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Modeling of Educated Unemployment Rates in Indonesia Using Geographically Weighted Regression

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Abstract - *Modeling the Educated Unemployment Rate (EUR) in Indonesia is an effort to reduce the number of unemployed, especially the unemployed who are able to complete their education at least high school. The SATKERNAS survey stated that more than half of the unemployed in Indonesia in 2022 were educated unemployed. Modeling was generally carried out to see the relationship between independent variables and dependent variables using linear regression analysis and specifically using Geographically Weighted Regression (GWR) analysis to understand significant differences in independent variables between provinces in Indonesia. In accordance with the model goodness criteria, GWR produces a model that has a smaller AIC value than the general model generated by linear regression. From linear regression analysis, EUR in Indonesia in 2022 is influenced by TPT, JPUP, and Investment. In addition to these variables, the PG variable also affects EUR in Aceh, North Sumatra, West Sumatra, and Riau Provinces according to GWR analysis with a fixed gaussian weighting function.*

Keywords: *Educated Unemployment Rate, Fixed Gaussian, Geographically Weighted Regression, Linear Regression.*

1. Introduction

Unemployment is a state of the labor force but does not have a job for a certain period of time or is looking for a job [1]. If the group has at least a high school diploma, then it can be said to be educated unemployed [2]. The lack of planning for education development that is not balanced with the development of employment causes many graduates from various high schools and even universities, both public and private, to be unable to be absorbed by the job market. Another factor that causes high educated unemployment is that there are still job seekers who choose the type of job they are interested in, as well as the quality of the educated workforce that does not match the needs of job providers [3].

In 2022, unemployment in Indonesia reached 8.42 million people, of which 5.24 million people were in the educated unemployed group. So that 62.46% of unemployment in Indonesia in 2022 is educated unemployed. In the research [1] mentioned that the high number is due to the large number of graduates who experience a waiting period (job search periode), the waiting period will vary according to the level of education but there is a tendency that the higher the education of the workforce, the longer the waiting period [4].

Some of the studies that discuss educated unemployment include [3] which is significantly influenced by wage levels, per capita income, and employment opportunities. While in the city of Padang job opportunities are not a factor of educated unemployment in Padang City, the factors that affect it are economic growth, wages, and the productive age population [4]. Research [5] stated that economic growth was significant but investment and inflation were not significant to educated unemployment in West Java Province in 2006-2020, as well as research [6] stated that the increase in educated unemployment during the 2020-2021 pandemic was 1.84%.

The independent variables in the above study explain the situation in general, meaning that it applies to the entire region without considering the spatial effects between independent variables at each observation point. Models with spatial influences can provide models for each observation area can be analyzed by the Goegraphically Weighted Regression (GWR). GWR is a model update that has spatial aspect considerations, so that the variables in this model have an influence on each observation area [7]. Research [8] using the GWR model on HDI in Indonesia to find different interpretations in each region.

The above description is the motivation for researchers to obtain the best model that is able to present factors that have an

influence on the Educated Unemployment Rate (EUR) in 34 provinces in Indonesia using GWR analysis.

2. Data and Methods

This research uses secondary data which means data obtained in an indirect way, namely through literature studies. The data in question are educated unemployment data as dependent and labor force variables, open unemployment rate, number of productive age population, population organization rate, economic growth, investment and provincial minimum wage as independent variables. The data was taken from BPS, the Ministry of Home Affairs, the Directorate General of PHI JSK, and the Indonesian Ministry of Manpower. In order for the results of secondary data processing to be complete, various information from various literature and various related articles are downloaded from internet media. The secondary data used for this study is 2022 data.

