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Research paper

Analysis and forecast of Turkey unemployment rate

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Abstract

This research develops techniques which are useful in forecasting single variable time series data. The techniques used in this study are moving averages (MA), Single Exponential Smoothing (SES), Adaptive Response Rate Exponential Smoothing (ARRES), Holt's Linear and Holt-Winter's Trend and Seasonality. For the purpose of this study, secondary data of Turkey Unemployment Rate covering the period 1996 up to 2015 was obtained from the Turkish Statistical Institute (TurkStat). From the result obtained, Adaptive Response Rate Exponential Smoothing (ARRES) was found to be the best method to forecast the Turkey Unemployment rate since it produces the lowest Mean Square Error (MSE) value which is 1.519.

Keywords: *Autocorrelation Coefficient; Exponential Smoothing; Forecasting; Moving Averages; Unemployment Rate*.

1. Introduction

The unemployment can explained as an economic and social phenomenon when a part of the active economic population is not occupied in the production and social process [5]. The unemployed comprises all persons 15 years of age and over who were not employed (neither worked for profit, payment in kind or family gain at any job even for one hour, who have no job attachment) during the reference period who have used at least one channels for seeking a job during the last three months and were available to start work within two weeks. Unemployment rate is the ratio of unemployed persons to the labor force [11]. When this situation take high proportions serious economic problems appear in that region or in that country, consists in an increase of social expenses with supporting the unemployed, increasing the poverty rate and criminality [5]. The unemployment rate has a strong tendency to move countercyclically, upward in general business slowdowns and contractions and downward in speedups and expansions [9].

Unemployment is one of the most important macroeconomic and social problems in Turkey economy. In addition, unemployment phenomenon in Turkey may say basically due to structural problems in the economy and the macroeconomic policies followed. Especially, after the economic crisis in 2001, Turkey economy showed a steady growth but this situation has not contributed enough to reduction of the unemployment rate [12]. In the analyzed 1996-2015 period in Turkey (TurkStat, 2016), the evolution of unemployment rate is presented in Table 1, this rate has been shown to rise along with 2001 crisis.

While 6.53% from the population (1 million 497 housand person) did not have a place to work in 2001, it was seen that this rate is 9.49% (2 million 388 thousand person) in 2005 or a gain of 2.96 points. In addition to experienced with global crisis in 2008, this rate advanced 13.05% level due to recession in foreign markets, decrease in demand in the domestic market, fluctuations in exchange rates in 2009. It has been rose to 11.13% level despite the reduction in the impact of the global crisis in 2010.

Table 1: Turkey Unemployment Rate Evolution, 1996-2015; Yearly Adjusted Series

Year	Unemployment rate (%)	Year	Unemployment rate (%)
1996	6.60	2006	9,03
1997	6.80	2007	9.18
1998	6.85	2008	10.02
1999	7.65	2009	13.05
2000	6.53	2010	11.13
2001	8.35	2011	9.10
2002	10.35	2012	8.43
2003	10.50	2013	9.04
2004	10.30	2014	9.90
2005	9.49	2015	10.30

Source: TURKSTAT, Labor Force statistics, 05.22.2016.
Note: Total figures may not be exact due to the rounding of the numbers

In this study to forecasting the Turkey unemployment rate, moving averages, exponential smoothing techniques and advanced forecasting techniques will be developed and compared in order to determine which technique is the best to forecast the Turkey unemployment rate. In the second part of the study, it has made a general informing about forecasting techniques. In the third part, the analyses of Turkey unemployment rate has been made summary. In fourth and last part of the study has been also summarized the results of studies related to forecasting of Turkey unemployment rate.

2. An overview of forecasting accuracy

In forecasting, we are trying to estimate how the sequence of observations will continue into the future. To make things simple, we will assume that the times of observation are equally spaced. This is not a great restriction because most business series are measured daily, monthly, quarterly, or yearly and so will be equally spaced [8].

