

# Comparison of Holt and Brown's Double Exponential Smoothing Methods in The Forecast of Moving Price for Mutual Funds

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## Abstract

Mutual funds are one of the promising investment media where the risk is directly proportional to the size of investment growth. With proper forecasting of NAV price movements will greatly help investors to make purchases and sales transactions, therefore the authors offer the use of two different forecasting methods namely Brown's method and Holt method in double exponential smoothing to get predictions of NAV price movements. The effectiveness of the use of the method will be measured from the value of Mean Average Percentage Error (MAPE). From the calculation results obtained by the data that the Holt method produces forecasting for 1809,657 with the best  $\alpha$  value of 0.6 and MAPE of 0.644373568, while for the Holt method obtained forecasting value of 1810,924 with the  $\alpha$  value and the best  $\beta$  value of 0.9 and 0.1 and the smaller MAPE value of 0.61604262. Looking at the amount of MAPE generated, the Holt method has a smaller forecasting error rate when compared to Brown's method.

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## 1. Introduction

One option for investing is mutual funds. Through mutual funds a person can invest with very low capital, and at the same time can diversify, have a small risk, but have competitive yields [1]. As an investment medium, mutual funds have several types that can be distinguished based on the level of risk and investment value growth. One type of mutual fund is a conventional mutual fund consisting of equity mutual funds, fixed income mutual funds, money market mutual funds and mixed mutual funds. Of the four types of mutual funds, equity funds are mutual funds that have the highest level of risk while offering the greatest growth in investment value. A fairly large growth rate encourages people to invest their funds through this type of mutual fund, the problem faced is how to minimize risks that are high enough to maximize profits. One way that can be used is by knowing the prediction of price movements in the coming period. In this case the writer will use the price movement of mutual fund prices, namely Mutual Fund Cipta Ovo Equitas from PT Ciptadana Asset Management investment management so that investors or the public who invest in the mutual fund know the right time to buy or sell their mutual fund products.

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Mutual fund price movements or henceforth will be referred to as Net Asset Value (NAV) have a tendency to follow trends because their movements are strongly influenced by the rise and fall of stock prices [2]. There are two prediction methods that are very suitable to be applied for data that are trending, namely the double exponential smoothing method or double exponential refinement where in this method is divided into one parameter linear method (Brown's method) and two parameter linear method (Holt method) [3].

Referring to a study conducted by Ruli Utami and Suryo Atmojo in 2017 [4] concerning the comparison of forecasting methods, where they compared the two forecasting methods, the method proposed by Holt and Winter, namely the two parameter double exponential smoothing method and double exponential smoothing method with three parameters in the research. The result shows that the winter double exponential smoothing method has a higher accuracy level, which is the Mean Absolute Percentage Error (MAPE) of 12.6%, and for the Holt double exponential smoothing method has a MAPE value of 20.5% [4], then The authors propose the application of the comparison of two double exponential smoothing methods, namely Brown's method and the Holt method with the same type of data, namely trends or seasonality with different cases, namely Mutual Fund price movements in Cipta Ovo Equitas where the level of accuracy and effectiveness of forecasting will be measured using the The mean Absolute Percentage Error (MAPE) measurement.

## 2. Research Methods

The method that the authors will use in this study is the Brown's double exponential smoothing method and Holt double exponential smoothing where the smoothing parameter values will be tested so as to produce the maximum value while to measure the effectiveness and accuracy of the two forecasting methods used will use the Mean Absolute method Percentage Error (MAPE).

The data that will be used as a case study is data on Net Asset Value (NAV) price movements from Cipta Ovo Equitas mutual funds from investment management of PT Ciptadana Asset Management over the past one year from January 1 2019 to January 1 2020, sourced from data presented by the Indonesian Investment Management Association (AMII) through its official website.

### 2.1. Brown's Double Exponential Smoothing

This method proposed by Brown's to overcome the forecasting process with data in the form of trends in the plot where the rationale of this method is similar to forecasting a linear moving average (Linear Moving Average) [6].

The formula used in Brown's double exponential smoothing method is as follows:

$$S'_t = \alpha_p X_t + (1 - \alpha_p) S'_{t-1} \tag{1}$$

In this first formula, the value of  $S'_{t-1}$  is not yet known, so it is assumed that the value of  $S'_{t-1}$  is the same as the actual data value, as well as the value of  $S''_{t-1}$ .

