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Comparison of Season Index Method and Fuzzy Time Series to Predict Inflation in Indonesia

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Abstract: Inflation is a rising trend in general price levels and occurs continuously. The purpose of this research is to predict the rise or fall of inflation by using the season index forecasting method and fuzzy time series and to find out which method is accurate with the Mean Absolute Percentage Error as a benchmark, so that it can be used by economy actors in the future. The data used in this research is secondary data obtained from the Central Bureau of statistics, data namely monthly inflation in 2013 to 2017. The results of research with the season index method produces MAPE of 1.51, and for the fuzzy time series methods produce MAPE of 0,33. Of research results, the use of the method of fuzzy time series more suitable to use in predicting inflation in Indonesia because the value of smaller MAPE i.e. 0,33.

Keywords: Inflation; Forecasting; Time Series; Season Index.

1. Introduction

Inflation is one of the economic indicators to measure the economic success of a country (Putong, 2015). Can be called inflation if the increase in price is widespread and result in price increases in other goods. It is still fresh in mind how inflation in mid-1998 destroyed the foundations of Indonesia's economy which shifted to a variety of social, cultural and political problems. Monetary policy compiled by Bank Indonesia as a monetary authority in Indonesia within a monetary policy framework using Inflation Targeting, a monetary policy framework that is characterized by setting inflation targets that are officially announced to the public and inflation is the only objective of monetary policy. In the inflation targeting framework, the delivery of an inflation target to the public early and openly is useful for shaping inflation expectations. This expectation will affect the level of inflation in the future, through the impact it has on aggregate demand and the level of output gap. With the difference in the estimated inflation figures issued by government and non-government institutions makes economic actors hesitant in determining the possibility of inflation that can arise. This raises the question of how to estimate the monthly inflation rate accurately and quickly. One way to produce a valid and precise and statistically tested forecast number is to use the right forecasting technique or method. Forecasting or forecasting is the art and science of estimating future events. This can be done by involving historical data retrieval and projecting it

into the future with a form of mathematical model. In addition, it can also be a subjective prediction of intuition. Or it can also be done by using a combination of mathematical models that are adjusted with good judgment from a manager (Heizer and Render, 2009). Some techniques in modeling time series include exponential smoothing methods, moving averages, artificial neural networks, season indices, fuzzy time series, and so on. This research will discuss the use of the season index forecasting method compared to the fuzzy time series forecasting method to predict inflation in Indonesia.

2. Methods

The data used in this study are secondary data obtained from BPS data on Indonesian inflation taken from 2013 to 2017, which can be seen in Table 1. Many forecasting methods are often used such as linear regression, double exponential smoothing, moving average, season index and others make a decision maker or a modeling faced with problems related to which technique is best and suitable for use as a forecasting technique. Current research compares the season index method and fuzzy time series in predicting inflation rates in Indonesia.

Table 1: Indonesian Monthly Inflation (%)

Year/Month	2013	2014	2015	2016	2017
January	1,03	1,07	-0,24	0,51	0,97
February	0,75	0,26	-0,36	-0,09	0,23
March	0,63	0,08	0,17	0,19	-0,02
April	-0,1	-0,02	0,36	-0,45	0,09
May	-0,03	0,16	0,5	0,24	0,39
June	1,03	0,43	0,54	0,66	0,69
July	3,29	0,93	0,93	0,69	0,22
August	1,12	0,47	0,39	-0,02	-0,07
September	-0,35	0,27	-0,05	0,22	0,13
October	0,09	0,47	-0,08	0,14	0,01
November	0,12	1,5	0,21	0,47	0,2
December	0,55	2,46	0,96	0,42	0,71

Research on Comparative Analysis of Season Index Method and Fuzzy Time Series to predict Inflation in Indonesia is carried out with the following stages:

1. Collecting secondary data taken from BPS data.
2. Inputing inflation data taken from BPS 2013-2017.
3. Analyze inflation data in Indonesia from 2013-2017 using graphs.
4. Perform mathematical modeling for the season index method which includes: calculating the value of the monthly weighted total, calculating the value of the monthly weighted moving average, calculating the ratio of moving average, calculating the median value, calculating the season index value, calculating the forecast and calculating the MAPE value.
5. Perform mathematical modeling for fuzzy time series methods which include: determining the set of universes, dividing the set of universes into several parts, performing fuzzification processes, doing defuzzification processes, calculating predictions and calculating MAPE values.
6. Make a comparison of the two methods which is the best with the MAPE value as a benchmark.

