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Modeling the Open Unemployment Rate in Indonesia Using Panel Data Regression Analysis

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ABSTRACT

Indonesia has entered the peak of the demographic bonus which can provide positive and negative impacts for various fields. One of them is in the economic field, namely the increasing number of productive population who are unabsorbed in the world of work and is referred to as an open unemployment. This research was conducted to build a model and to analyze the Open Unemployment Rate, Economic Growth, Provincial Minimum Wage, Level of education, Population growth, Labor Force Participation Rate, Employment, Human Development Index, Poor Residents, Illiterate Population, Average Length of School, Domestic Investment, Foreign Investment, and School Participation Rate, that influence the open unemployment rate in Indonesia using panel data regression analysis with data 2015-2021 from 34 provinces. A fixed effect model with different intercept values for every participant is the best panel data regression model (Fixed Effect Model) that could be found. Based on simultaneously research, it was discovered that every component of the model significantly effect the open unemployment rate. Partially, it was discovered that the following factors significantly effect the open unemployment rate in Indonesia: Employment, Labor Force Participation Rate, Economic Growth, Population Growth, Human Development Index, Poor Population, and Average years of Schooling.

Keywords: Regression Analysis, Panel Data, Fixed Effect Model, Open Unemployment Rate, Within Group

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1. Introduction

Indonesia is a country that belongs to the category of developing countries with a large population. Based on the 2020 population census, Indonesia's population continues to increase from 2010. The total population as a result of the census was obtained from residents belonging to two categories, namely the productive age population (15-64 years) and the population of non productive age (0-14 years old and 65 years and older). Most of them belong to the productive age population, which is as much as 70.72% of the total population as a result of the 2020 census. Based on the percentage of the productive age population, it can be said that Indonesia has entered the peak of the demographic bonus (BPS, 2021).

According to the Center for Welfare Research and Development, Ministry of Social Affairs of the Republic of Indonesia, a country has a demographic bonus if its population of working age is greater than its population of non-working age. These circumstances will affect Indonesia in a number of ways, including the social, cultural, educational, health, and economic spheres. Then, in order to fully benefit from the demographic bonus, the government has to raise employment and enhance the caliber of its human resources (Ministry of Social RI, 2022).

Increasing employment absorption is an important factor in taking advantage of the demographic bonus because if the very large population of productive age is not utilized properly or is not absorbed into the world of work it will

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increase unemployment and affect Indonesia's welfare. Based on data BPS from 2015 to 2021 the open unemployment rate in August 2015 continued to decline until August 2019, but in August 2020 the open unemployment rate again jumped and exceeded the government's target. The government's target for 2020 is 4,8 % to 5,1 % but has jumped up to 5,23 % (BPS-Statistics Indonesia, 2015-2021).

Therefore, to achieve the government's target in the following year, it is necessary to conduct research on the factors that significantly influence the Open Unemployment Rate in Indonesia. The factors that are thought to affect the open unemployment rate in each province have different conditions every year, so repeated observation of the same factor or variable is needed, both the Open Unemployment Rate data and data on the factors that influence it. The observational data can be arranged in the form of panel data, namely the combined data between cross-section data and time series data. Furthermore, regression analysis is a statistical tool required to ascertain the relationship pattern or the effect of predictor factors on the open unemployment rate.

A method of statistics for combining data from cross-section and time series sources is panel data regression analysis. It can show the inseparable economic impact of each individual over multiple time periods, which cannot be seen by using data from cross section or time series sources separately (Gujarati and Porter, 2009). Panel data regression analysis has several benefits, includng heterogeneous data, greater degrees of freedom, varied and informative information, increased efficiency, superiority in studyng dynamic changes, increased ability to identify and quantify unobserved effects on pure cross section data and pure time series, and reduced bias (Baltagi, 2005).

Panel data regression analysis to determine the factors that influence the open unemployment rate was carried out by Salsabila (2022), Suparman (2023), and Khayati (2024), but they used less independent variable data. Salsabila uses data from 2016 to 2019 and the independent variables are broadband access, education level, population numbers, and investment. Suparman uses data from 2010 to 2020 and the independent variables are regional inequality, human capital, and economic growth. Khayati uses data from 2018 to 2021 and the independent variables are gross regional domestic product, human development index, exertions force participation rate, and quantity of poor people.

Based on economic problems, population, achievement of the Open Unemployment Rate target for each province, and the data analysis method described earlier, a study was conducted on the analysis of the factors influencing the Open Unemployment Rate in Indonesia using the panel data regression analysis method.

2. Method

Regression analysis using panel data regression combines cross sectional and time series data with more observations than when the variables are used separately (Gujarati and Porter, 2009). Generally speaking, the panel data linear regression model can be expressed as follows (Baltagi, 2005):

$$Y_{it} = \beta_{i0t} + \sum_{j=1}^{k} \beta_{ijt} X_{ijt} + \varepsilon_{it} \qquad (1)$$

Three popular approaches, the Common Effect Model, Fixed Effect Model, and Random Effect Model approaches, can be utilized to estimate the panel data regression model:

2.1 Common Effect Model

Common Effect Model is the simplest technique for estimating the panel data regression model. This approach ignores heterogeneity between individual units and between time periods. It is considered that data behavior across individual units remains constant throughout different time intervals. Estimating the combined effect model is carried out using the Ordinary Least Squares (OLS) method by minimizing the sum of the squares of the residuals. Common Effect Model can be expressed in the following equation (Gujarati and Porter, 2009):

$$Y_{it} = \beta_0 + \sum_{j=1}^{k} \beta_j X_{ijt} + \varepsilon_{it} \qquad (2)$$

Fixed Effect Model

Approach models that can be used for Fixed Effect Models are the Within Group (WG) Fixed Effect Model and the Least Square Dummy Variable (LSDV) Fixed Effect Model using a dummy variable. According to Gujarati and Porter (2009), panel data regression yields distinct intercepts and regression coefficients for every individual and every time interval. Therefore, the Within Group (WG) Fixed Effect Model approach can assume a model with different intercepts for each individual or for each time period only.

