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Analysis of the Simultaneous Problems of Poverty and Gross Domestic Product (GDP) as Macroeconomic Factors in a Developing Country

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Abstract

When analyzing macroeconomic factors using an econometric approach that attempts to determine the successful economic development of countries, such as in the analysis of poverty and gross domestic product (GDP), problems have been repeatedly encountered in considering the variables involved simultaneously. To overcome this problem, it is necessary to use the two-stage least squares (2SLS) method as the best estimator by applying the simultaneous equation model. The objective of this study is to analyse the simultaneous equation model between poverty and GDP in a developing country such as Indonesia. The macroeconomic data sources used for this study are secondary time series data from 1990 to 2017 obtained from Indonesia Statistics Agency, IMF, UNDP and World Bank. The result shows that there is strong evidence that poverty and GDP act simultaneously or endogenously in the model. From the results, it is recommended that in order to achieve higher GDP in the future, the Indonesian government should pay more attention to alleviating poverty rates, reducing unemployment rates, lowering merchandise imports, and improving economic growth in addressing macroeconomic problems in the country.

Keywords: Poverty, GDP, simultaneous equation model, 2SLS, macroeconomics

Introduction

According to Ames et al. (2001) and Cowen et al. (2021), poverty and gross domestic product (GDP) are key parameters for monitoring a country's development success. GDP is usually measured annually as the total value of output produced in a country (Sloman & Garratt, 2010), while poverty is usually measured as the percentage of people living below the average poverty line within a nation (Greenlaw et al., 2017). Many studies have demonstrated that there are significant relationships between GDP growth and poverty in many countries, especially in developing countries (Aye, 2013; Janvry & Sadoulet, 2000).

However, when analysing macroeconomic factors using econometric tools, problems in the simultaneity of variables have been identified repeatedly (D Gujarati, 2004). In other words, there are situations where one economic variable affects another economic variable(s), such as the causal relationships between poverty and GDP; therefore, it is necessary to estimate parameters. Nevertheless, it is not enough to obtain the best prediction by using ordinary least squares (OLS) because it is not only biassed but also inconsistent due to correlation problems between the random error and the endogenous regressors (Greene, 2018; D Gujarati, 2004; Stock & Watson, 2003). Therefore, to overcome this problem, another best estimator is needed, which is the Two Stages Least Square (2SLS) by applying the simultaneous equation model.

This study aims to analyse the simultaneous equation model between poverty and GDP in Indonesia by applying 2SLS method in predicting parameters. In this study, the econometrics software application SPSS 21st version was used.

Materials and Methods

Simultaneous Equation Models (SEM)

SEM – Terms and Concept

Simultaneous equation models (SEM) are systems of equations consisting of two or more related variables within equations, where an exogenous regressor in one equation could become an endogenous regressor in another equation (Wooldridge, 2015). In general, each SEM consists of three variables (regressors), namely endogenous, exogenous (predetermined), and the error term. Endogenous regressors are variables that are determined within the model; however, this regressor may become a predetermined regressor in another equation, while exogenous (predetermined) regressors are defined as all regressors that are not correlated with the error term and are determined outside the model. The error term is the regressor that contains unobserved factors that affect the endogenous regressor. All equations within a model are called the structural equation, while the parameters are called the structural parameters. An example of a modest SEM can be written as follows, given a system of two regressions:

$$y1 = \beta 1y2 + u1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$y2 = \beta 2y1 + u2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

The equation of (1) and (2) are also called as the structural equation form and can be assumed that

$$E\,(u1u2) = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where the structural errors are uncorrelated. It is aimed to estimate the structural coefficient β that measures the causal effect of one endogenous regressor to the other one. However, there is an endogeneity problem of simultaneity issue when it is used these equations (Greene, 2018), when the equation (1) is plugged into the right-hand side of equation (2) that leads to $y2 = \beta 2\,(\beta 1y2+u1) + u2$. which indicates that

$$E(y2u1) = (\beta 2Eu12)/(1- \beta 2\beta 1) \neq 0 \Rightarrow \text{cov}\,(y2,u1) \neq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Therefore, structural model (1) suffers the endogeneity issue (simultaneity bias), where the regressor in equation (1) correlate with the error term. Consequently, if OLS is applied to the equation (1) will result in an inconsistent and biased estimate. Thus, the 2SLS method is proposed as the best estimator for the SEM (Greene, 2018; D Gujarati, 2004; Stock & Watson, 2003; Wooldridge, 2015).

