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JCI MODELING IN INDONESIA BASED ON INDUSTRIAL PRODUCTION INDEX WITH LOCAL POLYNOMIAL ESTIMATOR APPROACH

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ABSTRACT

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The industrial sector is the leading sector that contributes the most to Indonesia's economic growth. Industry can be caused by various factors, one of which is the Jakarta Composite Index (JCI). Indonesian stock prices have a high variance that requires proper modeling. Therefore, this study uses a local polynomial nonparametric regression approach. This study aims to estimate and obtain the best JCI model based on the production index of large and medium industries using a local polynomial estimator and also to know the accuracy of the JCI model based on the production index of large and medium industries. The data used in this study is secondary data using production index data for medium-large industries and data on the composite stock index in Indonesia in the form of time series, which were obtained through the Central Statistics Agency Publication website on the page www.bps.go.id. JCI modeling in Indonesia based on the production index of large and medium industries is most effective on local polynomials with polynomial degree two, which obtains an optimal bandwidth of 7,8795 with a minimum Cross-Validation (CV) value of 163170,3 and a Mean Absolute Percentage Error (MAPE) value of 9.1%. From the MAPE value, it is said that the model is good for making future predictions.

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1. INTRODUCTION

Development in the industrial sector is an integral part of national development, which must be carried out in an integrated and sustainable manner so that development in the industrial sector can provide great benefits to society [1]. Of all Indonesia's business fields, it shows that the manufacturing industry sector remains the leading sector that makes the largest contribution to Indonesia's economic growth, especially large and medium industries that are ready to produce to meet market demand [2]. The industrial sector not only has the potential to make a large economic contribution through added value, employment, and foreign exchange, but is also capable of making a major contribution to the nation's cultural transformation towards modernizing people's lives, which supports the formation of national competitiveness [3].

Many theories attempt to explain the relationship between economic growth and investment in a country. It is said that stock in the amount of production output in a certain period will affect the amount of output in the next period [4]. This theory explains that the amount of capital stock of a company depends on the output level of the company. The high level of output will increase the demand for capital, which is higher. The demand for capital is obtained through investment by increasing the amount of capital of a company, which in turn will affect the level of output produced.

Regression analysis is used to examine the relationship between two or more variables, especially to trace patterns of relationships whose models are not completely known or to determine the effect of several predictor variables on the response variable in a complex phenomenon [5]. In the regression analysis there are two kinds of approaches, namely, the parametric approach and the nonparametric approach [6]. The nonparametric approach is not bound by the assumption of a particular form of the regression function. One of the estimators in nonparametric regression is the local polynomial estimator [7].

The JCI and production index data may exhibit different patterns in various periods or market conditions. Local polynomial regression allows for adaptability by fitting different polynomials to different parts of the data. This adaptability helps capture local trends and variations. The local polynomial estimator is an estimator based on the principle of minimizing the sum of squared errors by weighting the kernel function, while the size of the weights is determined by a parameter called bandwidth [8]. Local polynomials are a flexible and efficient approach to statistical methods [9]. The local polynomial estimator depends on two parameters: the order of the local polynomial matches and a smoothing parameter, namely the bandwidth [10]. The effect of these parameters is to increase the variance and reduce bias if the fit order is higher and the bandwidth is smaller. However, reduces the variance and increases if orders are lower and bandwidth is large [11].

Research conducted by Izzuddin Khalid et al. in 2015 entitled “Nonparametric Regression Modeling of Longitudinal Data Using Local Polynomials (Case Study: Closing Price of Shares at Share Price Groups for January 2012-April 2015)” [12]. The result of his research is to estimate and get the best model of the closing price of stocks based on time. The difference in the current research is using large and medium industrial production index predictors. The movement of the large and medium industrial production index reflects the performance of the industrial sector in a country, encompassing various sectors such as manufacturing, mining, and utilities. This large and medium industrial production index influences market sentiment and investors and potentially affects the Composite Stock Price Index, which measures the performance of the stock market. In this research, the out-sample MAPE value was better than the previous research, which was 9.1%, a very good estimate.