The process of this research is shown in the form of flowcharts in Figure 1.

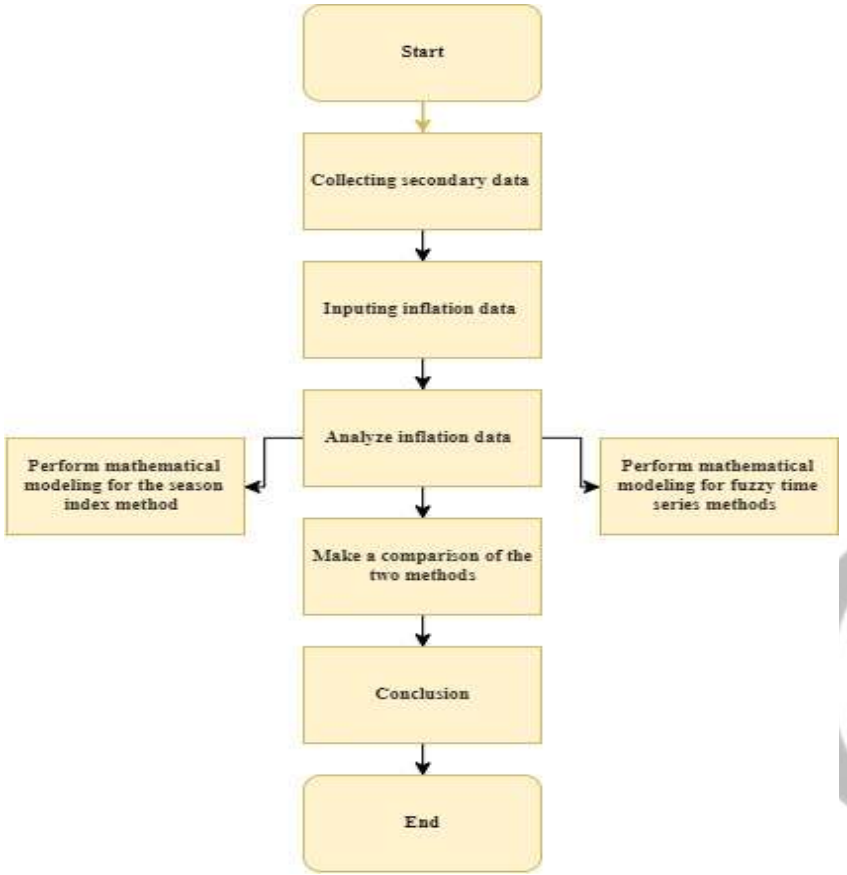

Figure 1: Research flow chart

3. Result and Discussion

3.1 Season Index

The stages in calculating the forecast using the season index method is by calculating the median, which is obtained from the median value of the median values from 2013 to 2017. The next stage is calculating the season index value, which is obtained by multiplying the median month value by the number of months from the data then divided by the total median. The next stage is to calculate the results of the forecast, which can be shown in Table 2.

Table 2: Median, Season Index and Prediction Results for 2018

Month	Median	Season Index	Forecast Results
January	0,97	2,47	1,07
February	0,23	0,59	0,25
March	0,17	0,43	0,19
April	-0,02	-0,05	-0,02
May	0,24	0,61	0,27
June	0,66	1,68	0,73
July	0,93	2,37	1,03
August	0,39	0,99	0,43
September	0,13	0,33	0,14
October	0,09	0,23	0,10
November	0,21	0,54	0,23
December	0,71	1,81	0,79

Table 3: Calculation of MAPE with Season Index

2018	Forecast Results	Relative Data	MAPE
January	1,07	0,62	0,06
February	0,25	0,17	0,04
March	0,19	0,2	0,00
April	-0,02	0,1	0,10
May	0,27	0,21	0,02
June	0,73	0,59	0,02
July	1,03	0,28	0,22
Augustu	0,43	-0,05	0,80

September	0,14	-0,18	0,15
October	0,10	0,28	0,05
November	0,23	0,27	0,01
December	0,79	0,62	0,02

From Table 3. It can be explained that the MAPE values obtained from the forecast results using the season index method is 1.51 obtained from the total MAPE from January to December.

3.2 Fuzzy Time Series

The stages in calculating predictions using the fuzzy time series method are fuzzification. The historical data used in the calculation example is shown in Table 4.