SEM Identification

Reduced-Form Equation

The objective of SEM identification is to determine the fit method in estimating the model, by simplifying its structural equation into a reduced form equation. For instance,

$y1 = \beta 1y2 + c1z1 + u1$ ………………………………………………… (5)

$y2 = \beta 2y1 + c2z2 + u2$ ………………………………………………… (6)

where z1 and z2 are determined in outside the model, so they are exogenous regressors (pre-determined).

Statistically, exogeneity means that

$E(z1u1) = 0; E(z1u2) = 0; E(z2u1) = 0; E(z2u2) = 0$ ………………… (7)

While, a reduced form is simplified equation derived from the related structural equations, which aim to estimate coefficients within the structural equation forms (Wooldridge, 2015); and can be written as follows:

$y1 = \pi 11z1 + \pi 12z2 + e^*_1$ …………………………………………… (8)

$y2 = \pi 21z1 + \pi 22z2 + e^*_2$ ……………………………………………… (9)

where e^* is a reduced-form error, which is a linear function of structural error. It should be noted that reduced-form error is correlated cov $(e^*_1, e^*_2) \neq 0$, whereas the structural error is uncorrelated.

Identification Test – Order Conditions

The identified equation is an equation parameter that can be consistently estimated, especially in models with endogenous regressors (Wooldridge, 2015). The order condition is defined as a necessary condition for identifying parameters in a model with one or more endogenous explanatory regressors. The identifying outcomes can be over-identified, just-identified, or exactly identified and unidentified equations (Wooldridge, 2015). Gujarati (2004 p. 748) explains more about these ordering conditions by proposing the following formulas:

m = number of endogenous variables in a given equation
K = number of predetermined variables in the model including the intercept
k = number of predetermined variables in a given equation

To determine the SEM is used the following criteria:

- If $K - k = m - 1$, is classified as just or exact-identified, than the Indirect Least Squares (ILS) is used to estimate this type of equation

- If $K - k > m - 1$, is classified as over-identified, than the 2SLS can be used to estimate this type of equation
- If $K - k < m - 1$, is classified as un-identified, than neither ILS/OLS nor 2SLS can be used

Two-Stage Least Squares (2SLS) Regression and Interpretation

The 2SLS should be calculated in two stages (Stock & Watson, 2003):

- #1st Stage - Estimating the reduced form equation by OLS, then computing the fitted values for the endogenous variables;
- #2nd Stage - Applying the fitted values instead of the endogenous explanatory variables as predetermined variables, and OLS can provide a consistent estimate of the coefficients.

The Two SLS Results Interpretations – Multiple R, R2, F and t-tests

The multiple R coefficient is called the multiple correlation coefficient and is used to describe the fit between the prediction (estimate) and the actual parameters. The coefficient of determination (R^2) is the key measure of goodness of fit in estimating the regression model. R^2 can describe the amount of variance in the dependent (endogenous) regressor that can be explained by the exogenous regressor (Wooldridge, 2015). The F-test, on the other hand, is used to determine whether there is a strong/weak relationship between the endogenous regressor and the entire set of exogenous regressors (Berenson et al., 2019). The rule of thumb for using a robust/relevant instrument is that the F-test value is greater than 10 (Kõrösi, 2016; Wooldridge, 2015). Next, the t-test is used to test whether there is a significant linear relationship between each exogenous regressor and the endogenous regressor within the model. If the p-value < is 0.05, it means that there is a significant relationship.

Testing for Simultaneity/Endogeneity

Wooldridge (2015, p481) notes, due to the 2SLS estimator is less efficient than OLS when the explanatory variables are exogenous; therefore, it is useful to conduct a test for endogeneity whether the 2SLS is essential. To solve this problem in a more easier way, the Durbin-Wu-Hausman Test (DWH Test) can be determined through comparing a β coefficient and standard errors (SE) of an expected endogenous variable between the OLS and the 2SLS results (Greene, 2018). If $|DWH| > 1.96$ (5% of significance level), then endogenous and instrumental variables (in the OLS) is the preferred estimator despite its inefficiency. The formula is as follows: $DWH = (\beta_{2SLS} - \beta_{OLS}) / \sqrt{(SE^2_{\beta SLS} - SE^2\, \beta_{OLS})}$.

