Journal of Computing Research and Innovation (JCRINN) Vol. 6 No. 2 (2021) (pp1-10)
https://jcrinn.com : eISSN: 2600-8793
https://doi.org/10.24191/jcrinn.v6i2.183

Forecasting Malaysian Ringgit Using Exponential Smoothing Techniques

Noreha Mohamed Yusof[1*], Norani Amit[2], Nor Faradilah Mahad[3], Noorezatty Mohd Yusop[4]
[1,2,4] *Center of Statistical and Decision Science Studies, Faculty of Computer and Mathematical Sciences*
Universiti Teknologi MARA Negeri Sembilan Branch
Persiaran Seremban Tiga/1, Seremban 3, 70300 Seremban,
Negeri Sembilan, Malaysia
[3] *Center of Mathematical Studies, Faculty of Computer and Mathematical Sciences*
Universiti Teknologi MARA Negeri Sembilan Branch
Persiaran Seremban Tiga/1, Seremban 3, 70300 Seremban,
Negeri Sembilan, Malaysia

Corresponding author: **noreh144@uitm.edu.my*

Received Date: 4 February 2021
Accepted Date: 20 February2021
Revised Date: 25 March 2021
Published Date: 1 April 2021

HIGHLIGHTS

- The exchange rate of Malaysian Ringgit (MYR) against USD for 5 years period starting from September 2013 to July 2018 was extracted from Investing.com.
- There are three methods used in this paper which are Single Exponential Smoothing, Double Exponential Smoothing, and Holt's Method.
- Error measure which is Mean Square Error and Mean Absolute Percentage Error are used to differentiate between a poor forecast model and a good forecast model.

ABSTRACT

Forecasting the foreign currency exchange is a challenging task since it is influenced by political, economic and psychological factors. This paper focuses on the forecasting Malaysian Ringgit (MYR) exchange rate against the United States Dollar (USD) using Exponential Smoothing Techniques which are Single Exponential Smoothing, Double Exponential Smoothing, and Holt's method. The objectives of this paper are to identify the best Exponential Smoothing Technique that describes MYR for 5 years period and to forecast MYR 12 months ahead by using the best Exponential Smoothing Technique. The comparison between these techniques is also made and the best one will be selected to forecast the MYR exchange rate against USD. The result showed that Holt's method has the smallest value of error measure which depending on the Mean Square Error (MSE) and Mean Absolute Percentage Error (MAPE) for the evaluation part. The MSE is $1.43915x10^{-14}$ and MAPE is 2.5413×10^{-6}. Meanwhile, the forecast value of MYR in August 2019 is RM 4.30226.

Keywords: *exponential smoothing techniques, forecasting, univariate model*

INTRODUCTION

The foreign exchange rate between two currencies is the rate at which one currency will be exchanged for another and it is determined by supply and demand factor (Das, Mishra, & Rout, 2017) and not all currency pairs are the same. Thus, all currency has its own buy price and a sell price with exchanging currencies at a current determined price. The need to use a good exchange rate forecasting method is crucial. This is because a currency can rise in value (appreciate or revalue) or decline in value (depreciate or devalue) in relationship to other currencies (Frieden, 2015). As of 27th May 2019, the ringgit opened marginally higher and rose to 4.1850/1900 against American Dollar (USD) compared with 4.1870/1900 at last 24th May 2019 close on improved oil prices, recovering some demand for the ringgit. The ringgit however traded lower against major currencies such as Singapore dollar, Japanese yen, British pound, and Euro (Bernama, 2019). The currency crash can be caused by an exogenous factor which is an unpredictable non-economic reason such as wars, natural disasters, political actions, and endogenous factors due to the great complexity of the system (Egorova & Klymyuk, 2017). Thus, forecasting the foreign exchange rates is a rather complex, challenging, and difficult task since it is influenced by economic, political, and psychological factors. Economists and investors forecast the exchange rates to exploit the predictions to derive monetary values (Bui, Truong Vu, & Huong Dinh, 2018).

There are two objectives of this paper. The first objective is to identify the best Exponential Smoothing Technique that describes Malaysian Ringgit (MYR) for 5 years period. The data about the exchange rate of Malaysian Ringgit (MYR) against USD for 5 years period starting from September 2013 to July 2018 was extracted from Investing.com and used in this paper. The second objective is to forecast MYR 12 months ahead by using the best Exponential Smoothing Technique.

