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# Forecasting The Total Assets of PT Bank Negara Indonesia (BNI) Using Brown's Double Exponential Smoothing Method

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## *ABSTRACT*

The total assets of a bank are among the main indicators used to assess its financial performance and to support strategic decision-making. Therefore, accurate forecasting is needed to estimate future asset values. This study tries to predict the total assets of Bank BNI by using the Brown Double Exponential Smoothing method. The study drew on secondary data from the financial statements of PT Bank Negara Indonesia (Persero) Tbk., released in July 2022 and June 2025, and analyzed 36 monthly observations. The forecasting model was created by testing the smoothing parameter $(\alpha)$ values from 0.1 up to 0.9, and the most accurate model was chosen because it had the lowest Mean Absolute Percentage Error (MAPE). The results showed that the optimal smoothing parameter was $\alpha = 0.2$, which produced a MAPE value of 2.208%, indicating a very good forecasting performance. Using this model, the projected total assets of Bank BNI for July to December 2025 were 1,126,063,148; 1,133,585,647; 1,141,108,145; 1,148,630,643; 1,156,153,141 and 1,163,675,640, respectively. These results indicate a gradual increase in Bank BNI's total assets over the forecast period. Therefore, the Brown Double Exponential Smoothing method is effective in predicting data that exhibits a rising trend, such as the total assets of Bank BNI.

**Keywords: Time series, financial, smoothing parameter, MAPE.**

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## INTRODUCTION

Financial and banking institutions play a vital role in society as drivers and bridges of a nation's economy (1). Banks provide various financial services, including loan facilities to meet the public's needs. When choosing a bank, the public is becoming increasingly selective, taking into account the bank's performance and financial health, one of which is based on the condition of its assets (2). Assets are economic resources owned or controlled by individuals, companies, or the state, with the expectation that they will provide future economic benefits (3). A bank's assets include cash, deposits with Bank Indonesia, deposits with other banks, loans extended, securities, fixed assets, and other assets that collectively support its operational activities (4). Bank asset management influences a bank's revenue levels; thus, effective asset management yields optimal profits for the bank (5). Therefore, forecasting a bank's asset levels is essential for risk management and strategic planning.

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BNI, as one of the largest state-owned banks in Indonesia, plays a strategic role in supporting national economic development. Based on data from Bank BNI's financial statements, the bank's total assets have increased each month. This indicates growth in the bank's business activities and financial performance. To ensure Bank BNI's financial performance continues to improve, it is necessary to forecast future asset levels. Accurate forecasting facilitates the development of appropriate strategies and financial decision-making.

Forecasting is one of the key elements in the decision-making process. Forecasts are typically based on past data, which is then analyzed using specific methods or approaches (6). A good forecast is one whose results closely match reality (7). Forecasting can be applied to various fields, including economics, finance, marketing, production, administration, and others (8).

Forecasting can be done using several methods, and one of those methods is called Brown's Double Exponential Smoothing. Brown's Double Exponential Smoothing is used when the data shows a trend (9). Unlike the Single Exponential Smoothing method, which works only with data that doesn't change much over time, the Brown Double Exponential Smoothing method can detect trends. This makes it better at predicting future values when the data is changing over time (10). One important benefit of the Brown Double Exponential Smoothing method is that it can handle data with strong trends and changes. This method considers slow changes in data trends, so it reacts better to shifts in complicated and changing data patterns (11).

Because of these problems, this study employs the Brown Double Exponential Smoothing method to predict Bank BNI's total assets. The study's findings should provide insights into how assets might grow in the future, help guide financial plans, and support further research.

## MATERIAL AND METHODS

This study uses data that have already been collected, specifically the monthly asset totals from Bank BNI, as reported in the financial statements of PT Bank Negara Indonesia (Persero) Tbk. The data includes information from July 2022 up to June 2025, with a total of 36 observation periods. After that, the data were studied using the Brown Double Exponential Smoothing technique, and the smoothing parameter, which is called alpha ($\alpha$) was tested with values from 0.1 to 0.9. The best model was chosen because it had the lowest Mean Absolute Percentage Error (MAPE) and was then used to predict Bank BNI's total assets for the next six periods.