2. RESEARCH METHODS

2.1 Data and Data Sources

The data used in this study is secondary data in the form of production index data for medium-large industries and data on the composite stock index in Indonesia. Production index data for large and medium industries were obtained through the monthly Central Statistics Agency Publication website for large and medium industries on the page www.bps.go.id, and Indonesian stock index data obtained from the Central Statistics Agency Publication website regarding transactions and stock index on the Stock Exchange on the www.bps.go.id page.

2.2 Research Variable

Theoretically, a variable can be defined as an attribute of a person or an object that varies from one person to another or from one object to another [13]. The independent variable (X) in this study is the Production Index for Large and Medium Industries. The dependent variable (Y) in this study is the Indonesian Composite Stock Price Index.

2.3 Analysis Procedure

The stages carried out in data analysis include [14]:

1. Describe the composite stock price index and the production index of large and medium industries.
2. Estimating and modeling the data of the composite stock price index and the production index of large and medium industries obtained using nonparametric regression based on the local polynomial estimator as follows:
   a. Create a scatterplot on in-sample data. If the results of the scatterplot show a monotonous trend up or down, then use order 1. If it shows fluctuating ups and downs then use order 2.
   b. Choose the bandwidth value (h) and the optimal order with the minimum CV (Coefficient of Variation) based on the equation on the in-sample data.
   c. Modeling the data with a local polynomial estimator based on the optimal bandwidth value and order at point b to get the best local polynomial model.
   d. Determining the suitability of the model using goodness of fit measures in the form of R^2, MSE, and MAPE.
   e. Comparing the estimation results with observations on out-sample data.
   f. Make an estimation plot between observed values and predicted values based on in-sample data with the best local polynomial estimation equation.
3. Analyze and interpret nonparametric regression models based on local polynomial estimators related to data on the composite stock price index and production index of large and medium industries.

3. RESULTS AND DISCUSSION

3.1 Data Descriptive Analysis

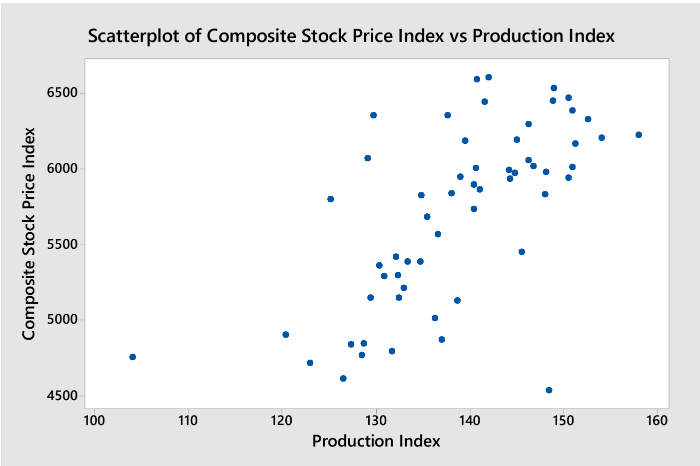

Figure 1. Scatterplot Indonesian composite stock price index which is influenced by the production index of large and medium industries

In Figure 1, it can be shown that the data fluctuates up and down. The highest Indonesian composite stock price index was in January 2018, with a value of 6605,63. Then, the highest large and medium industrial production index was in October 2019, with a value of 158.

3.2 Analysis Using Parametric Methods

Analysis using the parametric method was carried out to compare the R-Square values of several parametric regression models with nonparametric regression methods, especially using a local polynomial estimator.

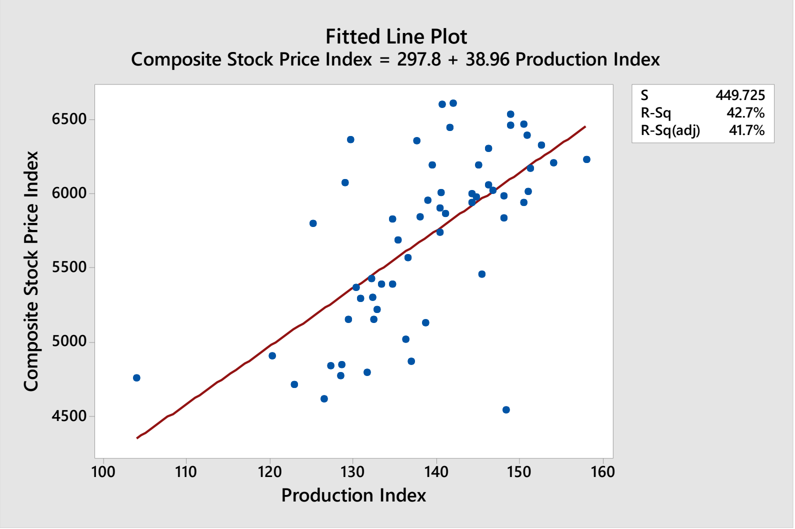

Figure 2. The plot of Indonesia's composite stock price index which is influenced by the production index of large industries is using linear parametric regression