Individual fixed effect models are models with different intercepts between individuals, but the coefficients for each subject do not change over time. The individual fixed effect model is stated as follows (Gujarati and Porter, 2009):

$$Y_{it} = \beta_{0i} + \sum_{j=1}^{k} \beta_j X_{ijt} + \varepsilon_{it} \qquad (3)$$

The time-fixed effect model is a model with different intercepts between times, but the coefficients for each subject do not change. The time fixed effect model is stated as follows (Gujarati and Porter, 2009):

$$Y_{it} = \beta_{0t} + \sum_{j=1}^{k} \beta_j X_{ijt} + \varepsilon_{it} \qquad (4)$$

2.2 Random Effect Mode

According to the Random Effect Model, every unit has an individual intercept. Here is how the random effect model can be expressed (Gujarati and Porter, 2009):

$$Y_{it} = \beta_0 + \sum_{j=1}^{k} \beta_j X_{ijt} + w_{it} \quad (5)$$

The Random Effect Model can be estimated by the Generalized Least Square (GLS) method to overcome the occurrence of heteroscedastic cross-sectional among individuals by adding weights to the parameters that contain heteroscedastic cross-sectional.

The Chow test, Hausman test, and Lagrange multiplier test are the three test kinds that are used to determine which panel data regression model is best.

- ***Chow Test***

The optimal panel data regression model between the fixed effect and common effect models was identified using the Chow test. The following is the hypothesis that has to be determined before the Chow test process can begin (Baltagi, 2005):

$H_0: \beta_{01} = \beta_{0i}; \quad i = 2, 3, \dots, k$
(There is no difference in intercept between individuals, the appropriate model is the common effect model)
H_1: there is at least one $\beta_{01} \neq \beta_{0i}; \quad i = 2, 3, \dots, k$
(If there are individual effects or at least one intercept differs between individuals, the fixed effect model is the appropriate model)

The basis for rejecting H_0 is by using the F test statistic, namely the Sum of Squares of Errors (JKG) test of each method with the following formula (Baltagi, 2005):

$$Chow = \frac{\frac{JKG_{mg} - JKG_{mpt}}{N-1}}{\frac{JKG_{mpt}}{NT - N - K}} \quad (6)$$

for,
$JKG = \mathbf{Y}'\mathbf{Y} - \widehat{\boldsymbol{\beta}}'\boldsymbol{X}'\boldsymbol{Y}$
JKG_{mg} : The sum of squared errors of the common effect model
JKG_{mpt}: The sum of squared errors of the fixed effect model

The Chow test statistic follows the distribution of the F test statistic is $F_{tabel} = F_{\alpha(N-1, NT-N-K)}$, if the value of $Chow > F_{tabel}$, then H_0 is rejected, hence the fixed effect model is the appropriate model, and vice versa.

- ***Hausman Test***

The optimal panel data regression model between the fixed effect and random effect models is found using the Hausman test. The following is the technique for determining the hypothesis in the first Hausman test (Baltagi, 2005):

$H_0: E(\varepsilon_{it}|X_{it}) = 0$ (The combined residuals and the independent variables do not correlate. The appropriate model is the random effects model)
$H_1: E(\varepsilon_{it}|X_{it}) \neq 0$ (There is a correlation between the combined residuals and the independent variables. The appropriate model is the fixed effect model)

The next step is to determine the test statistics, namely comparing the Hausman value with the Chi-Square. Hausman statistics is formulated by (Baltagi, 2005):

$$H = \left(\widehat{\boldsymbol{\beta}}_{mpt} - \widehat{\boldsymbol{\beta}}_{mpa}\right)' \left[var\left(\widehat{\boldsymbol{\beta}}_{mpt} - \widehat{\boldsymbol{\beta}}_{mpa}\right)\right]^{-1} \left(\widehat{\boldsymbol{\beta}}_{mpt} - \widehat{\boldsymbol{\beta}}_{mpa}\right) \quad (7)$$

$\boldsymbol{var-cov}(\widehat{\boldsymbol{\beta}}) = s^2(\boldsymbol{X}'\boldsymbol{X})^{-1}$
$\boldsymbol{var}(\widehat{\boldsymbol{\beta}}) = s^2\boldsymbol{C}$
$s^2 = \frac{JKG}{NT-N-k}$

for,
$\widehat{\boldsymbol{\beta}}_{mpa}$: Parameter $\boldsymbol{\beta}$ random effect model
$\widehat{\boldsymbol{\beta}}_{mpt}$: Parameter $\boldsymbol{\beta}$ fixed effect model
$\boldsymbol{C}$: Elements of the diagonal of the matrix$(\boldsymbol{X}'\boldsymbol{X})^{-1}$

The Hausman test statistic follows the Chi-Square as $\chi^2_{table} = \chi^2_{(\alpha;db)}$, with $db = k - 1$ where db is degrees of freedom. If $H > \chi^2_{table}$ then H_0 is rejected, so that the fixed effect model is the best suitable model and vice versa.

- **Lagrange Multiplier Test**

The optimum panel data regression model between the random effect model and the common effect model is identified using the Lagrange multiplier test. The multiplier lagrange test hypothesis is as follows (Baltagi, 2005):

$H_0: \sigma^2_\mu = 0$ (The intercept is not a random variable. The common effects model is the right model)
$H_1: \sigma^2_\mu \neq 0$ (The intercept is a random variable. The random effect model is the right model)

Furthermore, the statistics for the Lagrange Multiplier test use the following equation (Baltagi, 2005):

$$LM = \frac{NT}{2(T-1)} \left[\frac{\sum_{i=1}^{n} [\sum_{t=1}^{T} \varepsilon_{it}]^2}{\sum_{i=1}^{n} \sum_{t=1}^{T} \varepsilon_{it}^2} - 1\right]^2 \quad (8)$$

Where T is the number of periods, N is the number of individuals, and ε_{it} is the $i-th$ residual for the common effect models $t-th$ time period. With $db = 1$, the LM test statistic is $\chi^2_{table} = \chi^2_{(\alpha;1)}$, which is in line with the Chi-Square distribution. If the value LM > χ^2_{table} then H_0 is rejected, this indicates that the random effect model is the best relevant model..

