Quantitative Economics and Management Studies (QEMS) *ISSN: 2722-6247 (online)*
Vol. 5 No. 3 (2024)
https://doi.org/10.35877/454RI.qems2718

The Implementation of Holt-Winters Method to Forecast the Loan Interest Rate of Indonesia

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Abstract

This study aimed to anticipate the rupiah loan interest rates at commercial banks in Indonesia by employing the Holt-winters method. This study employs data on rupiah loan interest rates from commercial banks in Indonesia. The data comprises a time series element, with monthly intervals spanning from January 2013 to November 2015, which was obtained from the official website of BPS Indonesia. The study demonstrates that the Holt-winters technique yields the most accurate forecasts, as indicated by a Root Mean Square Error (RMSE) of 0.19720630. The parameters alpha, beta, and gamma, set at 0.6, 0.6, and 0.6 respectively, constitute the optimal configuration for this method. These results indicate that the Holt-winters method is an effective tool for capturing seasonality, trends, and patterns in credit interest rate data, making it a reliable choice for future loan interest rate forecasting. The findings of this study are expected to significantly contribute to strategic decision-making in the banking sector, particularly in risk management and loan interest rate strategy determination.

Keywords: Holt-winters, loan interest rate, forecasting.

Received: 4 January 2024 Revised: 29 May 2024 Accepted: 20 June 2024

1. Introduction

The Holt-Winters method, a popular forecasting technique, has been extensively studied and applied in various fields such as economics, statistics, and computer science. This method, introduced by Holt and Winters, is particularly useful for time series data that exhibit trend and seasonal patterns (Lima et al., 2019). In the context of forecasting the loan interest rate of Indonesia, the Holt-Winters method can be a valuable tool due to its ability to capture both trend and seasonality in the data (Bayu et al., 2021). By incorporating exponential smoothing, trend effects, and seasonal effects, the Holt-Winters method can provide accurate forecasts for complex time series data (Zhu et al., 2022).

The Holt-Winters method, being a classic time series technique commonly used for short-term forecasting, has been applied in various contexts beyond finance, including ecological footprint forecasting and precipitation variations (Bhagat, 2023; Cordeiro & Neves, 2012). Its versatility and effectiveness in handling different types of data make it a valuable tool for researchers and practitioners seeking reliable forecasting solutions. Moreover, the method has been utilized in forecasting scenarios involving multiple seasonal patterns, demonstrating its adaptability to complex data structures (Hani'ah et al., 2022).

Research comparing the Holt-Winters method with other forecasting techniques has shown promising results. For instance, a study by compared the Linear Regression method with the Holt-Winters method in forecasting oil and gas export volume in Indonesia, highlighting the effectiveness of the Holt-Winters approach (Sibuea et al., 2022). Additionally, a study by demonstrated the stability and accuracy of multiple seasonal Holt-Winters models in predicting hourly electricity demand in Spain, showcasing the method's robustness in handling complex forecasting tasks (Trull et al., 2020).

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Moreover, the Holt-Winters method has been applied in diverse scenarios beyond economics. For example, utilized the Holt-Winters Seasonal Additive Forecasting method to predict precipitation variations in central Vietnam, showcasing the method's versatility in different domains (Bhagat, 2023). Similarly, employed the Holt-Winters method to forecast foreign tourists' arrival at major airports in Indonesia, demonstrating its applicability in tourism forecasting (Ponziani, 2021).

Furthermore, the Holt-Winters method has been compared with other forecasting models in different contexts. Compared the accuracy of the Holt-Winters method with ARIMA and SutteARIMA in predicting the infant mortality rate in Indonesia, showing that the Holt-Winters method outperformed the other models in terms of Mean Absolute Percentage Error (MAPE) and Mean Squared Error (MSE) (Ahmar et al., 2022). Similarly, highlighted the statistical foundations of the Holt-Winters method, emphasizing its efficacy in dynamic nonlinear statistical models (Ord et al., 1997).

In the realm of energy forecasting, emphasized the suitability of the Holt-Winters method for analyzing time series data with trend, seasonality, and randomness, further underlining its relevance in forecasting energy production (Zhu et al., 2022). Additionally, applied the Holt-Winters method to forecast electricity demand in Indonesia, demonstrating its superiority over ARIMA in certain forecasting scenarios (Mardiana et al., 2020).

The Holt-Winters method, a well-established technique in time series forecasting, has found applications in various fields such as finance, marketing, and economics due to its ability to capture both trend and seasonal components in data (Chen, 1996). In the context of Indonesia, where the loan interest rate plays a pivotal role in financial decisions, accurate forecasting of this rate is crucial for stakeholders to make informed decisions and manage risks effectively. While previous studies have utilized different forecasting methods, including the Holt-Winters method, to predict the loan interest rate in Indonesia, there remains a gap in research evaluating the effectiveness of this method specifically for forecasting loan interest rates in the country (Hani'ah et al., 2022).