This paper focuses on the application of Exponential Smoothing Techniques to forecasting the MYR exchange rate against USD. Only 3 techniques which are Single Exponential Smoothing, Double Exponential Smoothing, and Holt's method will be used in this study. The comparison between these techniques is also made by using the error measures which are MSE and MAPE. Then, the best one will be selected to forecasting the MYR exchange rate. This paper is divided into 6 sections which are Introduction, Literature Review, Methodology, Findings and Conclusion.

LITERATURE REVIEW

Many researches related to time series data forecast has been conducted as an attempt to predict the future based on the scientific method (Fauziah, Aris, Sari, & Titi, 2017). In decades, time series models have been applied in many areas including forecasting exchange rates (Maria & Eva, 2011; Valakevicius & Brazenas, 2015). Different approaches have been discussed to forecast the exchange rate of MYR against other currencies. For instance, a study had proved the relevance of using the Smooth Transition Autoregressive (STAR) non-linear model and the conventional linear Autoregressive (AR) time series model for forecasting MYR/Yen series (Liew & Ahmad Zubaidi, 2002). Findings showed that the non-linear model, STAR performed better than the linear model, AR. On the other hand, hybrid ARIMA-GARCH and hybrid ARIMA-EGARCH models were employed to forecast daily data of the USD exchange rate against MYR (Mustafa, Ahmad, & Ismail, 2017). The volatility and leverage effect of the series fitted and performed better by ARIMA-EGARCH. Furthermore, a study on forecasting exchange rates of MYR against Great Britain Pound (GBP) showed that the Exponential Smoothing method can produce better forecasting for the short forecasting period (Wan Ahmad & Ahmad, 2013).

During the earlier studies of the time series model, researchers proved that random walk based models performed better than the use of macroeconomics indicators in forecasting exchange rates (Meese & Rogoff, 1983). However, studies on the performance of non-parametric and parametric models on a long term series of the exchange rate found that the efficiency will be lost for a time horizon of more than a year (Chinn, & Meese, 1995; Mark, 1995). Random walks model is said to perform better in short term series and will lose its superiority when the time horizon was increased to more than 3 years. Besides, many researchers agreed that the exchange rate was difficult to track due to some reasons such as poor forecasting performance caused by nonlinear series and fundamental predictors do not always contribute significantly to the variability of exchange rates (Sarno, 2000; Groen, 2000).

A good model to use on any time series data depends on factors such as simplicity, accuracy, and stability (Gooijer & Hyndman, 2006; Osarumwense, 2014). In many years, various forecasting methods from different fields and applications have been proposed. Models such as Exponential, Holt-Winters models or linear regression has been proven to provide a simple and comprehensive solution to forecasting time series data. In univariate time series, exponential smoothing methods suggested by Brown (Brown, 1959) and Holt (Holt, 1957) is widely used because of its simple and robust forecasting procedures (Vallet, Bermudes, & Vercher, 2011). The methods can track the trends or seasonality component from irregular variation. It is effectively used while using time series components that change slowly over time (Zhi-Peng, Hong, Yun-Cai, & Fu-Qiang, 2008). Generally, exponential smoothing is inexpensive techniques that produce good forecast in extensive applications. In advantage, low data storage and computing requirement are needed by this method which suits the real-time application (Yaffee & McGee, 2000).

Meanwhile, the Holt-Winters method (additive Holt-Winters and multiplicative Holt-Winters) was proposed by Winters (Winters, 1960), popularized for seasonal time series (Koehler, Snyder, & Ord, 2001). The formulation assumes that every time series came from the Holt-Winters model are sharing a common structure, smoothing parameters, and corresponding errors in the univariate models are correlated (Vallet, Bermudes, & Vercher, 2011).

METHODOLOGY

There are three methods used in this paper which are Single Exponential Smoothing, Double Exponential Smoothing, and Holt's Method.

Single Exponential Smoothing

This model is the simplest form of the model within the family of the exponential smoothing technique. The model requires only one parameter, which is the smoothing constant, α, to generate the fitted values and hence forecast. The advantage of this procedure over the moving average is that it takes into account the most recent forecasts.

General equation

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

where,

F_{t+m} is the single exponentially smoothed value in period *t*+*m* (this is also defined as forecast value when generated out-of-sample), for *m* = 1, 2, 3, 4,…

Y_t is the actual value in period *t*

α is the unknown smoothing constant to be determined with value lying between 0 and 1, i.e. ($0 \leq \alpha \leq 1$), selected by the forecaster or alternatively determined by the data

F_t is the forecast or smoothed value for period *t*.