Assumption Tests for 2SLS

The 2SLS should be able in providing the Best Linear Unbiased Estimator (BLUE) (Berenson et al., 2019; Greene, 2018; D Gujarati, 2004; Wooldridge, 2015). The assumptions are as follows:

(i) Linearity: the model is linear both in the regressors through applying a scatterplot analysis (Berenson et al., 2019);

(ii) Normality: the 2SLS estimators are asymptotically normally distributed; by applying the Kolmogorov Smirnov (K-S) test (Hassler, 2016). If the K-S value > 0.05, there is normally distributed;

(iii) Free of Serial Correlation (No Autocorrelation): to detect a correlation between the errors in different periods, by applying the Runs Tests (D Gujarati, 2004; Damodar Gujarati, 2014). If the value of Asymp.Sig 2 tailed > 0.05, there is no serial correlation problems;

(iv) No perfect collinearity (multicollinearity): Determine if there is a high correlation between variables within a model. If there is high correlation between the independent variables, the relationship between them is disturbed; the value of the variance-increasing factor (VIP) and the tolerance factor (Damodar Gujarati, 2014) are used to determine. If the tolerance factor > is 0.1 and the VIF < is 10, it means that there are no multicollinearity problems;

(v) Homoskesdacity (No Heteroskedascity): to test if whether there is a regression model residual variance inequality from one observation to another observation; by applying the Glejser test (D Gujarati, 2004). If the p-value of regressors > 0.05, there is no heteroskedascity problems.

Validation Model

To show whether the equation model can predict the endogeneity regressors as accurately as it actually does, model validation is needed by applying two approaches, namely logical economic theory and the statistical test between predicted and actual values. When the comparison of the mean values between them is almost similar, the constructed equation model has been shown to be valid to predict the real parameters.

Results and Discussion

Empirical Model, Dataset Description, and Interpretation Analysis

Data Sources, Model Specification and Identification Test

The macroeconomic data sources used for this study are secondary time series data from 1990 to 2017 obtained from the Indonesia Statistics Agency, IMF, UNDP, and World Bank. Primary data include GDP, poverty rates, imports, inflation rates, unemployment rates, and economic growth rates. In this study, SEM is used to analyse the relationship between poverty and GDP in Indonesia. This model is a modification of the previous empirical study by (Jonnadi et al., 2012), but different regressors were used. The model specification of the original structural equation form of this study is as follows:

$$Poverty_t = \alpha_0 + \alpha_1 lnGDP_t + \alpha_2 EconGrowth_t + \alpha_3 Unemployment_t + e_t \quad \text{............(3.1)}$$

$$lnGDP_t = \beta_0 + \beta_1 Poverty_t + \beta_2 lnImport_t + \beta_3 Inflation_t + u_t \quad \text{..............................(3.2)}$$

where, $Poverty_t$ = poverty rates (%) in year t
$lnGDP_t$ = GDP value (in log10) in year t
$EconGrowth_t$ = economics growth (%) in year t
$Unemployment_t$ = unemployment rates (%) in year t
$lnImport_t$ = import value (in log10) in year t
$Inflation_t$ = inflation rates (%) in year t
$e_t\ u_t$ = error terms

Next, the equation (3.1) and (3.2) are changed to become a reduced form equation to determining an endogenous and exogenous regressor of the analysed model by substituting the equation (3.2) into the equation (3.1), and vice versa. And the reduced form results are as follows:

$Poverty_t = \pi_0 + \pi_1 lnGDP_t + \pi_2 EconGrowth_t + \pi_3 Unemployment_t + v_t$ .... (3.3)

$lnGDP_t = \pi_4 + \pi_5 Poverty_t + \pi_6 lnImport_t + \pi_7 Inflation_t + w_t$ .... (3.4)

Identification Test - Order Conditions

As mentioned previously in the identification test, the 2SLS analysis can be run only for the over-identified classification, in which K-k > m-1. Therefore, it needs an identification test for the equation (3.1) and (3.2), as follows:

Table 1. Identification Test – Order Conditions

Equation	K value	k value	m value	Classification
(3.1) $Poverty_t$	6 ($Poverty_t$; $lnGDP_t$; $EconGrowth_t$; $Unemployment_t$; $lnImport_t$; $Inflation_t$)	4 ($Poverty_t$; $lnGDP_t$; $EconGrowth_t$; $Unemployment_t$)	2 ($Poverty_t$; $lnGDP_t$)	6-4 > 2-1 = 2 > 1 Over-identified
(3.2) $lnGDP_t$	6 ($Poverty_t$; $lnGDP_t$; $EconGrowth_t$; $Unemployment_t$; $lnImport_t$; $Inflation_t$)	4 ($lnGDP_t$; $Poverty_t$; $lnImport_t$; $Inflation_t$)	2 ($Poverty_t$; $lnGDP_t$)	6-4 > 2-1 = 2 > 1 Over-identified

Source: Own calculation

Since both structural equations included within the model are classified as over-identified; therefore, the 2SLS regression can be applied in estimating the coefficient of each equation.

The Two SLS Regression Results and Interpretation

Estimation Results of Poverty and GDP

After following the two stages in the 2SLS method as mentioned above, the summaries of estimated parameters results from SPSS with the 2SLS regression is described in Table 2.

Table 2. SEM Estimation Regression Results through 2SLS Method

SEM	Regressors	Estimated Coefficient	Sig (p-value)	Multiple R & R^2	F value (Sig.)
Model 1 (Poverty)	Constant	61.092	0.000***	Multiple R : 0.882	28.058***
	lnGDP	-2.240	0.000***		(0.000)
	Unemployment	0.818	0.000***	R^2 : 0.778	
	EconGrowth	-0.520	0.000***		
Model 2 (lnGDP)	Constant	3.119	0.000***	Multiple R : 0.997	1253.585***
	Poverty	-0.031	0.008***		(0.000)
	lnImport	0.942	0.000***	R^2 : 0.994	
	Inflation	-0.004	0.193		

Sources: SPSS processed results

Based on the regression output from the Table 2, the regression equation for both model can be generated as follows:

$\widehat{Poverty}_t = 61.092 - 2.240 lnGDP_t - 0.520 EconGrowth_t + 0.818 Unemployment_t$ …. (3.5)

$lnGDP_t = 3.119 - 0.031 \widehat{Poverty}_t + 0.942 lnImport_t - 0.004 Inflation_t$ ………………. (3.6)

Results Interpretations – Multiple R, R^2, F-test and t-test

The multiple R value or multiple correlation coefficient for both models is quite high, the value of model 1 (equation 3.5) and model 2 (equation 3.6) is 0.882 and 0.997, respectively, which means that the correlation between prediction and actual data in both models reaches 88.2% (equation 3.5) and 99.7% (equation 3.6).

The R^2 (coefficient of determination) of the two models also has higher values. For model 1 (poverty), the R^2 is 0.778, which means that 77.8% of the variance of poverty can be explained by the variance of the exogenous regressors, i.e., lnGDP, unemployment, and economic growth, while the rest (22.2%) is explained by other factors outside the model. For model 2 (lnGDP), the R^2 is 0.994, which means that 99.4% of the variance of lnGDP can be explained by the variance of the exogenous regressors, i.e., poverty, lnImport, and inflation, while the rest (0.06%) is explained by other factors outside the model. From an econometric point of view, both models can successfully measure the goodness of fit of the estimated regression model.

As for the F-value results, according to Berenson et al. (2019), the overall F-test is used to determine whether there is a significant relationship between the endogenous regressor and the entire set of exogenous regressors (the entire multiple regression model). Since in both models for the F-test the p-value is less than 0.05, it can be concluded that there is a strong relationship between the endogenous regressor and the entire set of exogenous regressors that affect poverty and lnGDP. In addition, it was found that in both models the Fstat value is above 10, which means that there is a robust instrument with a high correlation of the endogenous factors in the whole multiple regression model (Kõrösi, 2016; Wooldridge, 2015).