To determine which model from the panel data regression analysis was the best, the panel data regression model's viability was tested. Two tests, known as simultaneous and partial testing, were used to determine whether the panel data regression model could be implemented.

- ***Simultan Test***

Simultan test is used to test parameters together. The simultan parameter significance test hypothesis is as follows (Draper and Smith, 1998):

H_0: $\beta_j = 0$; $j = 1,2,\dots,k$, (The dependent variable is not significantly affected, indicating that the model is incorrect)

H_1: there is at least one $\beta_j \neq 0$; $j = 1,2,\dots,k$ (At least there is one variable that influences the dependent variable, the correct model)

The test statistics are stated as follows (Draper and Smith, 1998):

$$F_{count} = \frac{\frac{R^2}{k}}{\frac{1-R^2}{NT-N-k}} \tag{9}$$

for,
R^2 : The coefficient of determination
N : The number of cross section data
T : The number of time series data
k : The number of independent variables

Simultan test statistic (F) is $F_{table} = F_{\alpha;k;(NT-N-k)}$. If the value $F_{count} > F_{table}$, then H_0 is rejected so that the model is right and voce versa.

- ***Partial Test***

The partial test analyzes each parameter's significance or the effect of each independent variable's significance on the dependent variable. This is the hypothesis that was employed (Draper and Smith, 1998):

H_0 : $\beta_j = 0$ (Parameters are not significant)
H_1 : $\beta_j \neq 0,\ j = 1,2,\dots,k$(Significant parameters)

The test statistics used are as follows (Draper and Smith, 1998):

$$t_{count} = \frac{\hat{\beta}_j}{SE(\hat{\beta}_j)} \tag{10}$$

$$SE(\hat{\beta}_j) = \sqrt{var(\hat{\beta}_j)} \tag{11}$$

$$var(\hat{\boldsymbol{\beta}}_{\boldsymbol{j}}) = s^2\boldsymbol{C} \tag{12}$$

$$s^2 = \frac{JKG}{NT-N-k} \tag{13}$$

Where $\boldsymbol{C}$ is an element of the diagonal matrix $(\boldsymbol{X'X})^{-1}$. The test criterion used is the t statistic, namely $t_{table} = t_{\alpha/2;NT-k-1}$. If the value$|t_{count}| > t_{table}$ then H_0 is rejected so that the parameter is significant and vice versa.

R-studio 4.2.1 software was the instrument utilized in this study to process the data. Table 1 below displays the dependent variable (Y) and independent variable (X) for the secondary data utilized, which spans the period August 2015 to 2021.

Table 1 Research Variables

Variable	Information
Y	Open Unemployment Rate
X_1	Economic Growth
X_2	Provincial Minimum Wage
X_3	Level of education
X_4	Population growth
X_5	Labor Force Participation Rate
X_6	Employment
X_7	Human Development Index
X_8	Poor Residents
X_9	Illiterate Population
X_{10}	Average Length of School
X_{11}	Domestic Investment
X_{12}	Foreign Investment
X_{13}	School Participation Rate

The independent variables are used in this research are combination of variables from several previous studies to determine the variable that has the greatest influence on the open unemployment rate (Astuti (2019), Yulistiani (2020), Mahendra (2021), Salsabila (2022), Suparman (2023), and Khayati (2024)).

This research was conducted with the following stages: (1) Literature study and data collection, (2) Exploring data in general, (3) Test multicollinearity, (4) Estimated model, (5) Selection of the best model, (6) Parameter significance test, (7) Residual test, (8) Interpret the model, and (9) make a conclusion.

3. Results

3.1 Multicollinearity Test

The Variance Inflation Factors (VIF) values can be used to test the multicollinearity assumption and ascertain whether a relationship exists between the independent variables. Table 2 presents a summary of the VIF value computation for every independent variable.

Table 2 Value of Variance Inflation Factors (VIF) of Independent Variables

Information		VIF values
X_1	Economic Growth	1,2415
X_2	Provincial Minimum Wage	3,1717
X_3	Level of education	6,4808
X_4	Population growth	5,8019
X_5	Labor Force Participation Rate	1,6799
X_6	Employment	3,6783

	Information	VIF values
X_7	Human Development Index	5,7612
X_8	Poor Residents	3,1757
X_9	Illiterate Population	3,0532
X_{10}	Average Length of School	7,7858
X_{11}	Domestic Investment	4,6426
X_{12}	Foreign Investment	3,4476
X_{13}	School Participation Rate	6,6343

Table 2's VIF value indicates that all independent variables have VIF values less than 10, indicating that there is either no autocorrelation or no link between any of the independent variables. Thus, the analysis may proceed.

3.2 Model Estimation

Panel data regression analysis was used to form an estimate of the model equation between the dependent variable and the independent variable by taking into account individual characteristics and time characteristics. This allowed for the determination of the relationship between the dependent variable and the independent variable formed in the general equation model, as in Equation (1) below:

$$Y_{it} = \beta_{i0t} + \sum_{j=1}^{13} \beta_{ijt} X_{ijt} + \varepsilon_{it}$$

The parameter estimation results are obtained as in Table 3 below:

Table 3 Parameter Estimation Results of the Panel Data Model

$\boldsymbol{\beta_i}$	**Common Effect Model (MPG)**	**Individual Fixed Effect Model (MPTi)**	**Time Fixed Effect Model (MPTt)**	**Random Effect Model (MPA)**
β_0	$2{,}872\times10^{1}$			$2{,}591\times10^{1}$
β_1	$-1{,}292\times10^{-1}$	$-6{,}182\times10^{-2}$	$-9{,}739\times10^{-2}$	$-1{,}008\times10^{-1}$
β_2	$-4{,}034\times10^{-7}$	$1{,}186\times10^{-7}$	$-2{,}982\times10^{-7}$	$-2{,}202\times10^{-7}$
β_3	$-3{,}060\times10^{-2}$	$-3{,}980\times10^{-2}$	$-3{,}142\times10^{-2}$	$-4{,}241\times10^{-2}$
β_4	$3{,}940\times10^{-5}$	$7{,}757\times10^{-4}$	$4{,}358\times10^{-5}$	$4{,}254\times10^{-5}$
β_5	$-2{,}456\times10^{-1}$	$-1{,}335\times10^{-1}$	$-2{,}404\times10^{-1}$	$-2{,}384\times10^{-1}$
β_6	$3{,}726\times10^{-2}$	$-8{,}455\times10^{-2}$	$4{,}856\times10^{-2}$	$3{,}248\times10^{-2}$
β_7	$-1{,}771\times10^{-1}$	$-6{,}289\times10^{-1}$	$-1{,}692\times10^{-1}$	$-1{,}712\times10^{-1}$
β_8	$-2{,}653\times10^{-3}$	$2{,}684\times10^{-1}$	$6{,}257\times10^{-3}$	$-3{,}767\times10^{-3}$
β_9	$4{,}497\times10^{-2}$	$-8{,}875\times10^{-2}$	$4{,}129\times10^{-2}$	$5{,}763\times10^{-2}$
β_{10}	$1{,}572\times10^{0}$	$2{,}979\times10^{-0}$	$1{,}445\times10^{0}$	$1{,}570\times10^{0}$
β_{11}	$6{,}833\times10^{-6}$	$-2{,}756\times10^{-6}$	$6{,}079\times10^{-6}$	$6{,}283\times10^{-6}$
β_{12}	$1{,}264\times10^{-4}$	$-5{,}319\times10^{-5}$	$7{,}689\times10^{-5}$	$1{,}394\times10^{-4}$
β_{13}	$-6{,}730\times10^{-2}$	$-2{,}527\times10^{-1}$	$-5{,}623\times10^{-2}$	$-4{,}098\times10^{-2}$

Equation (6) can be used to perform the Chow test and evaluate if individual effects or time effects are present.

3.3 Chow Test for the Effect of Time

The following hypothesis is used in the Chow test to assess the effect of time:

$H_0: \beta_{01} = \beta_{0t}; \quad t = 2, 3, \ldots, T$
(There is no difference between intercepts over time, the appropriate model is the common effect model)
H_1: there is at least one $\beta_{01} \neq \beta_{0t}; \quad t = 2, 3, \ldots, T$
(The time fixed effect model is the appropriate model if there is a time effect or if at least one intercept that differs between times)

To ascertain whether time has an impact on the model, the Chow test is analyzed by selecting the appropriate model between the common effect model and the time fixed effect model. This is done using the sum of squares errors of the common effect model (JKG_{mpg}) and the sum of squares errors of the time fixed effect model (JKG_{mptt}):

$$\begin{aligned} JKG_{mpg} &= \boldsymbol{Y'Y} - \boldsymbol{\hat{\beta}'X'Y} \\ &= 7530{,}8816 - 7276{,}5954 \\ &= 254{,}2862 \end{aligned}$$

$$\begin{aligned} JKG_{mptt} &= \boldsymbol{\tilde{Y}^{*\prime}\tilde{Y}^{*}} - \boldsymbol{\hat{\beta}_j^{*\prime}\tilde{X}^{*\prime}\tilde{Y}^{*}} \\ &= 780{,}5907 - 557{,}5013 \\ &= 223{,}0894 \end{aligned}$$

So obtained:

$$\begin{aligned} Chow &= \frac{\frac{JKG_{mpg} - JKG_{mptt}}{T-1}}{\frac{JKG_{mptt}}{NT-T-k}} \\ &= \frac{\frac{254{,}2862 - 223{,}0894}{7-1}}{\frac{223{,}0894}{(34\times7)-7-13}} \\ &= 5{,}0811 \end{aligned}$$

The results of the Chow test comparing the common effect model to the time fixed effect model are 5,0811 and $F_{table} = F_{5\%;(T-1,NT-T-k)} = F_{5\%;(7-1,34\times7-7-13)} = F_{5\%;(6,218)} = 2{,}1403$, so that $Chow > F_{table}$ then H_0 is rejected, proving that, at the 5% level, the time Fixed Effect Model is the appropriate model.

3.4 Chow Test for the Effect of Individual

Determination of the existence of individual effect using the Chow test with the following hypothesis:

$H_0: \beta_{01} = \beta_{0i}; \quad i = 2, 3, \ldots, N$
(There is no difference in intercept between individuals, the appropriate model is the common effect model.)
H_1: there is at least one $\beta_{01} \neq \beta_{0i}; \quad i = 2, 3, \ldots, N$
(The individual fixed effect model is the appropriate model if there is a individual effect or if at least one intercept that differs between individuals)

The Chow test analysis is used to ascertain whether the model has an individual effect. It does this by identifying which model, between the common effect model and the individual fixed effect model, is correct. This model takes into account the sum of squares of errors for both the individual fixed effect model (JKG_{mpti}) and the common effect model (JKG_{mpg}):

$$JKG_{mpg} = \boldsymbol{Y}'\boldsymbol{Y} - \widehat{\boldsymbol{\beta}}'\boldsymbol{X}'\boldsymbol{Y} = 7530{,}8816 - 7276{,}5954 = 254{,}2862$$

$$JKG_{mpti} = \widetilde{\boldsymbol{Y}}'\widetilde{\boldsymbol{Y}} - \widehat{\boldsymbol{\beta}}_j{}'\widetilde{\boldsymbol{X}}'\widetilde{\boldsymbol{Y}} = 163{,}3311 - 73{,}1984 = 90{,}1328$$

So obtained:

$$Chow = \frac{\frac{JKG_{mpg} - JKG_{mpti}}{N-1}}{\frac{JKG_{mpti}}{NT-N-k}} = \frac{\frac{254{,}2862 - 90{,}1328}{34-1}}{\frac{90{,}1328}{(34\times 7)-34-13}} = 10{,}5411$$

Based on the Chow test results for the individual fixed effect model and the common effect model, the results obtained with a Chow value of 10,5411 with $F_{table} = F_{5\%;(N-1,NT-N-k)} = F_{5\%;(34-1,34\times7-34-13)} = F_{5\%;(33,191)} = 1{,}4976$, so $Chow > F_{table}$ then H_0 is rejected, proving that at the 5% level, the individual Fixed Effect Model is the appropriate model.

