Comparing The performance of Time Series Models For Forecasting the Kuwaiti Dinar against the US Dollar

Author : Wafaa Abdullah Alkhreef
Co-Author : Adel Hussian Mustafa

Project No. BS-13-10

الملخص باللغة العربية

تهدف ورقة البحث الى مقارنة نماذج السلاسل الزمنية وإستخدامها في التنبؤ لسعر صرف الـدولار الأمريكـي مقابـل الـدينار الكويتي ، ودراسة كفاءة ودقة النماذج المستخدمة في عملية التنبؤ وتحديد أفضلها كما تكمن الدراسة في تحديد مدى تأثير سعر صرف الدولار على الإقتصاد الكويتي للسنوات القادمة وذلك في مجال التجارة الخارجية . وبتطبيـق معـايير المفاضـلة بين النماذج المستخدمة للسلاسل الزمنية فقد تم إختيار افضل نموذجين وهما على التوالي :

-نموذج التجانس الأسي الثلاثي (ونتر الضربي)

-نموذج التجانس الأسي الثلاثي (ونتر الجمعي)

رمز التصنيف الرياضي للموضوعات لعام 2014 : 62M10
المصطلحات الأساسية : السلاسل الزمنية ، نماذج التجانس الأسية

Abstract

This research will attempt to compare different time series models to forecast exchange rate of Kuwaiti Dinar against US Dollar. Methodology for building exponential smoothing models will be used for KD / US $ exchange rate data . The study is aimed to illustrate predictability performance among different competitive models of exponential smoothing models to forecast the exchange rate of Kuwaiti Dinar against US Dollar .The aim of this study is to determine the most significant statistical model that can give an accurate forecasting of Kuwaiti Dinar and US Dollar exchange rate data. The results of the study reveals that the best models are the following two models :
-Triple Exponential Smoothing (Winter) ; A multiplicative Model.
-Triple Exponential Smoothing (Winter) ; A multiplicative Model.
The selection of the candidate models was based on the following accuracy forecasting measures :
- Mean Absolute Error (MAE)
-Sum Square Error (SSE)
-Mean Squared Error (MSE)
-Mean Percentage Error (MPE)
-Mean Absolute Percentage Error (MAPE)

2014 Mathematical Subject Classification : 62M10
Keywords : Time series , Exponential Smoothing Models

Table of Contents

Introduction

Our study will do close observation of the exchange rate of UD dollar against Kuwait dinar, which has witnessed fluctuation over the past years. This fluctuation came from the economic and financial crisis, the most important of which was the mortgage crisis in the United State of America which sequenced with the Global Financial Crisis in 2008.

The study observed the rate of exchange of US dollar against Kuwaiti dinar in 2009, which was 0.287 dinars, which achieved 7 % from previous year, otherwise it took a downward trend which reached 0.286 dinars on 2010. The dollar's exchange rate fell against dinar by 5 % on 2011 to be 0.271 dinars.

The slow recovery form financial crisis was one of the main reasons behind this decline in dollar exchange rate, as well as the mortgage crisis participated mainly in raising the fierce of such crisis.

In May 2007The Kuwait stopped the correlation between its currency and the US dollar, replaced it with a group of currencies due to the negative impact of the downward of US dollar value on the Kuwait economy in the last two years as well as led to local inflation in same time.

The policy of the Central Bank of Kuwait regarding the exchange rate of the Kuwait Dinar aims to improve the stability of the rate of Kuwaiti Dinar against the currencies as well as the rate of US dollar. The CBK's policy aims to protect the economy of Kuwait against the effects of the unfavorable inflation. All of these policies goes to achieve basic goal which is confirm the importance of the study the exchange rate policy in Kuwait while no imposed restrictions on the movement of funds.

The Central Bank of Kuwait followed, from the date of 18th March, 1975 till the end of 2002, a policy relays on correlation with a group of weighted currencies. This policy aims to determine the exchange rate of Kuwait dinar on special weighted basket of currencies, these currencies have high rate of financial and trade relations with Kuwait. This policy made improvement high stability in the rate of the Kuwait Dinar with some of major currencies in the entire world.

The Kuwaiti Dinar has been correlated by US dollar from the date of 5th January till 19th of May 2007, this step has been made according the Decree No. 266 of 2002 which stipulates pegging the Kuwaiti Dinar exchange rate to the US dollar with margins a parity rate as of the beginning of the year 2003. The Central Bank of Kuwait governor declared that the first business day of January 2003 which was 5th of January 2003 a parity rate will be applied on the KD exchange rate against the US dollar. this rate was set at 299.63 fils/dollar with margin of +/-3.5 %. By such decree the exchange rate of Kuwait Dinar against US dollar would be within range of 310.11 to 289.14 fils/dollar. This parity has been defined according to the principal and considerations monitored by Central Bank of Kuwait in order to determine the KD exchange rate under previous system which using the currency basket to achieve and secure a smooth change from currency basket peg to dollar peg within the set margin, Because of all above reasons, the period after 2003, the US dollar exchange rate has persistent decline against major currencies, then the putting upward pressure on Kuwait Dinar against US dollar.

By the virtue of the decree no. 147 of 2007, and as of the 20th of May, 2007, the Kuwait Dinar exchange rate against the US dollar is supported with unrevealed basket of international currencies of countries which have trade, commerce and financial relationships with Kuwait, then the Central Bank of Kuwait returned to apply the policy of exchange rate before 2003. The Central Bank governor pointed out that such action aims to protect the purchase power of the local currency and overcome the inflation pressure on the local economy.

The goal of this study is monitor the fluctuation of USD prices against Kuwaiti Dinar and except it in the coming years, as well as determines the impact of such fluctuation on the national economy of Kuwait. We can attain our goals through comparing the different time series models in order to choose the best model of forecast of the Kuwait dinar exchange rate against the USD.

Although there are many models to forecast the exchange rate, which are have different degrees of complications and they are used to define the relations between currencies, But they are not a available in full to gain full benefit from them, and most of exchange rate models based on the data of macroeconomic which are considered outperformed. We will use the prediction methods with focusing on random walk models and exponential smoothing techniques to observe and record the fluctuations in the short run. The goal we are going to achieve is to indicate the performance of methods for the purpose of set the exchange rate forecasting according to the exchange rate of KD against USD.

Literature Review

There is continue argue regarding the prediction of exchange rate according to time series, A large sum of literature which have been reviewed by Frankel and Rose in 1995, as they concentrated on if the theoretical and econometric models provide a good description of empirical data.

while the literature has not concentrated only on defined models which can defeat the Messe and Rogoff results which concluded in 1983, these results that confirmed that macro models can't outperform a naïve random walk, majority of studies found that monetary as GDP differential, inflation differentials, money growth, interests rate differential have insignificant prediction capabilities at least over short term, although there are many proofs which give high accurate prediction of fundamentals basing on the improved exchange rate models.

There are some of authors who have confirmed on the weakness of performance of the fundamental based models is not related to poor information of the fundamentals. While the prediction of random walk model is basing on the poor of the econometric techniques used in out of sample forecasts (please refer to Tylor & Peel 2000), in a new study, Sarno & Valente, on 2005, make a deep analysis of how to perfectly choose the accurate number of fundamentals to be used in calculating the best prediction model in each period.

They found that EX-ANTE mode is not able to apply a procedure that may consider the repeated changes in the weight each fundamental has in driving exchange rate fluctuations. In the recent study, a new empirical literature has been founded, which show solid proof that fluctuations govern the exchange rate behavior, and their relation doesn't showed by the line. (Taylor & Peel 2000) according to this research, Altavilla and DEe Grauw in 2005, indicated that exchange rate can follow a model of a nonlinear error-correction model where deviations from the long-run equilibrium are mean-reverting but occasionally follow a non stationary process. Nonlinearity leads to the inadequacy of the usual assumption made in the theoretical and empirical studies , but see the criticism of Faust and Rogers (2003).

The literature which approve the dynamic adjustment for the exchange rate always find the long run stability, this model has prove mixed evidences on the out of sample prediction ability of the nonlinear models. The Mark switching prediction has proved its accuracy especially regarding random walk model, this initiated by Engle and Hamilton in 1990, and then reviewed and confirmed by Clarida et al. (2003).

While these models proved their ability to give precise representation of the In-Sample Exchange Rate fluctuations, but these fail to regularly overcome Naïve Random Walk Model in OUT-of- SAMPLE prediction Model, we should make a comparative study about the prediction capability of the NON-linear against Linear models of prediction Exchange Rates.

