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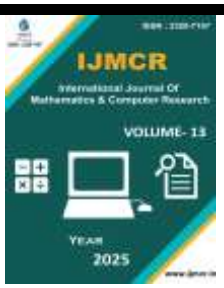

Application of the Holt Winters Method for Inflation Forecasting in Indonesia

Rado Yendra[1], Kholila Pratiwi[2], Muhammad Angga Piansyah HSB[3], Nofita Dwi Safitri[4], Puteri Nuraisyah[5], Ratih Pramudita[6], Ratih Triwahyuni[7]

[1,2,3,4,5,6,7]Department of Mathematics, Faculty of Science and Technology, Universitas Islam Negeri Sultan Syarif Kasim Riau – Indonesia

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Corresponding Author:
Rado Yendra

ABSTRACT

Inflation is a macroeconomic indicator that affects the economic stability of a country. Therefore, inflation forecasting is important in assisting policy makers in designing effective economic strategies. This study aims to apply the Holt-Winters method in forecasting inflation in Indonesia using data from January 2015 to December 2023. The Holt-Winters method is one of the exponential smoothing techniques that can handle trend and seasonal patterns in time series data. The models used in this study are Holt-Winters Additive and Holt-Winters Multiplicative. Evaluation of forecasting accuracy is done using Mean Absolute Error (MAE). The analysis results show that both models are able to provide fairly accurate forecasting with a small MAE value. The Holt-Winters Multiplicative model shows slightly better performance than the Holt-Winters Additive model, but the difference is not significant. Therefore, the Holt-Winters method can be used as a reliable alternative in forecasting inflation in Indonesia.

KEYWORDS: Inflation, Holt Winters, MAE.

1. INTRODUCTION

Inflation is one of the macroeconomic indicators that reflects the rate of increase in the prices of goods and services in general in an economy. Unstable inflation rates can have a negative impact on various aspects of the economy, such as people's purchasing power, investment, economic growth, and financial system stability [1]. Therefore, monitoring and forecasting inflation is very important for the government, especially Bank Indonesia, in designing effective monetary policies to maintain national economic stability [2].

In Indonesia, inflation is influenced by various factors, such as global commodity prices, fiscal and monetary policies, and domestic demand and supply conditions [3]. To anticipate inflation fluctuations, a forecasting method is needed that can provide accurate and reliable results. One of the widely used methods in forecasting time series data is the Holt-Winters method. This method was developed from the exponential smoothing approach that is able to handle data with seasonal patterns and trends, so it is suitable for use in analyzing inflation that has periodic patterns and long-term trends [4].

The Holt-Winters method has an advantage over simple forecasting methods because it is able to better capture patterns of inflation changes. In the economic context, this method can help policymakers in anticipating changes in inflation and developing the strategic measures needed to control price stability. In addition, the Holt-Winters method is also more flexible in adjusting forecasting parameters, so it can be applied to different types of economic data [5].

This study aims to apply the Holt-Winters method in inflation forecasting in Indonesia and evaluate the level of accuracy of the forecast results obtained. By analyzing historical inflation data, this study will test how the Holt-Winters method can provide more accurate results than other methods in predicting future inflation. The results of this study are expected to be a reference for Bank Indonesia, the government, and academics in understanding inflation patterns and formulating more effective economic policies in maintaining price stability and public welfare.

2. RESEARCH METHODS

The type of data used in this study is secondary data. The data used in this study is inflation data from January 2015 to December 2023 obtained from the Bank Indonesia website.

