Modeling of Poverty Determinants in Sumatera Island (Panel Regression Approach)

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Modeling of Poverty Determinants in Sumatera Island (Panel Regression Approach)

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Abstract— This paper examines to determine whether there is an effect of the human development index (HDI), the open unemployment rate, economic growth, and regional GRDP per capita on poverty levels in Sumatera Island. In general, the trend of the poverty rate by the province in Sumatera decreased during 2010-2019 period, however, there are five provinces which on average have a poverty rate above 11 percent (above the national average poverty rate), namely Aceh, Bengkulu, Lampung, South Sumatera, and North Sumatera. This study used a dynamic panel approach with the Random Effect Model (REM). The data source was obtained from Statistics Indonesia (BPS) for the period 2010-2019. The results showed that the HDI variables and economic growth had a negative and significant effect on poverty levels in Sumatera Island. Meanwhile, the variables of the open unemployment rate and regional GDP per capita have a negative and insignificant effect on poverty levels in Sumatera Island. Simultaneously, it is concluded that the independent variables overall affect the poverty level. The coefficient of determination is 65.6370 percent, which means that variations in the level of poverty can be explained by the independent variables by 65.6370 percent and the remaining 34.3630 percent is explained by other factors out of the model.

Keywords— Determinant, Model, Poverty, Sumatera

I. INTRODUCTION

The island of Sumatera (hereinafter referred to as Sumatera) is an area that is the second economic center in Indonesia after Java, contributing 22.40 percent of the Gross Domestic Product during the 2010-2019 period (the consideration of the observation period is based on: (1) the period after the global crisis, (2) the base year 2010 is the most recent base year used for calculating economic growth). Sumatera, which has abundant natural resources and the second largest population in Indonesia, is still struggling with the problem of poverty. In general, the development of the poverty rate by the province in Sumatera has a downward trend during the 2010 - 2019 period, however, five provinces have an average poverty rate of above 11 percent (above the average national poverty rate for the period 2010 - 2019) namely the Provinces of Aceh, Bengkulu, Lampung, South Sumatera, and North Sumatera.

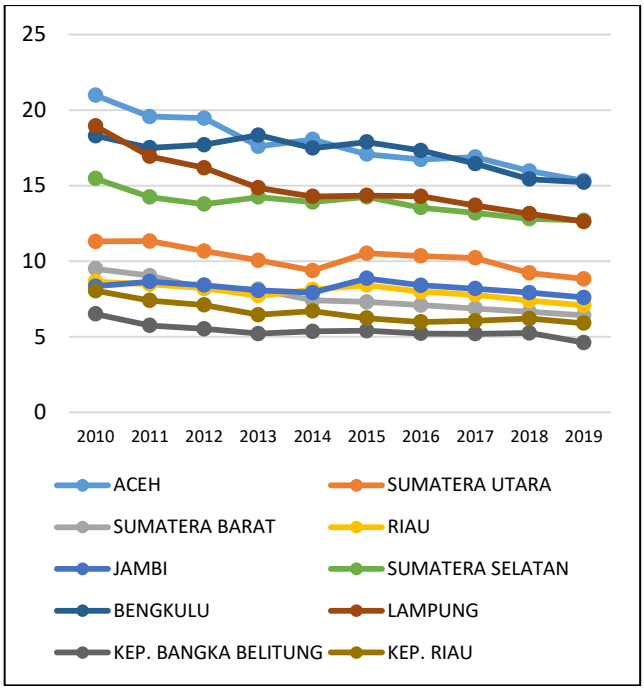
This indicates that it is necessary to accelerate and distribute poverty alleviation programs in various parts of Sumatera by taking into account the factors that determine poverty. This means that poverty reduction can be done by treating the determinants of poverty, so that poverty alleviation programs are made more effective, precise, and targeted.

No region is prosperous and happy if most of the population is in poverty and misery so that steps to increase human development are the key to eradicating poverty [14]. From the findings of reference [11] and [12], using the human development index (HDI) as a proxy for human development shows that a significant increase in human development can reduce the level of poverty in a region. This reflects that improvements in income, education, and health that underlie human development can reduce poverty that occurs in a region. Besides, HDI also reflects the quality of humans, where the level of human quality affects work productivity. The higher the quality of workers, the higher the resulting productivity. With high productivity, the income earned will also increase so that it helps reduce poverty.

