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A Comparison of the Smoothing Constant Values Among Exponential Smoothing Methods in Commodity Prices Forecasting

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Abstract

Commodity prices forecasting is one of the business functions to estimate future demand based on past data trend. This study aims to implement a trial and error technique of the constant (alpha α) value in the exponential smoothing method. Dealing with confusion that often researchers find in selecting an alpha (α) value among exponential smoothing families, which suits characteristics of the investigated case. As selection of the constant value precisely contributes to reduce the forecasting deviation. This paper used the alpha (α) value in the range 0,1 to 0,9 and utilized the mean absolute percentage error (MAPE) and Mean Absolute Error (MAE) as the parameter to know the grade of prediction. In data training, the authors used Single Exponential Smoothing (SES) and Brown's Double Exponential Smoothing (B-DES) as methods to compare the results of prediction. It is addressed that forecasting with alpha (α) 0,1 is the most optimal values for Single Exponential Smoothing (SES) in this case with margin error 0,00036 of MAPE and 16,84 of MAE.

Keywords: *forecasting, smoothing constant, exponential smoothing, B-DES, SES.*

1. Introduction

Commodity prices forecasting is an important part of decision-making activities. The main benefits in forecasting is ease in predicting future demand. One of forecasting method is the time series. Analysis of time series is used to data collected over time such as: daily, weekly, monthly, as well as annually data [1]. To model data in the time series, exponential smoothing is used. Besides being simple in solving problems, it can be used in all domain data in the form of time series [2] to forecast future data [3]. Two popular methods in exponential technique includes Single Exponential Smoothing (SES) and Brown's Double Exponential Smoothing (B-DES). The basis for applying both methods is due to the exponential smoothing provides a larger weight in the current data and calculates all prior observations [4]. To get accurate results in predictions, exponential smoothing required a constant value denoted by alpha (α), where alpha is a smoothing constant in range zero and one [5][6].

Many works have been using exponential smoothing constant application for forecasting. Such as forecasting for electricity load demand with alpha 0,9 [7]. Meanwhile, studied with alpha 0 to 1 have been carried out such as fish inventory prediction [8], rice price forecasting [9], liquefied petroleum gas [10] and prediction of monthly cargo weight [11] food commodity prices [12], forecasting Palm Oil real production [13] and wind energy predictions [14]. Furthermore, some researchers tried to integrate the Brown's Double Exponential Smoothing (B-DES) method with other methods such as predicting stock exchange composite index [15], and prices prediction [16] compared with Weighted Moving Average. Then predicted the number of batik cloth requests [17] and consumer price index [11] with alpha between 0-1. However, those previous works have not been discussed the comparison of these methods.

Selection of the constant value precisely is very important, as it contributes to reduce the forecasting deviation, or conversely elevates the deviation. In fact, researchers often find a confusion in selecting an alpha (α) value among exponential smoothing families that suits characteristics of the investigated case. Realize the importance of the constant values selection, the authors conducted a study to find the best alpha (α) value in forecasting commodity prices. In this paper the authors compared methods of Single Exponential Smoothing (SES) and Brown's Double Exponential Smoothing (B-

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DES). For this study, we used trial & error method to test alpha value from 0,1 to 0,9. The aim of the research is to find best alpha value in reducing the error measurement as well as to obtain the best method which is suitable with the training data. The proposed method will be implemented in the Modern Market of Makassar city, with case study of Chicken sales.

2. Research Methods

2.1 *Dataset Structure*

The study took place in Makassar city, South of Sulawesi, Indonesia. The dataset consists of three months' chicken meat process history. For simulation, we used chicken prices commodity dataset starting from August to October, 2019 as shown in Table I.