The recent studies still face ongoing debate about the possibility of the precise prediction of the exchange rate fluctuations, the econometric evidence concluded from such research can indicate which model should be applied to achieve better prediction, A common characteristic of

much of the existing researches is their focus on either linear or non-linear models. After this preliminary choice, selected models are then compared with a random walk process.

Methodology

The fundamental benefit of the exponential smoothing models is they are simple, instinctive, easily to be understood. These models have been proved their usefulness regarding make regular short term prediction of huge number of time series such as currencies exchange rate prices. Exponential Smoothing is considered low-priced technique that predict good enough rates in a wide variety of applications, otherwise these applications building a more sophisticated model (or learning enough to understand a more complex model) would not be worth the required time and money.

The exponential Models can be programmed easily to be digital computer program. In fact, it is quite easy to do this using a personal computer and some of the widely available spreadsheet languages (such as LOTUS 1-2-3). In addition, data storage requirements are minimal. Often the use of more sophisticated forecasting models requires expensive computer packages and access to a mainframe computer.

The disadvantage of exponential smoothing is that informal building methodology, the choice of exponential smoothing method will usually depends on the explanation of a plot of the time series . The choice of a particular technique will require that the practitioner decide whether a trend exists. If a trend exists, some kind of trend must be postulated. The practitioner must also decide whether seasonal variation exists .

If seasonal variation does exist, the kind of seasonal variation—increasing or constant (that is, multiplicative or additive)—must be arrived at. As we have seen, the different exponential smoothing techniques have been designed to handle different scenarios. Method selection is largely a matter of matching the data plot with an appropriate scenario.

Trying several methods and comparing them on the basis of the sum of squared one-period-ahead forecast errors when the methods are applied to a historical data set is often a useful strategy. When this is done, the value of the smoothing constant should be determined objectively by using the historical data set for each smoothing method tried (note that the best smoothing constant for one method may not be the best for other

techniques). It is common to choose a particular method on the basis of the experience a practitioner has had with other, successful applications of exponential smoothing.

Four techniques of exponential smoothing will be employed, they are :

I-***A Single Exponential Smoothing (SES).***

Suppose that the time series $y_1,.....y_n$ is described by the model

$y_t = \beta_\circ + \varepsilon_t$

where the average level $\beta_\circ$ may be slowly changing over time. Then the estimate $a_\circ(T)$ of $\beta_\circ$ made in time period *T* is given by the smoothing equation $a_\circ(T)=\alpha y_T +(1-\alpha)a_\circ(T-1)$

where α is smoothing constant between 0 and 1 and $a_\circ(T-1)$ is the estimate of $\beta_\circ$ made in time period T - 1.

A point forecast made in time period T for $y_{T+\tau}$ is $\hat{y}_{T+\tau}=a_\circ(T).$ Where τ *is a time horizon*
This model is applied assuming that the series is stationary , without trend . Simple exponential smoothing is used for short – range forecasting .The value of α is usually determined by minimizing the sum of squares of the forecast errors .

II-*HOLT-WINTERS' TWO-PARAMETER DOUBLE EXPONENTIAL SMOOTHING(HDES) .*

Suppose that the time series $y_1,.....y_n$ described by the model

$y_t = \beta_\circ + \beta_1 t + \varepsilon_t$

where the parameters $\beta_\circ$ and β_1 may be slowly changing over time. two-parameter double exponential smoothing is a smoothing approach for forecasting such a time series that employs two smoothing constants.

Suppose that in time period *T-1* we have an estimate $a_\circ(T-1)$ of the average level of the time series That is, $a_\circ(T-1)$ is an estimate of the intercept of the time series when the time origin is considered to be time period *T-1*. Also suppose that in time period *T* — 1 we have an estimate $b_1(T-1)$ of the slope parameter

β_1 . If we observe y_T in time period *T,* then we can update $a_\circ(T-1)$ and $b_1(T-1)$ then we can compute point estimate follows:

If we observe y_T in time period 'T, then

1. We obtain an updated estimate $a_\circ(T)$ of the intercept parameter $\beta_\circ$ by using the equation

$$a_\circ(T)=\alpha\, y_T+(1-\alpha)\left[a_\circ(T-1)+b_1(T-1)\right]$$

where α is a smoothing constant between 0 and 1.

2. We obtain an updated estimate $b_1(T)$ of the slope parameter β_1 by using the equation

$$b_1(T)=\beta\left[a_\circ(T)-a_\circ(T-1)\right]+(1-\beta)b_1(T-1)$$

where β is a smoothing constant between 0 and 1.

3. A *point forecast* of the future value $y_{T+\tau}$ made at time *T* is

$$\hat{y}_{T+\tau}(T)=a_\circ(T)+b_1(T)\tau$$

This model is appropriate for series with linear trend and no seasonal variations .

IV- ***HOLT-WINTERS' MULTIPLICATIVE EXPONENTIAL SMOOTHING(HMES).***

Winters' method is an exponential smoothing approach to handling seasonal data .Although the method is not based on a formal statistical model , multiplicative Winters' method is generally considered to be best suited to forecasting a time series that can be described by the equation $y_t=(\beta_\circ+\beta_1 t)\times SN_t+\varepsilon_t$

Where the time series parameters may be slowly changing over time .

The intercept is $\beta_\circ$ and the slope is β_1 and SN_t is the multiplicative seasonal factor .

Each of these three coefficients are defined by the following recursions :

$$a_\circ(T)=\alpha\frac{y_T}{sn_t(T-L)}+(1-\alpha)\left[a_\circ(T-1)+b_1(T-1)\right]$$ where α is a smoothing constant between 0 and 1 .

$$b_1(T)=\beta\left[a_\circ(T)-a_\circ(T-1)\right]+(1-\beta)b_1(T-1)$$ where β is a smoothing constant between 0 and 1 .

$$sn_t(T)=\gamma\frac{y_t}{a_\circ(T)}+(1-\gamma)sn_T(T-L)$$ where γ is a smoothing constant between 0 and 1 .

The initial estimate of the trend component , β_1 is : $b_1(0)=\dfrac{\bar{y}_m-\bar{y}_1}{(m-1)L}$

The initial estimate of the intercept component , $\beta_\circ$ is : $a_\circ(0)=\bar{y}_1-\dfrac{L}{2}b_1(0)$

The initial estimate of the multiplicative seasonal factor , $sn_t(0)=s\bar{n}_t\left[\dfrac{L}{\sum_{t=1}^{L}s\bar{n}_t}\right]$ *for* $t=1,,,,,,,,,L$

IIV- ***HOLT-WINTERS' ADDITIVE EXPONENTIAL SMOOTHING(HAES) .***

Additive Winters' method is a modification for handling a time series that displays constant seasonal variation. The method is generally regarded as best suited to forecasting time series that can be described by the equation :

$$y_t = (\beta_\circ + \beta_1 t) + SN_t + \varepsilon_t$$

Where SN_t is the additive seasonal factor ,the intercept is $\beta_\circ$ and the slope is β_1 .
The model parameters may be slowly changing over time .
Each of these three coefficients are defined by the following recursions :

$a_\circ(T) = \alpha\,[y_T - sn_T(T-L)] + (1-\alpha)[a_\circ(T-1) + b_1(T-1)]$ where α is a smoothing constant between 0 and 1 .

$b_1(T) = \beta[a_\circ(T) - a_\circ(T-1)] + (1-\beta)b_1(T-1)$ where β is a smoothing constant between 0and 1 .

$sn_t(T) = \gamma\,[y_T - a_\circ(T)] + (1-\gamma)\,sn_T(T-L)$ where γ is a smoothing constant between 0 and 1 .

Results & Discussions

Data Description

The prices of USD Dollar collected for the period of six years on a weekly basis start from 20th of January 2009 till 19th of January 2014 .

Stationary Estimation

The first step in any time series analysis is to inspect the plot of the series, from Fig-1 it is clear that the series does not exhibit sharp upward and downward trend. A series seems to be stationary with some major peaks and several minor peaks.