There is a strong correlation between high levels of unemployment and poverty. Most people who do not have a permanent job are among the very poor [1]. High unemployment rates lead to low income which caused poverty [15]. The opening of new business fields can absorb the labor from households and implies a reduction in unemployment. Then, households as providers of labor receive wages as compensation for labor, which increases welfare and reduces poverty.

Besides absorbing labor, increasing production capacity will directly increase economic growth. Economic growth and poverty have a very strong and opposite correlation, meaning that the increase in economic growth can reduce the level of poverty. This is because of the high poverty rate and low economic growth in the early stages of

development when the independence of the Republic of Indonesia. However, the poverty rate has been gradually reduced and is much lower as the development process progresses than in the early days of independence.



Source: BPS, compiled.
Note: the dashed blue line represents the average national poverty rate

Figure 1. The development of poverty levels in the provinces in Sumatera, 2010 - 2019 period

Therefore, in this study, the authors investigate the determinants of regional poverty in Sumatera with determinants, namely human quality, unemployment, economic growth, and community income. The benefits of this study include: (1) obtaining a regional poverty determinant model, (2) obtaining information on which determinant variables affect poverty reduction, and (3) based on point (2) it can be used as input for stakeholders in making policy reduction programs poverty.

This paper consists of five parts, namely: I. Introduction contains the background, objectives, and benefits of the research, II. Theoretical Basis contains a brief description of the theory and related research, III. Research methods contain methods and data sources used in the analysis, IV. Data Analysis and Discussion contain analysis and discussion of the estimation results of the modeling used, and V. Conclusions, Limitations, and Recommendations contain conclusions, on the results of the discussion obtained, the limitations of the methods used, and recommendations for the findings of this study.

II. RELATED WORK

Poverty in absolute terms is determined based on the inability to meet the minimum basic needs such as food, clothing, health, housing, and education to live and work. Minimum basic needs mean financial measures in terms of money. The minimum value of basic needs is known as the poverty line. People whose income is below the poverty line are classified as poor. To measure poverty, BPS-Statistics Indonesia uses the concept of the ability to meet basic needs (basic needs approach). With this approach, poverty is an economic inability to meet basic food and non-food needs in terms of expenditure. So, the poor are people whose average monthly per capita expenditure is below the poverty line.

The absolute poverty line is necessary to assess the effects of anti-poverty policies over time or estimate the impact of a project on poverty (small-scale crediting). The poverty rate will be comparable from one country to another only if both countries use the same absolute poverty line.

Poverty is a multidimensional problem that can be caused by various factors, such as social, economic, political, etc. The many factors that can influence a country's poverty make poverty alleviation efforts more comprehensive. The causes of poverty in terms of the economy according to Ref.[9] consists of:

a. From a micro perspective, poverty arises because of differences in resource ownership patterns that cause inequality in income distribution. The resources of the poor are limited and of low quality.
b. Poverty arises due to inequality in the quality of human resources (HR). Low quality of human resources results in low productivity so that the wages received are also low. The low quality of human resources is influenced by education, fate, discrimination, or heredity.
c. Poverty arises because of differences in access to capital.

Reference [7] researched poverty alleviation efforts using a dynamic panel data model in some developing countries. The results are foreign aid, bilateral grants and assistance have a significant effect on reducing poverty, political freedom does not have a significant effect on reducing poverty, the GDP per capita coefficient has a significant and negative effect, while the Gini coefficient has a positive effect, and the third lag variable of extreme poverty has a positive and significant effect.

The resulting GDP per capita is an approach to labor income. Residents with working status will receive wages that are used to meet their needs. This is related to the results of research conducted by Ref.[10] on the determinants of poverty in Korea. As a result, it was found that there are two main macroeconomic variables, namely, economic growth and unemployment, which have a major influence on poverty in Korea. The relation between unemployment has also been examined by Ref.[8]. As a result, there is a causal relationship between poverty and unemployment.