34 provinces in Indonesia are the objects of observation used in this study. The variable consists of one dependent variable and seven independent variables.

where:

y : Educated Unemployment Rate (EUR) per province Year 2022
x_1 : Labor Force (AK) per province in 2022
x_2 : Educated Unemployment Rate (TPT) per province Year 2022
x_3 : Number of Productive Age Population (JPUP) per province Year 2022
x_4 : Population Growth Rate (PG) per province Year 2022
x_5 : Economic Growth (PE) per province Year 2022
x_6 : Investment per province Year 2022
x_7 : Provincial Minimum Wage in 2022.

to analyze the influence of the variables of Labor Force (AK), Open Unemployment Rate (TPT), Number of Productive Age Population (JPUP), Population Growth Rate (PG), Economic Growth (PE), Investment, and Provincial Minimum Wage (UMP) on the Educated Unemployment Rate in Indonesia in 2022 with an analysis of Geographically Weighted Regression (GWR) using software R-Studio. To n observation and p independent variables in the observation, the GWR model used is as follows [9]:

$$y_i = \beta_0(u_i, v_i) + \sum_{k=1}^{p} \beta_k(u_i, v_i)\, x_{ik} + \varepsilon_i \quad (1)$$

Where $\boldsymbol{y_i;\ x_{i1}, x_{i2}, \dots, x_{ip}}$ are the observation values of the dependent variable y and the independent variable at the location in the province being studied. While $\boldsymbol{x_1, x_2, \dots, x_p(u_i, v_i)\beta_k(u_i, v_i) = (x^T w_j(u_i, v_i)x)^{-1}x^T w_j(u_i, v_i)y, k = 1, 2, \dots, p}$ is the regression parameter for each location $\boldsymbol{(u_i, v_i)}$ with is the weight of $\boldsymbol{w_j(u_i, v_i)}$ *location j* at location *i*, and is the $\boldsymbol{\varepsilon_i, i = 1, 2, 3, \dots, n}$ *location error i.*

GWR analysis using coordinates latitude and longitude to determine the weight. The first step in analyzing using the GWR method is to determine the distance Euclidean. Next is to determine the weighting function to be used, bandwidth following the function of the weights used. If the weighting function is a kernel adEURive so bandwidth between regions, but the kernel fixed give bandwidth same for the whole Observation area [10]. Bandwidth optimum selected using Cross Validation (CV) [9]. Results model GWR parameter estimation gives different weights to each observation area using the Weighted Least Square (WLS)

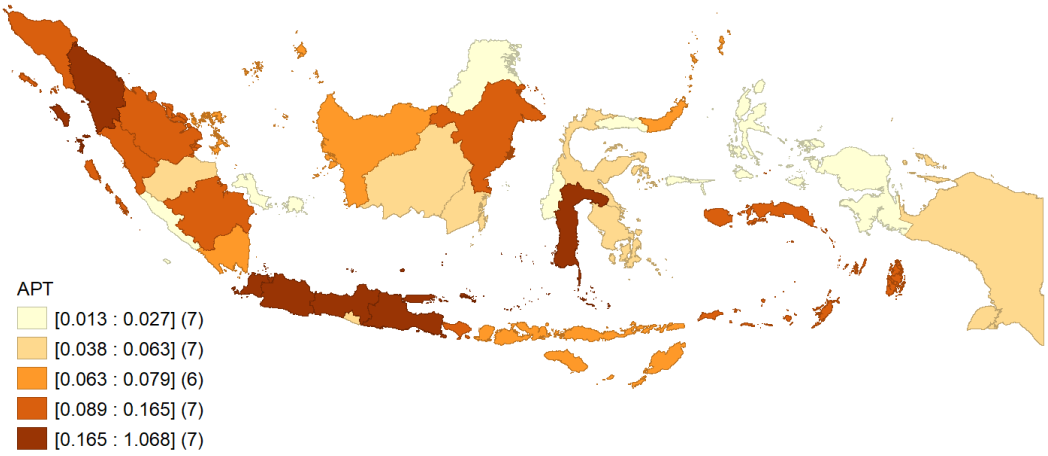

Figure 1. EUR Distribution Map by Province in Indonesia in 2022

3. Results and Discussion

3.1 Descriptive Analysis

The region with the highest EUR is in West Java Province with a total of 1,068 million people while the area with the lowest EUR is in North Kalimantan Province with 0.013 million people. Based on Figure 1, the pattern of spread of EUR cases in each region from low to high category tends to spread. The descriptive of the dependent variables and other dependent variables in this study are found in Table 1.