So the first data can be stated:

$$S'_1 = S''_1 = X_1 \tag{2}$$

$$S''_t = \alpha_p S'_t + (1 - \alpha_p) S''_{t-1} \tag{3}$$

$$a_t = S'_t + (S'_t - S''_t) = 2S'_t - S''_t \tag{4}$$

$$b_t = \frac{\alpha_p}{1 - \alpha_p} (S'_t - S''_t) \tag{5}$$

$$F_{t+m} = a_t + b_t m \tag{6}$$

with:

- $S'_t$  = Single smoothing exponential value
- $S''_t$  = The exponential value of double smoothing in the t-period
- $\alpha_p$  = Smoothing parameters that range from 0 to 1
- $a_t, b_t$  = Smoothing Constants

- $F_{t+m}$  = The value of forecasting in a certain period.
- $m$  = Many future periods are desired.
- $X_t$  = Actual data in the t-period

### 2.2. Holt Double Exponential Smoothing

This method was proposed by Holt as an answer to the problems that arise in forecasting with data that are influenced by trends. In this method, the trend value is not smoothed from the actual data smoothing process, but the trend smoothing process utilizes different parameters, therefore this method is also referred to as double exponential smoothing of two parameters [4]. The formula used in the Holt double exponential smoothing method is as follows:

$$S_t = \alpha X_t + (1 - \alpha)(S_{t-1} + T_{t-1}) \quad (7)$$

$$T_t = \beta(S_t - S_{t-1}) + (1 - \beta)T_{t-1} \quad (8)$$

To calculate the smoothing value we need the first smoothing value ( $S_1$ ) but in reality we don't have the  $S_1$ , value yet, for the  $S_1$ , value we can use the first actual data value.

$$S_1 = X_1 \quad (9)$$

Meanwhile, to get the first trend value smoothing ( $T_1$ ) we can assume that:

$$T_1 = \left( \frac{(X_2 - X_1) + (X_4 - X_3)}{2} \right) \quad (10)$$

As for calculating the value of forecasting in the t period plus the m period the following formula is used:

$$F_{t+m} = S_t + (T_t \times m) \quad (11)$$

with:

- $X_t$  : Actual data for the t-period
- $S_t$  : Graduation value t
- $T_t$  : Value of Smoothing trend to t-period
- $\alpha$  : Smoothing parameters for the actual data ( $0 \leq \alpha \leq 1$ )
- $\beta$  : Smoothing parameters for trend data ( $0 \leq \beta \leq 1$ )
- $F_{t+m}$  : Value of forecast data
- $m$  : Number of periods to be predicted

### 2.3. Mean Absolute Percentage Error (MAPE).

As a method to measure the effectiveness of the two methods used, the authors utilize the Mean Absolute Percentage Error (MAPE) formula which can be calculated using the following formula:

$$MAPE = \frac{1}{n} \sum_{t=1}^M |PE_t| \quad (11)$$

$$PE_t = \left( \frac{X_t - F_t}{X_t} \right) \times 100 \quad (12)$$

with:

- $n, M$  = Amount of data
- $PE_t$  = Percentage error from forecasting

### 2.4. Research Step

The steps - steps to be carried out in this study can be seen in the figure 1.

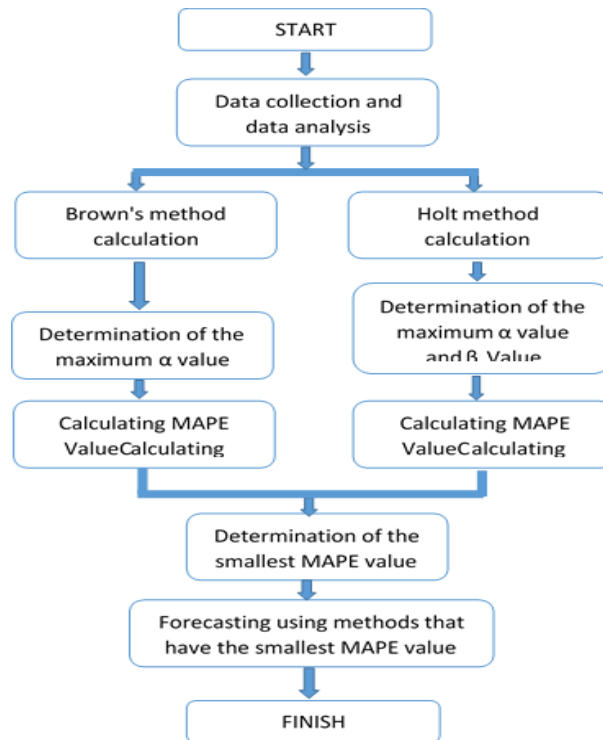


Fig. 1. Research flowchart

### 3. Results and Discussion

The data used in this study are NAV price data from Cipta Ovo Equitas mutual funds for one year from January 1, 2019 to January 1, 2020, sourced from the official website of the Indonesian Investment Manager Association, while if presented in graphical form from actual data currently available is as in the fig 2.