Based on **Figure 2**, it can be seen that the value of R^2 is 42.7%, meaning that the production index variable for large and medium industries can explain the diversity of the Indonesian composite stock price index variable in a linear manner of 42.7%. So that a moderate R^2 value is obtained so that the model estimation is quite good.

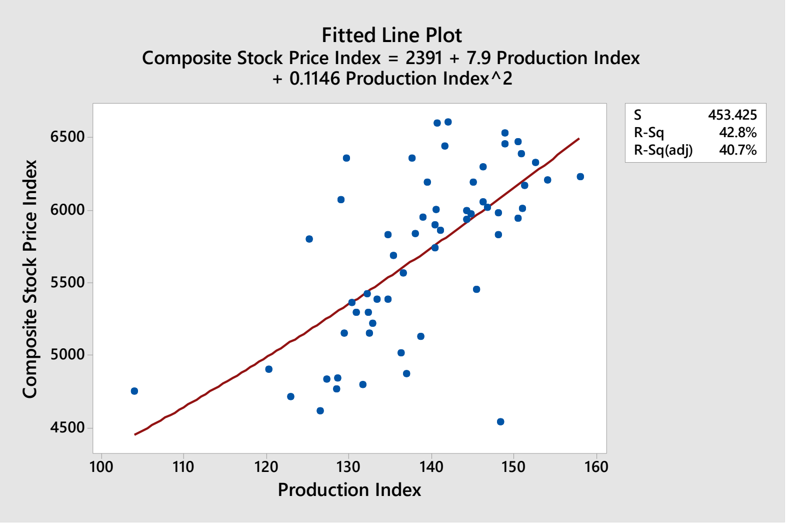

Figure 3. The Plot of Indonesia's composite stock price index which is influenced by the production index of large industries is using quadratic parametric regression

Based on **Figure 3**, it can be seen that the value of R^2 is 42.8%, meaning that the production index of large and medium industries can explain the diversity of the variable Indonesian composite stock price index in a linear manner of 42.8%. So that a moderate R^2 value is obtained so that the model estimation is quite good.

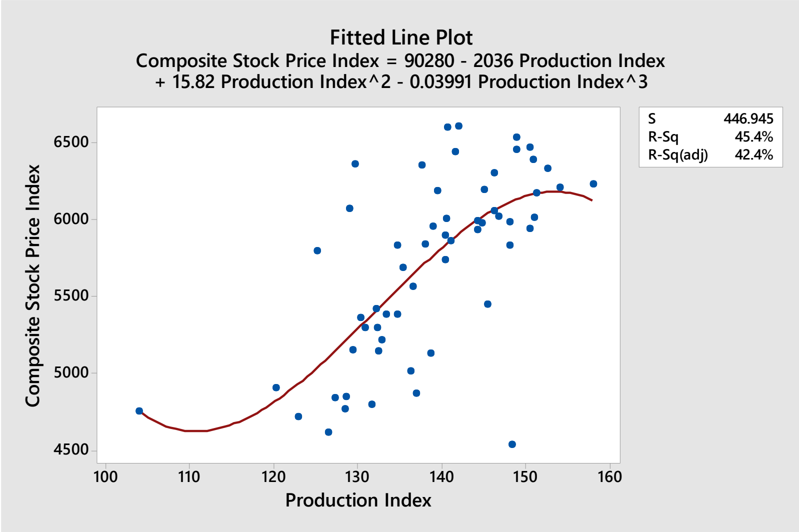

Figure 4. The plot of Indonesia's composite stock price index which is influenced by the production index of large industries is using cubic parametric regression

Based on **Figure 4**, it can be seen that the value of R^2 is 45.4%, meaning that the production index of large and medium industries can explain the diversity of the variable Indonesian composite stock price index in a linear manner of 45.4%. So that a moderate R^2 value is obtained so that the model estimation is quite good.