2.1. Measuring forecast accuracy

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If Y_t is the actual observation for time period t and F_t is the forecast for the same period, then the errors defined as

$$E_t = Y_t - F_t \tag{1}$$

If there are observations and forecasts for n time periods, then there will be n error terms [8].
The first of standard statistical measures used for forecast error is Mean Absolute Error (MAE). This measure can be defined

$$MAE = \frac{1}{n}\sum_{t=1}^{n}|E_t| \tag{2}$$

The MAE is defined by first making each error positive by taking its absolute value and then averaging the results [13].
The second of standard statistical measures used for forecast error is Mean Squared Value (MSE). This measure can be defined

$$MSE = \frac{1}{n}\sum_{t=1}^{n} E_t^2 \tag{3}$$

Here, errors are made positive by squaring each one, then the squared errors are averaged. This approach gives exaggerative results in case of large deviations [13].
In some cases, calculating the ratio instead of the value of the forecast error can be more useful. In such cases, Mean Absolute Percentage Error (MAPE) is frequently used and can be defined

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\frac{|E_t|}{Y_t} \tag{4}$$

A widely-used evaluation of forecasting methods, which does attempt to consider the effect of the magnitude of the actual values is MAPE [13].
Sometimes, it is necessary to determine the objectivity of forecasting methods. In these cases, Mean Percentage Error (MPE) is used in the determination of objectivity because of producing positive and negative values of error values and can be defined

$$MPE = \frac{1}{n}\sum_{t=1}^{n}\frac{|E_t|}{Y_t} \text{ [13].} \tag{5}$$

It would be helpful to have a measure that considers both the disproportionate cost of large errors and provides a relative basis for comparison with naive methods. One measure that has these characteristics is the U-statistic developed by Theil. Mathematically, Theil's U statistic is defined as

$$U = \sqrt{\frac{\sum_{t=1}^{n-1}\left(\frac{FPE_{t+1}-APE_{t+1}}{Y_t}\right)^2}{\sum_{t=1}^{n-1}(APE_{t+1})^2}}, \tag{6}$$

Where $FPE_{t+1} = \frac{F_{t+1}-Y_t}{Y_t}$ and $APE_{t+1} = \frac{Y_{t+1}-Y_t}{Y_t}$. Equation (6) is actually very straightforward, as can be seen by simplifying it to the form shown in (7). When the values of FPE_{t+1} and APE_{t+1} are substituted into equation (6), result is

$$U = \sqrt{\frac{\sum_{t=1}^{n-1}\left(\frac{F_{t+1}-Y_t-Y_{t+1}+Y_t}{Y_t}\right)^2}{\sum_{t=1}^{n-1}\left(\frac{Y_{t+1}-Y_t}{Y_t}\right)^2}} = \sqrt{\frac{\sum_{t=1}^{n-1}\left(\frac{F_{t+1}-Y_{t+1}}{Y_t}\right)^2}{\sum_{t=1}^{n-1}\left(\frac{Y_{t+1}-Y_t}{Y_t}\right)^2}}. \tag{7}$$

The value of $U-$statistics will be 0 only if $F_{t+1} = Y_{t+1}$ or $FPE_{t+1} = APE_{t+1}$ for $t = 1,2,\dots,n-1$. Alternatively, the value of the $U-$statistic will have a value of 1 only when FPE_{t+1} is equal to 0. The ranges of the U-statistic can be summarized as follows [8]:
$U = 1$: the naive method is as good as the forecasting technique being evaluated.
$U < 1$: the forecasting technique being used is better than the naive method. The smaller the $U-$statistic, the better the forecasting technique is relative to the naive method.
$U > 1$: There is no point in using a formal forecasting method, since using a naive method will produce better results.

2.2. Moving averages

Moving averages provide a simple method for smoothing the "past history" data. The term "moving average" is used to describe this procedure because as each new observation becomes available, a new average can be computed by dropping the oldest observation and including the newest one. This moving average will then be the forecast for the next period. Note that the number of data points in each average remains constant and includes the most recent observations. The main moving averages models are as follows:

- Simple moving averages
- Centered moving averages
- Double moving averages
- Weighted moving averages

2.3. Exponential smoothing methods

Exponential smoothing is a forecast method that weights the observed time series values unequally. The unequal weighting is accomplished by using one or more heavily than more remote observations. some practitioners strongly object to using the term "model" in the context of exponential smoothing [4]. They are commonly used in inventory control systems where many items are to be forecast and low cost is a primary concern. No clear theory exists for deciding which of these information criteria is best suited for choosing the appropriate method of exponential smoothing [3].