<u>The interpretation of estimated regression results and the t-test of equation (3.5)</u>

- β_0 = *intercept* = *constant* = is the estimated average value of Poverty when the value of all exogenous regressors is zero. The β_0 = 61.092; means the Poverty value is 61.092 if the other exogenous regressors (lnGDP, econgrowth and unemployment) are assumed zero. Since the p-value < 0.05, means constant individually has evidence a significant statistically affects to poverty;
- β_1 = *lnGDP slope* = estimates the change in the average value of Poverty as a result of a one-unit increase/decrease in endogenous regressor. The β_1 was -2.240; means that the mean value of Poverty will decrease by 2.240 on average for each one additional unit of lnGDP, and other exogenous regressors are assumed zero. The p-value < 0.05, means lnGDP regressor individually has a significant effect on poverty;
- β_2 = *EconGrowth slope* = estimates the change in the average value of Poverty as a result of a one-unit increase/decrease in endogenous regressor. The β_2 was -0.520; means that the mean value of Poverty will decrease by 0.520, on average for each one additional unit of the econgrowth, and other exogenous regressors are assumed zero. The p-value < 0.05, means econgrowth regressor individually has a significant effect on poverty;
- β_3 = *Unemployment slope* = estimates the change in the average value of Poverty as a result of a one-unit increase/decrease in endogenous regressor. The β_3 was 0.818; means that the

mean value of Poverty will increase by 0.818, on average for each one additional unit of the unemployment, and other exogenous regressors are assumed zero. The p-value < 0.05, means unemployment regressor individually has a significant effect on poverty.

<u>The interpretation of estimated regression results and the t-test of equation (3.6)</u>

- β_4 *= intercept = constant* = is the estimated average value of lnGDP when the value of all exogenous regressors is zero. The β_4 = 3.119; means the lnGDP value is 3.119 if the other exogenous regressors (poverty, lnimport, inflation) are assumed zero. Since the p-value < 0.05, means constant individually has evidence a significant statistically affects to the lnGDP;
- β_5 *= Poverty slope* = estimates the change in the average value of lnGDP as a result of a one-unit increase/decrease in endogenous regressor. The β_5 was -0.031; means that the mean value of lnGDP will decrease by 0.031 on average for each one additional unit of poverty, and other exogenous regressors are assumed zero. The p-value < 0.05, means poverty regressor individually has a significant effect on lnGDP;
- β_6 *= lnimport slope* = estimates the change in the average value of lnGDP as a result of a one-unit increase/decrease in endogenous regressor. The β_6 was 0.942; means that the mean value of Poverty will increase by 0.942, on average for each one additional unit of the lnimport, and other exogenous regressors are assumed zero. The p-value < 0.05, means lnimport regressor individually has a significant effect on lnGDP;
- β_7 *= inflation slope* = estimates the change in the average value of lnGDP as a result of a one-unit increase/decrease in endogenous regressor. The β_7 was -0.004; means that the mean value of lnGDP will decrease by 0.004, on average for each one additional unit of inflation, and other exogenous regressors are assumed zero. Since the p-value > 0.05, means inflation regressor individually has no significant effect on lnGDP.

Endogeneity, Assumption Tests and Validation Model Analysis

Endogeneity Test (Durbin-Watson-Hausman – DWH Test)

The objective of this test is to determine whether empirically within an equation model system has identified the simultaneous problems amongst its structural equation. It will apply the DWH Test by comparing a β coefficient and standard errors (SE) of expected endogenous regressor between the OLS and the 2SLS results (Qasim Alabed et al., 2021) (Table 3). In this case, will be compared the lnGDP regressor between equation (3.1) using OLS and equation (3.5) using 2SLS with the following formula of DWH as follows:

$DWH = (\beta_{2SLS} - \beta_{OLS}) / \sqrt{(SE^2_{\beta 2SLS} - SE^2_{\beta OLS})}$

Table 3. 2SLS and OLS Regression Results

2SLS Regression Results (from equation 3.5)

Coefficients

		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Beta	t	Sig.
Equation 1	(Constant)	61.092	6.448		9.475	.000
	EconGrowth	-.520	.090	-.547	-5.751	.000
	Unemploy	.818	.170	.543	4.810	.000
	lnGDP	-2.240	.322	-.785	-6.946	.000

OLS Regression Results (from equation 3.1)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	62.199	6.412		9.701	.000
	EconGrowth	-.520	.090	-.547	-5.755	.000
	Unemploy	.834	.170	.553	4.914	.000
	lnGDP	-2.296	.321	-.805	-7.161	.000

a. Dependent Variable: Pov

DWH = ((-2.240)-(2.296)/ $\sqrt{}(0.322^2)$-(0.321^2)) = 2.2084. Since the DWH test value > 1.96 (5% of significance level), then there is occurred endogeneity or simultaneous problems within instrumental variables (in the OLS), so applying the 2SLS method is the preferred estimator despite its inefficiency.