3.3 Analysis Using Nonparametric Methods

Based on **Figure 1**, it is known that the plot of the Indonesian Composite Stock Price Index, which is affected by the production index of large and medium industries, is showing a fluctuating pattern. So, by using nonparametric regression analysis with a local polynomial estimator, the authors estimate the model for the data by selecting the smoothest estimate using the CV method.

3.3.1 Choosing the Optimal Bandwidth

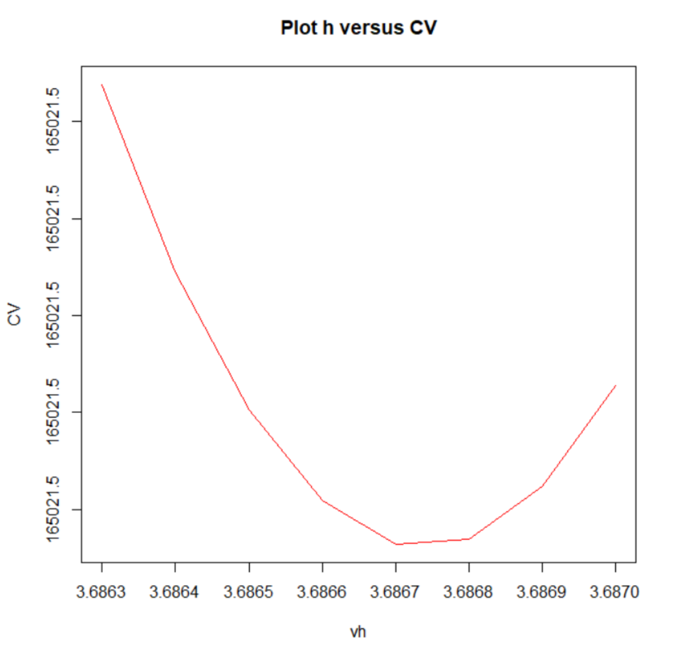

Figure 5. Plot of the value of h (bandwidth) with the value of cv with a polynomial degree of 0

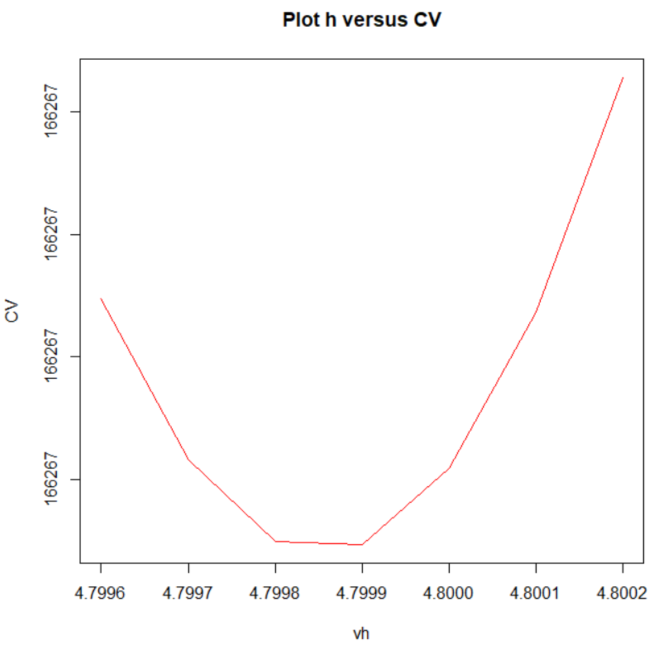

Figure 6. Plot of the value of h (bandwidth) with the value of cv with a polynomial degree of 1