2.3.1. Single exponential smoothing (SES)

The simplest exponential smoothing method is single exponential smoothing (SES), suitable for data with no trend or seasonal patterns. This forecasting method is most widely used of all forecasting techniques. The method of single exponential forecasting takes the forecast for the previous period and adjust it using the forecast error. That is, the forecast for the next period is

$$F_{t+1} = \alpha Y_t + (1-\alpha)F_t \tag{8}$$

Where α is a unknown smoothing constant between 0 and 1 [8].

2.3.2. Adaptive response rate exponential smoothing (ARRES)

The development of ARRES method is an attempt to overcome the fixed constant value of α by incorporating the effect of changing pattern of the data series into the model [1]. The basic equations for forecasting with the method of ARRES are

$$F_{t+1} = \alpha_t Y_t + (1-\alpha_t)F_t \tag{9}$$

where,

$$\alpha_{t+1} = \left|\frac{(A_t)}{M_t}\right|, \tag{10}$$

$$A_t = \beta E_t + (1-\beta)A_{t-1}, \tag{11}$$

$$M_t = \beta|E_t| + (1-\beta)M_{t-1}, \tag{12}$$

$$E_t = Y_t - F_t. \tag{13}$$

β is a parameter between 0 and 1 and | | defines absolute value function [8]. In equation (11), A_t denotes a smoothed average of forecast error. In equation (12), M_t denotes a smoothed absolute forecast error.

2.3.3. Holt's linear method

Holt extended single exponential smoothing to linear exponential smoothing to allow forecasting of data with trends. The forecast for Holt's linear exponential smoothing is found using two smoothing constants, α and β (with values between 0 and 1), and three equations

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + b_{t-1}), \quad (14)$$

$$b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1}, \quad (15)$$

$$F_{t+m} = L_t + b_t m. \quad (16)$$

Here L_t denotes an estimate of the level of the series at time t and b_t denotes an estimate of the slope of the series at time t [8].

2.3.4. Holt-winter's trend and seasonality method

Holt-Winter's method can account for data series that include both trend and seasonal elements. The basic equations for Holt Winter's multiplicative method are as follows:

$$L_t = \alpha \frac{Y_t}{S_{t-s}} + (1-\alpha)(L_{t-1} + b_{t-1}), \quad (17)$$

$$b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1}, \quad (18)$$

$$S_t = \gamma \frac{Y_t}{L_t} + (1-\gamma)S_{t-s}, \quad (19)$$

$$F_{t+m} = (L_t + b_t m)S_{t-s+m} \quad (20)$$

Where s is the length of seasonality (e.g., quarters in a year), L_t represents the level of the series, b_t denotes the trend, S_t is the seasonal component and F_{t+m} is the forecast for m periods ahead [8].

2.3.5. Determining the best α value

An optimal smoothing constant, based on certain performance measurement criteria can be obtained using Excel's Solver Ad-in. α should change to the optimal value that minimizes the forecasting performance selected earlier. "Best" is taken to mean that by applying a particular α and then certain measurement criterion is minimized. The error measurement used in this study is the standard criterion or error measure used by most practitioners for assessing the model's fitness to a particular series of data is known as MSE [10].

3. Analysis of Turkey unemployment rate

Often and especially with time series data, the data is correlated with itself, i.e. it is correlated with its lagged values. A lagged value is the value of the data one of more prior time periods before the current time period. The correlation between the lag values and the data itself is called autocorrelation. The formula to estimate the autocorrelation between observations k periods is

$$r_k = \frac{\sum_{t=k+1}^{n}(Y_t - \bar{Y})(Y_{t-k} - \bar{Y})}{\sum_{t=1}^{n}(Y_t - \bar{Y})^2}.$$

Where r_k is theoretical estimate of autocorrelation coefficient for lag of k periods and Y_t is actual value in time period t [7].
To analyze the autocorrelation between annual values of unemployment rate series and whether the series has a significant trend or not, autocorrelation coefficient for all lags is calculated and shown in Table 2.
If the time series values are entirely random, there should be no correlation between these variables [6]. Quenouille studied to understand whether the time series values are random in 1949 and his work maintains the validity [2].