Furthermore, to compare the Fixed Effect Model to the Random Effect Model using the Hausman Test, utilize Equation (7).

3.5 Hausman Test for the Effect of Time

The following hypothesis is applied in the Hausman test to identify the optimal model between the time fixed effect model and the random effects model:

$H_0: E(\varepsilon_{it}|X_{it}) = 0$ (The combined residuals and the independent variables do not correlate. The appropriate model is the random effects model)

$H_1: E(\varepsilon_{it}|X_{it}) \neq 0$ (There is a correlation between the combined residuals and the independent variables. The appropriate model is the time fixed effect model)

$$H = (\widehat{\boldsymbol{\beta}}_{mptt} - \widehat{\boldsymbol{\beta}}_{mpa})'\left[var(\widehat{\boldsymbol{\beta}}_{mptt} - \widehat{\boldsymbol{\beta}}_{mpa})\right]^{-1}(\widehat{\boldsymbol{\beta}}_{mptt} - \widehat{\boldsymbol{\beta}}_{mpa})$$
$$= \begin{bmatrix}-2{,}591\times10^{1} & \cdots & -1{,}525\times10^{-2}\end{bmatrix}_{(1\times14)} \begin{bmatrix}5{,}892\times10^{-5} & \cdots & 4{,}971\times10^{0}\\ \vdots & \ddots & \vdots\\ 4{,}971\times10^{0} & \cdots & 4{,}975\times10^{3}\end{bmatrix}_{(14\times14)} \begin{bmatrix}-2{,}591\times10^{1}\\ \vdots\\ -1{,}525\times10^{-2}\end{bmatrix}_{(14\times1)}$$
$$H = 2{,}0764$$

The Hausman value obtained is 2,0764 with $\chi^2_{table} = \chi^2_{(\alpha;db)} = \chi^2_{(5\%;12)} = 21{,}026$, so $H < \chi^2_{table}$ the hypothesis H_0 failed to be rejected, suggesting that either the Time Fixed Effect Model is erroneous or the Random Effect Model is the most suitable model.

3.6 Hausman Test for the Effect of Individual

The following hypothesis was used in the Hausman test to identify the appropriate model between the individual fixed effect model and the random effect model:

$H_0: E(\varepsilon_{it}|X_{it}) = 0$ (The combined residuals and the independent variables do not correlate. The appropriate model is the random effects model)

$H_1: E(\varepsilon_{it}|X_{it}) \neq 0$ (There is a correlation between the combined residuals and the independent variables. The individual fixed effect model is the correct model)

$$H = (\widehat{\boldsymbol{\beta}}_{mpti} - \widehat{\boldsymbol{\beta}}_{mpa})'\left[var(\widehat{\boldsymbol{\beta}}_{mpti} - \widehat{\boldsymbol{\beta}}_{mpa})\right]^{-1}(\widehat{\boldsymbol{\beta}}_{mpti} - \widehat{\boldsymbol{\beta}}_{mpa})$$
$$= \begin{bmatrix}-2{,}591\times10^{1} & \ldots & -2{,}177\times10^{-1}\end{bmatrix}_{(1\times14)} \begin{bmatrix}1{,}830\times10^{-2} & \cdots & 1{,}098\times10^{0}\\ \vdots & \ddots & \vdots\\ 1{,}098\times10^{0} & \cdots & 1{,}757\times10^{1}\end{bmatrix}_{(14\times14)} \begin{bmatrix}-2{,}591\times10^{1}\\ \vdots\\ -2{,}177\times10^{-1}\end{bmatrix}_{(14\times1)}$$
$$= 123{,}9104$$

The Hausman value obtained is 123,9104 with $\chi^2_{table} = \chi^2_{(\alpha;db)} = \chi^2_{(5\%;13)} = 21{,}026$, so *Hausman* > χ^2_{table} then hypothesis H_0 is rejected, suggesting that the right model is the individual Fixed Effect Model.

Table 4 below presents the outcomes of choosing model parameter estimates through the use of the Chow and Hausman tests:

Table 4 Best Model Selection Results

Method	Selection	Best Model
Chow Test	Common Effect Model with Time Fixed Efect Model	Time Fixed Efect Model
Chow Test	Common Effect Model with Individual Fixed Efect Model	Individual Fixed Efect Model
Hausman Test	Random Effect Model with Time Fixed Efect Model	Random Effect Model
Hausman Test	Random Effect Model with Time Fixed Efect Model	Individual Fixed Efect Model

A simultaneous and partial feasibility test of the panel data regression model was conducted in order to determine which model from the panel data regression analysis was the best.

3.7 Simultan Test

Simultan test is used to test the parameters together using the F test with the following hypothesis:

H_0: $\beta_j = 0$; $j = 1,2,\ldots,13$, (The dependent variable is not significantly affected, indicating that the model is incorrect)

H_1: there is at least one $\beta_j \neq 0$; $j = 1,2,\ldots,13$ (At least there is one variable that affects the dependent variable, the right model)

The F test uses the following Equation (9).

for,

$$R^2 = \frac{\hat{\boldsymbol{\beta}}'\mathbf{X}'\mathbf{Y} - \left(\frac{\boldsymbol{Y}'\mathbf{11}'\boldsymbol{Y}}{n}\right)}{\boldsymbol{Y}'\boldsymbol{Y} - \left(\frac{\boldsymbol{Y}'\mathbf{11}'\boldsymbol{Y}}{n}\right)}$$
$$= \frac{73{,}198374 - \left(\frac{1{,}771 \times 10^{-28}}{238}\right)}{163{,}33114 - \left(\frac{1{,}771 \times 10^{-28}}{238}\right)}$$
$$= 0{,}4481$$

The results of F_{count} are obtained as follows:

$$F_{count} = \frac{\frac{R^2}{k}}{\frac{1-R^2}{NT-N-k}}$$
$$= \frac{\frac{0{,}448}{13}}{\frac{1-0{,}448}{238-34-13}}$$
$$= 11{,}931876$$

Based on the calculation, it is obtained $F_{count} = 11{,}931876$ with $F_{table} = F_{\alpha;k;(NT-N-k)} = F_{5\%;13;(191)} = 1{,}77169$, so $F_{count} > F_{table}$ then H_0 is rejected. Therefore, it can be determined to infer that the model employed is appropriate or that the effect of the parameters is concurrently significant at a significant level of 5%; in other word, at least one independent variable influences Indonsia's Open Unemployment Rate.