Tabel 4: Fuzzification

Month	Low	Pretty Low	Medium	Pretty High	High
Jan-13	0,00251	0,328502	0,168649	0,00034	2,68E-09
Feb-13	0,07756	0,413778	0,008657	7,10E-07	2,29E-13
Mar-13	0,35873	0,141055	0,000218	1,32E-09	3,12E-17
Apr-13	0,15567	0,341389	0,002936	9,90E-08	1,31E-14
May-13	0,08161	0,410301	0,00809	6,26E-07	1,90E-13
Jun-13	0,00083	0,236112	0,261914	0,001139	1,94E-08
Jul-13	1,10E-06	0,010925	0,424384	0,064651	3,86E-05
Aug-13	0,00461	0,375312	0,119931	0,00015	7,39E-10
Sep-13	0,03619	0,442581	0,021228	3,99E-06	2,95E-12
Oct-13	0,21806	0,280522	0,001415	2,80E-08	2,17E-15
Nov-13	0,01371	0,432698	0,053569	2,60E-05	4,95E-11
Dec-13	0,0013	0,272892	0,225082	0,000728	9,24E-09
Jan-14	0,00167	0,294463	0,203314	0,000551	5,85E-09
Feb-14	0,16876	0,328725	0,002511	7,52E-08	8,84E-15
Mar-14	0,44038	0,059589	3,16E-05	6,58E-11	5,37E-19
Apr-14	0,43719	0,06277	3,53E-05	7,80E-11	6,76E-19
May-14	0,1755	0,322179	0,00232	6,55E-08	7,25E-15
Jun-14	0,01877	0,440649	0,040563	1,46E-05	2,07E-11
Jul-14	0,00866	0,413731	0,077556	5,70E-05	1,64E-10
Aug-14	0,00119	0,265583	0,232429	0,000798	1,07E-08
Sep-14	0,09019	0,402757	0,007054	4,84E-07	1,30E-13
Okt-14	0,34639	0,153344	0,000266	1,81E-09	4,84E-17
Nov-14	0,06296	0,425745	0,01129	1,17E-06	4,79E-13
Dec-14	0,01657	0,438012	0,045394	1,85E-05	2,94E-11
Jan-15	0,00461	0,375312	0,119931	0,00015	7,39E-10
Feb-15	0,22541	0,27329	0,001299	2,42E-08	1,77E-15
Mar-15	0,21077	0,287693	0,00154	3,23E-08	2,66E-15
Apr-15	0,11997	0,375425	0,004607	2,22E-07	4,19E-14
May-15	0,21077	0,287693	0,00154	3,23E-08	2,66E-15
Jun-15	0,01205	0,428231	0,059688	3,26E-05	6,99E-11
Jul-15	0,00705	0,402693	0,090175	7,92E-05	2,73E-10
Aug-15	0,001	0,250868	0,247178	0,000955	1,45E-08
Sep-15	0,25509	0,243997	0,000915	1,35E-08	7,77E-16
Okt-15	0,14934	0,34749	0,003171	1,13E-07	1,59E-14
Nov-15	0,21077	0,287693	0,00154	3,23E-08	2,66E-15
Dec-15	0,01997	0,4417	0,03832	1,30E-05	1,74E-11
Jan-16	0,00048	0,192658	0,304971	0,001893	4,61E-08
Feb-16	0,00495	0,380361	0,114551	0,000135	6,27E-10
Mar-16	0,01129	0,425715	0,06296	3,65E-05	8,31E-11
Apr-16	0,33347	0,166202	0,000325	2,49E-09	7,49E-17
May-16	0,2846	0,214769	0,000636	7,38E-09	3,36E-16
Jun-16	0,00048	0,192658	0,304971	0,001893	4,61E-08
Jul-16	2,63E-20	6,97E-12	7,24E-06	0,029466	0,470526
Aug-16	0,00019	0,134104	0,361872	0,00383	1,59E-07
Sep-16	0,44911	0,050871	2,26E-05	3,94E-11	2,69E-19
Okt-16	0,19639	0,301795	0,001819	4,30E-08	3,98E-15
Nov-16	0,1755	0,322179	0,00232	6,55E-08	7,25E-15