Like correlation, an autocorrelation coefficient can range from −1 to 1 and the closer the autocorrelation coefficient is to −1 or 1, the stronger the relationship. A particular autocorrelation coefficient is significantly different from zero if n, the number of time periods, is large. As a result, the sampling distribution of autocorrelations can be assumed to be approximately normal with a mean of zero, and with a standard deviation of $1/\sqrt{n}$. Hypothesis on whether series is random is as follows:

$H_0: r_k = 0$ (The data is random) and $H_1: r_k \neq 0$

In determining the critical limits in the correlogram, a level of Confidence of α is used. Thus, r_k should be in the $0 \pm z_{\alpha/2}(1/\sqrt{n})$ range. In this case, for $\alpha = 0.05$, calculated approximate interval would be

$$0 \pm (1.96)(0{,}25) \leftrightarrow [-0.490, 0.490].$$

Plotted correlogram according to the above intervals is shown in

Table 2: Autocorrelation Coefficient for All Lags

k	r_k	k	r_k
1	0.372	6	0.331
2	-0.287	7	0.164
3	-0.448	8	-0.204
4	-0.205	9	-0.490
5	0.188	10	-0.171

Figure 1. As shown in Figure 1, all r_k values are included in confidence interval. Then, H_0 hypothesis would be accepted for $k = 1,2,\ldots,10$. These figures are random and calculated r_k values are not equal to zero state that represents random error of the sample.

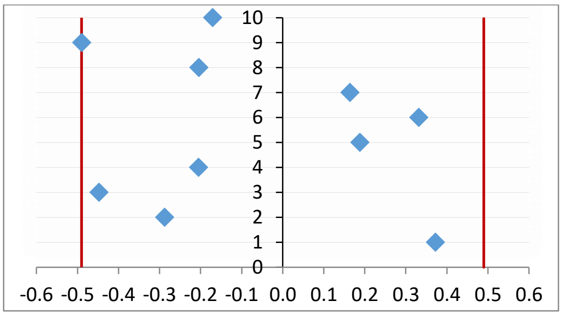

Fig. 1: Correlogram for All Lags.

According to the autocorrelation analysis results for Turkey unemployment rate series, the series is stable, that is, the data has no trend. In addition, the data has also seasonality.

4. Forecasting of Turkey unemployment rate

The data has no trend but has seasonality. Then, it is used simple and weighted moving averages techniques moving from moving averages techniques. k and w show optimum moving average level for simple moving average and weighted moving average, respectively. Best k value estimated is found to be 6 for simple moving averages and fitted series is shown in Figure 3. Best w value estimated is found to be 5 for weighted moving averages and fitted series is shown in Figure 4.

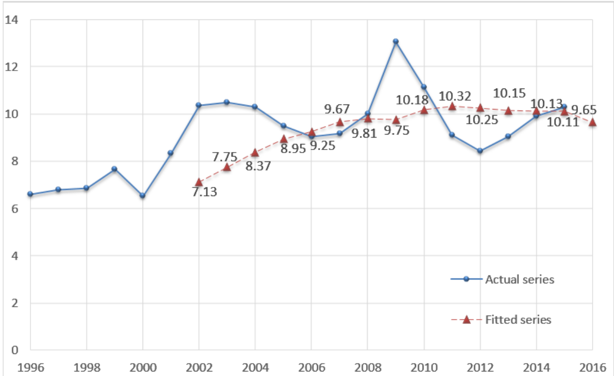

Fig. 2: Shows the Actual and Simple Moving Averages Fitted Series of Turkey Unemployment Rate for k = 6 (2000-2015).

