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MODELING THE IMPACT ANALYSIS OF THE COVID-19 PANDEMIC ON THE TOURISM SECTOR IN PALOPO CITY WITH A NONPARAMETRIC REGRESSION APPROACH

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ABSTRACT

The implementation of social distancing causes a huge effect on the life sector in Indonesia, one of which is the tourism sector which has experienced the greatest impact due to this policy. One of the treatments that can be done is to find out the factors that are thought to have an influence on the increase in the tourism sector in Palopo city, many methods can be done, one of which is the regression analysis method. This study uses Spline non-parametric regression in modeling the data. The non-parametric regression model was chosen based on results of the identification that the data does not follow a certain distribution pattern. Gross regional domestic product data is used in the model. This can be seen from the resulting R^2 value of 76.94%. Gross Regional Domestic Product data is also modeled using multiple linear regression. This modeling is intended as a comparison model. The results show that the use of the non-parametric Spline better model in modeling the data compared to multiple linear regression.

Keywords: Non-Parametric, Data, Spline, Regression

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PRELIMINARY

In 2020, the world was shocked by the outbreak of a new pneumonia, Covid-19. Covid-19 was first detected in Wuhan and then spread to various countries including Indonesia (Olivia et al., 2020). Covid-19 case at Indonesia cases began in March 2020 with increasing cases and wider spread so that in March 2021 Covid-19 cases were confirmed to reach 1.3 million people with a total of 40 thousand deaths (Hidayat, 2021). To prevent and

suppress the number of Covid-19 spread, the government took action with the implementation of social distancing (Qian & Jiang, 2022). The implementation of social distancing has a huge effect on the life sector in Indonesia, be it the economic sector, tourism, education and other sectors (Darsana & Sudjana, 2022). The tourism sector is one of the sectors that has experienced the greatest impact due to this policy (Dappa et al., 2021).

The Tourism and Creative Economy Office of Palopo city recorded as many as 680 businesses affected by the Covid-19 pandemic due to closed tourist access (Chaeruddin, 2020). Therefore, to restore the tourist sector after the Covid-19 pandemic in Palopo city, intensive handling from the government is needed. One of the treatments that can be done is knowing the factors that are thought to have an influence on increasing the tourism sector in Palopo city, to find out these factors can be done with mathematical modelling (Lee et al., 2020). Many methods can be done, one of which is the regression analysis method (Hidayat et al., 2017). Three models exist in regression analysis parametric, nonparametric, and semiparametric (Hidayat et al., 2020). After initial screening of the data, it turns out that the data does not follows a specific pattern or distribution so the model development can be carried out, namely the nonparametric regression model (Araveeporn, 2019). Nonparametric methods can be used to explain the relationship between the dependent variable and the independent (Hidayat et al., 2021). Nonparametric regression approaches have undergone many developments which include spline, fourier, local polynomial, kernel and wavelet (Pradana & Mahendra, 2021). One of the models in nonparametric regression that is often used to estimate regression curves is the spline (Gauthier et al., 2020). This happens because there are knot points in the function so that it can providing an overview of characteristics of the data (Al-Sudani, et al., 2019). To identify the modulus parameters in spline regression, the Generalized Cross Validation (GCV) method is used and the best model of nonparametric regression will be selected based on the largest R^2 value (Hidayat et al., 2021).

Research related to the tourism sector has been worked on by Dano et al. (2022) with the result showing that before the outbreak from pandemic Covid-19 that causes poverty rate in West Bandung Regency tended to decrease, but after the outbreak of Covid-19 the rate of poverty increase in West Bandung Regency increased. Syamsualam & Hidayat (2022) modeled the number of traffic accidents in the city of Palopo using Spline Truncated Nonparametric Regression with one variable. Results of this research indicate this population density affects amount traffic accidents in the city of Palopo. Looking at the

above, we are interest in modeling the factors that affect the tourism sector in Palopo city with Spline truncated nonparametric regression.

METHODS

The connecting model between the dependent variable and the independent variable whose function form is unknown can be determined using the regression method, namely the nonparametric regression method. Nonparametric regression provides a significant degree of flexibility because it assumes the nonparametric regression curve as a smooth function that contains a certain function space. This survey used data obtained from the Central Bureau of Statistics of Palopo City. The variables used are variables that are suspected of influencing GRDP growth rate described in the following table.