In the Indonesian context, where accurate forecasting of economic indicators like the loan interest rate is essential for decision-making, the Holt-Winters method presents a promising approach to enhance forecasting accuracy (Hani'ah et al., 2022). By evaluating the performance of this method specifically for forecasting loan interest rates in Indonesia, researchers can contribute valuable insights to the existing body of knowledge in financial forecasting (Hani'ah et al., 2022). This study aims to bridge the gap in research by providing a comprehensive analysis of the effectiveness of the Holt-Winters method in forecasting loan interest rates in Indonesia, thereby offering stakeholders valuable information to support their financial decisions and risk management strategies (Hani'ah et al., 2022).

In conclusion, the Holt-Winters method stands out as a robust and versatile forecasting technique that can be effectively applied to predict the loan interest rate of Indonesia. Its ability to capture trend, seasonality, and randomness makes it a valuable tool for forecasting in various domains, ranging from economics to climate science. By leveraging the strengths of the Holt-Winters method, researchers and practitioners can enhance their forecasting accuracy and make informed decisions based on reliable predictions

2. Methods

The Holt-Winters method is employed for data sets that exhibit both trend and seasonal components, as described by Makridakis (1999). The technique utilizes the equations (1-6):

$$S_t' = \propto X_t + (1-\propto)S_{t-1}' \quad (1)$$

$$S_t'' = \propto S_t' + (1-\propto)S_{t-1}'' \quad (2)$$

$$S_t''' = \propto S_t'' + (1-\propto)S_{t-1}''' \quad (3)$$

$$a_t = 3S_t' - 3S_t'' + S_t''' \quad (4)$$

$$b_t = \frac{\propto}{2(1-\propto)^2}[(6-5\propto)S_t' - (10-8\propto)S_t'' + (4-3\propto)S_t'''] \quad (5)$$

$$c_t = \frac{\propto^2}{(1-\propto)^2}(S_t' - 2S_t'' + S_t''') \quad (6)$$

Where; S_t' = First-order exponential smoothing value for period t, S_t'' = Second-order exponential smoothing value for period t, S_t''' = Third-order exponential smoothing value for period t, $\propto$ = Smoothing constant with $0 <\propto< 1$, $a_t =$

Adjusted average value for period t, b_t = Second-order smoothed trend for period t, and c_t = Triple smoothed trend for period t.

Root Mean Square Error (RMSE) is a widely used method for assessing the accuracy of a model's predictions for quantitative data. It is calculated as the square root of the average of the squared differences between the predicted and actual values. RMSE is a valuable metric as it assigns greater importance to larger errors, which may be particularly relevant in certain contexts.

The formula for RMSE is as follows (Ruliana, Rais, Marni, & Ahmar, 2024).):

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\hat{y}_i - y_i)^2} \quad (7)$$

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

This study employs data on rupiah loan interest rates from commercial banks in Indonesia. The data comprises a time series element, with monthly intervals spanning from January 2013 to November 2015, which was obtained from the official website of BPS Indonesia. It is important to note that the data was not collected through experimental means or by utilizing secondary data sources. Rather, the data was obtained by downloading it from the source URL: https://www.bps.go.id/indicator/13/383/8/suku-bunga-kredit-rupiah-menurut-kelompok-bank.html.

The following are the stages of data analysis for this research:

a) Data Collection:
   - Acquire the interest rate information for rupiah loans from the commercial banks operating in Indonesia.
   - Ensure the data includes a time series aspect with monthly intervals spanning from January 2013 to November 2015.
   - Obtain the data from the official BPS Indonesia website by accessing the provided Source URL.
b) Forecasting using the Holt-Winters method
c) Optimizing parameters of method
d) Find the RMSE values to determine the accuracy of method
e) Forecasting for the next 5 periods
f) Developing a plot that displays side-by-side actual and predicted data.
g) Conclusion and recommendations

3. Result and Discussions

3.1. Descriptive Analysis

In this study, historical data was utilized to predict and analyze loan interest rates for the period from December 2015 to September 2016 in Indonesia. The loan interest rate data can be found 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 purpose of visualizing the data in a time series plot is to enable analysis to determine if there is a trend present in the plot. The Loan Interest data plot for the period between January 2013 and November 2015 is illustrated in Figure 1.

According to Figure 1, the trend for commercial bank rupiah loan interest rates indicates a downward trajectory over a specific time period. Although there was a temporary increase at one point, the overall pattern in the data suggests a downward trend. Consequently, the Holt-winters forecasting method can be employed to predict the future direction of the data.