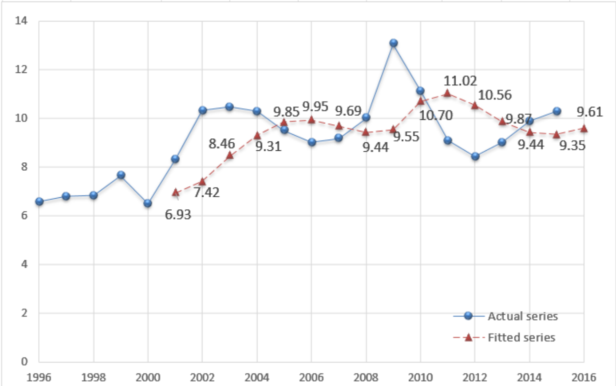

Fig. 3: Shows the Actual and Weighted Moving Averages Fitted Series of Turkey Unemployment Rate for w = 5 (1996-2015).

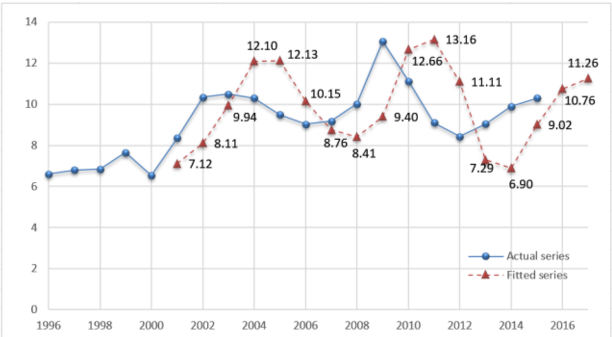

Fig. 4: Shows the Actual and Double Moving Averages Fitted Series of Turkey Unemployment Rate (1996-2015).

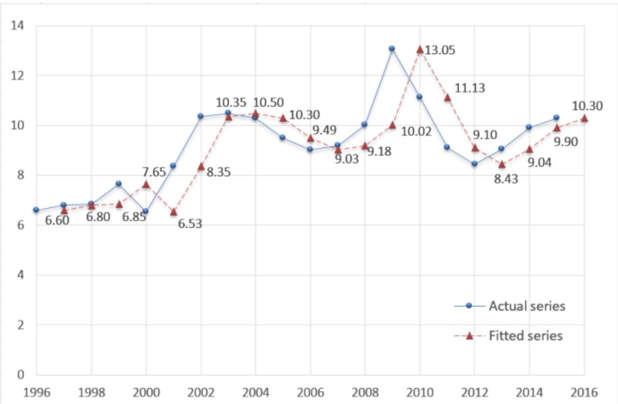

Fig. 5: Shows the Actual and Single Exponential Smoothing Fitted Series of Turkey Unemployment Rate (1996-2015). The Best Alpha (α) Value Estimated by Excel Solver Is Found to Be 0.99 and Minimum MSE Value Obtained Is 1.562.

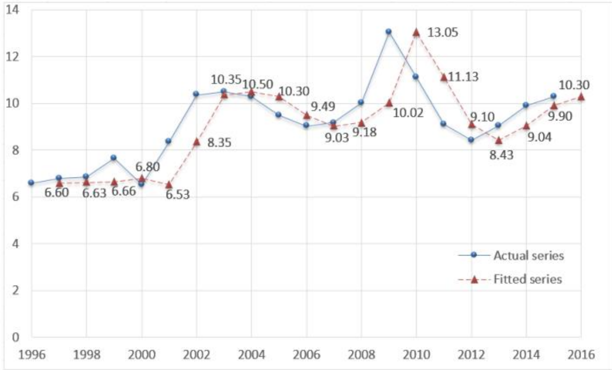

Fig. 6: Shows the Actual and ARRES Fitted Series Of Turkey Unemployment Rate (1996-2015). The α_t and β Values Estimated by Excel Solver Is Found to Be 0.14 and 1, Respectively. Minimum MSE Value Is 1.519.