Table 1. Research variables

No	Variabel	Description	Unit
1	y	Growth Rate of GRDP	Percentage
2	x_1	Number of Accommodation	Percentage
3	x_2	Room Occupancy Rate	Percentage
4	x_3	Labor Force Participation Rate	Percentage

Data analysis in this study uses statistical software to determine the effect between variables for multiple linear regression analysis modeling and truncated Spline. The following are the research stages carried out in this study

1. Perform descriptive statistical analysis on dependent variables and independent variables
2. Creating a relationship pattern (scatter plot) between the open unemployment rate, which is defined as the dependent variable, and the independent variables to determine the relationship pattern formed.
3. Modeling the independent variables using a spline nonparametric regression model with the selection of three knot points, namely knot points 1, 2, and knot point 3.
4. Selecting the optimal knot point based on the minimum GCV value.
5. Obtaining the best spline regression model by selecting the optimal knot points, through parameter estimation.
6. Conducting significant parameter tests on the nonparametric spline regression model simultaneously and partially.
7. Performing identical, independent, and normally distributed (IIDN) residual assumption test of the spline regression model.
8. Perform multiple linear regression analysis

9. Conducting a comparative study of the truncated spline model and multiple linear regression by looking at the largest R^2 value.
10. Make an interpretation of the analysis results and draw conclusions.

RESULT AND DISCUSSION

Descriptive Analysis

The descriptive analysis will discuss the characteristics of the GRDP of South Sulawesi province and influential factors presented in the form of data which includes the average value (mean), variance, minimum value and maximum value obtained from using SPSS software. The results of the analysis with SPSS show the characteristics of GRDP and influential factors presented in the table as follows.

Table 2. Characteristics of GRDP and Factors Expected to Affect

No	Variables	Mean	Varians	Minimum	Maximum
1	y	5,28	6,57	1,99	15,45
2	x_1	4,17	40,92	0,93	31,40
3	x_2	18,42	105,54	1,18	38,49
4	x_3	67,29	45,19	57,63	85,11

Based on the table above, variable y is the GRDP growth rate of the province of South Sulawesi in 2022, where average GRDP of South Sulawesi Province in 2022 is 5.28. The variance value of GRDP is 6.57 with minimum value of 1.99 and maximum value is 15.45. The minimum value of GRDP is in East Luwu Regency while the maximum value of GRDP is in Bantaeng Regency which is shown in the following figure.

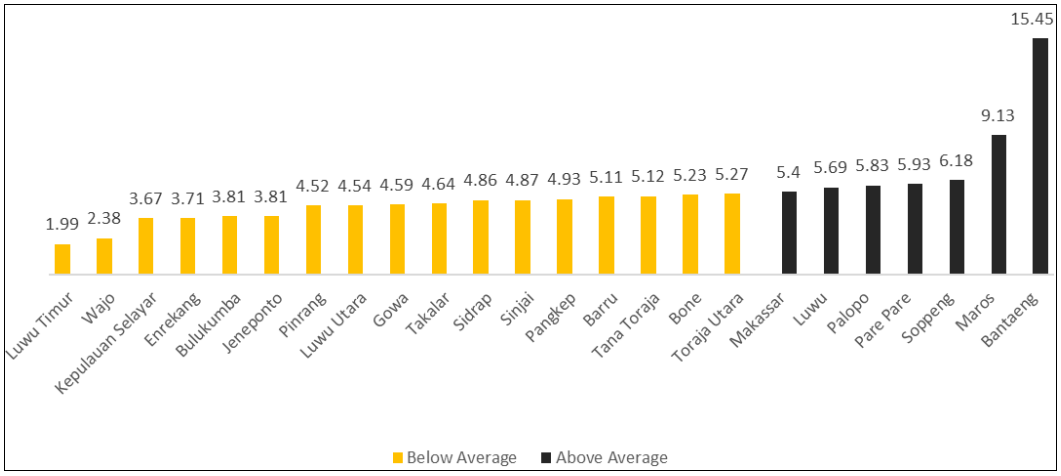

Figure 1. Growth rate GRDP of South Sulawesi Province

The figure above shows that the highest percentage of GRDP growth rate is in Bantaeng Regency, so it can be concluded that Bantaeng Regency is the region with the

highest GRDP growth rate. Meanwhile, East Luwu district is the district with the lowest GRDP. In the variable GRDP growth rate of South Sulawesi province, there are 17 regions below the provincial average, while 7 other regions are above the provincial average.

One of the regions that experienced gross regional income above the average was Palopo city. Judging from the GRDP growth rate of Palopo City from 2015-2019, it continued to increase, but in 2020 the GRDP growth rate decreased dramatically and slowly began to increase again in 2021-2020. The following is the GRDP growth rate of Palopo City in 2015-2022.