## FORECASTING

Forecasting is the process of estimating future needs, including requirements in terms of quantity, quality, timing, and location, to meet a given demand (12). Forecasting aims to predict or estimate future events using historical data. Forecasting takes into account relevant data, which is then processed in specific ways. Most people use forecasting to address various issues, such as weather, inflation rates, political issues, and a country's exchange rates (13). Forecasting is important because it is used in many different areas, such as business, industry, government, economics, environmental science, medicine, social sciences, politics, and finance (14).

Forecasting is categorized into three periods: short-term, medium-term, and long-term (15). Short-term forecasting is based on future time periods (daily, weekly, or monthly).

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Medium-term forecasting covers up to 2 years, while long-term forecasting extends over several years. Forecasting uses time-series methods that rely on past data to identify trends and predict future data (16). In time-series analysis, to determine the appropriate forecasting method, one can examine the patterns in the data. Based on time, data patterns are classified into four types: horizontal, seasonal, cyclical, and trend (17). Time series methods are divided into five categories: smoothing methods, trend projection methods using regression, seasonal methods, trend methods, and decomposition methods (12).

## BROWN'S DOUBLE EXPONENTIAL SMOOTHING METHOD

Brown's Double Exponential Smoothing method is used when the data has a trend. This method is designed to handle discrepancies between real data and predicted values when the data exhibit a trend. The Brown Double Exponential Smoothing method is a way to predict future values by using past data to estimate both the current level and the trend, then combining these estimates to make forecasts (11).

In Brown's Double Exponential Smoothing method, the smoothing process is done twice. This method can be calculated by using three data points and a value for alpha. The formula used when applying Brown's Double Exponential Smoothing method is as follows (18):

$$S_t' = \alpha X_t + (1-\alpha)S_{t-1}' \quad (1)$$
$$S_t'' = \alpha S_t' + (1-\alpha)S_{t-1}'' \quad (2)$$
$$a_t = 2S_t' - S_t'' \quad (3)$$
$$b_t = \frac{\alpha}{1-\alpha}(S_t' - S_t'') \quad (4)$$
$$F_{t+m} = a_t + b_t m \quad (5)$$

where:

$S_t'$ : first exponential smoothing value
$S_t''$ : second exponential smoothing value
$X_t$ : actual value at period $t$
$a_t$ and $b_t$ : smoothing constants
$\alpha$ : smoothing parameter, where $0 < \alpha < 1$
$F_{t+m}$ : forecast value for the $m$-th period ahead from period $t$

For the smoothing parameter, use a value of α in the range $0-1$. If $\alpha = 0$, the smoothing model completely ignores the most recent data, so the forecast value remains unchanged and becomes constant. If $\alpha = 0$, full weight is given to the most recent data, so the next forecast is exactly the same as the most recent observed value. To use this formula, values for $S_{t-1}'$ and $S_{t-1}''$. must be available. However, when $t = 1$, there are no values for $S_{t-1}'$ and $S_{t-1}''$. This problem can be resolved by setting the values of $S_{t-1}'$ and $S_{t-1}''$. equal to the value of $X_1$ (the actual data) (10).

## FORECAST ERROR MEASURES

The accuracy of a forecasting method refers to the extent to which that method can predict future values with a high degree of accuracy. The accuracy of a forecasting method can be assessed based on forecasting errors. Forecasting errors serve as a measure of accuracy and form the basis for comparing performance. There are three methods that can be used to calculate the error rate in forecasting: MAD (Mean Absolute Deviation), MSE (Mean Squared Error), and MAPE (Mean Absolute Percentage Error) (19). In this study, the

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error measure will be calculated using MAPE. MAPE is a method that helps check how accurate forecasts are. The formula for MAPE, which stands for Mean Absolute Percentage Error, is (20).

$$\text{MAPE} = \frac{1}{n}\sum_{i=1}^{n}|PE_t| \tag{6}$$

using the $PE$ (percentage of error) formula, which is

$$PE_t = \left(\left|\frac{X_t - F_t}{X_t}\right|\right) \times 100\% \tag{7}$$

where:

$n$ : number of observations or time periods
$X_t$ : actual value at period $t$
$F_t$ : forecast value at period $t$

A smaller MAPE value indicates higher forecasting accuracy. The criteria for interpreting MAPE values are presented in Table 1.

