International Journal of Engineering & Technology, 7 (4.30) (2018) 451-453

SPC

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Forecasting of Unemployment Rate in Malaysia Using Exponential Smoothing Methods

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Abstract

One of the issues that triggers worlds lately is the increasing rate of the unemployment rate. Consequently, this research objective is to compare the most accurate forecast method and to find the most suitable period to predict the future of Malaysia's unemployment rate in 2016. There are five sets of Malaysia's unemployment rate and three forecasting methods being used which are Naïve, Simple Exponential Smoothing (SES) and Holt's method. The forecasting model was then selected based on the smallest accuracy measures. The results indicated that Holt's is the optimal model in forecasting the overall yearly unemployment rate, male yearly unemployment rate and overall quarterly unemployment rate. Furthermore, for female yearly unemployment rate and overall monthly unemployment rate, the best forecasting method was SES. Meanwhile, the overall unemployment rate of Malaysia in year 2016 was predicted to be 2.9% while 3.4% was estimated to be the value of unemployment rate for second half year of 2016 by using quarterly and monthly data. The forecast value was remained the same as previous year for overall yearly male data and female data which were 2.9% and 3.3% respectively. Lastly, the best period in forecasting Malaysia's overall unemployment rate was found to be month with the value of 3.4%.

Keywords: *Accuracy Measures; Exponential Smoothing; Forecasting; Unemployment Rate*

1. Introduction

The economy of most developed and developing countries were threatened by the unemployment where unemployment is the state of unemployed [1]. The lower economic status that specifically causes the increase of unemployment rate also leads to economically motivated violent crime of robber [2]. Therefore, unemployment has been concerned by the government in order to cope with the negative effects that might be brought by unemployment. Forecasting in unemployment rate for the coming years is crucial for the government to take corrective action on the problems faced.

The unemployment rate had been predicted by many researchers in their countries by using different forecasting methods for example Japan by [3], selected European countries by [4], Nigeria by [5] and United Kingdom by [6]. One of the researcher estimated the unemployment rate in selected European countries by using exponential smoothing methods [4]. The performance of forecasting was being compared by using smallest value of MAE, MAPE and RMSE [7]. Moreover, the time period is also the important element to be considered when forecasting in any data sets. The finer the time period, the more accurate the forecasting value to be estimated [8].

2. Methodology

The Naïve method was used as a benchmark in forecasting unemployment rate in Malaysia [9]. It also utilized in computing the value of Theil's U (U). This model implies that all the forecast values can be set to be the last observed value of the series. It can be described in algebraic as

$$F_t = A_{t-1};\ t = 1, 2, \ldots \tag{1}$$

where F_t denoted as the forecast value for the time period of t and A_{t-1} denoted as the observed value of previous period ($t-1$).

Meanwhile, Simple Exponential Smoothing (SES) forecasts future values of the same series by using only past values of a time series. It is also properly employed when there is no trend and no seasonality present in the data. Larger weights were attached to more recent observations than to the observations that from distant past. The value of α was chosen by using the solver adds-in in the Microsoft Excel in order to get a minimized value of sum of square error (SSE). Formally, the SES model can be written as

$$F_t = \alpha Y_t + (1-\alpha) F_{t-1} \tag{2}$$

Where

F_t = Forecast value for period t

α = Smoothing constant; $0 < \alpha < 1$

Y_t = Actual value in period t

F_{t-1} = Forecast value for period $t-1$

Moreover, Holt extended the simple exponential smoothing in order to bring the forecast values closer to the values observed if

the data series exhibits a trend [10]. The trend that existed in the data will cause the simple smoothing model to have large errors that usually move from positive to negative or vice versa. A forecast equation and two smoothing equations are involved in the model [11]. The smoothing parameters of α and β* were computed by using the solver where the values of both smoothing parameters are between zero and one in order to get the minimized value of SSE.