Besides the financial aspect, the level of education, which is one of the components to measure human quality has a significant influence on research conducted by Ref [4] and

[5]. From the results of their research, besides the level of education, other factors also affect are marital status, religion, and employment status. These results are in line with the research conducted by Ref.[6], [11], and [12] regarding the correlation between human development and multidimensional poverty. The result obtained is that the level of human development has a negative correlation with multidimensional poverty.

Reference [16] was conducted using panel regression to know about the impact of agricultural exports on economic growth in some west African countries. From the results, agricultural exports had a significant and positive impact on economic growth when observed based on the common coefficient. But, when seen from the heterogeneous parameter estimates across the country, it shows mixed results.

III. METHODOLOGY

Data Source

The data used in this study is the percentage of poor people in an area as a proxy for the level of poverty as a response variable. Then, the predictor variables are: (1) the human development index as a proxy for the quality of society (HDI), (2) the open unemployment rate as a proxy for unemployment, (3) the growth of gross regional domestic product (GRDP) year on year as a proxy regional economic growth, (4) GRDP at constant prices per capita as a proxy for society income (GRDP per capita). The data sourced from the Statistics Indonesia-BPS and the data period used is 2010 - 2019 with the coverage of provinces in Sumatera.

Panel Regression

The panel regression model can be stated as follows [3]:

$$\boldsymbol{y}_{it} = \alpha\boldsymbol{\tau} + \boldsymbol{X}_{it}^{'}\boldsymbol{\beta} + \boldsymbol{\varepsilon}_{it} \quad (1)$$

where $\boldsymbol{y}_{it}$ is the vector of the response variable with dimension $KT \times 1$, α is scalar, $\boldsymbol{\tau}$ is a column vector with value 1 with dimension $KT \times 1$, $\alpha\boldsymbol{\tau}$ intercept in the form of a vector with dimension $KT \times 1$, $\boldsymbol{\beta}$ is a coefficient vector (slope) dimension $p \times 1$, $\boldsymbol{X}_{it}$ is the observation matrix on the independent variable with dimension $p \times KT$, $\boldsymbol{\varepsilon}$ it is the error vector with $KT \times 1$ dimension, p is the number of independent variables, K is the number of cross-section units, T is the number of points in time, i (i = 1,…, K) is the cross-section index, and t (t = 1,…, T) is the time index.

The panel regression is divided into three model structures as an implication of the assumptions made on the intercept, slope, and error, namely:

1. Common Effect Model (CEM)

$$\boldsymbol{y}_{it} = \alpha\boldsymbol{\tau} + \boldsymbol{X}_{it}^{'}\boldsymbol{\beta} + \boldsymbol{\varepsilon}_{it} \quad (2)$$

This model assumes constant intercept and $\boldsymbol{\beta}$ (slope) coefficient for all cross-section units and time, so it does not pay attention to individual dimensions or time.

2. Fixed Effect Model (FEM)

$$\boldsymbol{y}_{it} = \alpha_i\boldsymbol{\tau} + \boldsymbol{X}_{it}^{'}\boldsymbol{\beta} + \boldsymbol{\delta}_{it} \quad (3)$$

where $\boldsymbol{\delta}_{it}$ it is the error term in the FEM model. In model (2) it is assumed that the slope is constant but the intercept is not constant (varying). That is, the effect of the individual is assumed to be a fixed parameter. In fixed effects for panel data with a one-way error component, differences in individual characteristics are accommodated in the intercept so that the intercept changes between individuals.

3. Random Effect Model (REM)

$$\boldsymbol{y}_{it} = \alpha\boldsymbol{\tau} + \boldsymbol{X}_{it}^{'}\boldsymbol{\beta} + \boldsymbol{\vartheta}_{it} \quad (4)$$

with:

$$\boldsymbol{\vartheta}_{it} = \boldsymbol{v}_i + \boldsymbol{u}_{it}, \qquad E\left(\boldsymbol{\vartheta}_{it}\right) = 0,\ Var\left(\boldsymbol{\vartheta}_{it}\right) = \sigma_v^2 + \sigma_{\boldsymbol{u}}^2$$

In the REM model for panel data, the selection of individuals and time is random, so that the effects of individuals and time are assumed to be random variables. In random effects for panel data with a one-way error component, differences in individual characteristics are accommodated in the error of the model. In equation (4), $\boldsymbol{\vartheta}_{it}$ is the combined error of $\boldsymbol{v}_i$ and $\boldsymbol{u}_{it}$. $\boldsymbol{v}_i$ is the specific error for the i-th observation but it persists over time. Estimating parameters in the REM model, namely the Generalized Least Square (GLS) which is an OLS with a transformation variable.