Fig-1

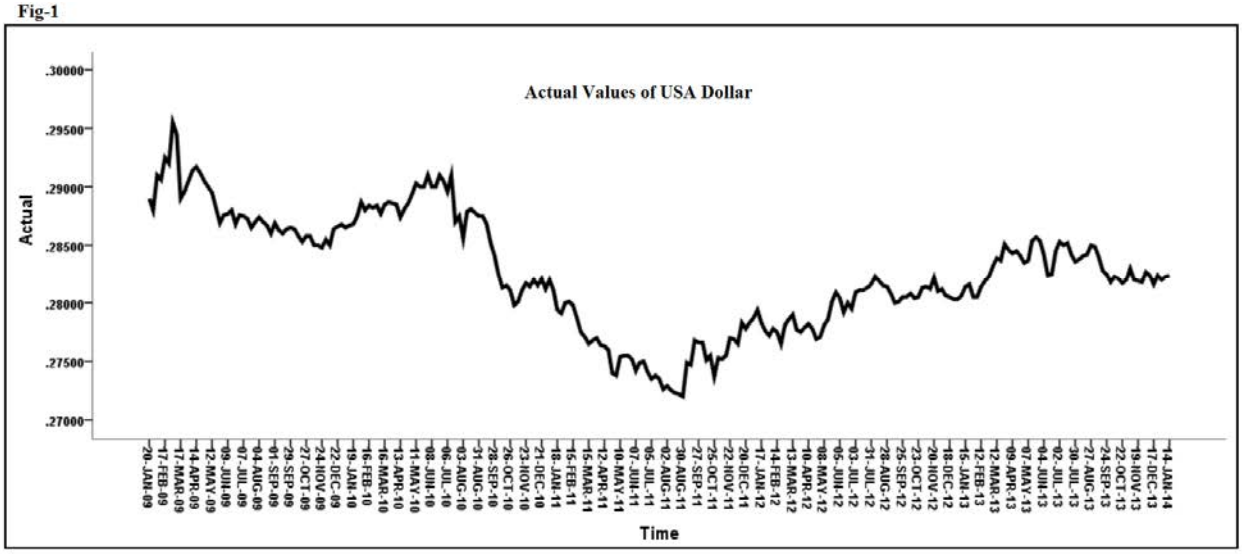
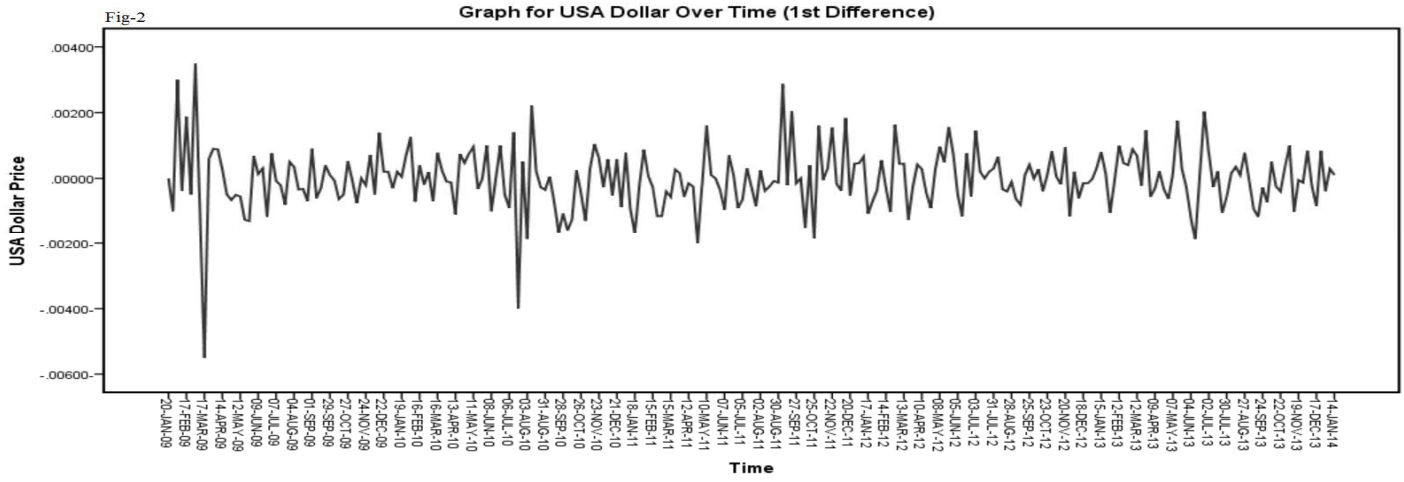


Fig-2 shows the result of first order differencing . This figure illustrate that the first order differencing has gone a long way to inducing stationary .

Fig-2



Fitting of *simple exponential smoothing , holt-winter's two –parameter double exponential smoothing , holt-winter's multiplicative exponential smoothing and holt – winter's additive exponential smoothing* .

I- ***Single Exponential Smoothing(SES) .***

Table-1 : Results of the Single Exponential Smoothing with $\alpha = 0.2$ Smallest Sum of Squared Errors

Table-1

Criteria	Accuracy Measures
Mean Absolute Error (MAE)	0.001067
Sum Square Error (SSE)	0.000494
Mean Squared Error (MSE)	0.000002
Mean Percentage Error (MPE)	-0.057451
Mean Absolute Percentage Error (MAPE)	0.377544

It is clear from table-1 that model of the smallest Sum of Squared Errors will be used to forecast with $\alpha = 0.2$.

Fig-3

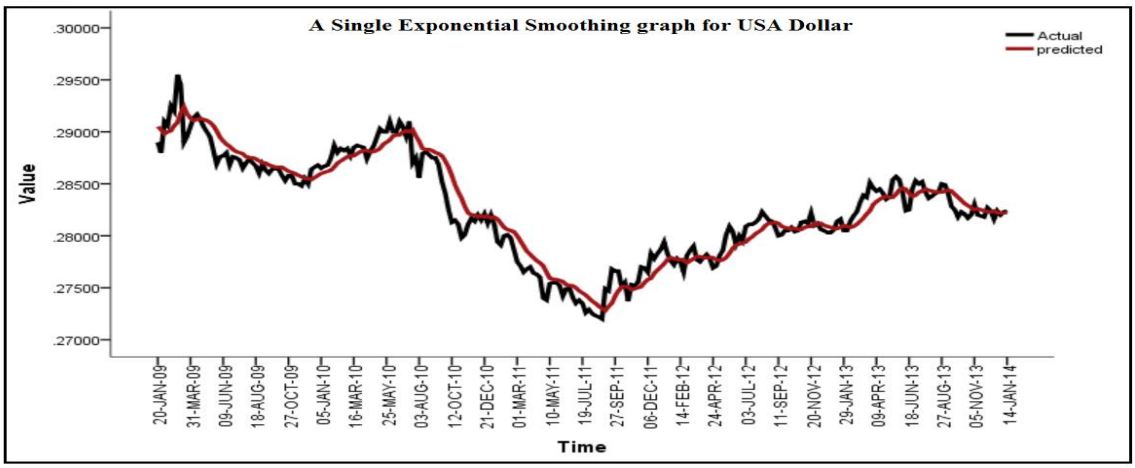


Fig-3 illustrates the gaps between the actual and predicted values of USA Dollar . In some points there is much gap than other points .

2-Double exponential Smoothing (Holt)

Table-2 : Results of the Double Exponential Smoothing with $\alpha = 0.2, \gamma = 0.2$ Smallest Sum of Squared Errors

Table-2

Criteria	Accuracy Measures
Mean Absolute Error (MAE)	0.001030
Sum Square Error (SSE)	0.000501
Mean Squared Error (MSE)	0.000002
Mean Percentage Error (MPE)	0.001595
Mean Absolute Percentage Error (MAPE)	0.363434

It is clear from table-2 that model of the smallest Sum of Squared Errors will be used to forecast with $\alpha = 0.2, \gamma = 0.2$.

Fig-4

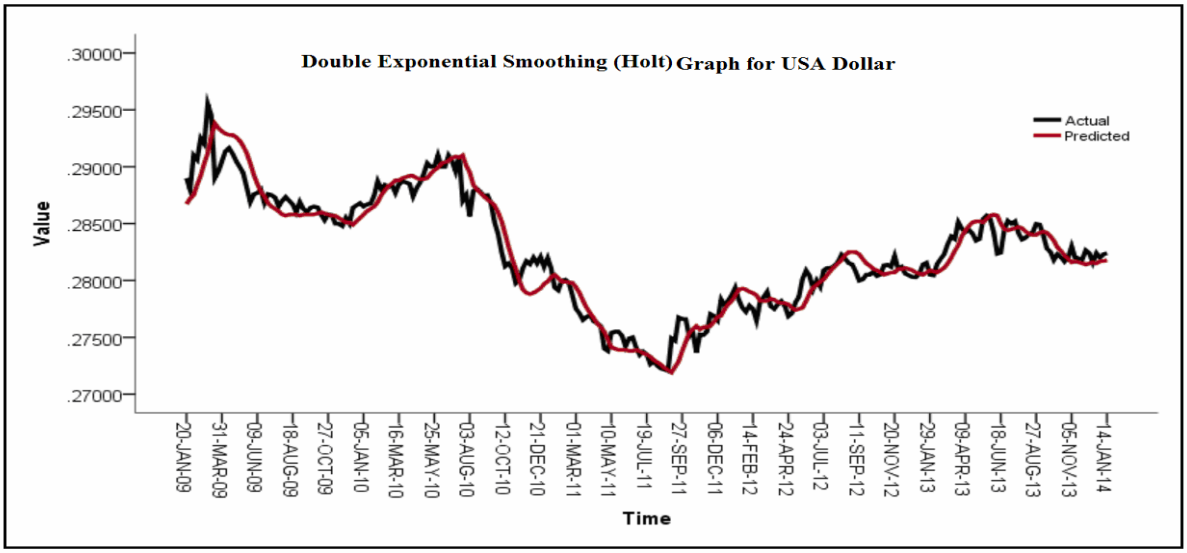


Fig-4 : illustrates the gaps between the actual and predicted values of USA Dollar . In some points there is much gap than other points .