$$\hat{Y}_{t+h|t} = l_t + hb_t \tag{3}$$

$$l_t = \alpha Y_t + (1-\alpha)(l_{t-1} + b_{t-1})$$

$$b_t = \beta^* \left(l_t - l_{t-1}\right) + (1-\beta^*) b_{t-1}$$

Where

$\hat{Y}_{t+h|t}$ = Forecast value for period $t + h$

l_t = Estimate of the level of the series at time t

h = number of periods ahead to be forecasted

b_t = Estimate of the series at time t

α = smoothing parameter for the level; $0 < \alpha < 1$

Y_t = Actual value at time t

β^* = Smoothing parameter for the trend; $0 < \beta^* < 1$

The accuracy of forecasting models over a number of periods can be evaluated by using the accuracy measures. It can help to identify which model that generally works the best for each used data [12]. The best period in forecasting unemployment rate also can be examined by using the accuracy measures. Four accuracy measures were used in this study which were

$$\text{MAE} = \frac{\sum_{t=1}^{n} |Y_t - \hat{Y}_t|}{n} \tag{4}$$

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{t=1}^{n} (Y_t - \hat{Y}_t)^2} \tag{5}$$

$$\text{MAPE} = \frac{1}{n}\sum_{t=1}^{n} \left| \frac{Y_t - \hat{Y}_t}{Y_t} \right| \tag{6}$$

$$U = \frac{\sqrt{\sum_{t=1}^{n} (Y_t - \hat{Y}_t)^2}}{\sqrt{\sum_{t=1}^{n} (Y_t - Y_{t-1})^2}} = \frac{\text{RMSE (model)}}{\text{RMSE (no-change model)}} \tag{7}$$

Where

Y_t actual observation at period t

$\hat{Y}_t$ forecast value at period t

n = number of periods used in the calculation

3. Results and Discussion

The five sets of data being used was labeled in Table 1 as below. The three sets of yearly, quarterly and monthly Malaysia's unemployment rate were taken from website of Bank Negara Malaysia while another two sets of data taken from Department of Statistics Malaysia.

Table 1: The descriptions of five sets of data used

Data Set	Data Description	Period (Year)
1	Overall Yearly Unemployment Rate	1998-2015
2	Overall Year Unemployment Rate of Male	1998-2015
3	Overall Yearly Unemployment Rate of Female	1998-2015
4	Overall Quarterly Unemployment Rate	1998-second quarter of 2016
5	Overall Monthly Unemployment Rate	2010-June of 2016

Each of the data sets was then used to compute models for three of the forecasting methods which are Naïve, Simple Exponential Smoothing (SES) and Holt's method by using different in-sample period. The in-sample period for the first three data sets was from year 1998 to year 2010 while the others used till year 2014. The forecast value for Naïve method estimated to be 3.3%, 3.1%, 3.6%, 2.8% and 3.0% respectively which were same as the last observations of that series. The models computed, and smoothing parameters used by using solver for SES and Holt's methods had been showed in Table 2 and Table 3 respectively.

Table 2: The SES model and alpha value computed

Data Sets	Forecast Equation	α value
1	$F_t = 0.2609Y_t + (1-0.2609)F_{t-1}$	0.2609
2	$F_t = 0.2366Y_t + (1-0.2366)F_{t-1}$	0.2366
3	$F_t = 0.4356Y_t + (1-0.4356)F_{t-1}$	0.4356
4	$F_t = 0.2834Y_t + (1-0.2834)F_{t-1}$	0.2834
5	$F_t = 0.3585Y_t + (1-0.3585)F_{t-1}$	0.3585

Table 3: The Holt's method model and smoothing parameters computed

Data	Forecast Equation	α	β
1	$\hat{Y}_{t+h\|t} = 0.2494Y_t + (1-0.2494)(l_{t-1} + b_{t-1}) + h(l_t - l_{t-1})$	0.24	1.0
2	$\hat{Y}_{t+h\|t} = 0.8222Y_t + (1-0.8222)(l_{t-1} + b_{t-1}) + h[0.6162(l_t - l_{t-1}) + (1-0.6162)b_{t-1}]$	0.82	0.62
3	$\hat{Y}_{t+h\|t} = 0.4356Y_t + (1-0.4356)(l_{t-1} + b_{t-1}) + hb_{t-1}$	0.44	0.00
4	$\hat{Y}_{t+h\|t} = 0.6514Y_t + (1-0.6514)(l_{t-1} + b_{t-1}) + h[0.1623(l_t - l_{t-1}) + (1-0.1623)b_{t-1}]$	0.65	0.16
5	$\hat{Y}_{t+h\|t} = 0.3483Y_t + (1-0.3483)(l_{t-1} + b_{t-1}) + h[0.0070(l_t - l_{t-1}) + (1-0.0070)b_{t-1}]$	0.35	0.01

The accuracy measures were then computed by using the out-of-sample data in order to evaluate the performance of forecasting. The out-of-sample period for first three sets of data was set from year 2011 to year 2015 while for quarterly and monthly data was from year 2015 till second half year of 2016. The values for each accuracy measures was then compared and shown in Table 4.