Fig.2 Graph of actual data  
Source: amii.or.id (2020)

From this graph, it can be seen that the movements of Cipta Ovo Equitas Mutual Fund NAV price growth tend to increase even though in some periods it has experienced a decline, but if drawn straight line then the tendency is to rise, meaning that the NAV price movement of this mutual fund is affected by the trend.

From the data about 365 days after sorting according to the active day of the exchange there are 244 data that will be processed using two forecasting methods that the authors have proposed with various variations in the values of the parameter  $\alpha$  and parameter  $\beta$  to then determine what is the maximum value that has an error rate the smallest using MAPE calculations.

### 3.1. Brown's Calculation Method

Before making forecast calculations using Brown's method, the author will first determine the maximum value of the  $\alpha$  parameter, which means having the smallest MAPE value by testing the calculation with variations in the value of  $\alpha$  from 0.1 to 0.9, here is an example calculation Brown's method with a value of  $\alpha = 0.1$ .

#### For t = 1:

In accordance with equation (2), the value  $S'_1 = S''_1 = X_1$  which is 1559.42.

Whereas the constant value for  $a_1$  can be calculated according to equation (4), i.e.:

$$\begin{aligned} a_1 &= 2S'_1 - S''_1 \\ a_1 &= 2(1559.42) - 1559.42 \\ a_1 &= 1559.42 \end{aligned}$$

Whereas the constant value of  $b_1$  can be calculated according to equation (5) below:

$$\begin{aligned} b_1 &= \frac{\alpha_p}{1-\alpha_p}(S'_1 - S''_1) \\ b_1 &= \frac{0.1}{1-0.1}(1559.42 - 1559.42) \\ b_1 &= 0 \end{aligned}$$

Furthermore, to predict the value of NAV in the next period one can use equation (6), to predict one future period, then the value of  $m$  is 1, following the calculation:  $F_{1+1} = a_1 + b_1m$

$$\begin{aligned} F_2 &= 1559.42 + (0 \times 1) \\ F_2 &= 1559.42 \end{aligned}$$

#### For t = 2:

In accordance with equation (1), the value:

$$\begin{aligned} S'_2 &= \alpha_p X_2 + (1 - \alpha_p)S'_{2-1} \\ S'_2 &= (0.1 \times 1561.3) + (1 - 0.1) \times 1559.42 \\ S'_2 &= 1559.608 \end{aligned}$$

Whereas the value of  $S''_2$  can be calculated according to equation (3), namely:

$$\begin{aligned} S''_2 &= \alpha_p S'_2 + (1 - \alpha_p)S''_{2-1} \\ S''_2 &= (0.1 \times 1559.608) + (1 - 0.1) \times 1559.42 \\ S''_2 &= 1559.439 \end{aligned}$$

Whereas the constant  $a_2$  can be calculated

$$\begin{aligned} a_2 &= 2S'_2 - S''_2 \\ a_2 &= 2(1559.608) - 1559.439 \\ a_2 &= 1559.777 \end{aligned}$$

Whereas the constant value of  $b_2$  can be calculated

$$b_2 = \frac{\alpha_p}{1-\alpha_p} (S'_2 - S''_2)$$

$$b_1 = \frac{0.1}{1-0.1} (1559.608 - 1559.439)$$

$$b_1 = 0.0188$$

Furthermore, to predict the price of NAV in the next one period can be calculated

$$F_{2+1} = a_2 + b_2 m$$

$$F_3 = 1559.777 + (0.0188 \times 1)$$

$$F_3 = 1559.796$$

and so on until  $t = 244$ , so that we can make comparisons between actual data and forecast results to find the MAPE values according to equations (11) and (12). Examples for calculating forecasting errors in period  $t = 2$  are as follows:

$$PE_2 = \left( \frac{X_2 - F_2}{X_2} \right) \times 100$$

$$PE_2 = \left( \frac{1561.3 - 1559.42}{1561.3} \right) \times 100$$

$$PE_2 = 0.120412$$

So that for the whole data we can calculate MAPE according to equation (11) below.