**Table 1.** MAPE Interpretation Criteria

| MAPE Value | Interpretation |
|---|---|
| $< 10\%$ | Highly Accurate |
| $10\% - 20\%$ | Good |
| $20\% - 50\%$ | Reasonable |
| $> 50\%$ | Inaccurate |

## RESULTS AND DISCUSSION

This part shows the results from an analysis that used Brown's Double Exponential Smoothing technique to predict the total assets of Bank BNI. The analysis covers basic data summaries, how the model was calculated, how the best smoothing settings were chosen using the Mean Absolute Percentage Error, and the predictions for total assets for the next six time periods. Then, the results are looked at to check how well the model can show the trends in Bank BNI's assets.

## DESCRIPTIVE STATISTICS

The descriptive statistics in this study aim to provide information on the characteristics of the research variable, namely the total assets of Bank BNI from July 2022 to June 2025. A summary of the descriptive statistics is presented in Table 2.

**Tabel 2** Descriptive Statistics Results

| Descriptive Statistics | | | | |
|---|---|---|---|---|
| N | Minimum | Maximum | *Mean* | *Std. Deviation* |
| 36 | 895,559,672 | 1,151,926,406 | 1,011,484,531 | 60,460,042.44 |

Based on the results of a descriptive analysis of Bank BNI's asset data over 36 observation periods, the lowest total assets of Bank BNI during the observation period were Rp895,559,672, and the highest total assets were Rp1,151,926,406. The mean value of assets, at Rp1,011,484,531, reflects the general condition of Bank BNI's assets, so it can be concluded that, overall, the total assets tend to hover around that figure. Meanwhile, the standard deviation of Rp60,460,042.44 indicates the degree of variation in the asset data from its mean.

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## FORECAST OF BNI'S TOTAL ASSETS

When using the Brown Double Exponential Smoothing method, you follow certain steps based on the Brown Double Exponential Smoothing formula. The process uses different values for $\alpha$, which are 0.1; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8 and 0.9. The following are the calculation steps for Brown Double Exponential Smoothing when $\alpha = 0.1$:

1) Determine the first smoothing value $(S')$
   $S'_t = 0.1X_t + (1-0.1)S'_{t-1}$
   $S'_1 = 913{,}283{,}740$
   $S'_2 = 0.1X_2 + (1-0.1)S'_1 = 911{,}511{,}333$
   $S'_3 = 0.1X_3 + (1-0.1)S'_2 = 911{,}324{,}067$
   Continue until $t = 36$
2) Determine the second smoothing value $(S'')$
   $S''_t = 0.1S'_t + (1-0.1)S''_{t-1}$
   $S''_1 = 913{,}283{,}740$
   $S''_2 = 0.1S'_2 + (1-0.1)S''_1 = 913{,}106{,}499$
   $S''_3 = 0.1S'_3 + (1-0.1)S''_2 = 912{,}928{,}256$
   Continue until $t = 36$
3) Determining the value of the constant $(a_t)$
   $a_t = 2S'_t - S''_t$
   $a_1 = 2S'_1 - S''_1 = 913{,}283{,}74$
   $a_2 = 2S'_2 - S''_2 = 909{,}916{,}167$
   $a_3 = 2S'_3 - S''_3 = 909{,}719{,}877$
   Continue until $t = 36$
4) Determining the value of the constant $(b_t)$
   $$b_t = \frac{0.1}{1-0.1}(S'_t - S''_t)$$
   $$b_1 = \frac{0.1}{1-0.1}(S'_1 - S''_1) = 0$$
   $$b_2 = \frac{0.1}{1-0.1}(S'_2 - S''_2) = -177{,}241$$
   $$b_3 = \frac{0.1}{1-0.1}(S'_3 - S''_3) = -178{,}243$$
5) Determining the forecast value $(F_{t+m})$
   $F_{t+m} = a_t + b_t m$
   $F_{1+1} = a_1 + b_1(1) = 913{,}283{,}740$
   $F_{2+1} = a_2 + b_2(1) = 909{,}738{,}926$
   $F_{3+1} = a_3 + b_3(1) = 909{,}541{,}634$
   Continue until $t = 36$.