3.8 Partial Test

The purpose of partial testing is to evaluate each parameter's significance or the impact of each independent variable's significance on the dependent variable using the following hypothesis:

H_0 : $\beta_j = 0, j = 1,2,\ldots,13$ (Parameter are not significant)
H_1 : $\beta_j \neq 0$, $j = 1, 2, \ldots, 13$ (Significant parameter)

The partial test uses the t test with Equations (10), (11), (12) and (13). So the following results are obtained:

$$JKG_{mpti} = \widetilde{\boldsymbol{Y}}'\widetilde{\boldsymbol{Y}} - \hat{\boldsymbol{\beta}}_j{}'\widetilde{\boldsymbol{X}}'\widetilde{\boldsymbol{Y}} = 163{,}3311 - 73{,}1984$$
$$= 90{,}1328$$

$$s^2 = \frac{JKG}{NT-N-k}$$
$$= \frac{90{,}1328}{(34 \times 7) - 34 - 13}$$
$$= 0{,}4719$$

$$\boldsymbol{C} = \begin{bmatrix} 4{,}2017 \times 10^{-3} \\ 5{,}0801 \times 10^{-4} \\ 3{,}6602 \times 10^{-13} \\ 1{,}3200 \times 10^{-3} \\ 9{,}4979 \times 10^{-8} \\ 2{,}6481 \times 10^{-3} \\ 1{,}4392 \times 10^{-3} \\ 9{,}7592 \times 10^{-2} \\ 2{,}6184 \times 10^{-2} \\ 1{,}6461 \times 10^{-2} \\ 1{,}1474 \times 10^{0} \\ 2{,}6256 \times 10^{-10} \\ 3{,}4403 \times 10^{-8} \\ 5{,}9639 \times 10^{-2} \end{bmatrix}$$

$$var(\hat{\boldsymbol{\beta}}_j) = s^2\boldsymbol{C} = \begin{bmatrix} 1{,}9828 \times 10^{-3} \\ 2{,}3973 \times 10^{-4} \\ 1{,}7273 \times 10^{-13} \\ 6{,}2292 \times 10^{-4} \\ 4{,}4820 \times 10^{-8} \\ 1{,}2497 \times 10^{-3} \\ 6{,}7915 \times 10^{-4} \\ 4{,}6054 \times 10^{-2} \\ 1{,}2356 \times 10^{-2} \\ 7{,}7678 \times 10^{-3} \\ 5{,}4147 \times 10^{-1} \\ 1{,}2390 \times 10^{-10} \\ 1{,}6235 \times 10^{-8} \\ 2{,}8144 \times 10^{-2} \end{bmatrix}$$

Next, determine the intercept value t_{count} for each individual and t_{count} the independent variable.

- ***Intercept***

$$t_{count} = \frac{\hat{\beta}_{01}}{SE(\hat{\beta}_0)} = \frac{55{,}47338}{\sqrt{0{,}00198}} = 1245{,}8$$
$$\vdots$$
$$t_{count} = \frac{\hat{\beta}_{034}}{SE(\hat{\beta}_0)} = \frac{47{,}64044}{\sqrt{0{,}00198}} = 1069{,}891$$

- ***Coefficient X_j***

$$t_{count} = \frac{\hat{\beta}_1}{SE(\hat{\beta}_1)} = \frac{-6{,}1821 \times 10^{-2}}{\sqrt{2{,}3973 \times 10^{-4}}} = -3{,}9927$$
$$\vdots$$
$$t_{count} = \frac{\hat{\beta}_{13}}{SE(\hat{\beta}_{13})} = \frac{2{,}5269 \times 10^{-1}}{\sqrt{2{,}8144 \times 10^{-2}}} = -1{,}5063$$

Based on the partial parameter test results, obtained $|t_{count}|$ for the intercept and the independent variable $(X_1, X_4, X_5, X_6, X_7, X_8, X_{10})$ is greater than t_{table} with $t_{table} = t_{\alpha/2;NT-k-1} = t_{0{,}025;238-13-1} = 2{,}2565699$, so the intercept parameters and independent variables $X_1, X_4, X_5, X_6, X_7, X_8, X_{10}$ are significant. Meanwhile $|t_{count}|$ $X_2, X_3, X_9, X_{11}, X_{12}, X_{13}$, smaller than t_{table}, so $X_2, X_3, X_9, X_{11}, X_{12}, X_{13}$ are not significant.