Double Exponential Smoothing

This technique is also known as Brown's Method. This method is useful for series that exhibits a linear trend characteristic. The following are four main equation used in this method

$$S_t = \alpha Y_t + (1-\alpha)S_{t-1} \tag{2}$$

$$S'_t = \alpha S_t + (1-\alpha)S'_{t-1} \tag{3}$$

$$\alpha_t = 2S_t - S'_t \tag{4}$$

$$b_t = \left(\frac{\alpha}{1-\alpha}\right)(S_t - S'_t) \tag{5}$$

$$F_{t+m} = a_t + b_t m \tag{6}$$

where,

S_t be the exponential smoothed value of y_t at time *t*

S'_t be the double exponentially smoothed value of y_t at time *t*

F_{t+m} is the forecast for period t for m=1,2,3,4…

Holt's Method

Holt's two parameter method is used to handle data with a linear trend was developed. This technique not only smooths the trend and the slope directly by using different smoothing constants but also provides more flexibility in selecting the rates at which the trend and slopes are tracked.

$$S_t = \alpha Y_t + (1-\alpha)(S_{t-1} + T_{t-1}) \tag{7}$$

$$T_t = \beta(S_t - S_{t-1}) + (1-\beta)T_{t-1} \tag{8}$$

$$F_{t+m} = S_t + T_t xm \tag{9}$$

where,

The α and β are the parameters to be determined with values from 0 to 1.

Error Measures

Error measure is used to differentiate between a poor forecast model and a good forecast model. In other words, the error measure was used to find which model is the best. A model that has the smallest error is

said to be the best model. MSE was chosen as an error measure because it is easy to understand and to calculate, and when used outside-sample usually matches the within-sample criterion.

$$\text{MSE} = \frac{\sum_{t}^{n} e_t^{\,2}}{n} \tag{10}$$

which $e_t = Y_t - \hat{Y}_t$

where,

Y_t is the actual observed value at time *t* and $\hat{Y}_t$ is the fitted value at time *t*.

Another error measure that can be used to differentiate poor and good forecast model is Mean Absolute Percentage Error (MAPE). The MAPE is used to measure the prediction of an accuracy of a forecasting method. It works best if there is no extremes to the data and no zeros. This measure is easy to understand because it provides the error in terms of percentages. MAPE can be written as;

$$\text{MAPE} = \frac{\sum_{t}^{n} \left| \left(e_t / y_t \, x100 \right) \right|}{n} \tag{11}$$

which $\left| e_t / y_t \, x100 \right|$ defines as the absolute percentage error calculated on the fitted values for a particular forecasting method.

In order to determine the model's forecasting performance, the data set which consists of 60 observations have been divided into two parts which are estimation part and evaluation part. For estimation part, ¾ of the data set which is from September 2013 until May 2017 is used to determine the error measures. Meanwhile, for the evaluation part, ¼ of the data set which is from June 2017 until August 2018 is used to evaluate the model's forecasting performance.

FINDINGS AND DISCUSSIONS

Data Description

The analysis has been done using the three techniques of exponential smoothing. First, the actual data of MYR against 1 USD is illustrated in Figure 1.

Journal of Computing Research and Innovation (JCRINN) Vol. 6 No. 2 (2021) (pp1-10)
https://jcrinn.com : eISSN: 2600-8793
https://doi.org/10.24191/jcrinn.v6i2.183

