Zero : Jurnal Sains, Matematika, dan Terapan
E-ISSN : 2580-5754
P-ISSN : 2580-569X
Vol. 6, No. 1, Juni 2022
pp. 32-38

IMPLEMENTATION OF THE DOUBLE EXPONENTIAL SMOOTHING (DES) METHOD TO FORECET THE CONSUMER PRICE INDEX (CPI) IN MEDAN CITY

Goklas Hutagalung[1], Hamidah Nasution[3],
[1,3]Department of Mathematics, Universitas Negeri Medan, Medan, Indonesia

Article Info

Article history:

Keywords:

Statistics Indonesia (BPS), forecasting, Double exponential smoothing.

ABSTRACT

The Central Statistics Agency (BPS) as a non-ministerial government agency has the task of providing data needs for the government and the public obtained through censuses and surveys conducted by BPS itself and also from other government departments or agencies as secondary data. The problem that occurs at BPS is the field of inflation, one of which is in the field of the consumer price index, which experiences price fluctuations which have an impact on the economy. Forecasting is an important tool used for effective and efficient planning, therefore, forecasting is needed to predict various events that will occur in the future. One of the methods used for forecasting is the linear Double Exponential Smoothing (DES) method from Brown, this method basically uses past data which is smoothed by exponen- tially weighting the older observation values or newer values and the data used shows trend pattern. Trend is a smoothed estimate of the average growth at the end of the period. In this study, the best parameter α for forecasting the consumer price index in the city of Medan is α= 0,8 with a MAPE percentage of 0,0223. And the results of the consumer price index forecast in the city of Medan in 2022-2023 show an increase every month.

Corresponding Author:

Goklas Hutagalung,
Department of Mathematics,
Universitas Negeri Medan, Medan, Indonesia
Email: goklasgalung96@gmail.com

1. INTRODUCTION

The Central Bureau of Statistics (BPS) is a government institution that plays a role in providing national and international statistical data to produce statistical data that has accurate truth and describes the actual situation, but BPS does not take approaches such as predicting or estimating from published data, one of which is price index.

The price index is a barometer of general economic conditions. With the price index, leaders or managers can manage existing data so that they can find out the development of the business or activities carried out, such as to find out the factors that affect economic progress, as a measure of the level of economic progress, or as a tool for the government to set price policies. raise or lower prices). In this case, the process of rising prices is generally and continuously referred to as inflation. Several price indices that are often used to measure inflation include the Consumer Price Index (CPI) (Siti 2018).

The Consumer Price Index (CPI) is an index that measures changes in the average price from time to time for a package of types of goods and services consumed by residents/households in urban areas on the basis of a certain period. Changes in the CPI from time to time describe the rate of increase (inflation) or the rate of decline (deflation) in the price of goods or services for daily household needs. The CPI is

calculated and announced to the public at the beginning of every month by the Central Statistics Agency (BPS)(Etri 2016).

Based on data from the Central Statistics Agency (BPS), the Consumer Price Index in Medan City in 2020-2021 experienced an increase in commodity inflation, resulting in increased commodity prices which had an impact on the economy in the city of Medan. Changes in commodity prices do not occur directly or suddenly, but experience prolonged ups and downs, but there are times when several events, such as natural disasters or holidays, some commodities experience relatively high price increases, such as Eid al-Fitr, Christmas Day, New Year's Day. and other big days.

The role of the Consumer Price Index (CPI) is evenly distributed in all cities that are observed or studied in Indonesia, namely to determine the level of price changes or inflation, as a material for formulating economic policies, measuring economic progress and to determine the factors that cause economic conditions regionally, nationally and internationally.

Definition of Forecasting

Forecasting is part of decision-making activities, because the effectiveness of a decision generally depends on several factors that cannot be seen at the time the decision was taken. Based on the forecast period, it is grouped into three parts, namely long-term forecasting, medium-term forecasting, and short-term forecasting.

Based on their nature, forecasting techniques can be divided into two main categories, namely:

1. Qualitative Forecasting

Qualitative forecasting is forecasting based on qualitative data in the past. The results of this forecast are very dependent on the person who composes it, because it is based on intuitive thinking, opinions and knowledge and experience of the people who compose it.

2. Quantitative Forecasting

Quantitative forecasting is forecasting which is based on past quantitative data. The results of this forecast are very dependent on the method used in the forecasting. Because with different methods will be obtained a forecasting result with the reality that happened. The smaller the deviation between the forecast and the reality that occurs, the better the method used.

Time Series

Time Series is a series of observations on a variable taken from time to time and recorded sequentially according to the time sequence of occurrence with fixed time intervals where each observation is expressed as a random variable obtained based on a certain time index as a sequence of observations.