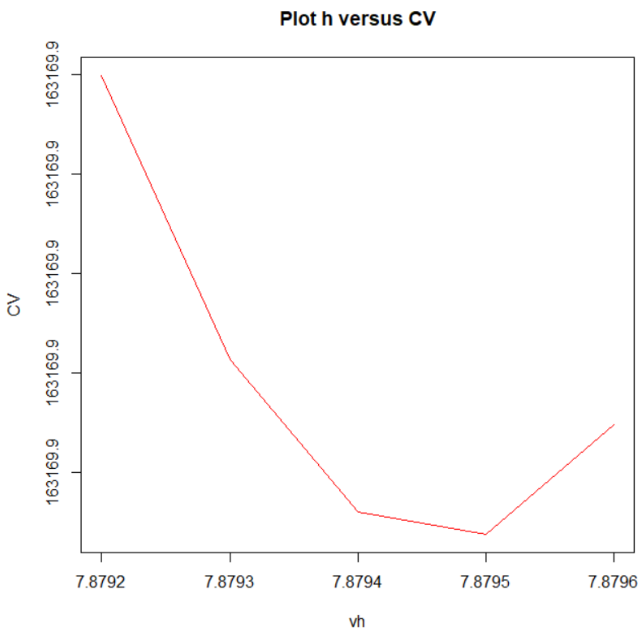

Figure 7. Plot of the value of h (bandwidth) with the value of cv with a polynomial degree of 2

Based on the three bandwidth selection plots above, the following results can be obtained:

Table 1. Choosing the Optimal Bandwidth Based on Minimum CV

	Order (Polynomial Degree)		
	0	**1**	**2**
Optimal h	3.6867	4.7999	7.8795
Minimum CV	165021.9	166267	163170.3
MSE in-sample	129727.7	148156.2	154236.7
R^2 in-sample	0.4200374	0.479706	0.4993935
MAPE in-sample	9.014295	9.230031	9.280855

The best model is the model that has the optimal bandwidth value with the minimum CV value. After several trials on polynomial degrees 0, 1, and 2, it was found that the most effective model on local polynomials with polynomial degree 2 obtained an optimal bandwidth of 7.8795 with a minimum CV value of 163170.3.

3.3.2 Estimation Results and Data Training Model Interpretation

The model of the estimation equation for the Indonesian composite stock price index, which is affected by the production index of large and medium industries at $x_0 = 104.02$ is as follows.

$$\hat{Y} = 33389.056 - 543.997\,x + 2.55\,x^2 \text{ with } 96.1405 < x < 111.8995 \qquad (1)$$

Based on the results of the $\hat{Y}$ estimate with a value of $x_0 = 104{,}02$ in the interval 97 to 111, the following plot of the Indonesia composite stock price index can be seen in **Figure 8** below.

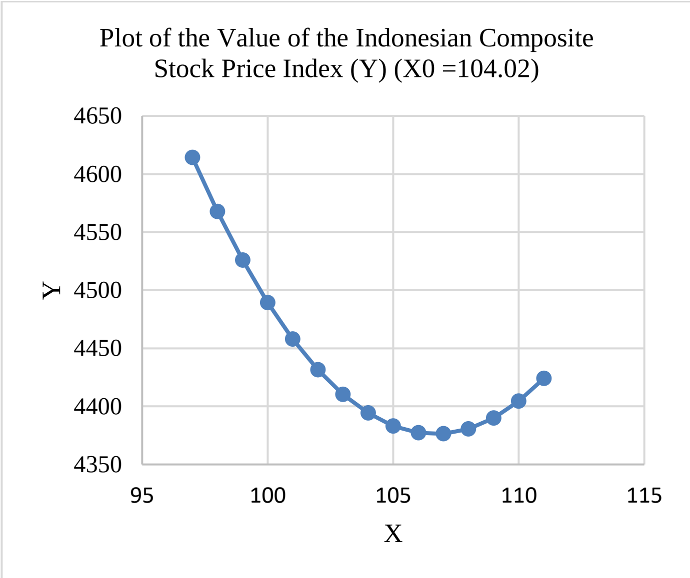

Figure 8. Plot of the value of the indonesian composite stock price index with $x_0 = 104.02$

The following is a plot between the in-sample percentage data for the Indonesian composite stock price index (Y) and the estimated value of the Indonesian composite stock price index ($\hat{Y}$) obtained after modeling.