Model Selection

Chow Test

Chow's test is used to find out whether the FEM model is more than CEM. The following test statistics are used:

Ho: The CEM model is better than the FEM model

H1: The FEM model is better than the CEM model

$$F_{stat} = \frac{\left(RSS_{CEM} - RSS_{FEM}\right)/K - 1}{RSS_{FEM}/(KT - K - P)} \sim F_{(alpha,(K-1),(KT-K-P))}$$

P is the number of parameters in FEM, RSS_{CEM} is the residual sum of squares of CEM, RSS_{FEM} is the residual sum of squares of FEM. If $F_{stat} > alpha$ at the specified $alpha$ level, then Ho is rejected, so it can be concluded that the panel regression model chosen is FEM. This is comparable to if the probability value of F_{stat} is less than the specified $alpha$ level, then Ho is rejected, so it can be concluded that the FEM regression model is a better model than the CEM model.

Pagan Breusch Test

The Breusch Pagan test is used to determine whether the FEM model is more than REM. The following test statistics are used:

Ho: The CEM model is better than the REM model

H1: The REM model is better than the CEM model

$$LM = \frac{KT}{2(T-1)}\left(\frac{\boldsymbol{\varepsilon}_{it}^{'}\left(\boldsymbol{I}_K \otimes \mathbf{1}_T \mathbf{1}_T^{'}\right)\boldsymbol{\varepsilon}_{it}}{\boldsymbol{\varepsilon}_{it}^{'}\boldsymbol{\varepsilon}_{it}} - 1\right)^2 \sim \chi^2_{alpha,1}$$

where $\mathbf{1}_T$ is a vector 1 of dimension $T \times 1$ and $\boldsymbol{I}_K$ is the identity matrix of $K \times K$ dimension. If $alpha$ is at the specified $alpha$ level, then Ho is rejected, so it can be concluded that the panel regression model chosen is REM. This is comparable to if the probability value of LM is less than the specified $alpha$ level, then Ho is rejected, so it can be concluded that the REM regression model is a better model than the CEM model.

Hausman Test

The Hausman test is used to choose between the FEM and REM models. The Hausman test statistics are formulated as follows:

Ho: The REM model is better than the FEM model

H1: The FEM model is better than the REM model

$$W = \left(\boldsymbol{\beta}_{REM} - \boldsymbol{\beta}_{FEM}\right)^{'} \boldsymbol{\Psi}^{-1} \left(\boldsymbol{\beta}_{REM} - \boldsymbol{\beta}_{FEM}\right) \sim \chi^2_{alpha,P}$$

where $\boldsymbol{\Psi} = V\left(\boldsymbol{\beta}_{REM}\right) - V\left(\boldsymbol{\beta}_{FEM}\right)$, $V\left(\boldsymbol{\beta}_{REM}\right)$ is the parameter covariance matrix (without intercept) of REM, $V\left(\boldsymbol{\beta}_{FEM}\right)$ is the parameter covariance matrix (without intercept) of FEM. If the value of $W >$ $alpha$, then Ho is rejected, so it can be concluded that the selected model is FEM or equivalent to a *p-value* of W less than a certain $alpha$ level, then Ho is rejected so it can be concluded that the chosen model is FEM.

IV. RESULTS AND DISCUSSION

Panel regression is a regression combining cross-section and time-series data. In this study, panel regression was applied to the determinant model of regional poverty in Sumatera. Table 4.1 shows the results of panel data processing with a common effects model using the OLS (Ordinary Least Square) estimation method. Based on CEM, information is obtained that the HDI, the level of open unemployment, economic growth, and GDP per capita significantly affect the poverty level at the alpha level of 5 percent, where the direction of the relationship between predictor variables in influencing poverty levels is by the theory. The F stat value of CEM is significant at the 5 percent level, so it can be concluded that CEM is a valid model, but not necessarily the best model. The coefficient of determination achieved by CEM reaches 42.4742 percent, which means that CEM can explain variations in the poverty level of 42.4742 percent, and the remaining 57.5258 percent is explained by other factors outside the model.

