The Accuracy Analysis of Loan Interest Rate Forecasting Using Double Exponential Smoothing Methods

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ABSTRACT

This study aims to forecast the rupiah loan interest rates at commercial banks in Indonesia using the exponential smoothing method. The data used is the credit interest rate data from December 2015 to September 2016. The exponential smoothing methods applied i.e. double exponential smoothing. The results show that the double exponential smoothing method provides the accurate predictions with the smallest Root Mean Square Error (RMSE) of 0,06629. The optimal parameters used in double exponential smoothing are an alpha of 0.3 and a beta of 0.3. These findings indicate that double exponential smoothing can effectively capture trends and patterns in credit interest rate data, making it a reliable tool for future loan interest rate forecasting. The results of this study are expected to make a significant contribution to strategic decision-making in the banking sector, particularly in risk management and loan interest rate strategy determination.

1. Introduction

Forecasting is a crucial aspect of business and economics, especially in planning and decision-making. In the banking context, the ability to predict loan interest rates has significant implications for risk management and the financial strategies of banks. One commonly used forecasting method is exponential smoothing, a statistical technique effective in handling time series data.

Exponential smoothing is a forecasting method that uses the exponential average of historical data to make predictions. It is a relatively simple and effective approach to forecasting [1],[2]. This technique has several variants, including single exponential smoothing, double exponential smoothing, and triple exponential smoothing, each with advantages suited to specific data patterns [3],[4]. The reliability and simplicity of its application make exponential smoothing a popular choice in economic and financial data analysis.

This research focuses on forecasting the rupiah loan interest rates (*suku bunga*) at commercial banks in Indonesia during the period Dec 2015 – Sep 2018. Loan interest rate data is a crucial indicator in the banking world, as it affects loan decisions for both banks and customers. By understanding the patterns of loan interest rates, banks can strategize more competitively and align their credit offerings with market conditions.

The aim of this research is to apply the exponential smoothing method in forecasting rupiah loan interest rates and to evaluate the accuracy of these predictions. Therefore, the findings from this

research are expected to make a meaningful contribution to strategic decision-making in the banking sector and provide insights into the effectiveness of the exponential smoothing method in the context of economic data in Indonesia.

2. Literature Review

Double exponential smoothing (DES) is a time series forecasting method that extends simple exponential smoothing to capture data with trends. While simple exponential smoothing is suited for data without trends, double exponential smoothing can handle data that shows a consistent upward or downward movement over time.

Key Components of DES [5],[6]:

Level (L): The smoothed value of the series at time t

Trend (T): The smoothed value of the trend at time t

Initialization:

Initial level $L_0 = Y_0$ (where Y_0 is the first observation). (1)

Initial trend $T_0 = Y_1 - Y_0$ (difference between the first two observations). (2)

For time $t \geq 1$:

- $L_t = \propto Y_t + (1-\propto)(L_{t-1} + T_{t-1})$ (3)
- $T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$ (4)

Where : $\propto$ is the smoothing parameter for the level $(0 <\propto< 1)$. β is the the smoothing parameter for the level $(0 < \beta < 1)$

The forecast for k periods ahead is given by: $\hat{Y}_{t+k} = L_t + kT_t$ (5)

Root Mean Square Error (RMSE) is a standard way to measure the error of a model in predicting quantitative data. It represents the square root of the average of the squared differences between predicted and observed values. RMSE is particularly useful because it gives a relatively high weight to large errors, which can be particularly important in some contexts.

The formula for RMSE [7]:

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\hat{y}_i - y_i)^2} \quad (6)$$

Where: n is the number of observations, $\hat{y}_i$ is the predicted value, and y_i is the observed value.

3. Research Method and Materials

This research uses data on rupiah loan interest rates from commercial banks in Indonesia. The data has a time series element with monthly periods from January 2013 to November 2015, downloaded from the official website of BPS Indonesia. The data was collected without conducting experiments, or secondary data, because the data was obtained by downloading the data already available on the Source URL: https://www.bps.go.id/indicator/13/383/8/suku-bunga-kredit-rupiah-menurut-kelompok-bank.html.

The stages of data analysis for this research are as follows:

a) Data Collection:
   - Obtain rupiah loan interest rate data from commercial banks in Indonesia.
   - Ensure the data has a time series element with monthly periods from January 2013 to November 2015.
   - Download the data from the official BPS Indonesia website (Source URL).

b) Analysis Descriptive
c) Forecasting using the Double Exponential Smoothing method
d) Optimizing parameters for each method
e) RMSE values to determine the method
f) Forecasting for the next 10 periods
g) Creating a comparison plot of actual data and forecasted data
h) Conclusion and recommendations

4. Results and Discussion

4.1. Descriptive Analysis

In this research, forecasting will be conducted using past data to analyze and then predict loan interest rates from December 2015 to September 2016 in Indonesia. Below is the loan interest rate data in Table 1.

Table 1. Loan Interest Rates Data

Month	Year	Interest Rate (%)
January	2013	13.62
February	2013	13.68
March	2013	13.68
⋮	⋮	⋮
September	2015	12.91
October	2015	12.78
November	2015	12.66

The data is visualized in a time series plot to facilitate analysis. The analysis is conducted to determine whether the data plot exhibits a trend pattern. The Loan Interest data plot from January 2013 to November 2015 is depicted in Figure 1.

