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Original Article

Spatial Dependency Model of Poverty in Southeast Sulawesi

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Abstract *- Poverty is a problem that is encountered by all countries. The high poverty rate is strongly influenced by the interrelationship between regions. This study aims to determine the spatial dependency model by using variable predictors of human development index, economic growth, income inequality, and unemployment by using the spatial model and GeoDa soft application. The results found that the best spatial model for analyzing spatial poverty is Spatial Error Models (SEM). The study also found spatial inter-district and city hangings in Southeast Sulawesi. The index of human development, economic growth, and income inequality have a significant influence on poverty in Southeast Sulawesi.*

Keywords *- Spatial Model, Poverty, Human Development Index, Economic Growth and Inequality.*

I. INTRODUCTION

Poverty is still one of the big problems in Southeast Sulawesi. The Central Statistics Agency (BPS, 2020) states that the number of people below the poverty line in March 2020 in Southeast Sulawesi still reached 11.00% or about 301.82 thousand people. Various efforts are made by the government to overcome this problem, including by predicting poor areas to the village level, so it is expected that poverty alleviation efforts will be more targeted. In determining whether a village area is poor or not, the analysis used is usually still global, such as regression analysis. This analysis model will provide reliable information for smaller regions (local areas) if there is or is little diversity between these local areas [1].

In the regression analysis itself, one of the necessary assumptions is that between observations should be free of each other. While the poverty condition of a village is very likely to be influenced by the observation location or geographical condition of the village, including its position towards other villages in the vicinity. This will make the assumption of freedom between observations in regression analysis difficult to meet [2]

Multilevel Regression Analysis is a regression analysis that considers hierarchy in the data. Hierarchies in the data are of a certain level or level, and there are similarities of traits between the groups studied. In a multilevel regression analysis model, individual response changers are measured at the lowest level (level 1), and there are one or more predictor modifiers. The spatial multilevel regression model is the same as the multilevel regression model, but what distinguishes is that the spatial multilevel regression coefficient is spatially weighted

The first law on geography was put forward by Tobler (Tobler's first law of geography) in [3], which states, "everything is related to everything else, but near things are more related than distant things." Everything is interconnected with each other, but something closer will have more effect than something far away. Tobler Law is used as a pillar of spatial data analysis studies. In spatial data, often observations in space depend on observations in other neighboring. Geographically Weighted Regression (GWR) is one of the solutions that can be used to form regression analysis but is localized for each observation site. GWR is part of a spatial analysis by weighting based on the position or distance of one observation location with another observation location. The result of this analysis is an equation model whose parameter values apply only to each observation location and are different from other locations. In GWR, a weighting matrix element is used. The closer a location is, the greater the weight of its influence.

This study aims to find the most appropriate spatial dependency model of poverty by using the variables explaining the Human Development Index, Economic Growth, Unemployment, and Income Inequality. The author's consideration uses these four explanatory variables because poverty is multidimensional to determine the right spatial model in analyzing poverty should be analyzed taking into account the economic and social factors of society.

Several previous studies analyzing poverty recommended different spatial models of poverty. [4] analyze poverty in West Java using research subjects of districts and cities. This study found that there is spatial dependence between districts and cities; there is a tendency to group from districts and cities that have high levels of poverty. The right spatial model recommendation for poverty analysis in West Java is Spatial Autoregressive Models (SAR). Still using the research subjects of districts and cities in East Java, Research [5] found that the SAR model is better compared to OLS models with lower RMSE criteria, as well as R^2 values and y coefficients against? Higher.

The spatial model recommendations of poverty are different from the previous two researchers; the study [6] recommended that the best spatial model of city analysis in Central Java is the Spatial Error Model (SEM), and there is also a spatial dependence between districts and cities in Central Java.

Based on the differences in recommendations of the best spatial models to analyze poverty, the study tried to re-analyze the model of spatial dependency of poverty using the subjects of districts and cities in Southeast Sulawesi Province. Differences with previous research on explanatory variables used to analyze poverty. This study uses a variable explanation of the Human Development Index, Economic Growth, Unemployment, and Income Inequality. This research will also be conducted a test of the significance of the influence of predictor variables on poverty after the determination of the best model of poverty.