Data patterns for time series are divided into horizontal patterns (H), seasonal patterns, cyclical patterns, and trend patterns,

Exponential Smoothing Method

The exponential smoothing method is a development of the moving average method. In this method, forecasting is done by repeating calculations continuously using new data. The general form of exponential smoothing is:

$$F_{t+1} = \alpha X_t + (1 - \alpha)F_t \quad (2.1)$$

Description:

F_{t+1} = Forecast for a period ahead

X_t = Actual data in period t

F_t = Forecast in period t

α = Smoothing parameter

Types of Exponential Smoothing

1. Single Exponential Smoothing Method

Also known as simple exponential smoothing used in short-term forecasts, usually only 1 month ahead. The model assumes that the data fluctuates around a fixed mean, with no consistent growth trend or pattern.

$$S_t^{'}=\alpha X_t\ (1-\alpha)S_{(t-1)}^{'} \quad (2.2)$$

2. Double Exponential Smoothing Method

This method is used when the data shows a trend. Exponential Smoothing in the presence of a trend is like simple smoothing except that the two components must be updated every period the level and the trend. Level is a smoothed estimate of the data value at the end of each period. Trend is a smoothed estimate of the average growth at the end of each period.

$$S_t^{''}=\alpha S_t^{''}\ (1-\alpha)S_{(t-1)}^{''} \quad (2.3)$$

$$a_t=2S_t^{'}-S_t^{''} \quad (2.4)$$

$$b_t=\alpha/(1-\alpha)(S_t^{'}-S_t^{''}) \quad (2.5)$$

$$F_{(t+m)}=a_t+b_t\ m \quad (2.6)$$

$$e_t=X_t-F_t \quad (2.7)$$

Information:

S_t^'= Single exponential Smoothing Value
S_t^"= Double exponential Smoothing value
α= The exponential smoothing parameter is 0<α<1
a_t,b_t= Smoothing constant
F_(t+m)= Forecasting results for the next m periods to be forecast
e_t= Error in period t

2. RESEARCH METHODE

The research to be carried out can be categorized as field research or case studies, namely research that goes directly to the object of research using direct interviews with practitioners and documents directly from the Central Statistics Agency (BPS) of Medan city.

The steps taken to conduct this research are as follows:

1. Collecting Consumer Price Index (CPI) data for Medan city by month
2. Plotting the data to find out the pattern of the data
3. Calculating the value of Single Exponential Smoothing
4. Calculating the value of Dpuble Exponential Smoothing
5. Calculating the values of the constants at and bt
6. Calculating the value (forecasting) based on the model
7. Calculating the error value.

3. RESULT AND ANALYSIS

The data obtained from the Medan City BPS are as follows

Year	t	Costumer Price Index
Jan-20	1	102,95
Feb-20	2	103,09
Mar-20	3	102,89
Apr-20	4	102,60
Mei-20	5	103,03
Jun-20	6	102,94
Jul-20	7	102,72
Agu-20	8	102,76
Sep-20	9	102,71
Okt-20	10	103,17
Nov-20	11	103,48
Des-20	12	105,15
Jan-21	13	104,55
Feb-21	14	104,21
Mar-21	15	104,18
Apr-21	16	104,22
Mei-21	17	104,47
Jun-21	18	104,50
Jul-21	19	104,82
Agu-21	20	104,71
Sep-21	21	105,03
Okt-21	22	104,98
Nov-21	23	105,46
Des-21	24	105,92

Table 4.1 Consumer Price Index Data

The CPI data is then plotted to find out the pattern of the data.

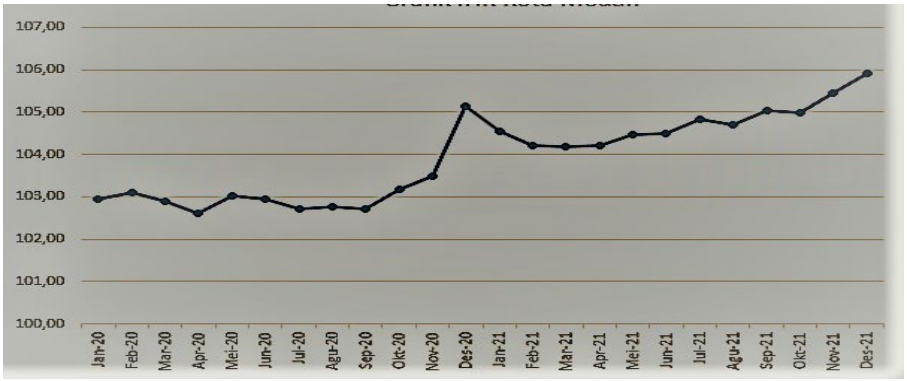

Figure 4.1 Medan City CPI Graph for 2020-2021

From Figure 4.1, it is known that the data obtained is not constant but tends to increase, this means showing data that has a trend pattern.