The Holt-Winters method is used for forecasting loan interest rate data in Indonesia. The parameters α, β, and γ are established through a process of trial and error, with values that range between 0 and 1. In this instance, the parameters α = 0.1, β = 0.1, and γ = 0.1, as well as α = 0.6, β = 0.6, and γ = 0.6, are utilized. To smooth the data, the forecast package in R Software is employed, with *h* representing the number of periods to be forecasted, which is 10 periods ahead, for each of the specified parameter sets: α = 0.1, β = 0.1, and γ = 0.1, and α = 0.6, β = 0.6, and γ = 0.6.

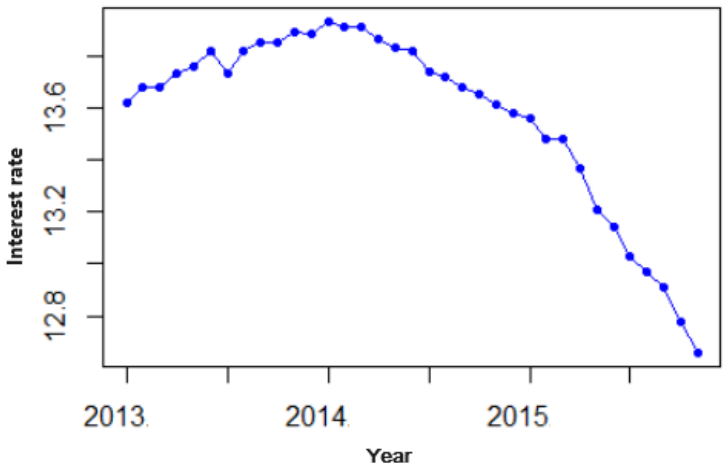

Figure 1. Plot of loan interest rate data

Table 2. Accuracy of Calculation Results for Triple Exponential Smoothing

Smoothing Parameter			Accuracy Values		
α	**β**	**γ**	**SSE**	**MSE**	**RMSE**
0.1	0.1	0.1	1.56146	0.04461	0.21122
0.6	**0.6**	**0.6**	**1.36116**	**0.03889**	**0.19721**

According to the accuracy calculations displayed in Table 2, it is clear that the smoothing method with α = 0.6, β = 0.6, and γ = 0.6 has smaller accuracy values than the smoothing methods with α = 0.1, β = 0.1, and γ = 0.1. Consequently, it can be inferred that the smoothing method with α = 0.6, β = 0.6, and γ = 0.6 is more effective for forecasting the data in this particular situation.

Thus, the forecasting results from the Holt-Winters method with α = 0.6, β = 0.6, and γ = 0.6 were employed to predict the car registration data for the following 5 months, as depicted in Table 3.

Month	Year	Interest Rate (%)
Dec	2015	12.60655
Jan	2016	12.50759
Feb	2016	12.40863
Mar	2016	12.30967
Apr	2016	12.21072

Next, as depicted in Figure 2, is a graph that displays a comparison between the actual data and the data that has been smoothed.

As demonstrated in Figure 2, the black line signifies the genuine data, while the red line represents the forecasts produced by the Holt-Winters technique. Evidently, the predictions closely adhere to the real data.

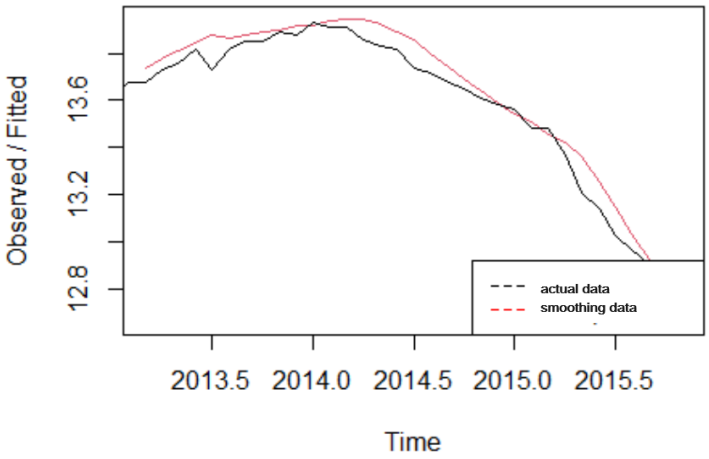

Figure 2. Plot comparing the actual data and the smoothed data

4. Conclusion

Based on the study's findings, it is possible to infer that: (1) Holt-winters methodology is more effective at predicting the rupiah loan interest rates in the Indonesian commercial banks more accurately, (2) the results of applying the Holt-winters method to forecast loan interest rate data at Indonesian banks using 35 monthly data points from January 2013 to November 2015 are as follows: (a) the values of the parameters α, β, and γ are set at 0.6, 0.6, and 0.6, respectively, which yield a forecasting accuracy with an RMSE of 0.19721; and (b) ccording to the current forecast data, the loan interest rate information obtained from banks in Indonesia is not identical to the actual data, but it closely corresponds to the actual data's movement.

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