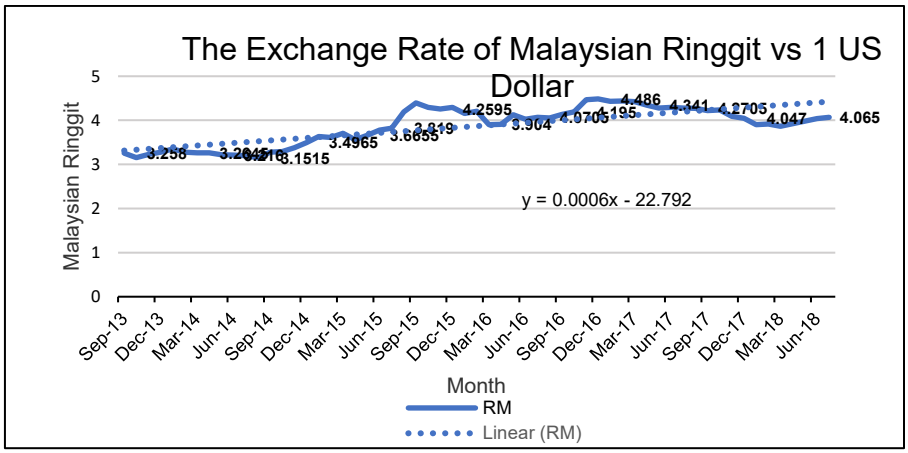

Figure 1: The Actual Price of MYR

Figure 1 shows the actual price of MYR starting from September 2013 to July 2018. It can be clearly seen that the price of MYR is increasing from 3.2865 in July 2013 to 4.065 in August 2018. The highest peak is in December 2016 with a value of 4.486 while the minimum value is in October 2013 with 3.1515. The graph contains a trend component but no identification of seasonal, irregular, and cyclical components exists. The trend line shows a positive slope exists indicating that for every one month increase, the MYR will increase about 0.0006.

Single Exponential Smoothing

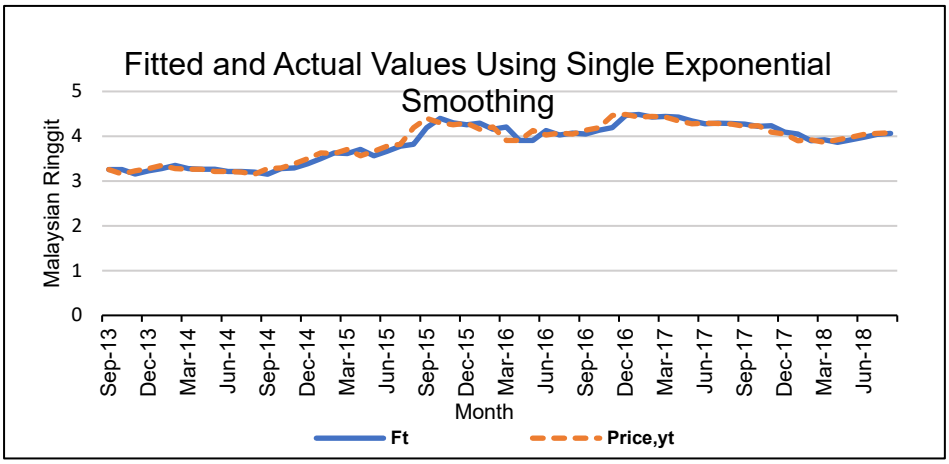

Figure 2: The Actual Price of MYR vs Single Exponential Smoothing Line of MYR

Figure 2 shows the fitted and actual values of MYR using single exponential smoothing. The component exists is trend component and the two types of lines show a similar pattern. The MSE estimation is 0.01351 and MSE evaluation is 0.00404. Meanwhile, the value of MAPE estimation is 2.1602 and MAPE evaluation is 1.1736.

Journal of Computing Research and Innovation (JCRINN) Vol. 6 No. 2 (2021) (pp1-10)
https://jcrinn.com : eISSN: 2600-8793
https://doi.org/10.24191/jcrinn.v6i2.183

Double Exponential Smoothing

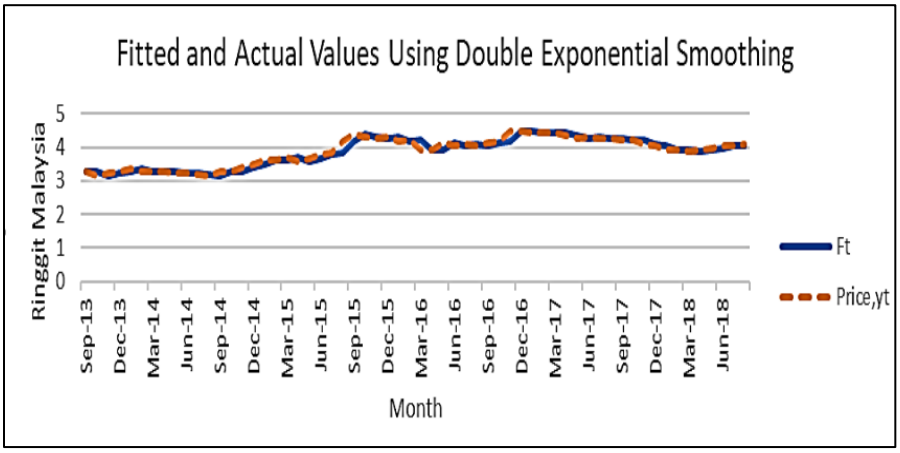

Figure 3: The Actual Price of MYR vs Double Exponential Smoothing Line of MYR

The fitted and actual values of MYR starting from September 2013 until Jun 2018 using double exponential smoothing is illustrated in Figure 3. The MSE estimation is 0.01352 and MSE evaluation is 0.00402. The MSE estimation of this method is slightly higher than using Single Exponential Smoothing and vice versa for MSE evaluation. The value of MAPE estimation and evaluation part for double exponential smoothing is 2.1610 and 1.1693, respectively.