Table 4: MAE, RMSE, MAPE and *U* of Naïve, SES and Holt's method

Accuracy Measure	Data Set				
	1	2	3	4	5
MAE	0.2600 0.2160 **0.1622**	0.2200 0.2630 **0.0936**	0.3000 **0.1902** **0.1902**	0.4333 0.2070 **0.1409**	0.2389 **0.1068** 0.1104
RMSE	0.2720 0.2458 **0.1856**	0.2408 0.2861 **0.1102**	0.3130 **0.2228** **0.2228**	0.4509 0.2136 **0.1844**	0.2858 **0.1322** 0.1383
MAPE	8.6296	7.7676	9.1711	13.2748	7.1597

(%)	7.1720	9.2235	**5.8294**	6.3673	**3.2820**
	5.3294	**3.2539**	**5.8294**	**4.4295**	3.3921
U	1.6257	1.4392	1.4924	2.9520	3.2404
	1.7379	1.7097	**1.0624**	1.3984	**1.4985**
	1.1089	**0.6586**	**1.0624**	**1.2071**	1.5685

The first row of each accuracy measures showed the values for Naïve method while the values in second row was the accuracy measure value for SES method. The last row in each accuracy measures showed the value computed from using Holt's method. The smallest values of accuracy measures indicated the most suitable method in forecasting each sets of data. The method was then used to compute the forecast value of Malaysia's unemployment rate in year 2016. The result was showed in Table 5.

Table 5: Forecast value of Malaysia's unemployment rate in year 2016

Data Set	Method Used	Forecast Value (%)
1	Holt's method	2.8701
2	Holt's method	2.8706
3	SES	3.3447
4	Holt's method	3.4687
5	SES	3.4111

The forecast value in year 2016 for overall yearly unemployment rate of male in Malaysia was expected to be the same as year 2015 which is 2.9%. Meanwhile, the unemployment rate of female in Malaysia was expected to be decreased by 0.1% in year 2016 to 3.3447%.

For the overall unemployment rate in Malaysia, the value of 2.9% was estimated to be unemployment rate in year 2016 by using yearly data which was decreased by 3.1% when compared to the value in year 2015. The values of third and fourth quarter in year 2016 was expected to be decreased 0.2% and 0.3% respectively for quarterly data set when compared to year 2015 which are 3.2%. Meanwhile for monthly data, July, August, September and November were predicted to be 3.4% which decreases 0.2% when compared to the respective month for previous year. The month of October decreased the most which is 0.3% when the forecast value compared to the actual value of October in year 2015. There is only 0.1% less in unemployment rate of December in year 2016 which the unemployment rate of December in year 2015 was 3.3%. The overall unemployment rate in Malaysia was then being compared by using the forecast value of year 2015 in order to get the best period in estimating unemployment rate among year, quarter and month. The result was then being showed in Table 6. The smallest values of MAE, RMSE and MAPE indicated that the best period in forecasting the unemployment rate was month.

Table 6: Actual, forecast mean of year 2015 and accuracy measures values

Values	Yearly Data	Quarterly Data	Monthly Data
Actual Mean	3.100	3.1500	3.1417
Forecast Mean	2.8923	2.9867	3.0523
MAE	0.2077	0.1633	0.1064
RMSE	0.2077	0.2074	0.1350
MAPE	6.7004	5.2279	3.3625

4. Conclusion

In this case study, different methods were utilized in forecasting different set of data accurately. Both methods were suitable to be used in forecasting unemployment rate in Malaysia. Hence, both of the methods recommended in forecasting unemployment rate of Malaysia for different data sets in different period used. The comparison of annually, quarterly and monthly data indicated that the smaller the scale used the more accurate the data being forecasted. So, the overall Malaysia's unemployment rate in year 2016 was estimated to be 3.4% by using the monthly data.

Acknowledgement

We would like to express our thanks to Universiti Tun Hussein Onn Malaysia for providing the facilities and financial supports to do this research. This research is supported by TIER 1 Project Grant Vot. U900.

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