Table 1. Descriptive Analysis

Variable Name	Minimum	Median	Maximum	Average
y	0,013091	0,065672	1,067578	0,154363
x_1	0,37	2,2661	25,578	4,2271
x_2	2,34	4,685	8,31	4,966
x_3	0,54717	3,234605	38,66781	6,159423
x_4	0,64	1,42	3,15	1,424
x_5	2,01	5,1	22,94	5,755
x_6	0,2683	2,24805	25,0621	4,4654
x_7	1,812935	2,688902	4,641854	2,725505

3.2 Linear Regression Model

Multiple linear regression analysis was carried out to understand the general relationship between independent variables and variables Depend on [11]. As for The results of the linear regression estimation are written into the following model:

$$\hat{y} = -0.0854274 - 0.0538431x_1 + 0.0078192x_2 + 0.0610855x_3 \\ -0.0079508x_4 + 0.0005177x_5 + 0.0029280x_6 + 0.0174583x_7 \quad (2)$$

From the linear regression model, the feasibility test of the model was carried out simultaneously and partially with the results displayed by Table 2 and Table 3

Table 2. Simultaneous Test Results

Model	Value	Level of Significance
F_{Count}	716	2.459108
p-value	$2.2e^{-16}$	0.05

Simultaneous tests were carried out to determine whether there was an influence of independent variables on the Depend on [12]. At [13] shows $F_{count} = 716 > F_{(0.95;7;26)} = 2.388$ Therefore, it can be concluded that there is at least one independent variable that affects theRiabel Dependence.

Furthermore, a partial test was carried out to find out what independent variables affect EUR in Indonesia in 2022 [13]. By looking at the value on t_{hitung}Table 3, if then these independent variables affect EUR in Indonesia in 2022. Significant variables affecting EUR in Indonesia in 2022 are the variables AK, TPT, JPUP, and INV. $t_{count} > t_{(0.025;26)} = 2.051831$

Table 3. Partial Test Results

Model	t_{hitung}	*p-value*	Conclusion
x_1(AK)	3.916	0.000581	Signifikan
x_2(TPT)	2.883	0.007795	Signifikan
x_3(JPUP)	6.336	$1.04091e^{-06}$	Signifikan
x_4(PG)	1.046	0.3050965	Insignificant
x_5(PE)	0.570	0.573456	Insignificant
x_6(INV)	2.786	0.009838	Signifikan
x_7(UMP)	2.047	0.050856	Insignificant

3.3 Multicollinearity Test

The multicollinearity test is used to determine the linear relationship between independent variables in the regression model [12]. Multicollinearity in the model occurs if the value of the *Variance Influence Factor* (VIF) more than 10 [14]. VIF is A value that describes the increase in variance from the expected parameters between independent variables.

Table 4. VIF Value of each Independent Variable

Variable	VIF Value
x_1	658,23
x_2	1,75
x_3	685,31
x_4	1,28
x_5	1,05
x_6	3,66
x_7	2,23

A VIF value of more than 10 is assumed to experience multicollinearity. Because it is eliminated, one of the independent variables that has a VIF value of >10 is x_1.