Holt's Method

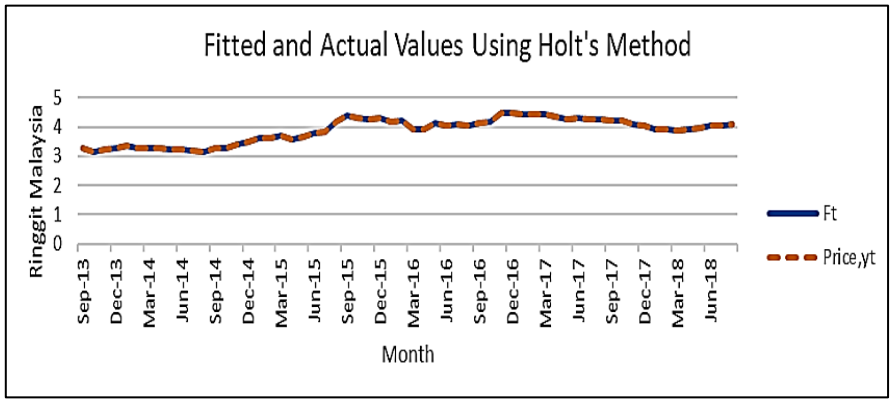

Figure 4: The Actual Price of MYR vs Holt's Method of MYR

The similarity of the trend appears in Figure 4. which describes the fitted and actual values using Holt's method. The MSE estimation is 2.95047×10^{-14} and MSE evaluation is 1.43915×10^{-14}, whereby the value of MAPE estimation is 3.0602×10^{-6} and MAPE evaluation is 2.5413×10^{-6}. The MSE and MAPE evaluation for Holt's is the lowest among the three methods.

Table 1: Error Measures for Three Different Methods

Method/Error Measures	MSE		MAPE	
	Estimation	Evaluation	Estimation	Evaluation
Single Exponential Smoothing	0.01351	0.00404	2.1602	1.1736
Double Exponential Smoothing	0.01352	0.00402	2.1610	1.1693
Holt's Method	2.95047×10^{-14}	1.43915×10^{-14}	3.0602×10^{-6}	2.5413×10^{-6}

Based on Table 1, the analysis for the three exponential smoothing techniques shows that the best model for forecasting purposes is Holt's method because it has the smallest values of MSE and MAPE evaluation part. This method is used to predict the 12 steps ahead forecast value which is in August 2019. The forecast value in August 2019 is RM 4.075 against 1 USD. The detail forecasting values for September 2018 till August 2019 against 1 USD are shown in Table 2.

Table 2: Forecasting Values Starting from September 2018 until August 2019

Month	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	July 2019	Aug 2019
Forecast Value (RM)	4.075	4.096	4.116	4.137	4.158	4.178	4.199	4.220	4.240	4.261	4.282	4.302

CONCLUSION AND RECOMMENDATIONS

As a conclusion, the first objective has been achieved as the best Exponential Smoothing Technique that describes MYR for 5 years period is Holt's method. The comparison between the three Exponential Smoothing Techniques and the result showed that Holt's method has the smallest value of error measures for both parts of data which are in the estimation and evaluation part. In order to forecast MYR 12 months ahead by using Holt's method, the forecast value of MYR in August 2019 is RM 4.30226 over 1 USD. At the time the journal is written (19 July 2019), the MYR is RM 4.11. The up and down of the MYR is definitely rely on the political, economic, and psychological factors. This study helps the decision maker especially top management of companies to monitor the forecasting performances of the MYR versus USD.

ACKNOWLEDGMENTS

The authors express their gratitude to the colleagues and research team members for their collaboration and discussions, which have improved methodologies presented in this work.

CONFLICT OF INTERESTS DECLARATION

The authors declare no conflict of interests regarding the publication of this article.

REFERENCES

Brown, R. G. (1959). Statistical forecasting for inventory control. New York: McGraw-Hill.