Table 1. Chicken Meat Prices History

Period (in weeks)	Prices (IDR)
01/08/2019	47000
07/08/2019	47000
14/08/2019	48320
21/08/2019	46674
28/08/2019	45465
05/09/2019	45320
12/09/2019	44642
19/09/2019	45001
26/09/2019	45044
03/10/2019	45049
11/10/2019	47338
17/10/2019	47877
24/10/2019	48821

Figure 1. Line Chart of the Dataset

2.2 *The Proposed Methods*

Basically, this research compares the Single Exponential Smoothing and Brown's Double Exponential Smoothing (B-DES) methods which is time series method for forecasting. Simple exponential smoothing (SES) is probably the widely used class of procedures for smoothing discrete time series in order to forecast the immediate future [18]. It presents an advantage for short-term forecasting [19]. The general model for SES is written in formula (1) [20].

$$F_{t+m} = \alpha y_t + (1-\alpha)F_t \quad (1)$$

F_{t+m} is single exponential smoothed value in period *t+m*, y_t is the actual value at time period *t*. While α is the smoothing constant (α) between 0 to 1, and F_t is the forecast made in period *t*.

Furthermore, another method using in this research is Brown's Double Exponential Smoothing (B-DES). This method was developed by Brown to overcome difference between actual data and forecast values. B-DES is usually used for loading data linear trend [21] as presented in formula (2) to (6) [17].

$$S'_t = \alpha X_t + (1-\alpha)S'_{t-1} \quad (2)$$

$$S"_t = \alpha S_t + (1-\alpha)S"_{t-1} \quad (3)$$

$$a_t = S'_t + S'_t - S"_t = 2S'_t - 2S"_t \quad (4)$$

$$b_t = \frac{\alpha}{1-\alpha}(S'_t - S"_t) \quad (5)$$

$$F_{t+m} = a_t + b_t . m \quad (6)$$

Symbol α is the smoothing constant (α) between 0 to 1, F_{t+m} is forecasting result for period t+m, S'_t is the value of single exponential smoothing for period t. While $S"_t$ is the value of double exponential smoothing for period t, and a_t, b_t are smoothing constant. Stages how this research conducted as presented in Figure 2, as well as the pseudocode in Figure 3.