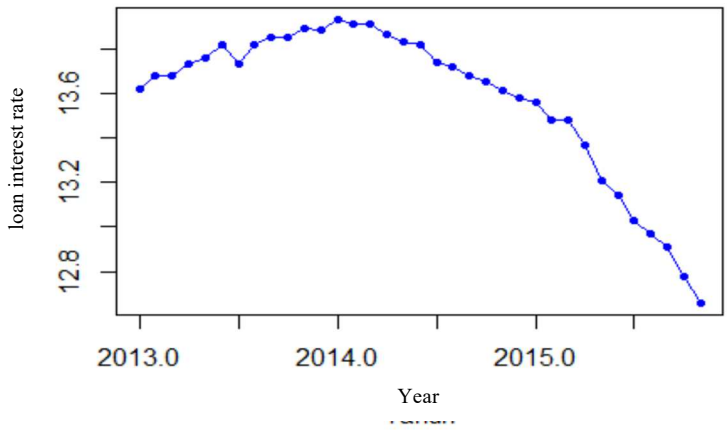

Figure 1. Plot of loan interest rate data

Based on Figure 1, it can be indicated that the rupiah loan interest rate data for commercial banks shows a downward trend over a certain period. The pattern in the above data can be concluded to have a downward trend, even though there was an increase at one point. Therefore, the DES (Double Exponential Smoothing) and TES (Triple Exponential Smoothing) forecasting methods can be used to predict the data.

4.2. Double Exponential Smoothing

The forecasting method for loan interest rate data in Indonesia using the Double Exponential Smoothing method. Input the parametervalues α and β:The parameters are determined by trial and error, with values ranging between 0 and 1. Here, α = 0.1 and β = 0.1, α = 0.3 and β = 0.3, and α = 0.6 and β = 0.6 are used.

Smooth the data: Smooth the data using the forecast package, where *h* is the number of periods to be forecasted, which is 10 periods ahead, for each of the parameter pairs: α= 0.1 and β= 0.1 and α= 0.3 and β= 0.3,

Table 2. Accuracy of Calculation Results for Double Exponential Smoothing

Smoothing Parameter		Accuracy Values		
∝	β	SSE	MSE	RMSE
0.1	0.1	4.88081	0.13945	0.37343
0.3	**0.3**	**0.15383**	**0.00439**	**0.06629**

Based on the accuracy calculations on Table 2, it is evident that, among the three goodness-of-fit measures (SSE, MSE, and RMSE), the smoothing method with alpha = 0.3 and beta = 0.3 has smaller accuracy values compared to the smoothing methods with alpha = 0.1 and beta = 0.1. Therefore, in this case, it can be concluded that the smoothing method with alpha = 0.6 and beta = 0.6 is better suited for forecasting the data.

Based on the RMSE values on Table 2, the best method for forecasting the loan interest rate data in Indonesia is determined to be the one with the lowest RMSE value is Double Exponential Smoothing. Therefore, the forecasting results from the double exponential smoothing method will be used to predict the car registration data for the next 10 months in Table 3.

Table 3. Forecasting of the loan interest rate in Indonesia the next 10 months

Month	Year	Interest Rate (%)
Dec	2015	12.60655
Jan	2016	12.50759
Feb	2016	12.40863
Mar	2016	12.30967
Apr	2016	12.21072
May	2016	12.11176
Jun	2016	12.01280
Jul	2016	11.91384
Aug	2016	11.81489
Sep	2016	11.71593

Next, as shown in Figure 2, is a plot comparing the actual data and the smoothed data.

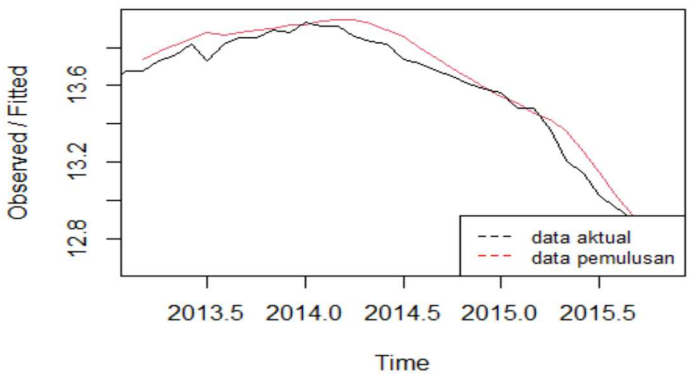

Figure 2. Plot comparing the actual data and the smoothed data

From the plot in Figure 2, it can be seen that the black line represents the actual data, while the red plot represents the forecast results from the Double Exponential Smoothing method. It is evident that the forecast results from the Double Exponential Smoothing method can follow the movement of the actual data.

5. Conclusion

Based on the above research results, it can be concluded that: Double Exponential Smoothing can forecast rupiah loan interest rate data in Indonesian commercial banks more accurately. The use of the DES method for forecasting loan interest rate data at Banks in Indonesia with 35 monthly data points from January 2013 to November 2015 presents the following results: The parameter values $\alpha = 0.3$ and $\beta = 0.3$ with a forecasting accuracy value resulting in an RMSE of 0.06629; The forecasted loan interest rate data at banks in Indonesia from December 2015 to September 2022 shows a gradual decline in each period compared to the previous period; Based on the existing forecast data, the loan interest rate data at banks in Indonesia obtained is not exactly the same as the actual data but sufficiently follows the movement of the actual data.

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