Dec-16	0,01877	0,440649	0,040563	1,46E-05	2,07E-11
Jan-17	0,00032	0,165335	0,331732	0,00261	8,06E-08
Feb-17	0,09473	0,39869	0,006581	4,26E-07	1,08E-13
Mar-17	0,20354	0,294788	0,001674	3,73E-08	3,26E-15
Apr-17	0,27728	0,222024	0,000697	8,59E-09	4,15E-16
May-17	0,14934	0,34749	0,003171	1,13E-07	1,59E-14
Jun-17	0,03832	0,441708	0,019967	3,54E-06	2,46E-12
Jul-17	0,00119	0,265583	0,232429	0,000798	1,07E-08
Aug-17	0,0304	0,444146	0,025448	5,72E-06	5,04E-12
Sep-17	0,09019	0,402757	0,007054	4,84E-07	1,30E-13
Okt-17	0,0304	0,444146	0,025448	5,72E-06	5,04E-12
Nov-17	2,61E-06	0,017102	0,438736	0,044142	1,74E-05
Dec-17	9,96E-13	1,93E-06	0,01461	0,434671	0,050717

The next stage is to carry out the defuzzification process and calculate the forecasting results, which can be seen in Table 5.

Table 5: Defuzzification

Month	Low	Pretty Low	Medium	Pretty High	High
Jun-13	0,051938	0,2691	0,16577	0,0132	7,7E-06
Jul-13	5,45E-02	0,3084	0,12411	0,013	7,7E-06
Aug-13	0,054772	0,3608	0,08425	0,0002	2E-09
Sep-13	0,054185	0,3446	0,10092	0,0003	3E-09
Okt-13	0,080701	0,3219	0,09718	0,0003	3E-09
Nov-13	0,125164	0,2777	0,0969	0,0003	3E-09
Dec-13	0,209862	0,2037	0,08619	0,0003	3E-09
Jan-14	0,244702	0,2135	0,04164	0,0001	1,2E-09
Feb-14	0,248123	0,2428	0,00909	3E-06	4,1E-12
Mar-14	0,216101	0,2598	0,0241	1E-05	3,7E-11
Apr-14	0,128263	0,301	0,07058	0,0002	2,2E-09
May-14	0,058862	0,369	0,07198	0,0002	2,2E-09
Jun-14	0,09304	0,3352	0,07157	0,0002	2,2E-09
Jul-14	0,101878	0,3322	0,06572	0,0002	2,2E-09
Aug-14	0,103462	0,3371	0,05929	0,0002	2,2E-09
Sep-14	0,104145	0,359	0,03679	3E-05	1,5E-10
Okt-14	0,131189	0,3331	0,03564	3E-05	1,5E-10
Nov-14	0,104065	0,36	0,03589	3E-05	1,5E-10
Dec-14	0,115465	0,3499	0,03455	3E-05	1,5E-10
Jan-15	0,154304	0,3199	0,02578	3E-05	1,5E-10
Feb-15	0,155792	0,3305	0,01373	7E-06	1,4E-11
Mar-15	0,112121	0,3563	0,03151	2E-05	6,9E-11
Apr-15	0,070167	0,349	0,08064	0,0002	3E-09
May-15	0,097191	0,3227	0,0799	0,0002	3E-09
Jun-15	0,084905	0,3347	0,08023	0,0002	3E-09
Jul-15	0,124649	0,3065	0,0686	0,0002	2,9E-09
Aug-15	0,127232	0,3143	0,05823	0,0002	2,9E-09
Sep-15	0,127128	0,3027	0,06978	0,0004	9,2E-09
Okt-15	0,077101	0,33	0,09251	0,0004	9,3E-09
Nov-15	0,049491	0,3456	0,10447	0,0004	9,4E-09
Dec-15	0,074032	0,3213	0,10423	0,0004	9,4E-09
Jan-16	0,126958	0,2759	0,09669	0,0004	9,4E-09
Feb-16	0,126958	0,2759	0,09669	0,0004	9,4E-09
Mar-16	0,125967	0,1999	0,07378	0,0063	0,09411
Apr-16	0,123748	0,1415	0,13356	0,007	0,09411
May-16	0,146875	0,1185	0,1335	0,007	0,09411
Jun-16	0,129233	0,1359	0,13374	0,007	0,09411
Jul-16	0,164238	0,1618	0,07321	0,0067	0,09411
Aug-16	0,167992	0,2499	0,08132	0,0008	3,2E-08
Sep-16	0,168018	0,2562	0,07529	0,0005	1,6E-08
Okt-16	0,097143	0,3257	0,0766	0,0005	1,6E-08
Nov-16	0,098573	0,3243	0,07657	0,0005	1,6E-08
Dec-16	0,118929	0,3043	0,07625	0,0005	1,6E-08
Jan-17	0,145042	0,2857	0,06877	0,0005	1,6E-08
Feb-17	0,152641	0,3409	0,00642	8E-07	5,2E-13