3-Triple Exponential Smoothing (Winter) : A Multiplicative Model (TESM)

Table-3 : Results of the triple exponential smoothing with $\alpha=0.2, \gamma=0.2, \beta=0.2$ Smallest Sum of Squared Errors .

Table-3

Criteria	Accuracy Measures
Mean Absolute Error (MAE)	0.000937
Sum Square Error (SSE)	0.000452
Mean Squared Error (MSE)	0.000002
Mean Percentage Error (MPE)	0.032346
Mean Absolute Percentage Error (MAPE)	0.330831

It is clear from table-3 that model of the smallest Sum of Squared Errors will be used to forecast with $\alpha=0.2, \gamma=0.2, \beta=0.2$.

Fig-5

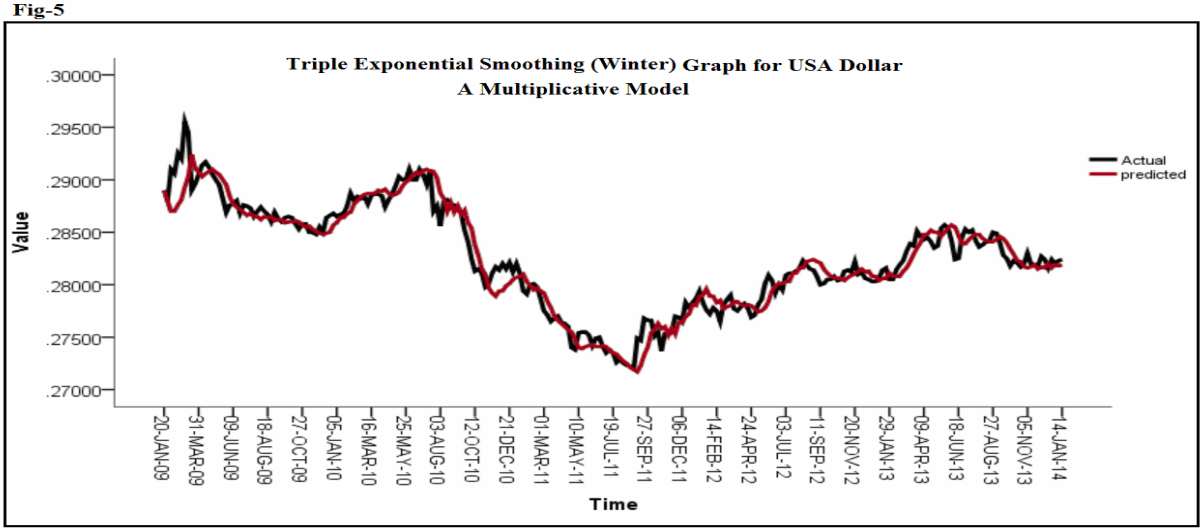


Fig-5 reveals that the predicted line is close to the actual line , exception only occurs for the from 20 Jan 2009 to 31 march 2009 and from 12 October 2010 to 21 December 2010 .

4-Triple Exponential Smoothing (Winter) : Additive Model (TESA)

Table-4 : Results of the triple exponential Smoothing with $\alpha=0.2, \gamma=0.2, \beta=0.2$ Smallest Sum of Squared Errors .

Table-4

Criteria	Accuracy Measures
Mean Absolute Error (MAE)	0.000937
Sum Square Error (SSE)	0.000452
Mean Squared Error (MSE)	0.000002
Mean Percentage Error (MPE)	0.032403
Mean Absolute Percentage Error (MAPE)	0.330844

Fig-6

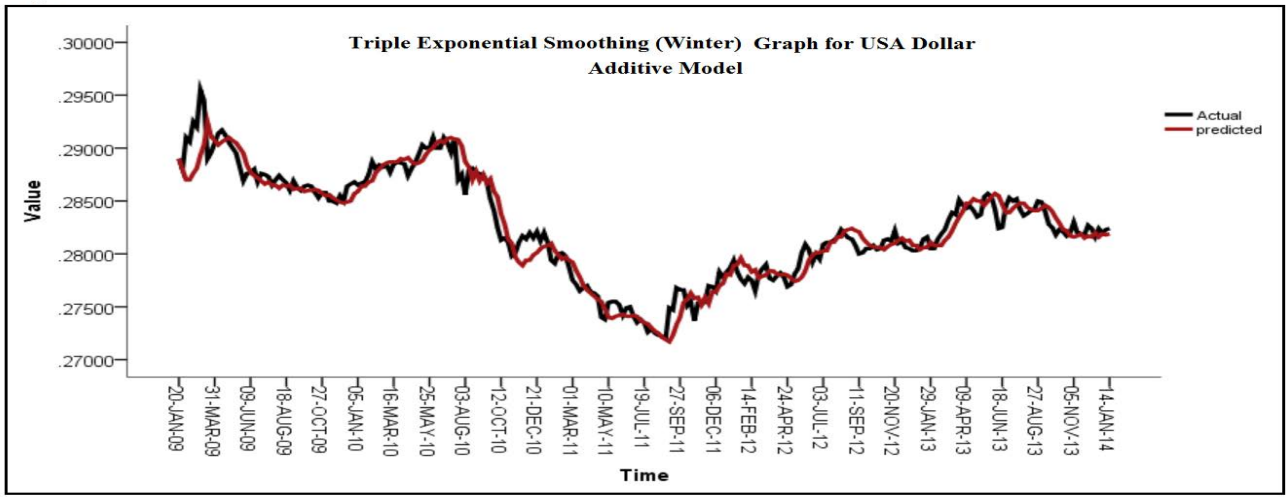


Fig-6 is the as Fig-5 for the multiplicative model , where the smoothing parameters are the same and the accuracy results also the same .

Residual Model Diagnostics .

Residual model diagnostics have been conducted with respect to the following :-

- Normality .
- Constant variance .
- Independence

To check the validity of the assumptions plot of residuals was created for normality , constant variance and independence assumptions. Plots are in appendices for all models .The normal plot of the residuals have a straight- line appearance approximately , which indicate that a normality assumptions hold , the pattern in which the residuals fluctuate around the zero indicate the constant variance assumption hold , due to the fact that the residual plot form a horizontal band appearance and finally a plot of residuals against fit values suggest that , there is no positive or negative autocorrelation exits in error terms , which indicate that the error terms occur in a random pattern over time , therefore ,these error terms are statistically independent . Appendix-II shows the Residual Model Diagnosis .

Forecasting Results

The forecasting results are measured by the following indicators :
Sum of squared error (SSE) .
Mean squared error (MSE) .
Mean absolute error (MAE) .
Mean percentage error (MPE) .
Mean absolute percentage error (MAPE) .
Root mean square error (RMSE)
These measures are used to compare the forecasting accuracy of the various models . The rule of thump is the smaller of SSE , MSE, MAE, MPE , RMSE and MAPE the better is the forecasting ability .The model with the smallest of the accuracy measures will be the best to be used for forecasting .

Comparison of Models

An important objective of this study is to search the best predictive performance model among all the competitive models , table-5 shows the summary results for all four models , the best models are the Triple Exponential Smoothing (Winter) : A Multiplicative Model (TESM) and Triple Exponential Smoothing (Winter) : Additive Model (TESA). The performance predictability of the two candidate models are illustrated in Fig-5 and Fig-6 respectively .