In the panel regression with FEM (in Table 4.2), the direction of the relationship between the predictor variables in influencing the poverty level has fit the theory. The significant variables that affect the poverty rate at the alpha level of 5 percent are only HDI and economic growth. Besides that, the individual fixed effects of all provinces in Sumatera are significant. Based on the F-stat of FEM is significant, which means FEM is a valid model. The coefficient of determination generated by FEM is 98.2636 percent, which means that FEM can explain the variation in the poverty level of 98.2636 percent, and the remaining 1.7364 percent is explained by other factors outside the model.

Table 4.1 Estimation Results of the CEM equation (2)

	Coefficient	Standard Error	*p-value*
Intercept	**51.3683**	13.6201	**0.0003**
HDI	**-0.5329**	0.1937	**0.0071**
Open Unemployment Rate	**0.5056**	0.2382	**0.0364**
Economic Growth	**-0.5371**	0.2568	**0.0392**
GRDP per capita	**-9.9646×10^{-5}**	2.3851×10^{-5}	**0.0001**
R^2	42.4742%	AIC	536.3441
F-stat	**17.5358**	*p-value* (F-stat)	**0.0000**
Test Statistics χ^2_2 for normality	3.881	*p-value* (χ^2_2)	0.1436
Sum squared residual	1130.8610		

Source: author processing.

Table 4.2 Estimation Results of the FEM equation (2)

	Coefficient	Standard Error	*p-value*
Intercept	**48.7317**	4.6816	**0.0000**
Individual *fixed effect*:			
Unit cross section: ACEH	**54.9764**	4.7959	**0.0000**
Unit cross section: SUMATERA UTARA	**48.0446**	4.7830	**0.0000**
Unit cross section: SUMATERA BARAT	**45.7842**	4.8412	**0.0000**
Unit cross section: RIAU	**46.2272**	4.6196	**0.0000**
Unit cross section: JAMBI	**45.8449**	4.6134	**0.0000**
Unit cross section: SUMATERA SELATAN	**50.6275**	4.5901	**0.0000**
Unit cross section: BENGKULU	**54.5871**	4.6302	**0.0000**
Unit cross section: LAMPUNG	**51.4064**	4.5696	**0.0000**
Unit cross section: KEP. BANGKA BELITUNG	**42.8873**	4.5827	**0.0000**

	Coefficient	Standard Error	*p-value*
Unit cross section: KEP. RIAU	**46.9285**	4.9343	**0.0000**
HDI	**-0.5326**	0.0620	**0.0000**
Open Unemployment Rate	0.0458	0.0885	0.6062
Economic Growth	**-0.1960**	0.0782	**0.0141**
GRDP per capita	-5.0100×10^{-6}	1.7661×10^{-5}	0.7773
R^2	**98,.636%**	AIC	204.2997
F-stat	374.3767	*p-value* (F-stat)	**0.0000**
Sum squared residual	34.1339		

Source: author processing.

In the REM panel regression (in Table 4.3), the direction of the relationship between the predictor variables in influencing the poverty level has fit the theory with only HDI and economic growth significantly affect the poverty rate at the alpha level of 5 percent. REM produces an F-stat value of 45.3650 with a p-value less than the 5 percent alpha level, so it can be concluded that REM is a valid model. The coefficient of determination generated by REM is 65.6370 percent, which means that REM can explain variations in the poverty level of 65.6370 percent, and the remaining 34.3630 percent is explained by other factors outside the model.

Table 4.3 Estimation Results of REM model equation (4)

	Coefficient	Standard Error	*p-value*
Intercept	**48.7449**	4.8280	**0.0000**
HDI	**-0.5303**	0.0612	**0.0000**
Open Unemployment Rate	0.0454	0.0872	0.6031
Economic Growth	**-0.2001**	0.0772	**0.0096**
GRDP per capita	-9.1264×10^{-6}	1.7113×10^{-5}	0.5938
[Correlation (y,y fitted)]^2	32.8792%	AIC	562.0046
F-stat	**45.3650**	*p-value* (F-stat)	**0.0000**
$\hat{\sigma}_v^2$	20.0167	$\hat{\sigma}_\varepsilon^2$	0.3969
Sum squared residual	1461.6760	R^2	65.6370%

Source: author processing.