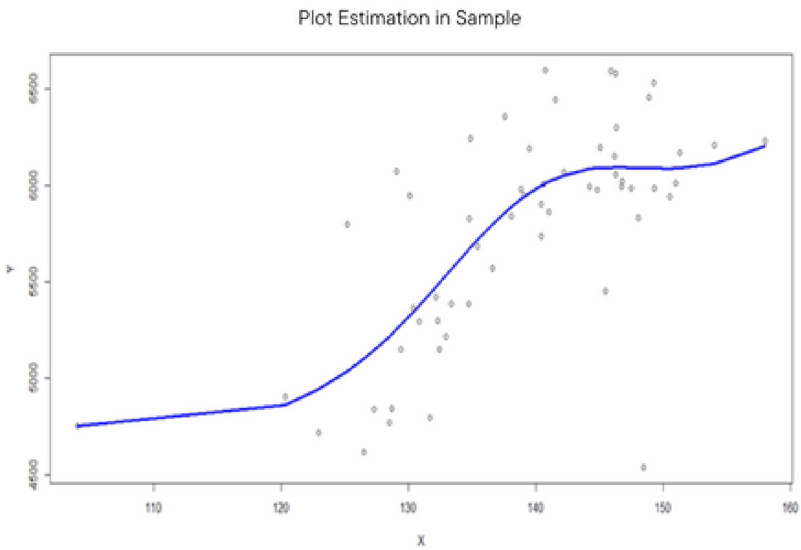

Figure 9. Plot of data in-sample observation

In the estimation results of a model with order 2, the MSE is obtained from in-sample data of 154326.4 with an R^2 of 0.4996841 or 49.96%, which means that the Indonesian composite stock price index is influenced by the production index of large and medium industries of 49.96%, while the rest is influenced by variables outside the regression model, and the MAPE obtained is very good at 9.28%. Forecasting results using this model will produce good forecasts because the MAPE value of 9.28% is below 10% [15]. After obtaining the estimation results of in-sample data, the average error test is carried out as follows.

Test

Null hypothesis	$H_0: \mu = 0$
Alternative hypothesis	$H_1: \mu \neq 0$

T-Value	P-Value
-0,21	0,837

Figure 10. Error average test output

The average error is zero if the p-value is greater than the alpha value. The alpha used is 5% or 0.05, based on the output of the Minitab software, and the p-value is 0.837. Then the p-value is greater than the alpha value, so the decision to accept H_0 is obtained, which means that the average error (error) is zero.

3.3.3 Estimation Results and Data Testing Model Interpretation

The model of the estimation equation for the Indonesian composite stock price index which is affected by the production index of large and medium industries at $x_0 = 150.55$ is as follows.

$$\hat{Y} = -58660.234 + 861.554\,x - 2.866\,x^2 \text{ with } 142.6705 < x < 158.4295 \qquad (2)$$

Based on the results of the $\hat{Y}$ estimate with a value of $x_0 = 150.55$ in the interval 143 to 158, the following plot of the Indonesia composite stock price index can be seen in Figure 11 below.

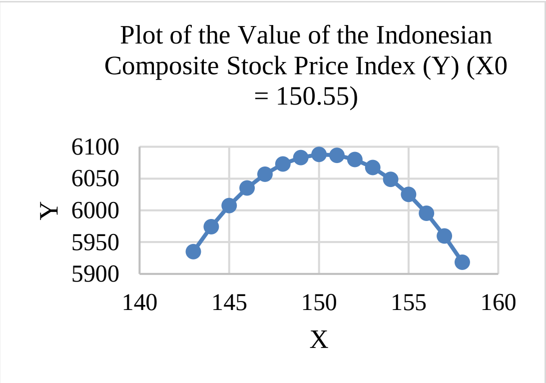

Figure 11. Plot of the Value of the Indonesian Composite Stock Price Index with $x_0 = 150.55$

The following is a plot between the out-sample percentage data for the Indonesian composite stock price index (Y) and the estimated value of the Indonesian composite stock price index ($\hat{Y}$) obtained after modeling.

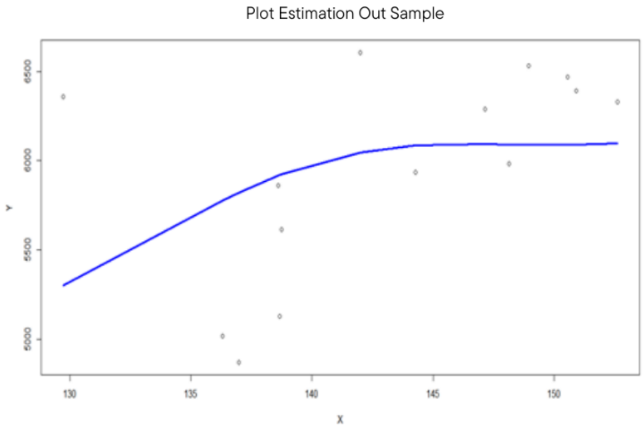

Figure 12. Plot of data out-sample observation

In the estimation results of a model with order 2, the MSE of out-sample data was 44232.92 with a very good MAPE of 9.4%. Forecasting results using this model will produce good forecasts because the MAPE value of 9.4% is below 10% [15].