Furthermore, the residual assumption test was run to verify that the residuals of the chosen aquation models were normal, homoscedastic, and independent:

$$\hat{Y} = \hat{\beta}_{0i} - 0{,}06182X_1 + 0{,}0000001186X_2 \\ -0{,}039797X_3 + 0{,}00077568X_4 - 0{,}13349X_5 \\ - 0{,}08455X_6 - 0{,}62886X_7 + 0{,}26836X_8 \\ -0{,}08875X_9 + 2{,}97923X_{10} - 0{,}0000027559X_{11} \\ -0{,}0000531898X_{12} - 0{,}25269X_{13}$$

Based on the $\hat{\beta}$ value in Table 2, the following model residual (ε_1) is obtained:

$$\hat{y}_1 = 55{,}4734 + (-0{,}06182 \times (-0{,}73)) \\ +(0{,}0000001186 \times 1900000) \\ +(-0{,}039797 \times 89{,}01) \\ +(0{,}00077568 \times 5018{,}7) \\ +(-0{,}13349 \times 63{,}44) \\ +(-\ 0{,}08455 \times 39{,}50) \\ +(-0{,}62886 \times 69{,}45) + (0{,}26836 \times 17{,}11) \\ +(-0{,}08875 \times 2{,}37) + (2{,}97923 \times 9{,}32) \\ +(-0{,}0000027559 \times 4192{,}40) \\ +(-0{,}0000531898 \times 21{,}20) \\ +(-0{,}25269 \times 97{,}71)$$

$$\hat{y}_1 = 8{,}0565$$

$$e_1 = y_1 - \hat{y}_1 = 9{,}93 - 8{,}0565 = 1{,}87$$

3.9 *Residual Normality Test*

The residual assumption test is normally distributed or not, using the Liliefors test with the following hypothesis:

H_0: The residuals are normally distributed
H_1: The residuals are not normally distributed

According to the computations, $L_{count} = L_{maks|F(Z_i)-S(Z_i)|} = 0{,}057110$ and $L_{table} = L_{(5\%,238)} = 0{,}057431$, indicating that $L_{count} < L_{table}$, hypothesis H_0 was not successfully rejected. Therefore, it can be claimed that the residuals normal assumptions are accepted or that the residuals are normally distributed at the 5% significance level.

3.10 *Residual Homoscedasticity Test*

Testing the assumption of residual homoscedasticity was carried out to find out whether the residuals were homogeneous or not. The Lagrange Multiplier test, which has the following hypothesis, was used to conduct the test:

$H_0: \sigma_i^2 = \sigma^2$ (The residual variance is the same/Heteroscedasticity does not occur)
$H_1: \sigma_i^2 \neq \sigma^2$ (The residual variance is different/heteroscedasticity occurs)

The Lagrange Multiplier test using the $\boldsymbol{e}_{it}$ value is obtained:

$$LM = \frac{nT}{2(T-1)}\left[\frac{\sum_{i=1}^{n}[\sum_{t=1}^{T} e_{it}]^2}{\sum_{i=1}^{n}\sum_{t=1}^{T} e_{it}^2} - 1\right]^2$$

$$= \frac{(34 \times 7)}{2(7-1)}\left[\frac{1{,}59785 \times 10^{-25}}{90{,}13277} - 1\right]^2$$
$$= 19{,}8333$$

The Lagrange Multiplier value obtained is 19,8333 and it is known that the value $\chi^2_{table} = \chi^2_{(5\%;N-1)} = \chi^2_{(5\%;34-1)} = \chi^2_{(5\%;33)} = 47{,}3999$, so the $Lagrange\ Multiplier < \chi^2_{table}$, then hypothesis H_0 fails to be rejected. Therefore, it can be claimed that the assumptions of residual homoscedasticity are accepted or that there is no heteroscedasticity in the residuals at the 5% significant level.

3.11 *Residual Independence Test*

The independence of the residuals is the last test for the residual assumption. This test is used to determine whether or not there is autocorrelation between the residuals in a model and whether the residuals are independent. The residual independence assumption test uses the Durbin-Watson test with the following hypothesis:

$H_0: \rho = 0$ (There is no correlation between residuals or independent residuals)
$H_1: \rho \neq 0$ (There is a correlation between the residuals or the residuals are not independent)
The Durbin-Watson value is obtained as follows:

$$d = \frac{\sum_{i=2}^{n}(e_i - e_{i-1})^2}{\sum_{i=1}^{n} e_i^2}$$
$$= \frac{155{,}7822896}{90{,}13277}$$
$$= 1{,}728365$$

The Durbin-Watson(d) value obtained was 1,728365 with $dL = 1{,}67369$ and $dU = 1{,}90361$, so $dL < d < du$ then hypothesis H_0 failed to be rejected. Thus, it can be said that the assumption of residual independence is accepted at the significant level of 5% or there is no autocorrelation between residuals.

3.12 *The Goodness of Panel Data Regression Model*

The value of the coefficient of determination, or the value that illustrates the diversity of the dependent variable that the model can explain, indicates how good the model is. The coefficient of determination is acquired:

$$R^2 = \frac{\widehat{\boldsymbol{\beta}}'\mathbf{X}'\mathbf{Y} - \left(\frac{\boldsymbol{Y}'\mathbf{11}'\boldsymbol{Y}}{n}\right)}{\boldsymbol{Y}'\boldsymbol{Y} - \left(\frac{\boldsymbol{Y}'\mathbf{11}'\boldsymbol{Y}}{n}\right)}$$
$$= \frac{73{,}198374 - \left(\frac{1{,}771 \times 10^{-28}}{238}\right)}{163{,}33114 - \left(\frac{1{,}771 \times 10^{-28}}{238}\right)}$$
$$= 0{,}4481$$

The coefficient of determination (R^2) obtained is 0,4481, this indicates that the model can account for the diversity of the dependent variable Open Unemployment Rate in Indonesia of 44,81% and the rest is explained by other variables. The value $R^2 < 50\%$ indicates that the R^2 value obtained is closer to zero, thus the model is not good. Draper & Smith (1998) stated that there is no absolute rule that the R^2 value should be, therefore a model is better if its R^2 value is closer to one, and if it is closer to zero, the model is growing worse.