Table-5

Accuracy Indicators	***Exponential Models***			
	SES	**Holt**	**TESM**	**TESA**
MAE	0.001067	0.001030	0.000937	0.000937
SSE	0.000494	0.000501	0.000452	0.000452
MSE	0.000002	0.000002	0.000002	0.000002
MPE	-0.057451	0.001595	0.032346	0.032403
MAPE	0.377544	0.363434	0.330831	0.330844

Out-of-Sample Forecasting

Out- of- sample forecasting conducted using the two candidate models Triple Exponential Smoothing (Winter) : A Multiplicative Model (TESM) and Triple Exponential Smoothing (Winter) : Additive Model (TESA), to study the behavior of the USA Dollar during the future period started from 26-Jan-14 till 12-April-15. Figures 7 illustrate the stabilized price of the USA Dollar price with seasonal pattern during the said forecasting period .

Fig-7

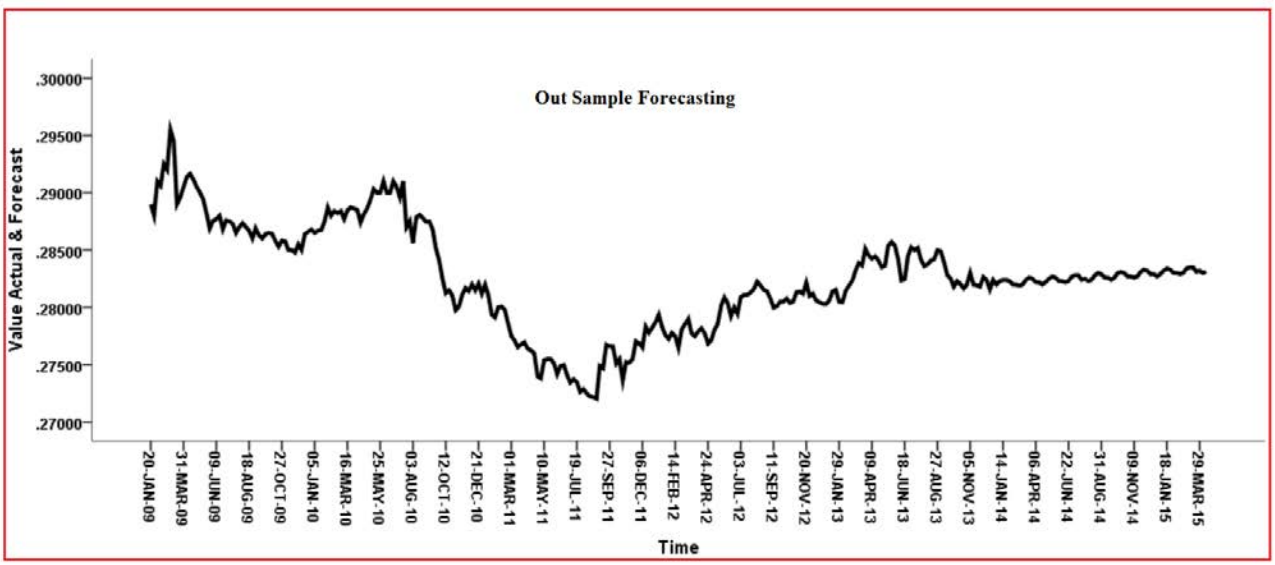


Table-5

No.	Time	Forecast
1	26-JAN-14	.28240
2	02-FEB-14	.28230

3	09-FEB-14	.28200
4	16-FEB-14	.28200
5	23-FEB-14	.28190
6	02-MAR-14	.28200
7	09-MAR-14	.28240
8	16-MAR-14	.28260
9	23-MAR-14	.28250
10	06-APR-14	.28220
11	13-APR-14	.28220
12	20-APR-14	.28200
13	27-APR-14	.28220
14	04-MAY-14	.28250
15	11-MAY-14	.28270
16	18-MAY-14	.28260
17	25-MAY-14	.28230
18	01-JUN-14	.28230
19	08-JUN-14	.28220
20	22-JUN-14	.28230
21	29-JUN-14	.28270
22	06-JUL-14	.28280
23	13-JUL-14	.28280
24	20-JUL-14	.28240
25	27-JUL-14	.28250
26	03-AUG-14	.28230
27	10-AUG-14	.28240
28	17-AUG-14	.28280
29	24-AUG-14	.28300
30	31-AUG-14	.28290
31	07-SEP-14	.28260
32	14-SEP-14	.28260
33	21-SEP-14	.28240
34	28-SEP-14	.28260
35	05-OCT-14	.28300
36	12-OCT-14	.28310
37	19-OCT-14	.28300
38	26-OCT-14	.28270
39	02-NOV-14	.28270
40	09-NOV-14	.28260
41	16-NOV-14	.28270
42	23-NOV-14	.28310
43	30-NOV-14	.28330
44	07-DEC-14	.28320
45	14-DEC-14	.28290
46	21-DEC-14	.28290
47	28-DEC-14	.28270
48	04-JAN-15	.28290
49	11-JAN-15	.28320
50	18-JAN-15	.28340
51	25-JAN-15	.28330
52	01-FEB-15	.28300
53	08-FEB-15	.28300
54	15-FEB-15	.28290
55	22-FEB-15	.28300
56	01-MAR-15	.28340
57	08-MAR-15	.28350
58	15-MAR-15	.28350
59	22-MAR-15	.28310
60	29-MAR-15	.28320
61	05-APR-15	.28300
62	12-APR-15	.28310

table-5 illustrate the satiability of USA Dollar price within the range prices of 0.2819 to 0.28320 for the future period end at 12 April 2015 .

Conclusion

This study has assessed the predictive capabilities of the Triple Exponential Smoothing (Winter) :

A Multiplicative Model (TESM) and Triple Exponential Smoothing (Winter) : Additive Model (TESA) exchange rate forecasting models.
This study reveals the fact that produce superior results .

Future Research

The current study has a few limitations that should be taken into consideration . One of them is that the multivariate time series is crucial to build a model for forecasting a collection of major currencies related to Kuwaiti Dinar .

Acknowledgment

Authors are grateful to The Public Authority for Applied Education & Training for providing a research project grant. The would also like to take this opportunity to thank Mrs. Fatima Al-Najjar, the Director of Research Department for her support and cooperative.

References

[1] Ai-Yee Ooi, Syed Azizi Wafa Syed Khalid Wafa, Nelson Lajuni, Mohd Fahmi Ghazali., "Causality between Exchange Rates and Stock Prices: Evidence from Malaysia and Thailand", *International Journal of Business and Management, 4(3), 86-98,2009.*
[2]An-Pin Chen, Yu-Chia Hsu, Ko-Fei Hu., "A Hybrid Forecasting Model for Foreign Exchange Rate Based on a Multi-neural Network," icnc, 5, 293-298, *Fourth International Conference on Natural Computation, 2008.*
[3]Clark, Todd E. and Kenneth D. West, 2007, "Approximately Normal Tests for Equal Predictive Accuracy in Nested Models," *Journal of Econometrics, 138(1), 291-311.*
[4]Clarida, R.H., Sarno, L., Taylor, M.P., Valente, G. (2003), The out-of-sample success of term structure models as exchange rate predictors: a step beyond, *Journal of International Economics, vol. 60, pp. 61-83.*
[5]Engel, Charles and Kenneth D. West, 2006, "Taylor Rules and the Deutschemark-Dollar Real Exchange Rate," *Journal of Money, Credit and Banking 38, 1175-1194.*
[6]Engel, Charles and Kenneth D. West, 2005, Exchange Rates and Fundamentals, *Journal of Political Economy 113, 485-517*
[7]Inoue, Atsushi and Lutz Kilian, 2006, "On the Selection of Forecasting Models," *Journal of Econometrics, 130(2), 273-306.*
[8]John Faust, John H. Rogers, Jonathan H.Wright, 2003, "Exchange rate forecasting: the errors we've really made", *Journal of International Economics, 60,pp 35-59.*
[9]Kilian, L., Taylor, M.P. (2003), Why is it so difficult to beat the random walk forecast of exchange rates? *Journal of International Economics, 60, 85-107.*
[10]Koopman, S.J., Jungbacker, B., Hol, E., 2005, "Forecasting daily variability of the S&P 100 stock index using historical, realised and implied volatility measurements", *Journal of Empirical Finance, 12, 3, 445-475.*
[11]Lutz Lillian and Mark P. Taylor,2003 , "Why it is so difficult to beat random walk forecast of exchange rates?", *Journal of International Economics,60,pp85-107*
[12]Molodtsova, Tanya, and David Papell, 2008, "Taylor Rules with Real-time Data: a Tale of Two Countries and One Exchange," *Journal of Monetary Economics 55, S63-S79.*
[13]Taylor, M. P., and Peel, D., (2000), Nonlinear Adjustment, Long-run Equilibrium and Exchange Rate Fundamentals, *Journal of International Money and Finance, 19, 33-53.*
[14]Taylor, M. P., Peel, D., and Sarno, L., (2001), Nonlinear Mean Reversion in Real Exchange Rates: Towards a Solution of the Purchasing Power Parity Puzzles, *International Economic Review, 42, 1015-1042.*
[15]Yang Y. and Zou H., (2004), Combining time series models for forecasting, *International Journal of Forecasting, vol.20 (2004) 69– 84.*
[16]Tambi, K. Mahesh, (2005), : Forecasting Exchange Rate: A Univariate Out-of-Sample Approach (Box-Jenkins Methodology), *The ICFAI Journal of Bank Management, IV, 60-74.*