3.4 Spatial Heterogeneity Test

This spatial heterogeneity test aims to find out whether there is diversity between provincial areas or not, the spatial heterogeneity test in this study uses a test *Breusch-Pagan*[14]

Hypothesis

H_0 : (no spatial heterogeneity between regions) $\sigma_1^2 = \sigma_1^2 = \cdots = \sigma_n^2 = \sigma^2$

H_1 : there is at least one (there is spatial heterogeneity between regions)$\sigma_i^2 \neq \sigma^2$

Level of Significance: $\alpha = 0{,}05$

Test Statistics

Table 5. Spatial Heterogeneity Test Results

Breusch-Pagan *Test*	
BP	22,948

Denial Zones Reject H_0 when BP $> X^2_{(0.05;6)}$

By [17] obtained a BP value of 22.948 which is greater than 12.592, so it was decided to reject and it can be concluded that there is spatial heterogeneity between provincial areas in Indonesia.$X^2_{(0.05;6)} = H_0$

3.5 Model Geographically Weighted Regression (GWR)

GWR analysis can be performed on the assumption that there is spatial heterogeneity in the linear regression model, so the accuracy of the linear regression model can be doubted. By using the GWR method, spatial heterogeneity can be overcome because the GWR method is an analysis method using a point approach. The first step in the analysis of the GWR method is to determine the distance Euclidean each region, Table 6 is one example of distance Euclidean centered in Riau Province against other provinces in Indonesia.

Table 6. Distance Euclidean each Region in Riau Province

Province	Latitude	Longitude	Rockrose *in Euclidea*
Aceh	4,72187	96,74726	6,616662672
North Sumatra	2,13396	99,71357	2,681166485
West Sumatra	-0,73296	100,47163	1,581290244
Riau	0,29973	101,66914	0
Jambi	-1,50185	103,58076	2,62678159
South Sumatra	-3,29098	103,80048	4,175620732
Bengkulu	-3,57611	102,30634	3,927869594
Lampung	-4,53835	105,33976	6,072929217
Bangka-Belitung District	-2,74579	106,47135	5,686511493
Riau Islands	0,90951	104,46194	2,85859467
Jakarta	-6,19065	106,81164	8,28072091
West Java	-7,10387	107,60334	9,488309786
Central Java	-7,16383	110,20161	11,33612686
IN Yogyakarta	-7,89356	110,34992	11,93674757
East Java	-7,52885	112,27253	13,18023309
Banten	-6,40017	106,0268	7,992362647

Province	Latitude	Longitude	Rockrose *in Euclidea*
Bali	-8,42101	115,11799	16,02881382
West Nusa Tenggara	-8,64917	117,30976	18,01976152
East Nusa Tenggara	-8,64373	120,83637	21,15107994
West Kalimantan	-0,23921	111,49799	9,843614613
Central Kalimantan	-1,63425	113,4206	11,90953781
South Kalimantan	-3,14352	115,2718	14,03169019
East Kalimantan	0,53532	116,36494	14,69768826
North Kalimantan	3,08679	116,15321	14,74977923
North Sulawesi	0,6493	123,99745	22,33104625
Central Sulawesi	-1,42695	121,40467	19,81092043
South Sulawesi	-3,67124	120,01613	18,77180452
Southeast Sulawesi	-4,13712	121,96498	20,77514763
Gorontalo	0,70703	122,29305	20,62793148
West Sulawesi	-2,81843	119,17293	17,77935843
Maluku	-3,18532	130,21682	28,75961764
North Maluku	1,49304	127,95364	26,31157405
West Papua	-1,2972	133,05129	31,42275488
Papua	-4,28161	138,03909	36,6573586

By using the Gaussian kernel fixed *weighting function*, the *bandwidth* used for all observation regions has the same value, by using *the Cross Validation* (CV) method to determine *the optimal bandwidth* with the aim of providing coverage of one region to another. The bandwidth value of each observation region is b = 4.531128 with *a minimum CV score* of 0.02844458. The *Euclidean distance* and the resulting *bandwidth* are then substituted into the weighting function used, which is *the fixed kernel Gaussian.*