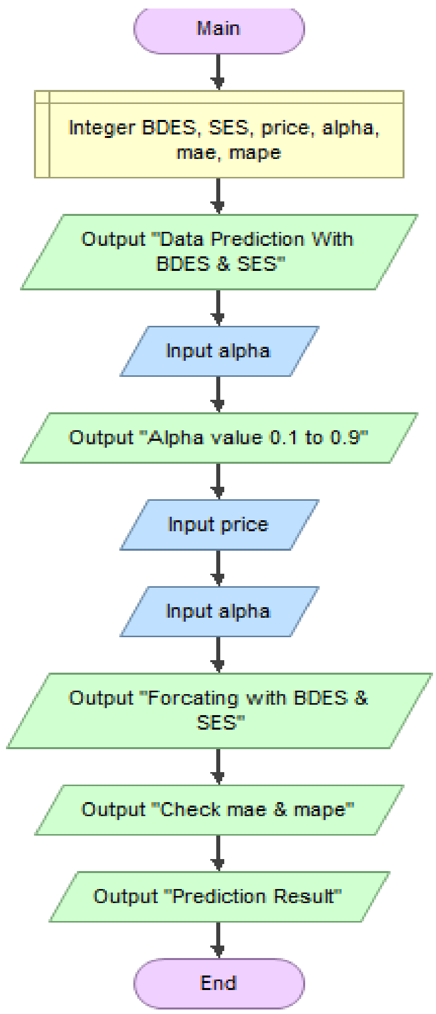

Figure 2. Flowchart of the research methodology

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```
function main()
   output "Data Prediction With BDES & SES"
   input ALPHA
   output "Alpha value 0.1 to 0.9"
   input PRICE
   input ALPHA
   output "Forcating with BDES & SES"
   output "Check mae & mape"
   output "Prediction Result"
end function
```

Figure 3. Pseudocode of the research methodology

2.3 Forecasting Error Measurements

In testing forecasting accuracy, it is needed to calculate the percentage error that occurs between the actual values and the predicted results. We use Mean Absolute Percentage Error (MAPE) and Mean Absolut Error (MAE) as measurement tools, where the best value is obtained from the smallest error value. MAPE is a prediction accuracy calculated using the absolute error[22]. It explains that how much error in forecasting data compared with the real values using formula (7) [17].

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\frac{|X_t - F_t|}{X_t} \quad (7)$$

Where n is number of data, X_t shows the actual data, F_t indicates the forecasted data. Meanwhile, MAE is the absolute value of the actual data minus the forecast result. The equation of MAE as shown in formula (8) [23].

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|e_i| \quad (8)$$

3. Results and Discussions

Historical data in Table I indicate significant fluctuation of chicken meat prices. As shown by irregular alternation of the increasing and decreasing sales pattern trends. Due to unstable, it is necessary to predict the chicken meat prices in certain periods in the future. The SES and B-DES methods are suitable for price forecasting in both short and long term. Both methods require the alpha (α) parameter. The input value (α) is to minimize the sum of squared and the absolute error number in forecasting [24]. In this study, we used a trial and error method to get the best alpha parameters to optimize the comparison of both methods. The estimation results of the model with alpha parameters are presented in Table 2.