$$MAPE = \frac{1}{n} \sum_{t=1}^M |PE_t|$$

$$MAPE = \frac{1}{243} \sum_{t=1}^{243} 280.2768$$

$$MAPE = 1.153402$$

After that proceed to variations in the value of  $\alpha = 0.2$  to  $0.9$  and the results can be seen in the following table After that proceed to variations in the value of  $\alpha = 0.2$  to  $0.9$  and the results can be seen in the following table:

Table 1 Testing Map of Brown’s method with variation  $\alpha$

Value of $\alpha$	MAPE	
0.1	1.153402458	–
0.2	1.153438675	–
0.3	0.694352235	–
0.4	0.659543156	–
0.5	0.659564068	–
0.6	0.644373568	Minimum
0.7	0.670705737	–
0.8	0.670746125	–
0.9	0.789431415	–

From the table 1, it is known that for Brown's method the maximum  $\alpha$  value that can be used for forecasting with values close to the actual data is  $0.6$  with a MAPE value of  $0.644373568$ .

Based on the  $\alpha$  value, the writer does the calculation to predict the NAV price in the next exchange period, namely in the period of January 2, 2020.

$$F_{244+1} = a_{244} + b_{244}m$$

$$F_{245} = 1809.685 + (-0.02812 \times 1)$$

$$F_{245} = 1809.657$$

Table 2 Brown's Forecasting Data for the last 5 periods

t	Periods	NAV Price	S'	S''	at	bt	Forecast
240	12/20/2019	1789.24	1789.861	1790.002	1789.72	-0.21152	1789.981
241	12/23/2019	1789.67	1799.472	1795.684	1803.261	5.682314	1789.508
242	12/26/2019	1805.88	1809.857	1804.188	1815.526	8.503695	1808.943
243	12/27/2019	1816.78	1813.459	1809.75	1817.167	5.562586	1824.03
244	12/30/2019	1815.86	1809.704	1809.722	1809.685	-0.02812	1822.73
245	1/20/2020	1807.2					1809.657

The more complete following forecast data for the last 5 periods from Brown's method with the value  $\alpha = 0.6$ .

### 3.2. Calculation of the Holt Method

As in the previous method, in the Holt method calculation the author will first determine the value of the  $\alpha$  parameter and the maximum  $\beta$  parameter that has the smallest MAPE value by testing the calculation with variations in the value of  $\alpha$  and the value of  $\beta$  from 0.1 to 0.9, here is an example calculation metode Holt with values  $\alpha = 0.1$  and  $\beta = 0.1$ .

**For t = 1:**

In accordance with equation (9), the value:

$$S_1 = X_1 \text{ i.e. } 1559,42.$$

Whereas the constant value of  $T_1$  can be calculated according to equation (10), namely:

$$T_1 = \frac{(X_2 - X_1) + (X_4 - X_3)}{2}$$

$$T_1 = \frac{(1561,3 - 1559,42) + (1591,7 - 1579,58)}{2}$$

$$T_1 = 7$$

Furthermore, to predict the price of NAV in one exchange period, the following equation (11) can be used, to predict a future period, then the value of  $m$  is 1, following the calculation:

$$F_{1+1} = S_1 + (T_1 \times 1)$$

$$F_2 = 1559,42 + (7 \times 1)$$

$$F_2 = 1566.42$$

**For t = 2:**

In accordance with equation (7), the value

$$S_2 = \alpha X_2 + (1 - \alpha)(S_{2-1} + T_{2-1})$$

$$S_2 = (0.1 \times 1561.3) + (1 - 0.1)(1559.42 + 7)$$

$$S_2 = 1559.608$$

Whereas the value of  $T_2$  can be calculated according to equation (8), namely:

$$T_2 = \beta(S_2 - S_{2-1}) + (1 - \beta)T_{2-1}$$

$$T_2 = 0.1(1559.608 - 1559.42) + (1 - 0.1) \times 7$$

$$T_2 = 6.9488$$

Furthermore, to predict the price of NAV in the next one period can be calculated

$$F_{2+1} = S_2 + (T_2 \times 1)$$

$$F_3 = 1559.608 + (6.9488 \times 1)$$

$$F_3 = 1572.8568$$

And continued until  $t = 244$ , then MAPE values will be searched according to equations (11) and (12). Examples of MAPE calculations for period  $t = 3$  are as follows:

$$PE_2 = \left( \frac{X_2 - F_2}{X_2} \right) \times 100$$

$$PE_2 = \left( \frac{1579.58 - 1572.8568}{1579.58} \right) \times 100$$

$$PE_2 = 0.42563213$$

So that for the whole data we can calculate MAPE according to equation (11) below.