Appendices

Appendix-I

The Data

Weekly USA Dollar Price

Case Number	TIME	open	high	low	last
1	20/01/2009	.28420	.28900	.28300	.28900
2	27/01/2009	.28800	.29041	.28700	.28800
3	03/02/2009	.28985	.29700	.28910	.29100
4	10/02/2009	.29311	.29350	.28795	.29062
5	17/02/2009	.29101	.29700	.28850	.29250
6	24/02/2009	.29351	.29400	.28675	.29201
7	03/03/2009	.29300	.29571	.29050	.29550
8	10/03/2009	.29280	.29555	.29125	.29451
9	17/03/2009	.29450	.29500	.28800	.28901
10	24/03/2009	.28900	.29100	.28775	.28960
11	31/03/2009	.29090	.29500	.28949	.29050
12	07/04/2009	.29059	.29500	.28900	.29138
13	14/04/2009	.29143	.29500	.29000	.29165
14	21/04/2009	.29169	.29275	.28981	.29116
15	28/04/2009	.29112	.29250	.28950	.29050
16	05/05/2009	.29115	.29200	.28900	.29000
17	12/05/2009	.28965	.29100	.28800	.28945
18	19/05/2009	.28986	.29120	.28682	.28819
19	26/05/2009	.28781	.29120	.28600	.28689
20	02/06/2009	.28720	.28940	.28550	.28757
21	09/06/2009	.28730	.29120	.28530	.28770
22	16/06/2009	.28750	.29120	.28675	.28800
23	23/06/2009	.28760	.29120	.28575	.28683
24	30/06/2009	.28709	.29120	.28575	.28759
25	07/07/2009	.28775	.29120	.28600	.28751
26	14/07/2009	.28726	.29120	.28575	.28730
27	21/07/2009	.28715	.28770	.28575	.28650
28	28/07/2009	.28675	.28761	.28475	.28700
29	04/08/2009	.28681	.28747	.28525	.28735
30	11/08/2009	.28741	.29120	.28580	.28701
31	18/08/2009	.28706	.29120	.28571	.28669
32	25/08/2009	.28665	.29120	.28525	.28600
33	01/09/2009	.28600	.29120	.28600	.28690
34	08/09/2009	.28710	.28870	.28455	.28630
35	15/09/2009	.28608	.28900	.28445	.28600
36	22/09/2009	.28633	.28710	.28500	.28640
37	29/09/2009	.28628	.28690	.28516	.28650
38	06/10/2009	.28648	.28680	.28425	.28643
39	13/10/2009	.28635	.28675	.28375	.28580
40	20/10/2009	.28567	.28720	.28325	.28530
41	27/10/2009	.28400	.28670	.28395	.28582
42	03/11/2009	.28410	.28640	.28410	.28575
43	10/11/2009	.28525	.28600	.28447	.28500
44	17/11/2009	.28500	.28560	.28345	.28500
45	24/11/2009	.28516	.28560	.28155	.28479
46	01/12/2009	.28470	.28590	.28205	.28550
47	08/12/2009	.28510	.29016	.27920	.28501
48	15/12/2009	.28420	.29191	.27920	.28640
49	22/12/2009	.28650	.28800	.28405	.28660
50	29/12/2009	.28650	.28712	.28475	.28680
	50	50	50	50	50

Weekly Dollar Price[a]

Case Number	TIME	open	high	low	last
51	05/01/2010	.28650	.28790	.28475	.28650
52	12/01/2010	.28654	.28703	.28400	.28670
53	19/01/2010	.28600	.28775	.28305	.28675
54	26/01/2010	.28700	.29120	.28400	.28746
55	02/02/2010	.28755	.29120	.28400	.28871
56	09/02/2010	.28850	.29120	.28400	.28800
57	16/02/2010	.28660	.29120	.28400	.28840
58	23/02/2010	.28950	.29120	.28545	.28821
59	02/03/2010	.28800	.29120	.28400	.28840
60	09/03/2010	.28825	.29120	.28670	.28770
61	16/03/2010	.28750	.29120	.28400	.28848
62	23/03/2010	.28835	.29120	.28670	.28872
63	30/03/2010	.28850	.29120	.28500	.28862
64	06/04/2010	.28840	.29236	.28477	.28850
65	13/04/2010	.28850	.29120	.28400	.28740
66	20/04/2010	.28700	.29120	.28400	.28814
67	27/04/2010	.28775	.29120	.28670	.28861
68	04/05/2010	.28840	.29120	.28670	.28936
69	11/05/2010	.28940	.29120	.28670	.29032
70	18/05/2010	.29065	.29214	.28647	.29000
71	25/05/2010	.28990	.29140	.28670	.29000
72	01/06/2010	.29120	.29161	.28690	.29100
73	08/06/2010	.29255	.29350	.28810	.29000
74	15/06/2010	.29000	.29310	.28810	.29000
75	22/06/2010	.28800	.29591	.28800	.29100
76	29/06/2010	.29100	.29310	.28810	.29050
77	06/07/2010	.29050	.29120	.28765	.28960
78	13/07/2010	.29000	.29120	.28655	.29100
79	20/07/2010	.28785	.29120	.28700	.28700
80	27/07/2010	.28655	.29000	.28443	.28751
81	03/08/2010	.28705	.28975	.28328	.28564
82	10/08/2010	.28585	.29020	.28371	.28785
83	17/08/2010	.28780	.28980	.28125	.28807
84	24/08/2010	.28833	.28975	.28557	.28780
85	31/08/2010	.28750	.28975	.28570	.28745
86	07/09/2010	.28650	.29020	.28570	.28750
87	14/09/2010	.28750	.29020	.28570	.28680
88	21/09/2010	.28680	.28880	.28455	.28515
89	28/09/2010	.28463	.28740	.28390	.28408
90	05/10/2010	.28330	.28515	.28155	.28250
91	12/10/2010	.28200	.28330	.28050	.28125
92	19/10/2010	.28160	.28405	.28045	.28150
93	26/10/2010	.28135	.28186	.28018	.28105
94	02/11/2010	.28055	.28145	.27841	.27976
95	09/11/2010	.27945	.28090	.27843	.28005
96	16/11/2010	.28050	.28169	.28000	.28109
97	23/11/2010	.28025	.28225	.27965	.28170
98	30/11/2010	.28110	.28288	.27952	.28143
99	07/12/2010	.28042	.28258	.27945	.28201
100	14/12/2010	.28050	.28258	.27960	.28149
	50	50	50	50	50

a. Limited to first 100 cases.

