far". This phenomenon is also known as spatial dependence. Whereas the concept of spatial heterogeneity refers to differences in spatial structures that present information on heteroscedasticity, variations in spatial coefficients, randomness of coefficients and changes in spatial structure. (*spatial regimes*) (Sukmawaty 2018); (Seya, Tsutsumi, and Yamagata 2012).

Spatial dependence in spatial regression consists of two models, namely a spatial lag model called Spatial Autoregressive (SAR) (Li and Kang 2019) and Spatial Error Model (SEM) (Wang et al. 2019). SAR is a model in which the response variable is influenced by the value of the adjacent response variable which is defined accordingly. This model describes the phenomenon or spatial dependence that occurs on the response variable only. The SEM model can be analogous to the serial model error correlation in time series, but in this case it is not related to the time variable, but space. Then, a special case of Spatial Autoregressive (SAR) is the addition of the influence of spatial lag on the response variable and predictor variables known as Spatial Durbin. Model (SDM) (Li and Li 2020) (Feng et al. 2019).

Several studies related to the application of econometric spatial models have been carried out. The estimation method most often used is Ordinary Least Square (OLS) (Kopczewska, Kudła, and Walczyk 2017) (Yildirim and Öcal 2016). However, in relation to cases of economic growth and spatial effects that are often faced, of course there is a tendency for heteroscedasticity to occur. Heteroscedasticity is a condition in which the variants of the error are not identical due to the presence of regional elements that vary widely from one another. Therefore, the use of the Maximum Likelihood (MLE) method in assessing model parameter estimates is expected to be able to solve cases where there are non-identical error variants (Suesse 2018). *Maksimum Likelihood Estimation (MLE) is the best estimator in the appropriate modeling. The suitability of the model is seen from the fulfillment of the assumptions in the regression, namely the model error is identical, independent and normally distributed (Drukker, Prucha, and Raciborski 2013).*

Based on the problems and solutions described, we are interested in modeling NTB economic growth with a spatial econometric approach using the user friendly Graphical User Interface (GUI) GeoDa program package, which is commonly used in handling statistical cases with spatial data elements.

B. LITERATURE REVIEW

Regression analysis is an analysis that aims to show a mathematical relationship between the response variable and the predictor variable. In general, this relationship is stated as follows (Silhavy, Silhavy, and Prokopova 2017):

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_p X_{ip} + \varepsilon_i \tag{1}$$

i is the number of units of observation and p is the number of predictor variables. Then β_0, β_p are the regression parameters and ε_i is the regression error with the assumption $\varepsilon_i \sim IIDN(0, \sigma^2)$. Written in matrix notation, sentence (2):

$$y = X\beta + \varepsilon \tag{2}$$

$$y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}; X = \begin{bmatrix} 1 & x_{11} & \dots & x_{1p} \\ 1 & x_{21} & \dots & x_{2p} \\ \vdots & \vdots & x_{ij} & \vdots \\ 1 & x_{n1} & \dots & x_{np} \end{bmatrix}; \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_p \end{bmatrix}; \varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

The spatial regression model can be expressed in general terms the equation will look like equation (3) and (4) (Suesse 2018):

$$\mathbf{y} = \rho \mathbf{W}_1 \mathbf{y} + \mathbf{X} \boldsymbol{\beta} + \mathbf{u} \quad (3)$$

$$\mathbf{u} = \lambda \mathbf{W}_2 \mathbf{u} + \boldsymbol{\varepsilon} \quad (4)$$

$$\boldsymbol{\varepsilon} \sim N(0, \sigma^2 \mathbf{I})$$

$$\mathbf{u} = [u_1, u_2, \dots, u_n]'; \boldsymbol{\varepsilon} = [\varepsilon_1, \varepsilon_2, \dots, \varepsilon_n]'; \mathbf{y} = [y_1, y_2, \dots, y_n]'$$

$$\mathbf{W}_1 = \mathbf{W}_2 = \mathbf{W}, \text{ so that } \mathbf{W} = \begin{bmatrix} w_{11} & w_{12} & \dots & w_{1n} \\ w_{21} & w_{22} & \dots & w_{2n} \\ \vdots & \vdots & & \vdots \\ w_{n1} & w_{n2} & \dots & w_{nn} \end{bmatrix}$$

$$\mathbf{X} = \begin{bmatrix} 1 & x_{11} & \dots & x_{1p} \\ 1 & x_{21} & \dots & x_{2p} \\ \vdots & \vdots & & \vdots \\ 1 & x_{n1} & \dots & x_{np} \end{bmatrix}; \mathbf{I}_n = \begin{bmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \dots & 1 \end{bmatrix}$$

The selection of a spatial weighting matrix is based on information on the contiguity between regions against other regions or what is commonly referred to as contiguity. The contiguity matrix is as follows (Suryowati, Bektı, and Faradila 2018):

1. Linear contiguity

This method defines that for $w_{ij} = 1$ for the area that is on the left and right edge of the area that is the focus and $w_{ij} = 0$ for other areas.

2. Rook contiguity

This method defines that $w_{ij} = 1$ for areas adjacent to the focus area and $w_{ij} = 0$ for other areas.

3. Bishop contiguity

This method defines that for $w_{ij} = 1$ for the area whose angle is tangent to the corner of the area in focus and $w_{ij} = 0$ for other areas.