Table 4.4 is the test results for determining the panel regression model. Based on the results of the Chow test, information is obtained that FEM is better than CEM, then from the Breusch Pagan test, it is also obtained information that REM is better than CEM at the alpha significance level of 5 percent. Both test results lead to the choice of a model between FEM and REM. The results of the Hausman test indicates that REM is better than FEM, so the modeling of poverty determination in this study is REM, where the estimation results of REM are shown in Table 4.3.

Table 4.4 Results of Panel Regression Model Selection Testing

	Test Statistic Value	*p-value*	Decision
Chow Test	**307.2220**	**0.0000**	**Ho was rejected**
Breusch Pagan Test	**378.8880**	**0.0000**	**Ho was rejected**
Hausman Test	2.3912	0.6642	**Ho was not rejected**

Source: author processing.

REM is the most suitable model as a determinant model of regional poverty in Sumatera. From this model, it is known that human development and economic growth have a negative and significant effect on poverty levels. This means that when the HDI increases by points, ceteris paribus, the poverty rate decreases. Likewise, when economic growth increases in percent, ceteris paribus, the poverty rate decreased by percent.

Although the open unemployment rate and the per capita GRDP are not significant, they have a directional relationship to the poverty level according to theory. The insignificance of the open unemployment rate and per capita GRDP is influenced by many factors. Unemployment with the concept of BPS, namely if the population only works in a week, then it is said to be working. The agricultural sector, which is one of the biggest contributors to GRDP, can absorb a lot of workers on the island of Sumatera. This can reduce productivity in the agricultural sector so that many people who work in the agricultural sector are still categorized as poor.

Because HDI is a predictor variable that significantly affects the level of regional poverty, it also reflects three dimensions of life-based on its constituent components, namely the health dimension, the education dimension, and the household income dimension. This indicates that the improvement and improvement of education, health infrastructure, and services, as well as the acceleration of social-economic activities, can improve human life and ultimately reduce the level of poverty that occurs. Optimizing regional spending for effective infrastructure is one way that regional governments can take immediate action. Attention to infrastructure traps (infrastructure traps, in a nutshell, can be said that infrastructure development that does not bring economic benefits and changes people's lives for the better, but instead adds to the operational burden on the budget) are signs in the realization of physical development.

In terms of economic growth, the expansion and creation of the business sector is massive and evenly distributed but has a social economy orientation in the Sumatera region, so that all levels of society who are actively involved in it can

improve economic welfare which has an impact on reducing regional poverty levels. The creation and strengthening of MSMEs (Micro, Small, and Medium Enterprises) along with the assistance of business stimuli is one solution that can be applied to grow the source of community income to all corners of the region, which results in an acceleration of regional economic growth so that massive poverty reduction occurs. Then, the agricultural sector (in a broad sense) is an economic base sector in which the active role of the community is directly involved in the productive process, can be optimized with the help of agricultural production tools for farmer and fishermen groups, business credit, irrigation revitalization, business partnerships between the food industry and Farmers, control the chain, and guarantee food stability, and control food. If the program is implemented simultaneously with strong law enforcement conditions, then gradually the agricultural sector will advance and increase added value, so that the poor who work in the agricultural sector become prosperous, which results in gathering in that area.

V. CONCLUSION & RECOMMENDATION

Based on the discussion, it concluded that the best model for modeling poverty determination in Sumatera is the random effect model (REM). From this model, economic growth and human development have a negative and significant effect on poverty levels. Therefore, an increase in economic growth and human development will reduce poverty levels.

Recommendations given for the findings of this study include: (1) Improving education, health infrastructure, and services, as well as accelerating social-economic activities by taking into account the infrastructure trap and optimizing regional spending on infrastructure must be carried out effectively and accountably, (2) Economic growth pro-poor can be done by creating and strengthening MSMEs as well as with assistance, which is strengthened by the realization of policies and programs in the agricultural sector.

The limitation of this study is this study does not accommodate the spatial relationship in determinant modeling. For further research, it can be applied and obtained on how much influence the distance that represents the spatial relationship in the mechanism affects poverty.

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