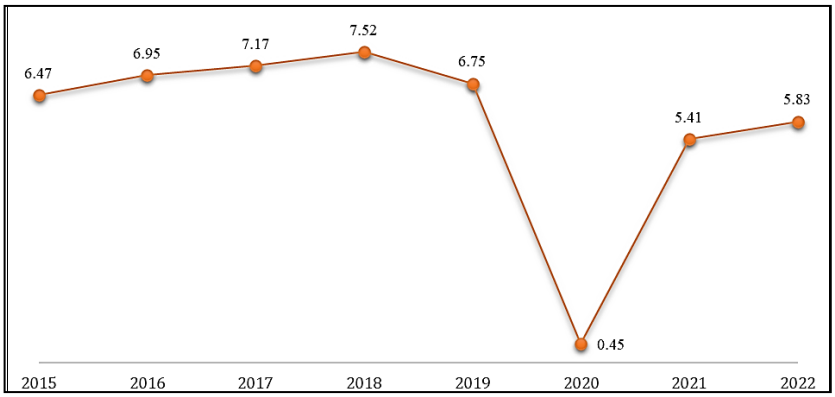

Figure 2. Growth rate curve of GRDP in Palopo City

Base on the curve above, we can see that GRDP growth rate of Palopo city decreased in 2020 which only reached 0.45 percent. The decline in the GRDP growth rate occurred when the Covid-19 pandemic entered Indonesia at the end of December 2019, causing the economy in Palopo in 2020 to decline. However, after the Covid-19 pandemic began to subside in 2021, the GRDP growth rate began to increase again.

Spline Truncated Regression Modeling

In modeling the truncated Spline is done through the selection of optimal knot points (Maharani & Saputro, 2021). Optimal node points produces the best models of the truncated Spline, the knot points to be used are knots 1, 2 and 3 with the selection of knot points by minimum GCV value (Adams & Yahaya, 2020). The following are the results of knot points 1, 2 and 3 base on the minimum GCV value.

Tabel 3. Minimum GCV Value

Knots	Parameters	GCV Minimum
1	7	9,864345
2	10	7,443896
3	13	4,948981

Based on the comparison of GCV values in the table, it can be seen that the minimum GCV is at knot 3, so it can be concluded that the modeling with 3 knot points is the best model for conducting truncated Spline nonparametric regression analysis on the GDP growth rate with 13 parameters including the β_0 parameter. The following is the Spline regression model with 3 knots.

$$\hat{y} = 11{,}95 - 0{,}12x_1 + 0{,}14(x_1 - 18{,}96)_+^1 + 0{,}12(x_1 - 20{,}21)_+^1 + 0{,}11(x_1 - 21{,}45)_+^1 + 0{,}16x_2 - 14{,}32(x_2 - 23{,}26)_+^1 + 27{,}48x_2(x_2 - 24{,}78)_+^1 - 13{,}47(x_2 - 26{,}31)_+^1 - 0{,}13x_3 - 1{,}14(x_3 - 73{,}89)_+^1 + 35{,}60(x_3 - 75{,}02)_+^1 - 38{,}35(x_3 - 76{,}14)_+^1$$

Spline truncated regression modeling of 3 knot points produces an R^2 value of 76.94%. The R^2 value of 76.94% can explain the influence on the GRDP growth rate.

Comparison of Multiple Linear Regression Models with Spline Truncated Regression

The best regression model selection will be selected based on the largest R^2 value (Mariati et al., 2022). The following is a compilation of Spline truncated regression models with multiple Linear regression.

Table 4. Comparison of Regression Models

Models	R^2
Spline Truncated	76,94%
Multiple Linear Regression	10,3%

From the table above, it can be seen that Spline truncated regression modeling has an R^2 value that is greater than multiple linear regression, so it concludes that the Spline truncated model is the best model for modeling the GRDP growth rate.

Interpretation of the Best Model

The best regression model produced to model the growth rate of GRDP in South Sulawesi Province is done by comparing knot points 1, 2 and 3 by looking at the most optimal knots. From the comparison of knots, it was found that the most optimal knot was to use 3 knots with a GCV value of 4.948981 so that 3 knots were the best model in modeling the GDP growth rate and an R^2 value 76.94%. The regression model shows that the variables x_2 and x_3 are significant to the GRDP growth rate while the variable x_1 is not significant to the GRDP growth rate. The influence of these variables can be interpreted as follows.