Based on the completed panel data regression study, which included evaluating residual assumptions and model specification, the best model created is the Fixed Effect Model with individual effect. The best models used are:

$$\begin{aligned}\hat{Y}_i = \hat{\beta}_{0i} &- 0{,}06182\mathrm{X}_{i1} + 0{,}0000001186X_{i2}\\ &-0{,}039797X_{i3} + 0{,}00077568\mathrm{X}_{i4}\\ &-0{,}13349\mathrm{X}_{i5} - 0{,}08455\mathrm{X}_{i6} - 0{,}62886\mathrm{X}_{i7}\\ &+0{,}26836\mathrm{X}_{i8} - 0{,}08875X_{i9}\\ &+2{,}97923\mathrm{X}_{i10} - 0{,}0000027559X_{i11}\\ &-0{,}0000531898X_{i12} - 0{,}25269X_{i13}\end{aligned}$$

Based on the model it can be stated that:

1. The economic growth coefficient is $-0{,}06182$ which indicates that if the rate of economic growth rises by 1% it will reduce the open unemployment rate by $0{,}06182\%$ presuming that the remaining independent variables remain unchanged.
2. The Provincial Minimum Wage Coefficient is $0{,}0000001186$ which indicates that if the Provincial Minimum Wage increases by one unit (thousand rupiahs) it will increase open unemployment by $0{,}0000001186\%$ presuming that the remaining independent variables remain unchanged.
3. The coefficient on the level of education is $-0{,}039797$ which indicates that if the education level increases by 1% it will reduce the open unemployment rate by $0{,}039797\%$ presuming that the remaining independent variables remain unchanged.
4. The population growth coefficient is $0{,}00077568$ which indicates that if population growth increases by one unit (thousand people) it will increase open unemployment by $0{,}00077568\%$ presuming that the remaining independent variables remain unchanged.
5. The coefficient of the labor force participation rate is $-0{,}13349$ which indicates that if the labor force participation rate increases by 1% it will reduce the open unemployment rate by $0{,}13349\%$ presuming that the remaining independent variables remain unchanged.
6. The labor absorption coefficient is $-0{,}08455$ which indicates that if labor absorption increases by 1% it will reduce open unemployment by $0{,}08455\%$ presuming that the remaining independent variables remain unchanged.
7. The Coefficient of Human Development Index (IPM) is $-0{,}62886$ which indicates that if the HDI increases by 1% it will reduce open unemployment by $0{,}62886\%$ presuming that the remaining independent variables remain unchanged.
8. The coefficient for poor people is $0{,}26836$ which shows that if the poor population increases by 1%, open unemployment will increase by $0{,}26836\%$ presuming that the remaining independent variables remain unchanged.
9. The coefficient of the illiterate population is $-0{,}08875$ which indicates that if the illiterate population increases by 1% it will reduce the open unemployment rate by $0{,}08875\%$ presuming that the remaining independent variables remain unchanged.
10. The average length of schooling coefficient is $2{,}97923$ which indicates that if the average length of schooling of the population increases by one unit (year) it will increase unemployment open by $2{,}97923\%$ presuming that the remaining independent variables remain unchanged.
11. The Coefficient of Domestic Investment (PMDN) is $-0{,}0000027559$ which indicates that if PMDN increases by one unit (billions of Rupiah) it will reduce the open unemployment rate by $0{,}0000027559\%$ presuming that the remaining independent variables remain unchanged.
12. The coefficient on foreign investment (PMA) is $-0000{,}53189$ which indicates that if PMA increases by one unit (millions of US$) it will reduce the open unemployment rate by $-0000{,}53189\%$ presuming that the remaining independent variables remain unchanged.
13. The coefficient of school enrollment rate is $-0{,}25269$ which indicates that if school enrollment rate increases by 1% it will reduce the open unemployment rate by $0{,}25269\%$ presuming that the remaining independent variables remain unchanged.
14. The Open Unemployment Rate is directly proportional to the variable provincial minimum wage (X_2), population growth(X_4), poor population (X_8), average length of schooling (X_{10}). That is, the higher the population growth, the higher the TPT in Indonesia, and the more the number of poor people, the higher the TPT in Indonesia, as well as if the provincial minimum wage, the average length of schooling (SMP/MTs/equivalent) of the population is getting higher. the TPT in Indonesia is also getting higher.
15. The Open Unemployment Rate is inversely proportional to the variables of economic growth (X_1), education level (X_3), labor force participation rate (X_5), employment (X_6), human development index (X_7), illiterate population (X_9), domestic investment (X_{11}), foreign investment (X_{12}), and school enrollment rate (X_{13}). This implies that Indonesia's open unemployment rate will decrease in proportion to economic development, and if the education level of the population is higher, the Open Unemployment Rate in Indonesia will be lower, if the number of people who are included in the labor force category increases, the Open Unemployment Rate will be lower, if employment in Indonesia increases, then Open Unemployment Rate is getting lower, as well as the Human Development Index, the illiterate population, as well as investment, if it increases, the Open Unemployment Rate in Indonesia will be lower.

Based on the best model, there are seven significant independent variables in the model, namely Economic Growth (X_1), Population Growth (X_4), Labor Force Participation Rate (X_5), Labor Absorption (X_6), Human

Development Index (X_7) Poor Population (X_8), and average length of schooling (X_{10}) with normal, identical and independent distribution of residuals and has a coefficient of determination of 0,4481, this indicates that a 44,81% model can account for the variability of the dependent variable, the Open Unemployment Rate in Indonesia..

4. Conclusion

The studys result, derived from the analysis conducted, are as follows:

The Fixed Effect Model with Individual Effect, which uses panel data regression, is the most effective model for Indonesia's Open Unemployment Rate:

$$\hat{Y}_i = \hat{\beta}_{0i} - 0{,}06182X_{i1} + 0{,}0000001186X_{i2} \\ -0{,}039797X_{i3} + 0{,}00077568X_{i4} \\ -0{,}13349X_{i5} - 0{,}08455X_{i6} - 0{,}62886X_{i7} \\ +0{,}26836X_{i8} - 0{,}08875X_{i9} \\ +2{,}97923X_{i10} - 0{,}0000027559X_{i11} \\ -0{,}0000531898X_{i12} - 0{,}25269X_{i13}$$

with each province having a different estimate of the parameter $\hat{\beta}_{0i}$.

Based on the model obtained, the factors that significantly affect the open unemployment rate in Indonesia are Economic Growth (X_1), Population Growth (X_4), Labor Force Participation Rate (X_5), Labor Absorption (X_6), Human Development Index (X_7) Poor Population (X_8), and average length of schooling (X_{10}).

Considering the findings and conclusions of the analysis, autor recommended that future researchers to use the simpler model with a higher level of significance.

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