Calculations using Brown's double exponential smoothing method were performed repeatedly until $\alpha = 0.9$ and $t = 36$, yielding the results shown in Table 3.

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**Table 3** Results of the Brown Double Exponential Smoothing Calculation with $t = 36$

| $\alpha$ | $S_t'$ | $S_t''$ | $a_t$ | $b_t$ | $F_{t+m}$ |
|---|---|---|---|---|---|
| 0.1 | 1,058,174,975 | 1,012,367,048 | 1,103,982,902 | 5,089,770 | 1,092,736,895 |
| 0.2 | 1,088,450,657 | 1,058,360,664 | 1,118,540,650 | 7,522,498 | 1,099,761,162 |
| 0.3 | 1,102,902,698 | 1,078,941,339 | 1,126,864,057 | 10,269,154 | 1,100,778,754 |
| 0.4 | 1,112,660,758 | 1,092,278,155 | 1,133,043,360 | 13,588,402 | 1,099,473,502 |
| 0.5 | 1,120,400,641 | 1,102,509,203 | 1,138,292,079 | 17,891,438 | 1,097,389,097 |
| 0.6 | 1,127,208,329 | 1,111,518,737 | 1,142,897,921 | 23,534,388 | 1,095,498,374 |
| 0.7 | 1,133,584,009 | 1,120,456,938 | 1,146,711,080 | 30,629,833 | 1,093,978,340 |
| 0.8 | 1,139,763,123 | 1,129,961,753 | 1,149,564,494 | 39,205,483 | 1,092,878,608 |
| 0.9 | 1,091,279,033 | 1,091,150,189 | 1,091,407,878 | 1,159,601 | 1,087,031,565 |

Based on Table 3, the results of the Brown Double Exponential Smoothing calculation for the 36th period show that changes in the smoothing parameter ($\alpha$) affect the first-order smoothing value ($S_t'$), the second-order smoothing value ($S_t''$), the level component ($a_t$), the trend component ($b_t$), and the forecast value ($F_{t+m}$). In general, an increase in the value of α results in changes to the level and trend components, so the resulting forecast values also differ. The forecast values range from 1,087,031,565 to 1,100,778,754, with the highest value at $\alpha = 0.3$ and the lowest at $\alpha = 0.9$. These results indicate that the choice of $\alpha$ affects the forecast results; therefore, the optimal value of α must be determined based on the error measure.

## FORECAST ACCURACY

The optimal value of the parameter α is selected based on the MAPE value. The smaller the MAPE value, the more accurate the forecast. The MAPE value is calculated based on the percentage error of a forecast. The percentage error of a forecast can be calculated using Equation (7). The following shows the calculation of the percentage error for $\alpha = 0.1$ in the second period (July 2022):

$$PE_2 = \left(\left|\frac{X_2 - F_2}{X_2}\right|\right) \times 100\%$$
$$= \left(\left|\frac{895{,}559{,}672 - 913{,}283{,}740}{895{,}559{,}672}\right|\right) \times 100\%$$
$$= 1.98\%$$

The results of the percentage error calculations for $t = 3$ through $t = 36$ are shown in Table 4.