4. Double linear contiguity

This method defines that for $w_{ij} = 1$ for the area where two edges intersect with the edge of the area in focus and $w_{ij} = 0$ for other areas.

5. Double rook contiguity

This method defines that for $w_{ij} = 1$ for the area where the two corners are tangent to the angle in focus and $w_{ij} = 0$ for other areas.

6. Queen contiguity

This method defines that for $w_{ij} = 1$ for areas whose corners and sides intersect with the corners and sides of the focal area and $w_{ij} = 0$ for other areas.

C. RESEARCH METHODS

The analysis steps carried out to answer the problems in this study are as follows (Setiawan, Santi Puteri Rahayu 2017) (Seya et al. 2012):

- 1) Descriptive data on economic growth between districts in NTB and the factors that influence it can be presented based on the following stages:
 - a) Determine the response variable and predictor variable from the data that has been obtained.
 - b) Describe each variable in the study as a picture of the economy in NTB and the factors that are thought to influence it.
 - c) Identify the relationship pattern between response variables and predictor variables through a scatter plot.
- 2) Applying the spatial econometric method to find out the economic growth model between districts / cities in NTB through the following stages:

- a) Set a spatial weighting matrix for each region using the Queen contiguity weight.
- b) To test the spatial aspects (spatial dependency and spatial heterogeneity).
- c) Test a suitable spatial model using the Lagrange Multiplier.
- d) Evaluating the model.
- e) Interpret the model that has been obtained.

D. RESULT AND DISCUSSION

The hypothesis used in testing the spatial dependence with the LM test is as follows:

$H_0 : \rho = 0$ (there is no spatial dependency on the model)

$H_1 : \rho \neq 0$ (there is a spatial dependency on the model)

Testing of spatial dependencies using GeoDa software can be seen in Table 1.

Table 1 Spatial Dependency Test

Test	Value	Prob
Lagrange Multiplier (lag)	1.471	0.225
Robust LM (lag)	4.936	0.026
Lagrange Multiplier (error)	0.761	0.092
Robust LM (error)	3.557	0.059
Lagrange Multiplier (SARMA)	5.028	0.080

Based on Table 1, it can be seen that there is a spatial dependence on the model. Referring to the significance of the Robust LM (Error), the model formed is the Spatial Error Model (SEM) model.

Heteroscedasticity testing was performed using the Breusch-Pagan test. The hypothesis used in the Breusch-Pagan test is:

$H_0 : \sigma_1^2 = \sigma_2^2 = \dots = \sigma_n^2 = \sigma^2$ (Homoscedasticity)

$H_1 : \text{there is at least one } \sigma_i^2 \neq \sigma^2 \text{ Where } i = 1, 2, \dots, n$ (Heteroscedasticity)

The test results with the Breusch-Pagan test can be seen in Table 2.

Table 2 Heteroscedasticity Test

Breusch-Pagan LM-statistic	0.272
Chi-squared probability	3.903
Degrees of freedom	3

Based on Table 2, it is known that the Breusch-Pagan value is 0.272, while the chi-square table value with 3 degrees of freedom at 5% alpha is 7,815. Based on the results obtained, it is concluded that reject H_0 , which means there is no heterogeneity in the data.

Tabel 3 SEM Model Parameter Estimation

Variable	Coefficient	Std.Error	Z-value	Probability
Constant	-18435.1	9060.52	-2.03466	0.04189
Modal	4.75705e-008	1.1669e-008	4.07667	0.00005
Tenaga Kerja	0.0217454	0.00476035	4.56803	0.00000
Rasio Elektrifikasi	81.4117	97.7795	0.832605	0.40507
Lambda	-0.615709	0.214278	-2.87341	0.00406
Rho	0.711489			

Signifikansi = 5%

The value of the coefficient ρ in Table 3 is negative, which is -0.615, with a p-value of 0.004. So it can be concluded that there is significant relationship at $\alpha = 5\%$. A negative lambda value indicates a spatial dependency that occurs between regions in NTB. Besides, the coefficient value of the labor, capital, weighted

labor variables is also positive and significant. Only the electrification ratio, weighted capital and weighted electrification ratio are negative and insignificant.

In general, it can be concluded that the level of diversity of economic growth is indicated by the resulting R-squared value of 0.711. This implies that 71.1% of economic growth can be explained by the model formed. Meanwhile, 28.9% cannot be explained by the model, because there are other variables that actually have an effect but are not included in the model.

E. CONCLUSION AND SUGGESTION

This research was conducted to determine the economic growth model in NTB, where the GRDP is the basis for the use of spatial analysis. The results of the Moran's Index test show a spatial dependence effect. Based on the Lagrange Multiplier test, spatial dependence occurs on errors, lags and SARMA. The determination of the analysis tool is based on the AIC value, where the Spatial Error Model (SEM) has an AIC value that is smaller than the AIC value for the Spatial Autoregressive Model (SAR) so that the appropriate model is the SEM model. In SEM modeling, 5 parameters are significant at the 5% level. The SEM model produces AIC 173.34 which is considered better than the OLS regression model with AIC 174.59.

The suggestion that can be conveyed is that it is necessary to apply this method to more complex data, such as panel data. Further research can also be carried out related to the use of Bayesian in spatial models by paying attention to the presence of outliers. The last thing that can be suggested is that the government should make equal distribution of capital by opening job opportunities in each district / city in NTB so that the economic growth of the Province of NTB is increasing and more equitable.

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