Multidisciplinary Informatics Journal
Vol. 1, No. 1, June 2018, Pg. 9-16

FORECASTING ANALYSIS ON PERAK STATE OF CONSUMER PRICE INDEX

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Received: 10 April 2018 / Accepted: 15 May 2018/ Published online: 1 June 2018

ABSTRACT
Consumer Price Index (CPI) is important to predict the fluctuation of inflation on each country. The objectives of this study are to study the pattern of component exist in the time series, to determine the most suitable model best fits and to forecast on the step ahead forecast on the best model. In this study, Perak's state data has been obtained from January 2013 until February 2018. All 62 data were analyzed by using Naïve with trend, Single Exponential Smoothing, Double Exponential Smoothing and Holt's Method as the error measure are Mean Square Error (MSE) and Mean Absolute Error Percentage (MAPE). As a result, Perak State CPI has a linear trend model and the best model for the time series is Single Exponential Smoothing method with $\alpha = 0.99$.
Keywords: Forecasting Technique, Consumer Price Index

1. INTRODUCTION

Consumer Price Index (CPI) is one of economic indicators. The CPI can be published on monthly, quarterly and annual basis. It is used to determine the inflation rate whether is raising or falling [1]. Before 2006 the items that has been included in CPI were divided into nine groups which are food, beverages and tobacco, clothing and footwear; gross rent, fuel & power; furniture, furnishing & household equipment and operation; medical care and health expenses;

transport and communication; recreation, entertainment, education & cultural services; and miscellaneous goods and services according to Classification of Household Goods & Services (CHGS). After January 2006 onwards the items were divided into 12 groups which are food and non-alcoholic beverages, alcoholic beverages and tobacco, clothing and footwear; housing, water, electricity, gas and other fuels; furnishing, household equipment and routine household maintenance; health, transportation, communication, recreation services and culture, education, restaurants and hotels, and miscellaneous goods and services according to Classification of Individual Consumption According to Purpose (COICOP) [2].

The CPI it is important since it used to measure the percentage change through time cost of purchasing a constant basket of goods and services. Malaysia one of the country that contribute to the inflation rate of worldwide. On February 1987 the first publication on CPI was released as base year 1980 = 100 [3]. Is it has been stated in an article that the average of CPI inflation for 2018 is 3%. The inflation rate has been declined after February 2018. The CPI has been dropped from 2.7% on January to 1.4% on February and the expectation of consensus is 1.9% but it is closer to its forecast of 1.6% [4]. Perak State one of the state that contribute for Malaysia's CPI value. Starting in 2015 until 2017 there are increasing in CPI value for Perak State which are 1.6% to 3.4% [5]. It is show that there are more used on the of prices basket of consumer goods and services such as foods, health, education and others. So by determining the forecast on CPI in Perak State, so an organization can know the future events that may occur. The objectives of this study are:

1. To study the patterns of component exist in the time series data.
2. To determine the most suitable model best fits in the data.
3. To forecast on step ahead forecast on the best model.

2. LITERATURE REVIEW

[6] carried out studies to study the analysis to China's urban and rural CPI data. The study found that there are differences on urban and rural area which leads that there is distinct of consumer habits according to surrounding. It is also stated that there is a relationship between urban and rural area where the model used in this research is Vector Autoregression (VAR) and the error measure is Hylleberg-Ebgle-Granger-Yoo (HEGY) known as Granger causality test. Furthermore, in demand forecasting in food retail is used to compared the performances between Autoregressive Integrated Moving Average (ARIMA) and Holt-Winter (HW) model according to group of dairy products while the error measure is MAPE and Theil inequality index (U-Theil). As the final result, HW model is better in predicting demand in food retail [7].

In the other research that have been carried out by [8] on inflation forecasting in United State America and the best model to predict inflation is ARIMA-GRACH based on the error measure is MAPE. It is also stated that the value of the prediction on inflation are almost the same. Thus, based on the situation there are few models that can do a prediction on CPI data and inflation. So, predicting and forecasting CPI is important to know the crucial factor in monetary policy these days and to study the pattern of inflation in the future itself. As determining the right model to predict and forecast CPI, it can improve the accuracy of economy growth.