Weekly USA Dollar Price

Case Number	TIME	open	high	low	last
101	21/12/2010	.28192	.28275	.28050	.28207
102	28/12/2010	.28070	.28250	.28018	.28120
103	04/01/2011	.28018	.28250	.27980	.28198
104	11/01/2011	.28190	.28270	.28038	.28105
105	18/01/2011	.28020	.28147	.27910	.27938
106	25/01/2011	.27855	.28026	.27815	.27913
107	01/02/2011	.27845	.28080	.27570	.28000
108	08/02/2011	.27976	.28029	.27840	.28007
109	15/02/2011	.27945	.28078	.27870	.27980
110	22/02/2011	.27830	.28020	.27750	.27865
111	01/03/2011	.27860	.27915	.27700	.27750
112	08/03/2011	.27751	.27855	.27685	.27710
113	15/03/2011	.27735	.27890	.27592	.27653
114	22/03/2011	.27650	.27795	.27545	.27680
115	29/03/2011	.27715	.27835	.27625	.27696
116	05/04/2011	.27709	.27790	.27552	.27640
117	12/04/2011	.27615	.27720	.27515	.27625
118	19/04/2011	.27638	.27750	.27469	.27600
119	26/04/2011	.27530	.27650	.27310	.27400
120	03/05/2011	.27425	.27535	.27273	.27380
121	10/05/2011	.27520	.27625	.27360	.27540
122	17/05/2011	.27570	.27655	.27360	.27550
123	24/05/2011	.27565	.27705	.27410	.27550
124	31/05/2011	.27473	.27625	.27345	.27515
125	07/06/2011	.27350	.27500	.27230	.27420
126	14/06/2011	.27435	.27625	.27350	.27490
127	21/06/2011	.27430	.27550	.27365	.27500
128	28/06/2011	.27480	.27555	.27295	.27410
129	05/07/2011	.27360	.27530	.27300	.27345
130	12/07/2011	.27425	.27600	.27310	.27375
131	19/07/2011	.27405	.27500	.27280	.27349
132	26/07/2011	.27320	.27625	.27185	.27264
133	02/08/2011	.27236	.27375	.27150	.27288
134	09/08/2011	.27265	.27470	.27165	.27250
135	16/08/2011	.27255	.27280	.27105	.27225
136	23/08/2011	.27210	.27280	.27095	.27217
137	30/08/2011	.27190	.27240	.27090	.27204
138	06/09/2011	.27230	.27498	.27190	.27491
139	13/09/2011	.27563	.27625	.27400	.27470
140	20/09/2011	.27460	.27730	.27420	.27675
141	27/09/2011	.27647	.27778	.27440	.27660
142	04/10/2011	.27610	.27760	.27525	.27660
143	11/10/2011	.27666	.27680	.27400	.27510
144	18/10/2011	.27560	.27625	.27380	.27550
145	25/10/2011	.27489	.27575	.27315	.27365
146	01/11/2011	.27334	.27625	.27275	.27525
147	08/11/2011	.27525	.27625	.27420	.27520
148	15/11/2011	.27445	.27660	.27445	.27550
149	22/11/2011	.27620	.27720	.27505	.27704
150	29/11/2011	.27646	.27726	.27575	.27687

Weekly USA Dollar Price

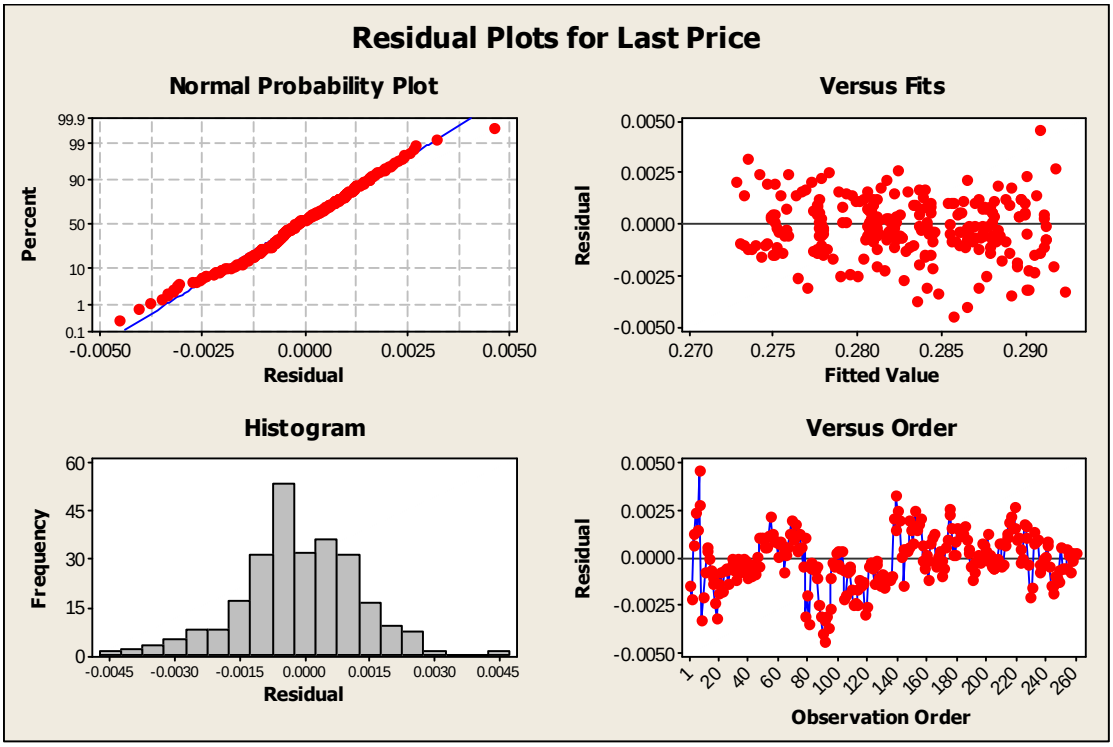
Case Number	TIME	open	high	low	last
151	06/12/2011	.27678	.27750	.27575	.27650
152	13/12/2011	.27650	.27855	.27595	.27833
153	20/12/2011	.27790	.27849	.27665	.27780
154	27/12/2011	.27814	.27874	.27713	.27825
155	03/01/2012	.27848	.27888	.27688	.27871
156	10/01/2012	.27870	.28000	.27780	.27937
157	17/01/2012	.27951	.28000	.27705	.27830
158	24/01/2012	.27862	.27900	.27690	.27760
159	31/01/2012	.27710	.27810	.27622	.27724
160	07/02/2012	.27744	.27795	.27599	.27779
161	14/02/2012	.27737	.27860	.27615	.27750
162	21/02/2012	.27767	.27810	.27600	.27648
163	28/02/2012	.27667	.27816	.27600	.27811
164	06/03/2012	.27750	.27864	.27700	.27855
165	13/03/2012	.27849	.27960	.27738	.27900
166	20/03/2012	.27805	.27920	.27738	.27774
167	27/03/2012	.27790	.27828	.27650	.27749
168	03/04/2012	.27734	.27892	.27650	.27791
169	10/04/2012	.27816	.27890	.27700	.27819
170	17/04/2012	.27792	.27890	.27700	.27775
171	24/04/2012	.27810	.27810	.27650	.27685
172	01/05/2012	.27810	.27810	.27615	.27712
173	08/05/2012	.27810	.27851	.27615	.27808
174	15/05/2012	.27810	.27970	.27770	.27857
175	22/05/2012	.27872	.28028	.27810	.28013
176	29/05/2012	.27988	.28105	.27939	.28088
177	05/06/2012	.28026	.28090	.27945	.28039
178	12/06/2012	.27933	.28068	.27913	.27924
179	19/06/2012	.27905	.28045	.27871	.28000
180	26/06/2012	.28040	.28082	.27912	.27945
181	03/07/2012	.27938	.28138	.27910	.28090
182	10/07/2012	.28103	.28200	.28050	.28110
183	17/07/2012	.28145	.28204	.28055	.28110
184	24/07/2012	.28170	.28240	.28097	.28130
185	31/07/2012	.28132	.28244	.28090	.28160
186	07/08/2012	.28155	.28254	.28079	.28226
187	14/08/2012	.28135	.28275	.28102	.28193
188	21/08/2012	.28193	.28246	.28055	.28153
189	28/08/2012	.28160	.28229	.28070	.28142
190	04/09/2012	.28150	.28225	.28012	.28079
191	11/09/2012	.28120	.28200	.27932	.27999
192	18/09/2012	.28085	.28085	.27916	.28009
193	25/09/2012	.28050	.28117	.27945	.28050
194	02/10/2012	.28095	.28180	.27953	.28050
195	09/10/2012	.28090	.28140	.27960	.28078
196	16/10/2012	.28115	.28135	.27936	.28039
197	23/10/2012	.28035	.28140	.27971	.28051
198	30/10/2012	.28095	.28154	.27990	.28133
199	06/11/2012	.28158	.28205	.28051	.28138
200	13/11/2012	.28215	.28240	.28083	.28120
	50	50	50	50	50