II. LITERATURE REVIEW

A. Human Development and Poverty Index

The theory of new growth explained the importance of the role of the government, especially in increasing the development of human capital. The quality of human resources can be seen from the quality of education, health, or other indicators.

A good level of education will affect the economy through increasing population capability, thus increasing productivity and creativity, as well as determining the ability to absorb and manage sources of economic growth. The high quality of education will not matter if the level of public health is relatively low. Low levels of health will have an impact on productivity that is not maximal, so that the quality of health must be maintained by providing adequate health services for the community. A person who has high productivity skills will increase. This can be proven from the increase in income and consumption. The low productivity of the population can be caused by their low access to education, health, and so on [7].

Thus it can be drawn proposition that the higher the education, health, and economic access of the population, the better the quality of human resources and the implications on the increasing quality of human development that can affect the level of productivity of the population. Increasing employee productivity will increase the income of the population, which further increases the level of welfare of the population or lowers the poverty level.

The results of research that support the relationship between human development index and poverty are [8]; [9]; [10]; [4] dan [11].

B. Economic Growth and Poverty

Economic growth is one indicator of successful development. At the same time, the most important goal of development is the reduction of poverty level that can be achieved through economic growth and/or through income redistribution [12]. This is based on the trickle-down effect theory first developed by Arthur Lewis (1954) and expanded by Ranis and Fei (1968) in [13]. This theory is one of the important topics in the literature on economic development in developing countries (LDCs).

Trickle-down effect theory explains that the progress obtained by a group of people will itself trickle down to create jobs and various economic opportunities that in turn will foster various conditions for the creation of equitable distribution of economic growth results. The theory implies that economic growth will be followed by a vertical flow from the rich to the poor that happens by itself. The benefits of economic growth will be felt by the wealthy first, and then in the later stages, the poor begin to benefit when the wealthy begin to spend the proceeds from the economic growth it has received. Thus, the influence of economic growth on poverty reduction is an indirect effect by the vertical flow from the rich to the poor. This also means that poverty will be reduced on a very small scale if the poor receive little benefit from the total benefits resulting from economic growth. This condition can open the possibility of increasing poverty as a result of rising income inequality caused by economic growth that favors the rich population than the poor.

Therefore, it can be concluded that economic growth can have a positive impact on poverty reduction if economic growth occurs in favor of the poor. [14] also stated that economic growth is a necessary condition for poverty reduction, while the sufficient condition is that economic growth must be effective in reducing poverty. That is, growth should spread in every income group, including in the poor (growth with equity). Directly, this means that growth needs to be ensured in sectors where the poor work (agriculture or labor-intensive sectors). As for indirectly, it means that the government needs a fairly effective redistribution of growth benefits.

The results of research that supports the relationship between economic growth and poverty are: [4]; [15]; [16]; [17]; [10]; [12]

C. Unemployment and Poverty

The imbalance between the growth of the labor force and the creation of employment opportunities has an impact on the migration of labor both spatially between villages and sectoral. This is in line with [18] statement, which explained that the displacement of the population is caused by the high wages or income that can be obtained in the destination area.

The bad effect of unemployment on poverty, according to [19], is that people's income is reduced because they do not have jobs, which ultimately reduces the level of prosperity that a person has achieved. People's welfare is declining because being unemployed will certainly increase their chances of being trapped in poverty because they have no income. If unemployment in a country is very bad, it can have a political, social, adverse effect on people's well-being and economic development prospects in the long term.

The results of research supporting the relationship between unemployment and poverty are:[20]; [10]; [21]

D. Income Inequality and Poverty

According to Neo-Classical growth theory, convergence is a condition in which disadvantaged areas that have not yet reached establishment tend to grow faster than developed regions that have reached establishment. Convergence theory states that the level of prosperity experienced by developed regions and developing regions will one-day converge (meet at one point). Economics also mentioned that there will be a catching-up effect, namely when developing regions successfully pursue developed areas [22].