**Table 4** Percentage Error Calculation for $\alpha = 0.1$

| No | Month | Total Asset (IDR) | $F_{t+m}$ (IDR) | $\lvert PE_t \rvert$(%) |
|---|---|---|---|---|
| 1 | Jul-2022 | 913,283,740 | | |
| 2 | Aug-2022 | 895,559,672 | 913,283,740 | 1.98 |
| 3 | Sep-2022 | 909,638,667 | 909,738,926 | 0.01 |
| 4 | Oct-2022 | 985,528,530 | 909,541,634 | 7.71 |
| 5 | Dec-2022 | 997,556,847 | 924,560,770 | 5.23 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 36 | Jun-2025 | 1,151,926,406 | 1,092,736,895 | 5.14 |
| | | Total | | 77.72 |

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The percentage error values for parameters ranging from $\alpha = 0.2$ to $\alpha = 0.9$ can be calculated using the same method. After determining the percentage error values, the next step is to calculate the MAPE. The following is the MAPE calculation for $\alpha = 0.1$:

$$\text{MAPE} = \frac{1}{35}\sum_{i=1}^{35}|PE_t|$$
$$= \frac{77.72}{35}$$
$$= 2.220$$

The results of the MAPE calculations for $\alpha = 0.1$ through $\alpha = 0.9$ are shown in Table 5.

**Table 5** MAPE Calculation Results

| No | $\alpha$ | MAPE (%) |
|---|---|---|
| 1 | 0.1 | 2.220 |
| 2 | 0.2 | 2.208 |
| 3 | 0.3 | 2.361 |
| 4 | 0.4 | 2.436 |
| 5 | 0.5 | 2.511 |
| 6 | 0.6 | 2.605 |
| 7 | 0.7 | 2.811 |
| 8 | 0.8 | 3.040 |
| 9 | 0.9 | 3.402 |

Based on Table 5, the smallest MAPE value was obtained when $\alpha = 0.2$ with a MAPE of 2.208%. Since the MAPE value is less than 10%, it falls within the Highly Accurate category. Forecasts of Bank BNI's total assets for the next period can be calculated using Brown's Double Exponential Smoothing method with $\alpha = 0.2$.

## BEST FORECAST RESULTS

Forecasts for Bank BNI's total assets for the next period, July 2025 through December 2025, can be made using Brown's double exponential smoothing method with $\alpha = 0.2$. Based on the latest available data, forecasts for the next six periods can be made using equation (5). The calculations are as follows:

1. Forecast for the 37th period (July 2025). $m = 1$
$$f_{37} = f_{36+1} = a_{36} + b_{36}(1)$$
$$= 1{,}118{,}540{,}650 + 7{,}522{,}498(1)$$
$$= 1{,}126{,}063{,}148$$
2. Forecast for the 38th period (August 2025). $m = 2$
$$f_{38} = f_{36+2} = a_{36} + b_{36}(2)$$
$$= 1{,}118{,}540{,}650 + 7{,}522{,}498(2)$$
$$= 1{,}133{,}585{,}647$$
3. Forecast for the 39th period (September 2025). $m = 3$
$$f_{39} = f_{36+3} = a_{36} + b_{36}(3)$$
$$= 1{,}118{,}540{,}650 + 7{,}522{,}498(3)$$
$$= 1{,}141{,}108{,}145$$
4. Forecast for the 40th period (October 2025). $m = 4$
$$f_{40} = f_{36+4} = a_{36} + b_{36}(4)$$

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$$= 1{,}148{,}630{,}643$$

5. Forecast for the 41st period (November 2025). $m = 5$

$$f_{41} = f_{36+5} = a_{36} + b_{36}(5)$$
$$= 1{,}118{,}540{,}650 + 7{,}522{,}498(5)$$
$$= 1{,}156{,}153{,}141$$

6. Forecast for the 42nd period (December 2025). $m = 6$

$$f_{42} = f_{36+6} = a_{36} + b_{36}(6)$$
$$= 1{,}118{,}540{,}650 + 7{,}522{,}498(6)$$
$$= 1{,}163{,}675{,}640$$

Based on the forecast results, Bank BNI's total assets are projected to increase gradually over the next six periods. Figure 1 shows a graph of Bank BNI's actual total assets and the forecast results for the next six periods.