3. METHODOLOGY

For this study, a few types of models will be use to study the patterns of component exist in the data which are Naïve with trend, Single Exponential Smoothing, Double Exponential Smoothing and Holt's Method. Naïve with trend model (1) is the most popular model since it can be used for a short time series and can be present as,

$$F_{t+1} = y_t \frac{y_t}{y_{t-1}} \quad (1)$$

Where in model (1) y_t can be denoted as the actual value at time *t* and y_{t-1} is the actual value in the preceding period. Then, Single Exponential Smoothing is determined by adjusting the current period forecast by a portion of the difference between the current forecast and the current actual value. The general equation as below (2),

$$F_{t+m} = \alpha y_t + (1 - \alpha) F_t \quad (2)$$

where

F_{1+m} is the single exponential smoothed value in period $t+m$,
for m=1,2,3,4….
$y_t$is the actual value in time period, t
α is the unknown smoothing constant to be determined with value lying between 0 and 1; and
F_t is the forecast or smoothed value for period t.

Double Exponential Smoothing is also known as Brown's method. It is useful for series that has a linear trend characteristic and useful to generate multiple-ahead forecast. It can be denoted as following:

Let,
$S_t$be the exponentially smoothed value of y_t at time t,
S'_tbe the double exponentially smoothed value of y_t at time t

where

$$S_t = \alpha y_t + (1-\alpha)S_{t-1} \quad (3)$$

$$S'_t = \alpha S_t + (1-\alpha)S'_{t-1} \quad (4)$$

$$a_t = 2S_t - S'_t \quad (5)$$

$$b_t = \frac{\alpha}{1-\alpha}(S_t - S'_t) \quad (6)$$

$$F_{t+m} = a_T + b_{T\times m} \quad (7)$$

In model (5) and (6) are used to computes the difference between the exponentially smoothed values while in model (7) is used to compute *m-step-ahead* forecast in Double Exponential Smoothing. Lastly, Holt's Method is used to overcome the problem when the estimated line trend values obtained are sensitive to random influences. Holt's method obtained two parameters will provide more flexibilities in selecting rates which the trend and slopes are tracked. It can be donated ad following:

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

$$T_t = \beta(S_t - S_{t-1}) + (1-\beta)T_{t-1} \quad (9)$$

$$F_{T+m} = S_T + T_T \times m \quad (10)$$

In model (8) is used to compute the exponentially smoothed series, model (9) used to compute the trend estimate and model (10) is used to compute *m-step-ahead* into the future. In evaluating the models, Mean Square Error (MSE) and Mean Average Percentage Error (MAPE) will be used to compare the performance of the models. It can be denoted as following:

$$MSE = \frac{\sum_t^n e_t^2}{n} \quad (11)$$

$$MAPE = \sum_{t=1}^{n} \frac{\left|\left(\frac{e_t}{y_t}\right) \times 100\right|}{n} \quad (12)$$

In model (11) $e_t = y_t - \hat{y}_t$ where the actual observed value at time *t* and $\hat{y}_t$ is the fitted actual at time *t*. In model (12) *n* is the value of effective data points and $|(e_t/y_t) \times 100|$ is the absolute percentage error calculated on the fitted values for a particular forecasting method.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics Analysis

In this analysis, there are only one variable since it was a univariate modelling technique which

is value of consumer price index. Based on table 1, it shows that the average of CPI in Perak State is 111.4. Then, the minimum value of CPI in Perak is 105.1 while the maximum CPI value is 117.6. Thus, the maximum value indicates that the latest CPI value which is on February 2018.

Table 1. Descriptive Statistics Analysis of the Data Set

Variable	Mean	Minimum	Maximum
CPI	111.4	105.1	117.6

4.2 Component Exist In Time Series Data

For determining the component exist in the time series, the method is by using line graph. The result as below in Fig.1. The line chart above show that there is a component exist in the time series data which is linear trend model. This is because the line chart show that there is a general upward and downward movement along the linear line. The linear equation as follow:

$$\hat{T}_t = 105.5367 + 0.1847t \quad (13)$$

where

$\hat{T}_t$ is the value of CPI at the time *t*,

t is the time variable

This equation is useful to forecast the value of CPI in the future. The estimation can be change as the time is change.

Fig.1. Chart of Consumer Price Index in Perak from January 2013 until February 2018

4.3 Suitable Model For Time Series Data

In this section, the CPI value were evaluated by using Naive with Trend, Single Exponential Smoothing, Double Exponential Smoothing and Holt's Method. By using Microsoft Excel is employed to solved the models. The best model is determined by the lowest value of MSE and MAPE. The summary of evaluation on MSE and MAPE represented in Table 2 and Table 3.