Table 7. Weighted Value of each Region in Riau Province

Province	Rockrose *in Euclidea*	*Bandwidth*	Weighted Value
Aceh	6,616662672	4.531128	0,344317259
North Sumatra	2,681166485	4.531128	0,83940057
West Sumatra	1,581290244	4.531128	0,940922178
Riau	0	4.531128	1
Jambi	2,62678159	4.531128	0,845322442
South Sumatra	4,175620732	4.531128	0,654018912
Bengkulu	3,927869594	4.531128	0,68679036
Lampung	6,072929217	4.531128	0,407318376
Bangka-Belitung District	5,686511493	4.531128	0,454981963
Riau Islands	2,85859467	4.531128	0,819546354
Jakarta	8,28072091	4.531128	0,188263594
West Java	9,488309786	4.531128	0,111639869
Central Java	11,33612686	4.531128	0,043735948
IN Yogyakarta	11,93674757	4.531128	0,031117059
East Java	13,18023309	4.531128	0,014543441
Banten	7,992362647	4.531128	0,21105532
Bali	16,02881382	4.531128	0,001917155
West Nusa Tenggara	18,01976152	4.531128	0,000367865
East Nusa Tenggara	21,15107994	4.531128	$1{,}8553e^{-05}$
West Kalimantan	9,843614613	4.531128	0,094443548
Central Kalimantan	11,90953781	4.531128	0,031612665
South Kalimantan	14,03169019	4.531128	0,00827203
East Kalimantan	14,69768826	4.531128	0,005190923
North Kalimantan	14,74977923	4.531128	0,005000585
North Sulawesi	22,33104625	4.531128	$5{,}31816e^{-06}$
Central Sulawesi	19,81092043	4.531128	$7{,}06345e^{-05}$
South Sulawesi	18,77180452	4.531128	0,000187521

Province	Rockrose *in Euclidea*	*Bandwidth*	Weighted Value
Southeast Sulawesi	20,77514763	4.531128	$2{,}72342e^{-05}$
Gorontalo	20,62793148	4.531128	$3{,}15922e^{-05}$
West Sulawesi	17,77935843	4.531128	0,00045364
Maluku	28,75961764	4.531128	$1{,}78656e^{-09}$
North Maluku	26,31157405	4.531128	$4{,}76328e^{-08}$
West Papua	31,42275488	4.531128	$3{,}60481e^{-11}$
Papua	36,6573586	4.531128	$6{,}13356e^{-15}$

Table 7, then the weight matrix formed by the function *gaussian* in the region, namely Riau Province are:(u_4, v_4)

$\boldsymbol{w_{(u_4,v_4)}} = \boldsymbol{diag}$ (**0,344317259 0,83940057 0,940922178 1 0,845322442 0,654018912 0,68679036 0,40731837 0,454981963 0,819546354 0,188263594 0,11163986 0,043735948 0,031117059 0,014543441 0,21105532 0,00191715 0,000367865 1,8553 0,094443548 0,031612665 0,00827203 0,005190923 0,00500058 5,31816 7,06345 0,000187521 2,72342 3,15922 0,00045364 1,78656 4,76328 3,60481** $\boldsymbol{6{,}13356e^{-05}e^{-06}e^{-05}e^{-05}e^{-05}e^{-09}e^{-08}e^{-11}e^{-15}}$)

The matrix above is used to estimate parameters in the Riau Province area, while for estimation in other provinces, it is necessary to first search for the weighting matrix in the same way as the step above, so for the last province $w_{(u_i,v_i)}\, w_{(u_{34},v_{34})}$ [9].