2.1 Holt Winters

Holt Winters is a simple exponential smoothing method that has three constant variables, namely trend, level, and

seasonal. Holt Winters' forecasting method is divided into two models, namely additive and multiplicative models. In the Holt Winters method, the additive model is used on Overall smoothing

$$St = \propto (Xt - It{-}1) + (1{-}\propto)(St{-}1 - bt{-}1) \quad (1)$$

Trend smoothing

$$bt = \beta(St - St{-}1) + (1 - \beta)bt{-}1 \quad (2)$$

Seasonal smoothing

$$It = \gamma(Xt - St) + (1 - \gamma)It{-}1 \quad (3)$$

Divination

$$Yt{+}m = S_t + mbt + I_{t-L+m} \quad (4)$$

Where:

St	: Forecasting smoothing value for period t;
Xt	: Actual value in period t;
Bt	: Trend smoothing value;
It	: Seasonal component in the t-period;
Yt+m	: Forecast for m future period of t;
m	: The number of periods that will be forecast in the future;
$\propto$	: Refinement parameter for trend ($0 < \propto < 1$);
γ	: Refinement parameter for trend ($0 < \gamma < 1$);
β	: Refinement parameter for trend ($0 < \beta < 1$);
L	: Seasonal length.

In the Holt Winters method, the multiplicative model is used on data patterns of varying seasonal fluctuations. The three equations used in the Holt Winters additive method are [8] :

Overall smoothing

$$St = \propto \frac{Xt}{I_{t-1}} + (1{-}\propto)(St{-}1 - bt{-}1) \quad (5)$$

Trend smoothing

$$bt = \beta(St - St{-}1) + (1 - \beta)bt{-}1 \quad (6)$$

Seasonal smoothing

$$It = \gamma \frac{Xt}{S_{t-1}} + (1 - \gamma)It{-}1 \quad (7)$$

Divination

$$Yt{+}m = (S_t + mbt)It{-}L{+}m \quad (8)$$

Information:

St	: Forecasting smoothing value for period t;
Xt	: Actual value in period t;
Bt	: Trend smoothing value;
It	: Seasonal component in the t-period;
Yt+m	: Forecast for m future period of t;

m : The number of periods that will be forecast in the future;
$\propto$: Refinement parameter for trend ($0 < \propto < 1$);
γ : Refinement parameter for trend ($0 < \gamma < 1$);
β : Refinement parameter for trend ($0 < \beta < 1$);
L : Seasonal length.

2.2 Mean Absolute Error (MAE)

Mean Absolute Error (MAE) is a method used to measure the accuracy of a forecasting model. The Mean Absolute Error (MAE) result shows the average value of the absolute error from the actual value to the forecast value. The Mean Absolute Error (MAE) equation is as follows [9]:

$$MAE = \frac{\sum_{i=1}^{n} |Xt - Yt|}{n} \quad (9)$$

Information:
Xt : Actual data in period t;
Yt : Forecasting value in period t;
n : Amount of data.

3. RESULTS AND DISCUSSION

3.1 Inflation Data

Indonesia's inflation data from 2015 to 2023 is obtained from the official website of Bank Indonesia. The data is displayed in the R software as shown in Figure 1.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	2.57	4.33	4.94	1.66	1.55	2.67	3.32	3.16	3.82	3.58	4.42	7.15
2016	2.61	4.97	4.35	1.60	1.68	2.96	3.28	2.88	3.88	3.31	4.14	6.79
2017	2.86	5.47	3.55	1.59	1.59	2.98	3.32	3.20	4.37	3.07	3.35	6.38
2018	2.56	5.28	3.47	1.52	1.44	2.68	2.83	3.18	4.33	2.79	4.89	6.29
2019	2.28	5.51	2.64	1.33	1.42	2.72	2.48	3.25	4.17	3.21	6.25	6.96
2020	3.27	5.42	2.06	1.68	1.32	3.00	2.57	3.61	3.61	3.45	6.83	2.57
2021	3.08	5.71	2.18	1.42	1.54	3.13	2.82	3.30	3.83	3.33	7.18	2.61
2022	3.52	5.95	1.87	1.37	1.96	3.39	3.13	3.58	3.49	3.60	7.26	2.86
2023	4.00	4.69	1.75	1.38	2.19	3.49	3.23	3.72	3.02	4.45	7.26	2.56

Figure 1. Indonesia Inflation Data

3.2 Modeling Methods

At this stage, the data that has been obtained will be modeled using Holt-Winters Additive and Multiplicative forecasting. By using seasonal period=12, which shows the number of months in 1 year.