Based on the result recapitulated in Table II, it can be seen that the two methods produce different results and show high error differences between both methods due to unstable prices. The selection of the best α parameter is chosen based on the smallest MAPE and MAE values. To calculate the MAPE and MAE values used the formula in equations (7 and 8). The α parameter determined are 0.1, 0.2, 0.3, 0.4, 0.5, 0.6.7, 0.8, 0.9. While specific comparison among parameters are presented in Fig.1 to Fig.4 respectively.

Table 2. Comparison of *B-DES* and *SES* Result

Constant α	Brown's Double Exponential Smoothing (*B-DES*)		Single Exponential Smoothing (*SES*)	
	MAE	MAPE	MAE	MAPE
0,9	943,60	36,74	1121,83	0,02423
0,8	767,26	27,15	938,98	0,02018
0,7	712,55	20,73	744,44	0,01594
0,6	687,13	16,49	563,80	0,01205
0,5	661,16	13,59	406,63	0,00867
0,4	600,48	11,31	275,71	0,00587
0,3	540,89	9,20	167,96	0,00358
0,2	474,40	7,13	70,92	0,00151
0,1	368,13	4,44	16,84	0,00036

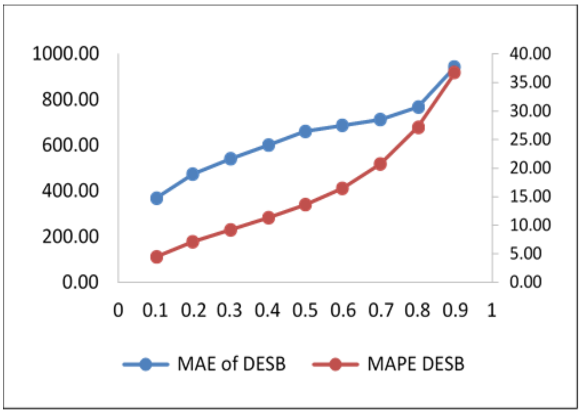

Figure 4. Results of MAE and MAPE for Brown's Double Exponential Smoothing (B-DES) Method

Referring to Fig. 4, it can be seen that forecasting using Brown's Double Exponential Smoothing (B-DES) method with alpha parameter α = 0.1 gives the best performance, with MAPE value of 4.44 and MAE value of 368.13. Meanwhile, Fig.5 displays the value of α in the range of 0.1 to 0.9 for Single Exponential Smoothing (SES) method, shows the best performance at parameter α = 0.1, with MAPE and MAE values are 0,00036 and 16.84. Those values indicate that the best result for forecasting Chicken meat prices both for B-DES and SES methods is with smoothing constant (α) = 0,1 as also shown in Table 2.

Furthermore, Fig. 6 shows Mean Absolute Percentage Error (MAPE) results for Single Exponential Smoothing (SES) method compared to the Smoothing (*B-DES*). It is demonstrated that concerning MAPE values, the SES method has smaller error compared to the DESB methods in forecasting commodity prices. On the other hand, Fig. 7 shows the comparison between *SES* and *B-DES* methods using Means Absolute Error (MAE) test. It is obtained that *SES* method with α = 0.1 has the smallest error value. Where the highest MAE value for the *B-DES* method is 943.60, and for *SES* method is 1121.83. Meanwhile, the highest MAPE for the *B-DES* method is 36.74 and for *SES*