1. Analysis using the Double Exponential Smoothing (DES) method from Brown

The solution using the Double Exponential Smoothing Method from Brown has predetermined steps or formulas. From the data in table 4.1 and figure 4.1, a forecasting of the value of the Consumer Price Index (CPI) in the city of Medan will be carried out for the next two years.

After analyzing the alpha values from 0.1 to 0.9, the calculation steps or procedures performed are the same for all alpha values, so that in this study, data analysis will show only the best alpha value, namely alpha 0.8.

Table 4.2 Alpha value 0.8

Year	X	S_t'	S_t''	a_t	b_t	F_{t+m}	e_t
Jan-20	102,95	102,95	102,95	0	0	0	0
Feb-20	103,09	103,06	103,04	103,08	0,08	0	0
Mar-20	102,89	102,92	102,95	102,90	-0,12	103,1644	-0,2744
Apr-20	102,60	102,66	102,72	102,61	-0,24	102,7814	-0,1814
Mei-20	103,03	102,96	102,91	103,00	0,2	102,3684	0,6616
Jun-20	102,94	102,94	102,94	102,95	0	103,2041	-0,2641
Jul-20	102,72	102,76	102,80	102,73	-0,16	102,9501	-0,2301
Agu-20	102,76	102,76	102,77	102,75	-0,04	102,5703	0,1897
Sep-20	102,71	102,72	102,73	102,71	-0,04	102,7133	-0,0033
Okt-20	103,17	103,08	103,01	103,15	0,28	102,6705	0,4995
Nov-20	103,48	103,40	103,32	103,48	0,32	103,4301	0,0499
Des-20	105,15	104,80	104,50	105,10	1,2	103,7980	1,3520
Jan-21	104,55	104,60	104,58	104,62	0,08	106,2956	-1,7456
Feb-21	104,21	104,29	104,35	104,23	-0,24	104,6991	-0,4891
Mar-21	104,18	104,20	104,23	104,17	-0,12	103,9894	0,1906
Apr-21	104,22	104,22	104,22	104,21	0	104,0526	0,1674
Mei-21	104,47	104,42	104,38	104,46	0,16	104,2135	0,2565
Jun-21	104,50	104,48	104,46	104,50	0,08	104,6193	-0,1193
Jul-21	104,82	104,75	104,69	104,81	0,24	104,5848	0,2352
Agu-21	104,71	104,72	104,71	104,72	0,04	105,2185	-0,2385
Sep-21	105,03	104,97	104,92	105,02	0,2	104,7633	0,2667
Okt-21	104,98	104,98	104,97	104,99	0,04	105,2185	-0,2385
Nov-21	105,46	105,36	105,28	105,44	0,32	105,0297	0,4303
Des-21	105,92	105,81	105,70	105,91	0,44	105,7631	0,1569

Best Alpha Parameter Selection

The choice of parameter in this study was chosen based on the Mean Absolute Percentage Error which has the smallest value. The value of has been determined to be between $0 < \alpha < 1$, namely 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9. The purpose of calculating the standard error is to determine the percentage error value of the method that has been applied to solve the problem in this CPI. MAPE calculation results for parameters = 0.1 to = 0.9 can be seen in the table below.

Table 4.3 MAPE values for parameters = 0.1 to = 0.9

Parameter α	MAPE
0,1	0,3349
0,2	0,1370
0,3	0,0564
0,4	0,0493
0,5	0,0382
0,6	0,0276
0,7	0,0232
0,8	**0,0223**
0,9	0,0411

Based on Table 4.3 it is concluded that the smallest MAPE value is at = 0.8, namely with MAPE = 0.0223

Forecasting the Consumer Price Index (CPI)

After analyzing using the past data of the Consumer Price Index from the BPS Medan City, it can be calculated the prediction of the increase in CPI commodity inflation in the city of Medan for the following years, namely for 2022 and 2023. The calculation is carried out using the formula (2.8) by using the values of at and bt on the 24th data while the value of m indicates the period to be forecasted. The forecasting results are as follows:

Period	CPI Value
Jan-2022	106,35
Feb-2022	106,79
Mar-2022	107,23
Apr-2022	107,67
Mei-2022	108,11
Jun-2022	108,55
Jul-2022	108,99
Agu-2022	109,43
Sep-2022	109,87
Okt-2022	110,31
Nov-2022	110,75
Des-2022	111,19
Jan-2023	111,63
Feb-2023	112,07
Mar-2023	112,51
Apr-2023	112,95
Mei-2023	113,39
Jun-2023	113,83
Jul-2023	114,27
Agu-2023	114,71