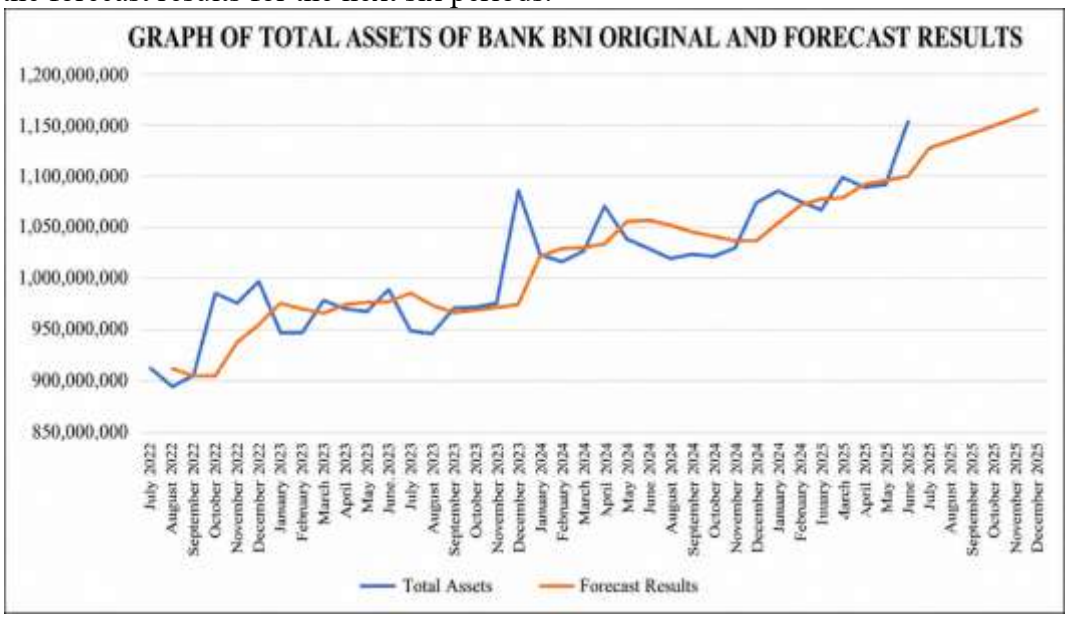


**Figure 1.** Actual and Forecasted Total Assets of Bank BNI

The graph comparing BNI Bank's actual asset figures with the forecast results shows that the forecasting model captures asset growth fairly well. In general, both lines move in the same direction, following an upward trend from 2022 to 2025. At the beginning of the period, specifically from mid-2022 to early 2023, there was a slight discrepancy between the actual asset figures and the forecast results, with the actual data showing sharper fluctuations than the forecast. From late 2023 through 2024, the two trends converged again, though there were minor deviations at times, particularly during sudden spikes in the actual data. In 2025, the forecast results increasingly align with the movements of the actual assets, showing a relatively parallel upward trend. Overall, this graph demonstrates that the forecast results are fairly representative of Bank BNI's asset growth trend, despite discrepancies at certain points.

## CONCLUSION

From the analysis and discussion, it is clear that the Brown Double Exponential Smoothing method is effective for predicting Bank BNI's total assets with a very high degree of accuracy. The test results indicate that the best smoothing parameters are achieved when

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$\alpha$ is set to 0.2, resulting in a MAPE of 2.208%. A MAPE value of less than 10% indicates that the model has excellent forecasting capability. Based on this best model, the forecast results for Bank BNI's total assets for the period from July through December 2025 are, in order: 1,126,063,148; 1,133,585,647; 1,141,108,145; 1,148,630, 643; 1,156,153,141, and 1,163,675,640. These forecast results show a gradual upward trend in Bank BNI's total assets over each period, indicating positive growth prospects and reflecting the bank's ability to maintain stability and improve its business performance.

## AUTHOR CONTRIBUTIONS

Conceptualization, F.; methodology, F.; results and discussion, F and A.R.; writing-original, F and A.R.; writing-revision and editing, F and A.R. All authors have read and agreed to the published version of the manuscript.

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## CONFLICT OF INTEREST

The authors declare no conflicts of interest

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