1. The effect of the variable relationship Room Occupancy Rate (ROR) (x_2) on the growth rate of GRDP (y) in South Sulawesi Province in 2022 with the assumption that other variables are constant.

$$\hat{y} = 0{,}16x_2 - 14{,}32(x_2 - 23{,}26)_+^1 + 27{,}48x_2(x_2 - 24{,}78)_+^1 - 13{,}47(x_2 - 26{,}31)_+^1$$

$$= \begin{cases} 0{,}16x_2 & ; x_2 < 23{,}36 \\ -14{,}16x_2 + 333{,}08 & ; 23{,}26 \leq x_2 < 24{,}78 \\ 13{,}32x_2 - 347{,}87 & ; 24{,}78 \leq x_2 < 26{,}31 \\ -0{,}15x_2 - 6{,}53 & ; x_2 \geq 26{,}31 \end{cases}$$

The model shows that districts/cities with a ROR (x_2) below 23.36% cause the GRDP growth rate to increase by 0.16% for every 1 unit increase in ROR. Based on ROR data in South Sulawesi Province in 2022, there are 14 districts/cities that fall into this category with values < 23.36 namely Wajo, North Luwu, Sidrap, Selayar Islands, Luwu, Soppeng, Maros, Tana Toraja, Enrekang, East Luwu, Sinjai, Bulukumba, Gowa, and Pangkep.

Districts/cities with ROR (x_2) in the interval 23.26% to 24.78% caused the GRDP growth rate to decrease by 14.16% for every 1 unit increase in ROR. Based on ROR data in South Sulawesi Province in 2022, districts/cities that fall into this category with values 23.36 to 24.78 namely Barru and Jeneponto.

Districts/cities with ROR (x_2) in the interval 24.78% to 26.31% caused the GDP growth rate to increase by 13.32% for every 1 unit increase in ROR. Based on ROR data in South Sulawesi Province in 2022, there are no districts/cities in this category.

Meanwhile, districts/cities with a ROR (x_2) above 26.31% caused the GDP growth rate to decrease by 0.15% for every 1 unit increase in ROR. Based on ROR data in South Sulawesi Province in 2022 there are 8 districts/cities in this category with values $24{,}78 \leq x_2 < 26{,}31$ namely Bantaeng, North Toraja, Takalar, Palopo, Pinrang, Bone, Pare Pare, and Makassar.

The classification based on the room occupancy rate can be visually represented in the figure below with the assumption that other variables are constant.

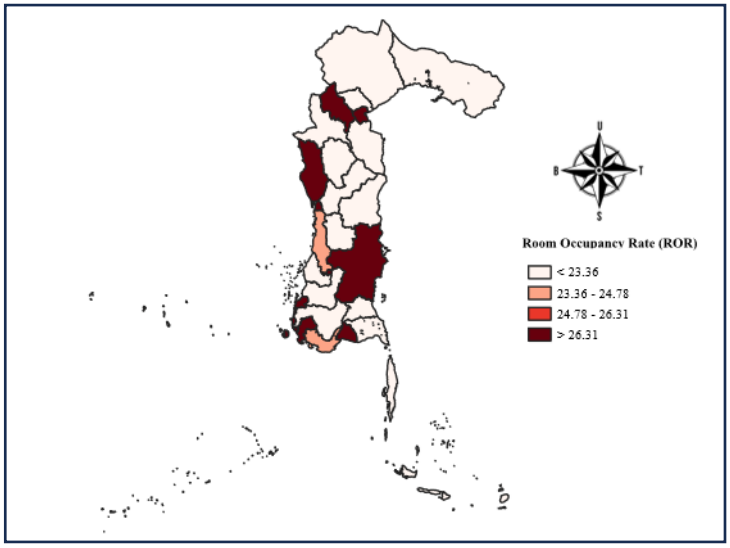

Figure 3. Distribution of Districts/Cities by Room Occupancy Rate

The figure above shows that the majority of districts/cities in South Sulawesi have an ROR below the average which can be seen based on the regions in South Sulawesi Province which are still in the interval 1. This is in accordance with the analysis results show that the mean value of the ROR level is 18.42.

2. The effect of the variabele relationship Labor Force Participation Rate (LFPR) (x_3) on the growth rate of GRDP (y) in South Sulawesi Province in 2022 assuming other variables are constant.

$$\hat{y} = -0{,}13x_3 - 1{,}14(x_3 - 73{,}89)_+^1 + 35{,}60(x_3 - 75{,}02)_+^1 - 38{,}35(x_3 - 76{,}14)_+^1$$

$$= \begin{cases} 0{,}13x_3 & ; x_3 < 73{,}89 \\ -1{,}27x_3 + 83{,}43 & ; 73{,}89 \leq x_3 < 75{,}02 \\ 33{,}79x_3 - 2587{,}3 & ; 75{,}02 \leq x_3 < 76{,}14 \\ -4{,}56x_3 - 332{,}6 & ; x_2 \geq 76{,}14 \end{cases}$$

The model shows that districts with LFPR (x_3) below 73.89% cause the GRDP growth rate to increase by 0.13% for every 1 unit increase in LFPR. Based on LFPR data in South Sulawesi Province in 2022, there are 20 districts/cities in this category with values < 73.89 namely Sidrap, Pinrang, Makassar, Wajo, Maros, Soppeng, Barru, Sinjai, Pare Pare, Palopo, Takalar, Bulukumba, Bone, Luwu, North Toraja, Selayar Islands, East Luwu, Enrekang, North Luwu and Gowa.