Bui, L. T., Truong Vu, V., & Huong Dinh, T. T. (2018). A novel evolutionary multi-objective ensemble learning approach for forecasting currency exchange rates. *Data and Knowledge Engineering*, *114*, 40–66.

Chinn, M., & Meese, D. (1995). Banking on currency forecasts: how predictable is the change in money? *Journal of International Economics*, 38, 161-178.

Das, S. R., Mishra, D., & Rout, M. (2017). A hybridized ELM-Jaya forecasting model for currency exchange prediction, Journal of King Saud University - Computer and Information Sciences, 1–22.

Egorova, L., & Klymyuk, I. (2017). Hawkes processes for forecasting currency crashes: Evidence from Russia. *Procedia Computer Science*, 122, 1182–1188.

Fauziah, F. N., Aris, G., Sari, K., & Titi, R. (2017). Comparison forecasting with double exponential smoothing and artificial neural network to predict the price of sugar. *International Journal of Simulation - Systems, Science & Technology*, 18(4), 13.1-13.8.

Frieden, J. A. (2015). Currency politics: The political economy of exchange rate policy, Princeton University Press: New Jersey.

Groen, J. (2000). The monetary exchange rate model as a long-run phenomenon. *Journal of International Economics*, 52, 299-319.

Gooijer, J. G. D. & Hyndman, R. J. (2006). 25 years of time series forecasting. *International Journal of Forecasting*, 22, 443– 473.

Holt, C. C. (1957). Forecasting trends and seasonals by exponentially weighted averages. O.N.R. Memorandum 52/1957. Carnegie Institute of Technology.

Koehler, A. B., Snyder, D. R., & Ord, K. J. (2001). Forecasting models and prediction intervals for the multiplicative Holt-Winters method. *International Journal of Forecasting*, 17(2), 269-286.

Liew, V. K., and Ahmad Zubaidi, B. (2002). How well the Ringgit-Yen rate fits the non-linear Smooth transition autoregressive and linear autoregressive models. *Pertanika Journal of Social Science and Humanities*, 10 (2), 1-15.

Mark, N. (1995). Exchange rates and fundamentals: evidence on long-horizon predictability. *American Economic Review*, pp. 201-218.

Maria, F. C., & Eva, D. (2011). Exchange-rates forecasting: exponential smoothing techniques and arima models. *Annals of Faculty of Economics*. 1(1), 499-508.

Meese, R., & Rogoff, K. (1983). The out-of-sample failure of empirical exchange rates: sampling error or misspecification, *Exchange Rates and International Macroeconomics*, 67-105, University of Chicago Press.

Mustafa, A., Ahmad M. H., & Ismail, N. (2017). Modelling and forecasting US Dollar/ Malaysian Ringgit exchange rate. *Reports on Economics and Finance*, 3(1), 1 – 13.

Osarumwense, O. (2014). Time series forecasting models: a comparative study of some models with application to inflation data, 2(2), 24-29. Published online April 20, 2014 (http://www.openscienceonline.com/journal/osjsa).

Ringgit marginally higher against US dollar at opening. Bernama. Retrieved May 27, 2019 from http://bernama.com/en/business/markets/news.php?id=1730007.

Sarno, L. (2000). Real exchange rate behavior in high inflation countries: empirical evidence from Turkey, 1980 – 1997. *Applied Economics Letters*, 7, 285-291.

Valakevicius, E, & Brazenas, M. (2015). Application of the seasonal holt-winters model to study exchange rate volatility. *Inzinerine Ekonomika-Engineering Economics*, 26(4), 384-390

Vallet, A. C., Bermudes, J. D., & Vercher, E. (2011). Forecasting correlated time series with exponential smoothing models. *International Journal of Forecasting*, 27, 252–266.

Wan Ahmad, W. K. A., & Ahmad, S. (2013). Arima model and exponential smoothing method: A comparison. AIP Conference Proceedings 1522, 1312. https://doi.org/10.1063/1.4801282

Winters, P. R. (1960). Forecasting sales by exponentially weighted moving average. *Management Science*, 6, 324-342.

Yaffee, R. A., & McGee, M. (2000). Introduction to time series analysis and forecasting: With Applications in SAS and SPSS. San Diego: Academic Press.

Zhi-Peng, L., Hong, Y., Yun-Cai, L., & Fu-Qiang, L. (2008). An improved adaptive exponential smoothing model for short-term travel time forecasting of urban arterial street. *Acta Automatica Sinica*, 34(11), 1404-1409.