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method is 0.02423. Therefore, the best model based on MAPE and MAE criteria for both Brown's Double Exponential Smoothing (*B-DES*) and Single Exponential Smoothing (*SES*) methods is in commodity prices forecasting is by using smoothing constant α = 0.1 or below. Overall comparison is presented in Fig. 8 which compares all four models, namely MAE & MAPE of the SES and MAE & MAPE of the *B-DES*. Finally, Table 3 recapitulates the whole comparison aspects including two additional evaluation models (MFE and MSE) as an enrichment.

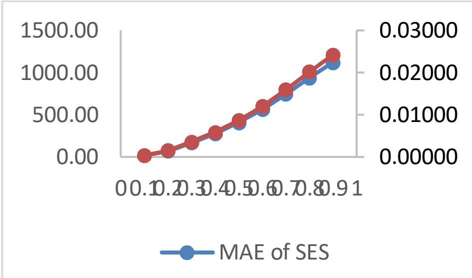

Figure 5. *Results of MAE and MAPE for Simple Exponential Smoothing (SES) Method*

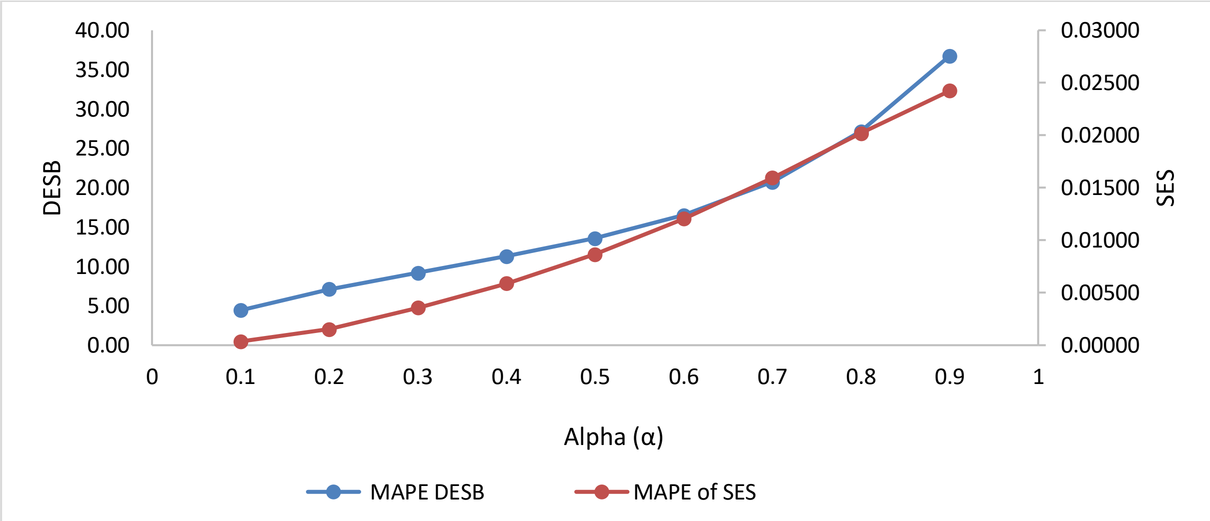

Figure 6. Comparison of B-DES and SES Methods on Mean Absolute Percentage Error (MAPE)

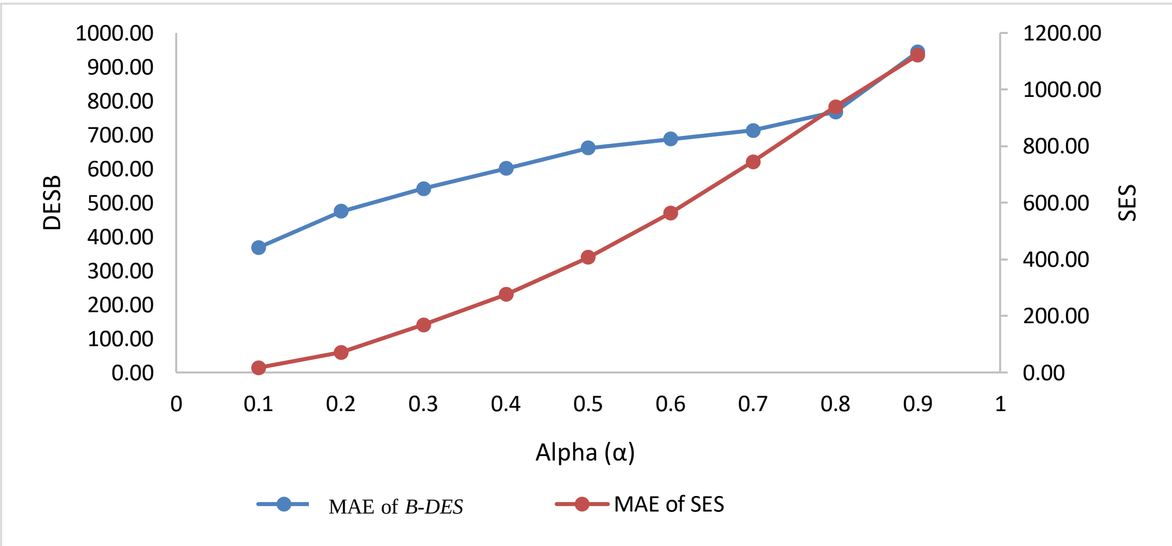

Figure 7. Comparison of B-DES and SES on Mean Absolut Error (MAE)

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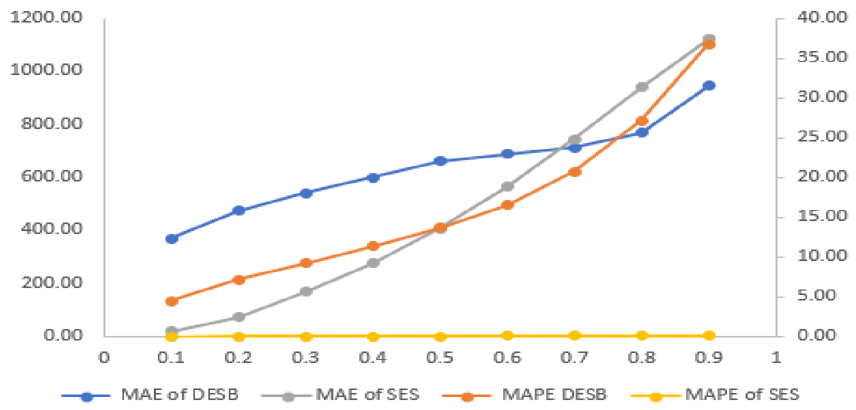

Figure 8. Comparison of B-DES and SES on MAE and MAPE

Table 3. Comparison of alpha accuracy of MFE, MAE, MSE and MAPE

	MFE		MAE		MSE		MAPE	
α	BDE	SES	BDE	SES	BDE	SES	BDE	SES
0.9	-70.85	-230.80	943.60	1121.83	1722855.45	1641556.87	36.74	0.02423
0.8	-67.81	-50.29	767.26	938.98	1272699.18	1197957.42	27.15	0.02018
0.7	-57.45	32.73	-57.45	744.44	970996.13	804961.58	20.73	0.01594
0.6	-34.74	61.27	687.13	563.80	771277.26	494781.07	16.49	0.01205
0.5	5.49	61.79	661.16	406.63	634034.43	275336.25	13.59	0.00867
0.4	65.91	49.37	600.48	275.71	525243.58	133266.54	11.31	0.00587
0.3	139.92	32.08	540.89	167.96	424974.69	49777.38	9.20	0.00358
0.2	198.52	13.92	474.40	70.92	329218.63	9060.49	7.13	0.00151
0.1	171.41	-3.34	368.13	16.84	206639.59	533.47	4.44	0.00036

4. Conclusion

Comparison results of the Single Exponential Smoothing (SES) and Brown's Double Exponential Smoothing (B-DES) based on MAPE and MAE criteria, shows that the SES method is better due to its smaller error value than the B-DES method. Furthermore, testing with Mean Absolute Percentage Error (MAPE) model shows that Single Exponential Smoothing (SES) was optimum for predicting unstable prices by using smoothing constant α = 0.1 or below.

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