Table 2. Summary of Evaluation using the MSE's

MSE	**Model Types**			
	Naive with Trend	**Single Exponential α = 0.99**	**Double Exponential α = 0.45**	**Holt's Method α = 0.99, β = 0.01**
Fitted Period: January 2013 - February 2017	0.55733	0.004532	0.091153	0.002108
Evaluation Period: March 2017 - February 2018	0.231119	0.001625	0.040832	0.15733

Based on table 2 and table 3, the most suitable model to predict the value of CPI on Perak is Single Exponential Smoothing with α = 0.99. Since, this model has the smallest value of MSE and MAPE for both evaluation parts compared to other models. On the second spot is Double Exponential Smoothing with α = 0.46, followed by Holt's Method with α = 0.99 and β = 0.01; and lastly the worst model is the Naive with Trend. Thus, it can be concluded that the *'best'* model is Single Exponential with α = 0.99.

Table 3. Summary of Evaluation using the MAPE's

MAPE	**Model Types**			
	Naive with Trend	**Single Exponential α = 0.99**	**Double Exponential α = 0.46**	**Holt's Method α = 0.99, β = 0.01**
Fitted Period: January 2013 - February 2017	0.4582953	0.004083163	0.21690615	0.03668089
Evaluation Period: March 2017 - February 2018	0.344107	0.00265081	0.144512736	0.262853597

Based on table 2 and table 3, the most suitable model to predict the value of CPI on Perak is Single Exponential Smoothing with α = 0.99. Since, this model has the smallest value of MSE

and MAPE for both evaluation parts compared to other models. On the second spot is Double Exponential Smoothing with $\alpha = 0.46$, followed by Holt's Method with $\alpha = 0.99$ and $\beta = 0.01$; and lastly the worst model is the Naive with Trend. Thus, it can be concluded that the *'best'* model is Single Exponential with $\alpha = 0.99$. As result, the one-step-ahead-forecast of the CPI value for Single Exponential Smoothing with $\alpha = 0.99$ is 117.6.

5. CONCLUSION

This study studied the component exist in the time series data, determine the most suitable model best fits and forecast one step ahead forecast on the best model on CPI of Perak state. Based on the analysis, the component that exist in CPI of Perak state is linear trend model. Then, it was analysis by using Naïve with trend, Single Exponential Smoothing, Double Exponential Smoothing and Holt's Method to achieve objective two. It is also evaluating by using error measure such as MSE and MAPE. It is determining by the lowest value of error measure. So, the best model is used to determine the one step ahead forecast. Thus, all of the objectives have been achieved. For further implementation that can be used in this time series such as analyzing by using Autoregressive Integrated Moving Average (ARIMA) model.

6. REFERENCES

[1] Amadeo, K. (2018, February 26). How the Government Measures Inflation? Retrieved April 10, 2018, from https://www.thebalance.com/consumer-price-index-cpi-index-definition-and-calculation-3305735

[2] Jabatan Perangkaan Malaysia. (2016). 04 INDEX HARGA PENGGUNA CONSUMER PRICE INDEX [PDF file]. Retrieved from https://www.dosm.gov.my/v1/uploads/files/3_Time%20Series/Malaysia_Time_Series_2016/04_Indeks_Harga_Pengguna.pdf

[3] Jabatan Perangkaan Malaysia. (2006). 04 INDEX HARGA PENGGUNA CONSUMER PRICE INDEX [PDF file]. Retrieved from https://www.dosm.gov.my/v1/uploads/files/3_Time%20Series/Malaysia_Time_Series_2016/04_Indeks_Harga_Pengguna.pdf

[4] Nomura Research sees Malaysia's inflation averaging 3% for 2018. (2018, March 21). Retrieved April 10, 2018, from https://www.thestar.com.my/business/business-news/2018/03/22/nomura-research-sees-malaysias-inflation-averaging-3-for-2018/

[5] Jabatan Perangkaan Malaysia. (2017). 3.15. CONSUMER PRICE INDEX BY STATE 2010 = 100, Malaysia [PDF file]. Retrieved from http://www.treasury.gov.my/pdf/economy/er/1718/st3_15.pdf

[6] Sun, F. (2012). *Analysis to China's Urban and Rural CPI Data* (Master). Uppsala University.

[7] Veiga, C., Catapan, A., Tortato, U., & Silva, W. (2014). Demand forecasting in food retail: A comparison between the Holt-Winters and ARIMA models. *WSEAS Transactions On Business and Economics*, *11*, 608-614.

[8] He, Q., Shen, H., & Tong, Z. (2012). Investigation of Inflation Forecasting. *Applied Mathematics & Information Sciences*, *6*(3), 649-655.