Mar-17	0,133933	0,3143	0,05159	0,0002	2,1E-09
Apr-17	0,099306	0,3442	0,05634	0,0002	2,1E-09
May-17	0,061888	0,3803	0,05761	0,0002	2,1E-09
Jun-17	0,0381	0,3997	0,06207	0,0002	2,2E-09
Jul-17	0,030436	0,3147	0,14582	0,009	3,5E-06
Aug-17	0,030198	0,2616	0,10226	0,0958	0,01015
Sep-17	0,024118	0,1728	0,09717	0,0958	0,01015
Okt-17	0,006081	0,0922	0,09576	0,0958	0,01015
Nov-17	5,23E-07	0,0034	0,09067	0,0958	0,01015
Dec-17	1,99E-13	4E-07	0,00292	0,0869	0,01014

The next stage after making the forecast is to calculate the MAPE value, which is shown in Table 6.

Table 6: Calculation of MAPE with fuzzy time series

Month	Actual – Forecast Results	MAPE
Jun-13	0,123775972	0,120170847
Jul-13	2,558097429	0,777537213
Aug-13	0,624516784	0,557604272
Sep-13	-0,914597174	-2,613134783
Okt-13	-0,42353064	4,705896003
Nov-13	-0,332321812	2,769348437
Dec-13	0,255725858	0,464956106
Jan-14	1,004936724	0,9391932
Feb-14	0,332627984	1,279338399
Mar-14	0,048218616	0,602732698
Apr-14	-0,360527478	-18,02637389
May-14	-0,280020326	1,750127035
Jun-14	0,037834535	0,08798729
Jul-14	0,573616422	0,616791852
Aug-14	0,141975159	0,302074807
Sep-14	0,035199469	0,130368405
Okt-14	0,27642744	0,58814349
Nov-14	1,268737771	0,84582518
Dec-14	2,249582625	0,914464482
Jan-15	-0,362224611	-1,509269213
Feb-15	-0,431049215	-1,197358929
Mar-15	-0,032482522	0,191073662
Apr-15	-0,100183944	0,278288733
May-15	0,079338131	0,158676263
Jun-15	0,101409347	0,187795086
Jul-15	0,592473846	0,637068651
Aug-15	0,098241085	0,251900217
Sep-15	-0,390016681	-7,800333615
Okt-15	-0,580252782	-7,253159777
Nov-15	-0,37626137	1,79172081
Dec-15	0,407889594	0,424884994
Jan-16	0,06009097	0,117825431
Feb-16	-0,53990903	-5,998989224
Mar-16	-0,469053805	2,468704235
Apr-16	-1,359696247	-3,021547216
May-16	-0,638199555	2,659164812
Jun-16	-0,243001705	0,368184402
Jul-16	0,082792291	0,119988827
Aug-16	-0,353975651	-17,69878254
Sep-16	-0,088003715	0,400016885
Okt-16	-0,269114012	1,922242944
Nov-16	0,06293645	0,133907341
Dec-16	0,041762863	0,099435389
Jan-17	0,657496673	0,677831622
Feb-17	0,184499263	0,802170708
Mar-17	-0,275502302	-13,7751151
Apr-17	-0,231648412	2,573871244
May-17	0,012615687	0,032347917

Jun-17	0,262335273	0,380196048
Jul-17	-0,609828404	2,771947293
Aug-17	-1,252934758	-17,89906796
Sep-17	-0,995305128	7,656193289
Okt-17	-1,088810018	108,8810018
Nov-17	-0,841180388	4,20590194
Dec-17	0,12200901	0,171843676

From Table 6. It can be explained that MAPE obtained from the forecast results using the fuzzy time series method is 0.33 obtained from the average MAPE.

4. Conclusion

Based on the results of studies in determining / selecting the appropriate time series data forecasting method in predicting inflation in Indonesia from the season index method and fuzzy time series, a conclusion can be drawn by comparing the MAPE values between the two methods. The smaller the error value, the better the method is in predicting or predicting inflation. The calculation for the season index method with inflation data for 2013-2017 result a MAPE value of 1.51. As for the fuzzy time series method, the MAPE value is 0.33. From this it can be concluded that the best method for predicting inflation in Indonesia is the fuzzy time series method. This is because the MAPE value obtained is smaller than the MAPE value of the season index.

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