Assumption Tests for 2SLS

From all assumption tests, the 2SLS regression analysis has already fulfilled all criteria as follows:

a) *A fulfilled Linearity assumption*. From the below chart (Figure 1) can be concluded there is a clear linear relationship between poverty and lnGDP as regressors by applying a scatter-plot analysis.

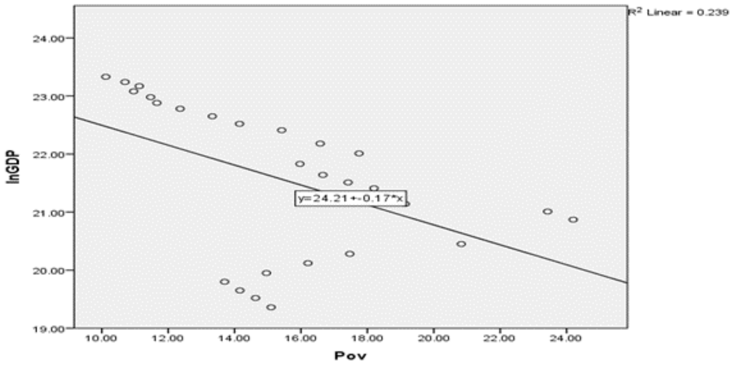

Figure 1. The Scatter Plot Chart between Regressors (Poverty and lnGDP)

b) *Fulfilled Normality distributed assumption*. Through using the Kolmogorov Smirnov (K-S) test (Hassler, 2016), it found that all regressors within the model are distributed normally since the K-S value is over than 0.05, is as shown in the following table 4 :

Table 4. Kolmogorov Smirnov test Results

One-Sample Kolmogorov-Smirnov Test

		lnGovtExpedtr	Pov	lnImport	Infl	Y	Unem
N		28	28	28	28	28	28
Normal Parameters[a,b]	Mean	18.9596	15.5757	20.1164	9.7857	4.9325	6.4596
	Std. Deviation	1.42511	3.63633	1.28745	10.10884	3.82231	2.41240
Most Extreme Differences	Absolute	.120	.075	.121	.314	.348	.124
	Positive	.114	.075	.112	.314	.195	.124
	Negative	-.120	-.067	-.121	-.261	-.348	-.074
Kolmogorov-Smirnov Z		.636	.397	.640	1.661	1.840	.654
Asymp. Sig. (2-tailed)		.814	.997	.807	.008	.002	.786

a. Test distribution is Normal.
b. Calculated from data.

c) *Fulfilled a free of Autocorrelation (Serial Correlation) assumption*. By applying the Runs test for both simultaneous equations, it has found no serial correlation problems since the value of Asymp.Sig (2-tailed) larger than 0.05 in both models after measuring the unstandardized residual of lnGDP and poverty, as shown in the below table 5 :

Table 5. Runs test Results for GDP and Poverty Equation

Runs Test

	Unstandardized Residual lnGDP
Test Value[a]	-.00389
Cases < Test Value	14
Cases >= Test Value	14
Total Cases	28
Number of Runs	13
Z	-.578
Asymp. Sig. (2-tailed)	.563

a. Median

Runs Test

	Unstandardized Residual Poverty
Test Value[a]	-.34978
Cases < Test Value	14
Cases >= Test Value	14
Total Cases	28
Number of Runs	13
Z	-.578
Asymp. Sig. (2-tailed)	.563

a. Median

d) *Fulfilled No perfect Collinearity (Multicollinearity) assumption*; All regressors within the model have the Tolerance value > 0.1 and the value of VIF < 10, as can be summarised as follows (Table 6):