According to [18], the influence between income distribution inequality and poverty is influenced by the increase in population. The increase in population tends to negatively affect the poor, especially the very poor. Most poor families have large numbers of family members, so their economic condition at the poverty line is getting worse as income or welfare inequality worsens. The cause of poverty is the inequality of resource ownership patterns, which will further lead to a lame distribution of income.

The results of research supporting the relationship between income inequality and poverty are: [23]; [4]; [24]

III. METHOD

The data used in this study are secondary in the form of poverty level data, Human Development Index, and Income Distribution from 15 Districts (Buton, North Buton, Central Buton, South Buton, Muna, West Muna, Konawe, South Konawe, North Konawe, Konawe Islands, Kolaka, North Kolaka, East Kolaka, Bombana, and Wakatobi) and 2 Cities (Kendari City and Bau-Bau City) in Southeast Sulawesi. The data comes from the Central Statistics Agency of Southeast Sulawesi. The initial stages of research are: describing research variables from the regional angle with thematic maps. Then do spatial modeling of poverty levels and the factors influencing them (Human Development Index and Income Distribution).

The spatial models proposed in this study did [25] are:

$$y = \rho W y + X\beta + \mu \ldots . (1)$$

$$\mu = \lambda W u + \varepsilon \ldots \ldots (2)$$

$$\varepsilon \sim N(0, \sigma^2 I)$$

Classic Regression

$$Poverty = c + \beta_1 HDI + \beta_2 EGROWTH + \beta_3 UNEMPLOY + \beta_4 GR + \varepsilon \ldots (3)$$

Spatial Model Error (SEM)

If $\rho = 0$ and $\lambda \neq 0$in the equation (1), the spatial error (SEM) model of the equation is:

$$y = X\beta + \mu \ldots . (4)$$

$$\mu = \lambda W u + \varepsilon \ldots \ldots (5)$$

$$\varepsilon \sim N(0, \sigma^2 I)$$

Based on equation (3), the SEM equation of this research is:

$$Poverty = c + \beta_1 HDI + \beta_2 EGROWTH + \beta_3 UNEMPLOY + \beta_4 GR + \lambda W u + \varepsilon \ldots (6)$$

Model Spasial Autoregressive (SAR)

If $\rho = 0$ and $\lambda = 0$ on the equation (1), then the autoregressive spatial model (SAR) is:

$$y = \rho W y + X\beta + \varepsilon \ldots . (7)$$

$$\varepsilon \sim N(0, \sigma^2 I)$$

Based on equation (3), the SAR equation of this research is:

$$Poverty = c + \beta_1 HDI + \beta_2 EGROWTH + \beta_3 UNEMPLOY + \beta_4 GR + \rho W poverty + \varepsilon \ldots . (8)$$

The stages of analysis: identifying relationship patterns by using scatterplot and correlation analysis, spatial dependency test using Moran's I test statistics on each variable is continued by forming Moran's scatterplot to determine the spread between locations, and modeling Ordinary Least Square /OLS, namely: guessing the parameters of independent variables against dependent variables and performing hypotheses of parameter significance, residual assumption checks to determine residual assumptions meet identical, independent, and normal distribution, perform spatial dependency tests using Moran's I and perform heterogeneous spatial tests. The last step is to perform a hypothesis test using a partial test (t-test). Criteria test is if the probability value of variable dependent influence is less than the alpha value of 5%, then the proposed hypothesis is accepted.