Furthermore, the GWR model produced from the above estimate was tested for model suitability and model parameter significance test. The conformity test was carried out with the aim of determining the difference in significance between the linear regression model and the GWR [10]

Hypothesis

H_0 : $\beta_k(u_i, v_i) = \beta_k; k = 1,2, \dots, p\ dan\ i = 1,2, \dots, n$ (there is no significant difference between the regression model and the GWR model)

H_1 : (there is a significant difference between the regression model and the GWR model) $\beta_k(u_i, v_i) \neq 0$

Level of Significance: $\alpha = 0{,}05$

Test Statistics

Table 8. Statistical Results of GWR Model F Test

Model Conformance Test	
F_{count}	3,2064
p-value	0,0353
df_1	27
df_2	9,1711

Denial Zones

Reject H_0 if $p\text{-}value < \alpha = 0.05$ atau $F_{hitung} > F_{(0.05;27;9.1711)}$

Verdict and Conclusion

By Table 8 a value of 3.2064 was obtained, which is greater than that, it was decided to reject and it can be concluded that there is a significant difference between the linear regression model and the GWR model. Therefore, the GWR model is useful for modeling EUR cases in Indonesia.$F_{hitung} F_{(0.05;27;9.1711)} = 2{,}8490 H_0$

Variables that The significance of the GWR model is different for each region. [10]. This can be seen from the statistical value of the t-test if the independent variable has it, then the related variable has a significant effect on the dependent variable.$\left|t_{hitung}\right| > t_{(0.025;27)} = 2{,}051831$

Each province has a different GWR model. From provinces that only have one significant independent variable showing an increase or decrease in EUR (East Nusa Tenggara, East Kalimantan, North Kalimantan, North Sulawesi, Central Sulawesi, South Sulawesi, Southeast Sulawesi, Gorontalo, West Sulawesi, Maluku, North Maluku, West Papua, and Papua), to provinces that have 4 significant independent variables showing an increase or decrease in EUR (North Sumatra, West Sumatra, and Riau).

The Riau Province which has four significant independent variables has a model $y_4 = -$of $0.0794 + 0.02160.0214x_2 + x_3 -$ 0.0264 with the influencing variable being which means that if other independent variables are considered constant then every decrease of one percent of TPT will decrease EUR by 0.0216 EUR units, if other independent variables are considered constant then every decrease of one JPUP unit will decrease EUR by 0.0214 EUR units, if other independent variables are considered constant then every one percent increase in PG will decrease EUR by 0.0264 EUR units, and if other independent variables are considered

constant then any decrease in investment will decrease EUR by 0.0049 EUR units. $x_4 + 0{,}0049x_6x_2, x_3, x_4 \text{dan } x_6$

Table 9. Significant Variables in the GWR model of Each Province in Indonesia

Province	Influential Variables	Province	Influential Variables
Aceh	x_2 , x_3 , x_4	West Nusa Tenggara	x_2 , x_3
North Sumatra	x_2 , x_3 , x_4 , x_6	East Nusa Tenggara	x_3
West Sumatra	x_2 , x_3 , x_4 , x_6	West Kalimantan	x_2 , x_3 , x_6
Riau	x_2 , x_3 , x_4 , x_6	Central Kalimantan	x_3 , x_6
Jambi	x_2 , x_3 , x_6	South Kalimantan	x_3 , x_6
South Sumatra	x_2 , x_3 , x_6	East Kalimantan	x_3
Bengkulu	x_2 , x_3 , x_6	North Kalimantan	x_3
Lampung	x_2 , x_3 , x_6	North Sulawesi	x_3
Bangka-Belitung District	x_2 , x_3 , x_6	Central Sulawesi	x_3
Riau Islands	x_2 , x_3 , x_6	South Sulawesi	x_3
Jakarta	x_2 , x_3 , x_6	Southeast Sulawesi	x_3
West Java	x_2 , x_3 , x_6	Gorontalo	x_3
Central Java	x_2 , x_3 , x_6	West Sulawesi	x_3
IN Yogyakarta	x_2 , x_3 , x_6	Maluku	x_3
East Java	x_2 , x_3 , x_6	North Maluku	x_3
Banten	x_2 , x_3 , x_6	West Papua	x_3
Bali	x_2 , x_3 , x_6	Papua	x_3