Table 6. Multicollinearity Test Results

Regressors	Tolerance (> 0.1)	VIP (< 10)	Notes
PredPoverty	0.310	3.221	No Multicollinearity
PredlnGDP	0.697	1.435	No Multicollinearity
lnImport	0.696	1.436	No Multicollinearity
Inflation	0.384	2.601	No Multicollinearity
EconGrowth	0.996	1.004	No Multicollinearity
Unemployment	0.694	1.441	No Multicollinearity

e) *Fulfilled Homoskedascity (No Heteroskedascity) assumption*. Through applying a Glejser test (Gujarati, 2004), it found there is no heteroskedascity problems or homoskesdascity met for all regressors since the p-value larger than 0.05 as can be seen in the below table 7.

Table 7. Heteroskedacity Test Results

Regressors	Sig (> 0.05)	Notes
Poverty	0.198	No Heteroskesdascity
lnGDP	0.078	No Heteroskesdascity
lnImport	0.154	No Heteroskesdascity
Inflation	0.221	No Heteroskesdascity
EconGrowth	0.322	No Heteroskesdascity
Unemployment	0.648	No Heteroskesdascity

Validation Model

a. Logic Economic Perspective

The logic economic approach is used to determine whether the equation (3.5) and (3.6) can be explained based on the perspective economic theory and assumptions by comparing the expected economic theory assumption with the SPSS regression results, as follows (Table 8):

Table 8. Expected Economic Logic vs SPSS Regression Results

Equation	Regressors	Signed		Notes
		Expected Economic Logic	SPSS regression results	
(3.5) Poverty	lnGDP	Negative	Negative	True and accepted, in both signed
	EconGrowth	Negative	Negative	True and accepted, in both signed
	Unemployment	Positive	Positive	True and accepted, in both signed
	Poverty	Negative	Negative	True and accepted, in both signed

(3.6) lnGDP	lnImport	Positive	Positive	True and accepted, in both signed
	Inflation	Negative	Negative	True and accepted, in both signed

From the above table can be concluded that in both expected economic assumptions and the SPSS regression results are correct and accepted of the equation models that were constructed previously.

b. Statistics Test

From the statistics test results by applying the SPSS has found that mean predicted value of poverty and lnGDP are quite similar to the mean value of their actual results, i.e., 15.5757 and 21.5386, respectively (Table 9).

Table 9. Predicted Value Results

Statistics

		lnGrossDom Prod	Pov	Pred for PovertyOK, MOD_8 Equation 1	Pred for lnGDP2, MOD_3 Equation 1
N	Valid	28	28	28	28
	Missing	0	0	0	0
Mean		21.5386	15.5757	15.5757143	21.5385714

Thus, it can be resolved that the equation model previously constructed has proven and valid to predict the real parameters.

Conclusion

Based on the results of the regression analysis of the 2SLS model using SPSS in estimating poverty and lnGDP in Indonesia, the following can be stated:

The DWH test, which was greater than 1.96, strongly suggests that poverty and lnGDP act simultaneously or endogenously in the model. In addition, the identification test of the order conditions in both structural equations showed an overidentified classification, which means that the 2SLS regression method can be applied to solve the simultaneous problems within the model.

The results of the 2SLS regression method can show the BLUE (best linear unbiased estimator) because they meet all the assumptions and satisfy the validation model tests economically and statistically. Moreover, the 2SLS regression results show a robust model as they have a strong correlation fit between the prediction and the actual data (a higher multiple R value, more than 88%) and a strong goodness of fit (higher R^2 value, more than 78%). In addition, the F-tests in both models have higher values (greater than 10) and the p-value is less than 0.05, indicating that there are significant relationships between the endogenous regressors and the overall multiple regression model. For the t-test interpretations, it is clear that most of the exogenous regressors within the model have an individual significant effect on the endogenous regressors because the p-value is less than 0.05, except for the inflation regression where the p-value is greater than 0.05.

Recommendation

For the Indonesian government, it can also be recommended from these regression results that in order to achieve higher GDP in the future, it should pay more attention to alleviating poverty, reducing unemployment, lowering imported goods, and improving economic growth in addressing macroeconomic problems in this nation.

Nevertheless, this study has the limitation that it can only analyse the relevant regressors within the model, ceteris paribus, since many other regressors could likely have an impact on poverty and GDP in different countries.

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