IV. RESULT AND DISCUSSION

Descriptive Analysis

Fig. 1 Regency and City Map of Southeast Sulawesi

A. Moran's Test

Fig. 2 Connectivity Graph

Classic Spatial Model (OLS)

$$\text{Poverty} = 61.225 - 0.634\ \text{HDI} + 0.609\ \text{EGROWTH} + 0.231\ \text{UNEMPLOY} - 25.098\ \text{GR} \ldots (9)$$

R-squared: 0.783140; F-statistic: 10.8338; AIC: 69.1143

Spatial Error Models (SEM)

$$\text{Poverty} = 83.516 - 0.622\ \text{HDI} + 0.922\ \text{EGROWTH} + 0.290\ \text{UNEMPLOY} - 35.63\ \text{GR} + 0.813\lambda \ldots (10)$$

R-squared: 0.871542; AIC: 65.1537;
Probability Likelihood Ratio Test: 0.04658

Spatial Autoregressive Models (SAR)

$$\text{Poverty} = 65.543 - 0.174\ \text{W} - 0.611\text{HDI} + 0.131\ \text{EGROWTH} + 0.345\ \text{UNEMPLOY} - 28.033\ \text{GR} \ldots (11)$$

R-squared: 0.839321; AIC: 66.1521;
Probability Likelihood Ratio Test: 0.02591

Which model is best for estimating poverty is used R-squared and AIC criteria. The best models are the models with the highest R-squared and the lowest AIC. Based on equations 9, 10, and 11 are Spatial Error Models (SEM). The results of sem spatial model data processing are seen in the table below.

Table 1. SEM Spatial Model Results

Variable	Coefficient	Std.Error	z-value	Probability
CONSTANT	63.516	6.446	9.853	0.000
HDI	-0.622	0.100	-6.228	0.000
UNEMPLOY	0.290	0.226	1.285	0.199
GR	-35.630	8.099	-4.399	0.000
EGROWTH	0.922	0.395	2.333	0.020
LAMBDA	0.813	0.100	8.159	0.000

Source: Central Statistics Agency processed authors (2021)

Table 1, it is known that there are three significant variable predictors, namely: HDI, GR, and EGROWTH, the model of poverty in Sulawesi Tenggara is:

$$\text{Poverty} = 83.516 - 0.622\ \text{HDI} + 0.922\ \text{EGROWTH} - 35.63\ \text{GR} \ldots . (12)$$

Spatial dependency test results found spatial dependency as evidenced by the probability of lambda value that is less than the alpha value of 5%.

V. CONCLUSION

Based on the results of research and discussion, it can be concluded as follows:

1. The best spatial model for estimating poverty in Southeast Sulawesi is Spatial Error Models (SEM).
1. There are a spatial dependency and spatial heterogeneity of districts and cities in Southeast Sulawesi
2. Human Development Index, Economic growth, and inequality of opinion have a significant influence on poverty in Southeast Sulawesi