Sep-2023	115,15
Okt-2023	115,59
Nov-2023	116,03
Des-2023	116,47

Table 4.4 Results of the Medan City CPI Forecast

4. CONCLUSION

After doing research at BPS Medan City, which then processed the data using the Double Exponential Smoothing method, it was concluded that the CPI data from January 2020 to December 2021 had the best parameter, namely = 0.8 with a percentage of 0.0223. The results of the Consumer Price Index forecast in Medan City always increase with a range equal to 0.44 for each month. Following are the forecast results obtained in January 2022 of 106.35, February 2022 of 106.79, March 2022 of 107.43, April 2022 of 107.67, May 2022 of 108.11, June 2022 of 108.55, July 2022 of 108.99, August 2022 of 109.43, September 2022 of 109.87, October 2022 of 110.31, November 2022 of 110.75, December 2022 of 111.19, January 2023 of 111.63, February 2023 of 112.07, March 2023 is 112.51, April 2023 is 112.95, May 2023 is 113.39, June 2023 is 113.83, July 2023 is 114.27, August 2023 is 114.71, September 2023 is 115 15, October 2023 is 115.59, November 2023 is 116.03, December 2023 is 116.47.

REFERENCES

[1] Alda, Raharja, d., (2010): Penerapan Metode *Exponential Smoothing* Untuk Peramalan Penggunaan Waktu Telepon di PT.Telkomsel DIVRE3 Surabaya, *Jurnal Sistem Informasi*, .

[2] Alfiah, Izat, M. T. J., (2018): Peramalan Indeks Harga Konsumen (IHK) Dengan Menggunakan Metode *Double Exponential Smoothing* Dan *Fuzzy Time Series*, *Jurnal Statistika Industri Dan Komputasi*, **3**(2).

[3] Anjani, Y., (2010): Perbandingan Metode Peramalan Exponential Smoothing Dengan Box-Jenkins (ARIMA) Untuk Deret Waktu Musiman, *Skripsi UIN Maulana Malik Ibrahim Malang*,

[4] Dyah, Puji, d., (2020): Peramalan Menggunakan Metode *Double Exponential Smoothing* Dan Verifikasi Hasil Peramalan Menggunakan Grafik Pengendali *Tracking Signal*, *Bareking Jurnal Ilmu Matematika Dan Terapan*, **14**(1).

[5] Etri, Pujiati, d., (2016): Peramalan Dengan Menggunakan Metode *Double Exponential Smoothing* Dari Brown (Study Kasus:Indeks Harga Konsumen (IHK) Kota Samarinda), *Jurnal Eksponensial*, **7**(1).

[6] Indah Lely, C, d., (2020): Pengaruh Indeks Harga Konsumen (IHK) Dan Inflasi Terhadap Suku Bunga Tahun 2008-2018 Indonesia, *Artikel Program Studi Pendidikan Ekonomi FKIP Universitas Kristen Satya Wacana*, .

[7] Iwa S, Ries T, M., (2011): Penerapan Ukuran Ketapatan Nilai Ramalan Data Deret Waktu Dalam Seleksi Model Peramalan Volume Penjualan PT Satria Mandiri Citra Mulia, *ComTech*, **2**(2).

[8] Makridakis, d., (1999): *Metode dan Aplikasi Peramalan*, Erlangga, Jakarta.

[9] Rusdiana, Y., (2015): Perancangan, Pembuatan dan Analisis Kinerja Kondensor Pada Destilator Limbah Kayu Manis *(Cinnamomum bark residue)* Pasca Panen Sebagai Bahan Baku Minyak Atsiri Dengan Menggunakan Autoclave, *Skripsi Fakultas Teknik Universitas Lampung*,

[10] Siti, Nurul, d., (2018): Sistem Peramalan Indeks Harga Konsumen (IHK) Menggu- nakan Metode *Double Exponential Smoothing*, *Jurnal Ilmiah Teknologi Informasi Asia*, **12**(1).

[11] St Syahdan, S. A., (2020): Peramalan Indeks Harga Konsumen (IHK) Kota Tarakan Dengan Metode *Double Exponential Smoothing* Dari Brown, *Jurnal Matem- atika dan Pendidikan Matematika*, **5**(1).

[12] Vivy, K., (2018): Analisis Pengaruh Indeks Harga Konsumen Terhadap Inflasi,

[13] *Jurnal Aplikasi Manajemen Ekonomi Dan Bisnis*, **3**(1)