Weekly USA Dollar Price

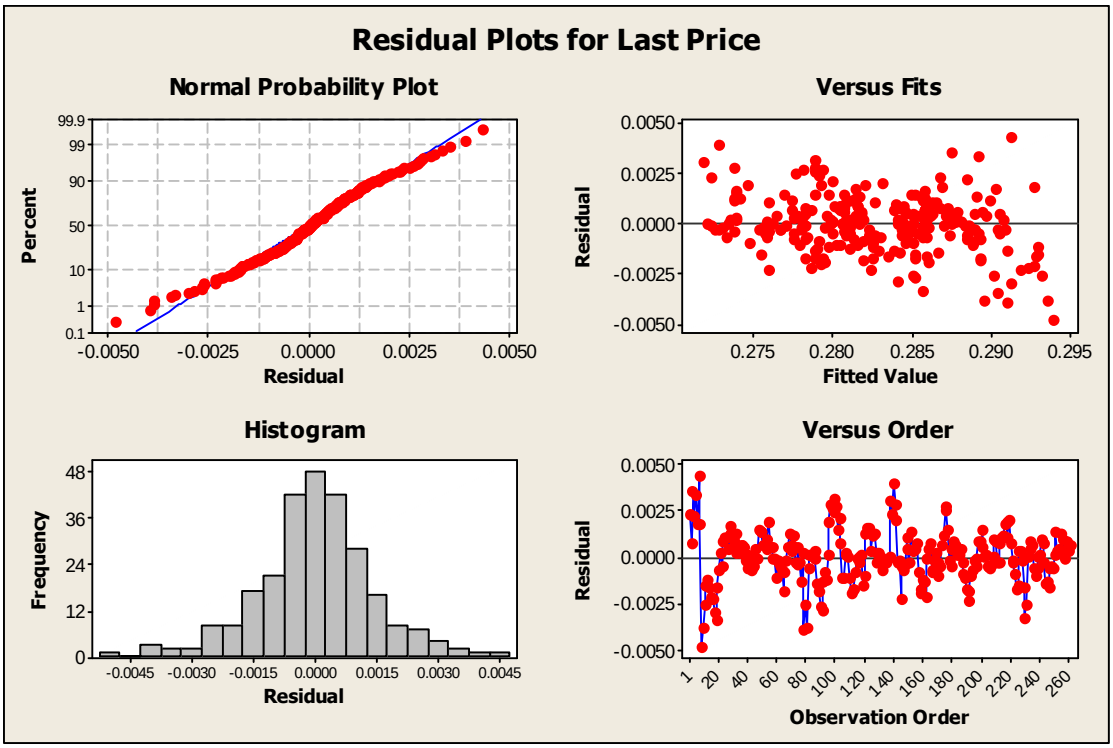
Case Number	TIME	open	high	low	last
201	20/11/2012	.28210	.28283	.28086	.28215
202	27/11/2012	.28240	.28240	.28044	.28100
203	04/12/2012	.28120	.28187	.28016	.28120
204	11/12/2012	.28095	.28230	.28014	.28060
205	18/12/2012	.28175	.28175	.27978	.28045
206	25/12/2012	.28102	.28159	.27990	.28030
207	01/01/2013	.28097	.28246	.28000	.28028
208	08/01/2013	.28147	.28278	.28038	.28060
209	15/01/2013	.28130	.28230	.28030	.28140
210	22/01/2013	.28125	.28200	.28051	.28155
211	29/01/2013	.28129	.28185	.27972	.28050
212	05/02/2013	.28091	.28206	.28023	.28045
213	12/02/2013	.28190	.28245	.28064	.28144
214	19/02/2013	.28155	.28317	.28115	.28190
215	26/02/2013	.28270	.28378	.28155	.28230
216	05/03/2013	.28310	.28435	.28270	.28318
217	12/03/2013	.28429	.28490	.28295	.28387
218	19/03/2013	.28429	.28516	.28333	.28365
219	26/03/2013	.28426	.28585	.28330	.28511
220	02/04/2013	.28480	.28640	.28400	.28455
221	09/04/2013	.28520	.28610	.28340	.28425
222	16/04/2013	.28452	.28550	.28342	.28446
223	23/04/2013	.28455	.28550	.28379	.28412
224	30/04/2013	.28480	.28500	.28283	.28350
225	07/05/2013	.28441	.28530	.28319	.28365
226	14/05/2013	.28527	.28650	.28430	.28540
227	21/05/2013	.28623	.28680	.28511	.28570
228	28/05/2013	.28615	.28680	.28455	.28542
229	04/06/2013	.28542	.28585	.28350	.28422
230	11/06/2013	.28413	.28480	.28215	.28235
231	18/06/2013	.28272	.28433	.28203	.28245
232	25/06/2013	.28310	.28540	.28270	.28448
233	02/07/2013	.28497	.28670	.28410	.28525
234	09/07/2013	.28620	.28710	.28446	.28499
235	16/07/2013	.28543	.28576	.28420	.28520
236	23/07/2013	.28520	.28535	.28275	.28415
237	30/07/2013	.28405	.28535	.28316	.28360
238	06/08/2013	.28481	.28498	.28305	.28375
239	13/08/2013	.28415	.28479	.28310	.28410
240	20/08/2013	.28427	.28477	.28301	.28420
241	27/08/2013	.28420	.28540	.28320	.28498
242	03/09/2013	.28525	.28596	.28390	.28491
243	10/09/2013	.28537	.28560	.28345	.28398
244	17/09/2013	.28415	.28455	.28200	.28281
245	24/09/2013	.28295	.28385	.28198	.28253
246	01/10/2013	.28273	.28320	.28140	.28180
247	08/10/2013	.28264	.28360	.28150	.28230
248	15/10/2013	.28266	.28315	.28155	.28205
249	22/10/2013	.28186	.28235	.28070	.28165
250	29/10/2013	.28165	.28265	.28030	.28200
251	05/11/2013	.28200	.28370	.28120	.28300
252	12/11/2013	.28321	.28360	.28190	.28199
253	19/11/2013	.28254	.28345	.28155	.28194
254	26/11/2013	.28229	.28340	.28168	.28181
255	03/12/2013	.28270	.28305	.28159	.28265
256	10/12/2013	.28220	.28295	.28111	.28240
257	17/12/2013	.28221	.28282	.28094	.28156
258	24/12/2013	.28270	.28270	.28155	.28240
259	31/12/2013	.28225	.28272	.28101	.28201
260	07/01/2014	.28261	.28300	.28147	.28230
261	14/01/2014	.28230	.28295	.28156	.28240
	61	61	61	61	61

Appendix-II
Residual Model Diagnosis

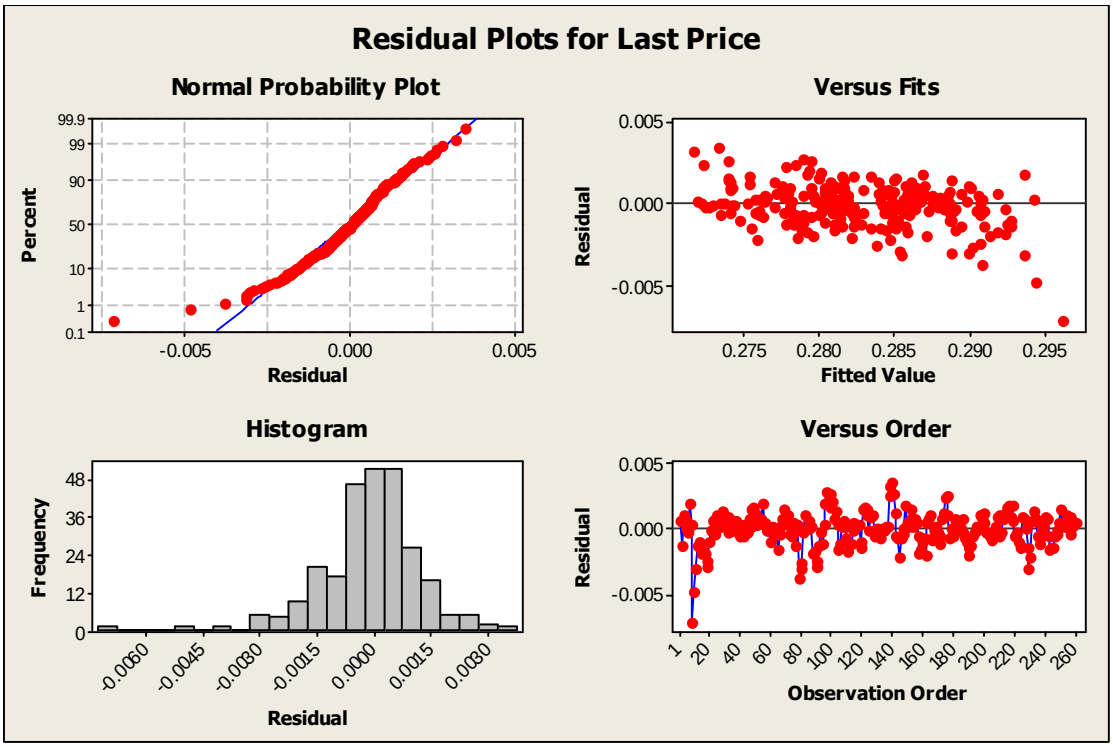
A Single Exponential Smoothing



A Double Exponential Smoothing Model



Multiplicative Exponential Smoothing Model



Additive Exponential Smoothing Model