APPENDIX A

A. Classic Model

```
>>02/10/21 12:48:39
REGRESSION
----------
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            : SULAWESI TENGGARA
Dependent Variable  : poverty                Number of Observations   : 17
Mean dependent var  : 3.4671                 Number of Variables      : 5
S.D. dependent var  : 2.95639                Degrees of Freedom       : 12
R-squared           : 0.783140               F-statistic              : 10.8338
Adjusted R-squared  : 0.710853               Prob(F-statistic)        : 0.000592745
Sum squared residual: 32.222                 Log likelihood           : -29.5572
Sigma-square        : 2.68517                Akaike info criterion    : 69.1143
S.E. of regression  : 1.63865                Schwarz criterion        : 73.2804
Sigma-square ML     : 1.89541
S.E of regression ML: 1.37674
--------------------------------------------------------------------------------
    Variable     Coefficient       Std.Error     t-Statistic     Probability
--------------------------------------------------------------------------------
    CONSTANT       61.2245         10.9839       5.57403        0.00012
         HDI      -0.63366        0.148517      -4.26658        0.00109
   UNEMPLOY      0.230658         0.42385       0.544198        0.59627
        GINI      -25.0978         13.5805       -1.84808        0.08937
    EGROWTH      0.608876        0.599699       1.0153          0.33000
--------------------------------------------------------------------------------
REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER   80.627102
TEST ON NORMALITY OF ERRORS
TEST             DF         VALUE           PROB
Jarque-Bera       2          0.2813         0.86881

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST             DF         VALUE           PROB
Breusch-Pagan test  4        4.7819         0.31041
Koenker-Bassett test  4      5.5197         0.23801
================== END OF REPORT ====================
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B. Spatial Error Models (SEM)

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>>02/10/21 13:01:39
REGRESSION
----------
SUMMARY OF OUTPUT: SPATIAL ERROR MODEL - MAXIMUM LIKELIHOOD ESTIMATION
Data set            : SULAWESI TENGGARA
Spatial Weight      : SULAWESI TENGGARA
Dependent Variable  : poverty          Number of Observations   :  17
Mean dependent var  : 13.467059        Number of Variables      :   5
S.D. dependent var  : 2.956390         Degrees of Freedom       :  12
Lag coeff. (Lambda) : 0.813249
R-squared           : 0.871542         R-squared (BUSE)         : -
Sq. Correlation     : -                Log-likelihood           : -27.576846
Sigma-square        : 1.12276          Akaike info criterion    :  65.1537
S.E of regression   : 1.0596           Schwarz criterion        :  69.3198
------------------------------------------------------------------------------
    Variable     Coefficient     Std.Error       z-value     Probability
------------------------------------------------------------------------------
CONSTANT        63.5158        6.44618        9.85324     0.00000
HDI             -0.621821      0.0998495      -6.22758    0.00000
UNEMPLOY        0.289933       0.225601       1.28516     0.19874
GINI            -35.6297       8.09908        -4.39923    0.00001
EGROWTH         0.922128       0.395213       2.33324     0.01964
LAMBDA          0.813249       0.0996718      8.15927     0.00000
------------------------------------------------------------------------------
REGRESSION DIAGNOSTICS
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                           DF      VALUE       PROB
Breusch-Pagan test              4       2.9635     0.56395
DIAGNOSTICS FOR SPATIAL DEPENDENCE
SPATIAL ERROR DEPENDENCE FOR WEIGHT MATRIX: SULAWESI TENGGARA
TEST                           DF      VALUE       PROB
Likelihood Ratio Test           1       3.9606     0.04658
========================= END OF REPORT =============================
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C. Spatial Autoregressive Models (SAR)

```
>>02/10/21 13:12:23
REGRESSION
----------
SUMMARY OF OUTPUT: SPATIAL LAG MODEL - MAXIMUM LIKELIHOOD ESTIMATION
Data set            : SULAWESI TENGGARA
Spatial Weight      : SULAWESI TENGGARA
Dependent Variable  : poverty          Number of Observations   :  17
Mean dependent var  : 13.4671          Number of Variables      :   6
S.D. dependent var  : 2.95639          Degrees of Freedom       :  11
Lag coeff.   (Rho)  : -0.174069
R-squared           : 0.839321         Log-likelihood           :  -27.0761
Sq. Correlation     : -                Akaike info criterion    :   66.1521
Sigma-square        : 1.40437          Schwarz criterion        :   71.1514
S.E of regression   : 1.18506
------------------------------------------------------------------------------
    Variable     Coefficient     Std.Error       z-value     Probability
------------------------------------------------------------------------------
W_POVERTY       -0.174069      0.0694433      -2.50663    0.01219
CONSTANT        65.5432        8.08054        8.11124     0.00000
HDI             -0.610958      0.107916       -5.6614     0.00000
UNEMPLOY        0.344593       0.309367       1.11386     0.26534
GINI            -28.0331       9.89558        -2.83289    0.00461
EGROWTH         0.130911       0.463314       0.282554    0.77752
------------------------------------------------------------------------------
REGRESSION DIAGNOSTICS
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                           DF      VALUE       PROB
Breusch-Pagan test              4       4.8976     0.29797
DIAGNOSTICS FOR SPATIAL DEPENDENCE
SPATIAL LAG DEPENDENCE FOR WEIGHT MATRIX: SULAWESI TENGGARA
TEST                           DF      VALUE       PROB
Likelihood Ratio Test           1       4.9622     0.02591
============================== END OF REPORT ================================
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