$$MAPE = \frac{1}{n} \sum_{t=1}^M |PE_t|$$

$$MAPE = \frac{1}{243} \sum_{t=1}^{243} 397.9595$$

$$MAPE = 1.637694$$

After that, it is continued to vary the value of  $\alpha = 0.2$  to  $0.9$  and  $\beta$  values  $0.2$  to  $0.9$  to obtain 81 MAPE data where the minimum value is sought, the following 5 smallest MAPE data from 81 data can be seen in the following table:

Table 3 Testing Map of the Holt method with variations in  $\alpha$  and  $\beta$

Value of $\alpha$	Value of $\beta$	MAPE	
0.9	0.1	0.61604262	Minimum
0.8	0.1	0.623142892	-
0.9	0.2	0.625572979	-
0.8	0.2	0.630259215	-
0.9	0.3	0.632103977	-

From the table above it is known that for the Holt method the maximum  $\alpha$  value that can be used is  $0.9$  and the maximum  $\beta$  value used is  $0.1$  with a MAPE value of  $0.61604262$ . Thus based on the  $\alpha$  value and the  $\beta$  value with the maximum value it will be used to forecast NAV prices in the next exchange period, namely in the period of January 2, 2020 as follows:

$$F_{244+1} = S_{244} + T_{244} m$$

$$F_{245} = 1808.465 + (2.458529 \times 1)$$

$$F_{245} = 1810.9238$$



For more details, the following table forecasting results for the last 6 periods using the Holt double exponential smoothing method.

Table 4 Holt forecast data in the last 6 periods

t	Periode	Value of NAB	St	Tt	F
240	43819	1789.67	1789.879	1.852858	1791.761
241	43822	1805.88	1804.465	3.126183	1791.732
242	43825	1816.78	1815.861	3.953159	1807.591
243	43826	1815.86	1816.255	3.597273	1819.814
244	43829	1807.2	1808.465	2.458529	1819.853
245	43830				1810.924

As for seeing more clearly the comparison of actual NAV prices, with Brown's forecasting and the Holt method, the following forecast results are presented in the last 10 periods as shown figure 3.

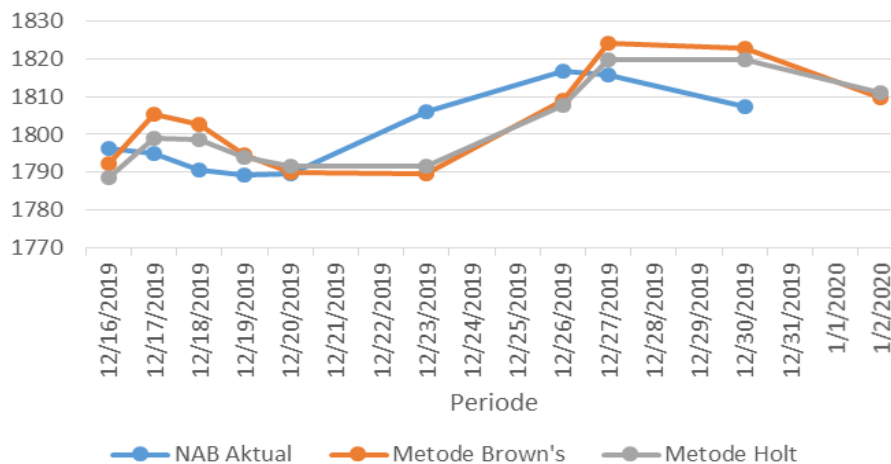


Fig.3 Comparison of actual and forecast data

#### 4. Conclusion

After calculating the forecasting of OAV Equitas Mutual Fund NAV price movements for one-year data using two different methods, namely Brown's double exponential smoothing and Holt double exponential smoothing, the results show that the Holt method has a smaller forecasting error level of 0.61604262 when compared to the method Brown's, which has a forecasting error rate of 0.644373568, shows that the Holt method is more appropriate to predict the movement of Mutual Fund NAV Price where this is not separated from the type of NAV price movement of mutual funds influenced by trends. Suggestions that may be given in further research is the need to make a forecasting application using the Holt method so that it will be more easily utilized for investors in monitoring and forecasting the price movements of mutual funds.

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