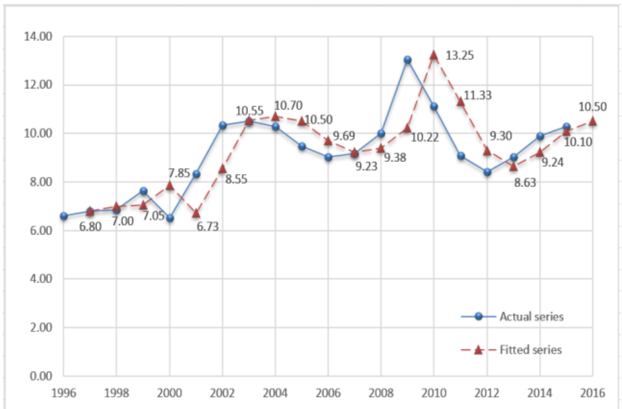

Fig. 7: Shows the Actual and Holt's Linear Method Fitted Series of Turkey Unemployment Rate (1996-2015). The α and β Values Estimated by Excel Solver Is Found to Be 0.999 and 0.001, Respectively. Minimum MSE Value Is 1.526.

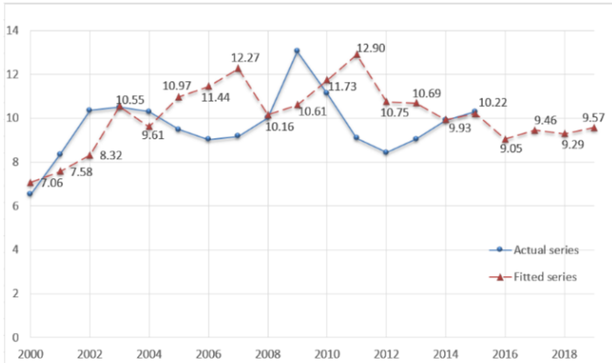

Fig. 8: Shows the Actual and Holt-Winter's Trend and Seasonality Method Fitted Series of Turkey Unemployment Rate (1996-2015). The α, β and γ Values Estimated by Excel Solver Is Found to Be 0.243, 0.280 and 0.155, Respectively. Minimum MSE Value Is Obtained 3.24.

5. Conclusion

In this study, Firstly autocorrelation analysis for characterization of annual unemployment rates is used. According to autocorrelation analysis results, it was shown that there is not correlation between Turkey unemployment rates. In addition, these series have also seasonality. Thus, it was decided that best forecasting models are simple moving average, weighted moving average, simple exponential smoothing, adaptive response rate exponential smoothing, Holt's Linear Forecasting and Holt-Winter's trend and seasonality method.

Table 3: Comparison between Methods

Method	MSE	Theil's U	MPE	MAPE	MAE
Simple moving averages	4.016	1.114	0.062	0.177	1.817
Weighted moving averages	2.653	1.141	0.033	0.133	1.331
Double moving averages	4.940	1.485	0.003	0.200	1.971
Single exponential smoothing	1.562	1.000	0.015	0.100	0.954
Adaptive response rate exponential smoothing (ARRES)	1.519	0.983	0.025	0.096	0.928
Holt’s Linear Forecasting	1.526	0.963	-0.007	0.098	0.929
Holt - Winter's trend and seasonality method	3.245	1.258	-0.078	0.063	0.607

Table 3 shows the comparison between all methods in this study. It can be concluded that ARRES is the most appropriate method for Turkey unemployment rate since it calculated the lowest Mean Square Error (MSE)) value which is 1.519 compared to 4.016 for simple moving averages, 2.653 for weighted moving averages, 4.940 for double moving averages,1.562 for SES, 1.526 for Holt’s Linear method and 3.245 for Holt-Winter’s Trends and seasonality methods. ARRES is then used to forecast the Turkey unemployment rate and it is found that the forecast Turkey unemployment rate will be 10.30.

In comparison of forecasting models, criticisms related to used the standard statistical error measures and mean squared value was taken into account. Then, it was made comparison according to second criteria. Theil’s U statistics used in selecting the most appropriate technique to forecasting was calculated for all models. Calculated data were shown Table 3. In according to this table, Holt’s Linear Forecasting is the most appropriate methods for Turkey unemployment rate. According to this technique, the forecast Turkey unemployment rate will be 10.50.

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