3.3.4 Estimation Results and Check Interpretation

The model of the estimation equation for the Indonesian composite stock price index which is affected by the production index of large and medium industries at $x_0 = 142$ is as follows.

$$\hat{Y} = -69285.457 + 1030.85\,x - 3.49\,x^2 \text{ with } 134.1205 < x < 149.8795 \qquad (3)$$

Based on the results of the $\hat{Y}$ estimate with a value of $x_0 = 142$ in the interval 135 to 149, the following plot of the Indonesia composite stock price index can be seen in Figure 13 below.

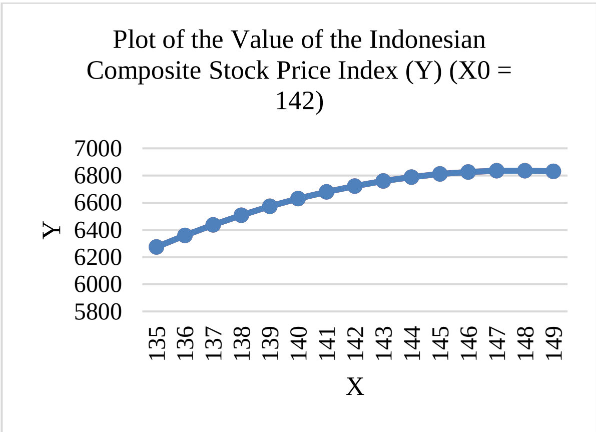

Figure 13. Plot of the value of the Indonesian composite stock price index with $x_0 = 142$

The following is a plot between the all-sample percentage data for the Indonesian composite stock price index (Y) and the estimated value of the Indonesian composite stock price index ($\hat{Y}$) obtained after modeling.

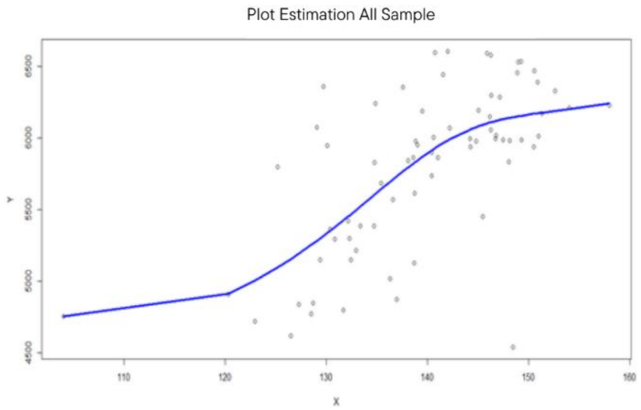

Figure 14. Plot of data all-sample observation

In the estimation results of a model with order 2, the MSE of all-sample data was 1400049.9 with a very good MAPE of 9.1%. Forecasting results using this model will produce good forecasts because the MAPE value of 9.1% is below 10% [15].

4. CONCLUSIONS

1. Based on the plot of the Indonesia Composite Stock Price Index, which is influenced by the production index of large and medium industries, it is showing a fluctuating pattern. So, by using nonparametric regression analysis with a local polynomial estimator, the authors estimate the model for the data by selecting the smoothest estimate using the CV method.

2. Modeling the Indonesian composite stock price index based on the production index of large and medium industries, which is most effective on local polynomials with polynomial degree 2, obtained an optimal bandwidth of 7.8795 with a minimum CV value of 163170.3.
3. The MAPE value obtained was very good at 9.1%. Forecasting results using this model will produce good forecasts because the MAPE value of 9.1% is below 10%. From this value, it is said that the model is good for making predictions in the future.
4. In this research, the selection of the bandwidth value (h) and the optimal order is using the minimum CV. So that future research can use other methods such as Generalized Cross Validation (GCV), Maximum Likelihood Cross Validation (MLCV), and so on.

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