Districts/cities with LFPR (x_3) in the interval 73.89% to 75.02% cause the GRDP growth rate to decrease by 1.27% for every 1 unit increase in LFPR. Based on LFPR data

in South Sulawesi Province in 2022, Kabupaten Pangkep is a region that falls into this category.

Districts/cities with LFPR (x_3) in the interval 75.02% to 76.14% cause GRDP to increase by 33.79% for every 1 unit increase in LFPR. Based on LFPR data in South Sulawesi Province in 2022, districts/cities in this category are Jeneponto and Bantaeng.

Meanwhile, districts/cities with TPAK LFPR (x_3) above 10.74% caused GRDP to increase by 8.68% for every 1 unit increase in LFPR. Based on LFPR data in South Sulawesi Province in 2022 Tana Toraja district is an area that falls into this category.

The classification based on districts/cities with LFPR in South Sulawesi province in 2022 can be visually represented in the figure below with the assumption that other variables are constant.

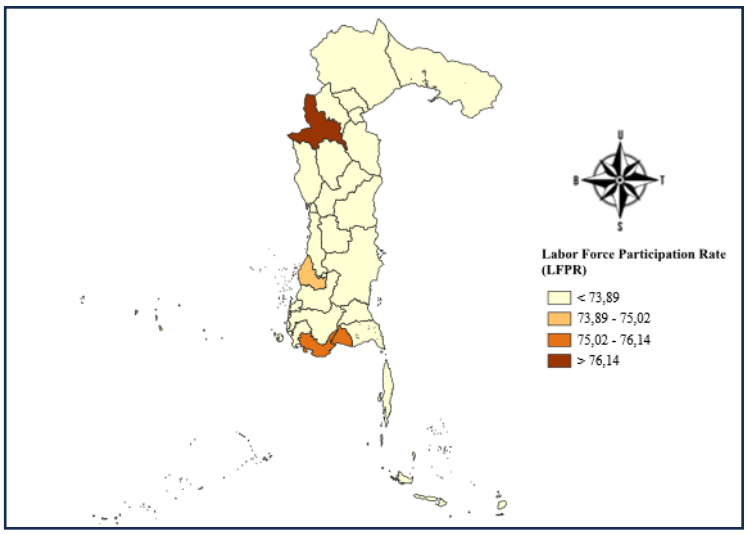

Figure 4. Distribution of Districts/Cities Based on LFPR

The figure above shows that most of the regions in South Sulawesi have a low LFPR as shown in the figure above. This is in accordance with the results of descriptive analysis which shows that the average value of LFPR is 67.29.

CONCLUSION

Due to the Covid-19 outbreak, GRDP growth in Palopo City, which is a location with above-average gross regional income, experienced a significant decline in 2020. However, the GRDP growth rate started to increase again in 2021 after the outbreak ended, indicating a recovery of GRDP due to the covid-19 pandemic. The best nonparametric regression model to model the growth rate of GRDP is Spline truncated regression at 3 knots with a GCV value of 4.948981. There is one variable that is not significant the

model, namely the number of accommodation (x_1) while the hotel Room Occupancy Rate (ROR) (x_2) and the Labor Force Participation Rate (x_3) are significant to the model.

The R^2 value in Spline regression models shows the goodness of the model, which is 76.94%. The following is a truncated Spline regression model with 3 knot points.

$$\hat{y} = 11{,}95 - 0{,}12x_1 + 0{,}14(x_1 - 18{,}96)_+^1 + 0{,}12(x_1 - 20{,}21)_+^1 + 0{,}11(x_1 - 21{,}45)_+^1 + 0{,}16x_2 - 14{,}32(x_2 - 23{,}26)_+^1 + 27{,}48x_2(x_2 - 24{,}78)_+^1 - 13{,}47(x_2 - 26{,}31)_+^1 - 0{,}13x_3 - 1{,}14(x_3 - 73{,}89)_+^1 + 35{,}60(x_3 - 75{,}02)_+^1 - 38{,}35(x_3 - 76{,}14)_+^1$$

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