3.6 Comparison of GWR Model with Linear Regression Model

The GWR model of educated unemployment cases in Indonesia that was formed is a better model compared to the linear regression model. This can be seen in Table 10

Table 10. AIC Value Comparison

Type	AIC
Linear Regression Model	-151,059
Model GWR	-185,5876

By Table 10, the AIC value of the GWR model is -185.5876 which is smaller than the multiple linear regression model of -151.059. This shows that the GWR model is better at explaining the diversity of EUR cases in Indonesia

4. Discussion

This Research on the topic of unemployment has been carried out a lot, from research [15][16][17] with the independent variables of net regional products, regional minimum wages, and the percentage of the population aged 15 years based on the highest education that was completed affects unemployment. Unemployment with high school graduates can be said to be educated unemployment [8] [9] [10] and [11], influenced by economic growth, wages, and a significant productive age population in educated unemployment.

This research was carried out with the aim of modeling the 2022 Educated Unemployment Rate with the hope that the modeling can be able to help relevant agencies in decision-making to deal with the problem of educated unemployment in Indonesia with the Labor Force, Open Unemployment Rate, Number of Productive Age Population, Population Growth Rate, Economic Growth, Investment and Provincial Minimum Wage as independent variables and the Educated Unemployment Rate in Indonesia as an independent variable dependent variables. Labor force variables are significant in open unemployment research [17], the variable of the open unemployment rate is significant in [3], the number of productive age population has been significant in the research [4], then the population growth rate is significant in [1], economic growth has experienced significance in [4] and has no effect on [17], investment and provincial minimum wage have a significant effect simultaneously on [4], but had a significant negative effect on open unemployment in Central Java Province in 2009-2015 [17].

However, with the seven independent variables mentioned earlier, there are two independent variables with a VIF value of >10, so the deletion of independent variables is carried out according to [18]. The labor force variable is ignored in the next test according to the test results on the [18], the model by using the number of productive age population or without the labor force variable as the independent variable has a higher value and adj- then the variable of the number of productive age population is maintained in the model R^2R^2[13]. So that the model obtained consists of six independent variables, namely the Open

Unemployment Rate, the Number of Productive Age Population, the Population Growth Rate, Economic Growth, Investment, and the Provincial Minimum Wage. In a linear regression analysis with six existing independent variables, the variables of the open unemployment rate, the number of the productive age population, and investment partially significantly affected the educated unemployment rate in Indonesia in 2022. And the variables of population growth rate, economic growth, and provincial minimum wage turned out to have no effect. The variable that does not have a partial effect is still included in the model with the assumption that it may actually have no effect in general but has an effect in certain provinces.

The linear regression model on the educated unemployment rate in Indonesia in 2022 is in accordance with Equation (2) with the Open Unemployment Rate, Number of Productive Age Population, Population Growth Rate, Economic Growth, Investment, and Provincial Minimum Wage as independent variables. The regression model experiences spatial heterogeneity, which is a situation where independent variables give different responses in some regions [10]. This means that the model is less relevant in interpreting data, so it can be solved using methods that contain spatial data such as *Geographically Weighted Regression* (GWR).

The GWR analysis in this study uses the *Fixed Gaussian* kernel function, with *the same bandwidth* value between the observation regions. After obtaining the size weight matrix, the GWR model parameter is estimated. Each province has a different model, but has significant similarities in independent variables in several adjacent provinces such as North Sumatra, West Sumatra, and Riau provinces that have the same significant independent variables or between all regions have significant JPUP on EUR. Based on GWR analysis, variables that have an influence on EUR in Indonesia are TPT, JPUP, PG, and Investment $n \times n$.

5. Discussion

Each province has a different model, but has significant similarities in independent variables in several adjacent provinces such as North Sumatra, West Sumatra, and Riau provinces that have the same significant independent variables or between all regions have significant JPUP on EUR. Based on GWR analysis, variables that have an influence on EUR in Indonesia are TPT, JPUP, PG, and Investment

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