3.4 Model Evaluation

Model evaluation was conducted to assess the extent to which the Holt-Winters method can accurately predict inflation. The following are the forecasting results with a comparison chart of the actual data displayed as shown in Figure 2.

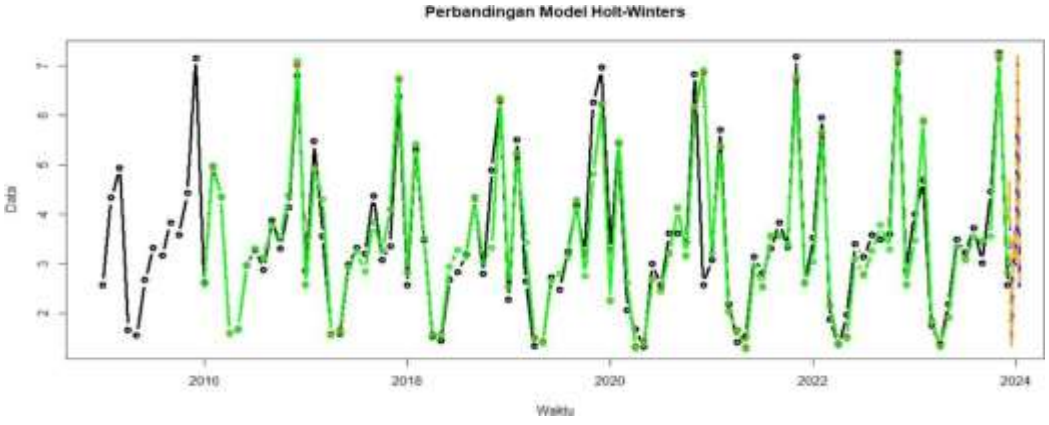

Figure 2. Comparison of Forecast Results with Actual Data

Information:
Black : Actual data;
Green: Holt-Winters Additive; Red:
Holt-Winters Multiplicative; Orange: Additive Forecasting Results;
Blue : Forecast Results Multiplicative.

From Figure 2 above, the graph comparing the results of inflation forecasting with actual data using the Holt-Winters method in the Additive and Multiplicative models shows that the forecasting results are close to the actual data. The results of the forecasting for the next 12 months using the Holt-Winters method on the Additive model are shown in Table 1.

Table 1. Forecasting Results with the Holt-Winters Additive Method

The month of	1	2	3	4	5	6	7	8	9	10	11	12
Divination	3,95	4,67	1,71	1,34	2,14	3,44	3,18	3,67	2,98	4,39	7,21	2,52

As for the forecasting results for the next 12 months using the Holt-Winters method on the Multiplicative model, it can be seen in Table 2.

Table 2. Forecasting Results with the Holt-Winters Multiplicative Method

The month of	1	2	3	4	5	6	7	8	9	10	11	12
Divination	3,94	4,65	1,73	1,36	2,16	3,44	3,18	3,67	2,99	4,38	7,16	2,53

3.4 Results Analysis

Forecasting results with the Holt-Winters Additive and Multiplicative forecasting models have the same MAE score is very good. These values are shown in Table 3.

Forecasting Methods	**MAE Score**
Holt-Winters Additive	0.3359614
Holt-Winters Multiplicative	0.3356553

4. CONCLUSION

Based on the results of the analysis and discussion that has been carried out, it can be concluded that the Holt-Winters Additive and Multiplicative methods are able to provide fairly accurate inflation forecasting. The Holt-Winters Multiplicative method is slightly superior to the Holt-Winters Additive method because it has a smaller MAE value. However, the difference is very small, so both methods can be used as an equally good alternative in forecasting inflation.

Thus, the Holt-Winters method can be a tool that can predict inflation trends in Indonesia and can be used as a basis for decision-making related to economic and financial policies.

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