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DEVELOPING A MODEL FOR FINANCIAL FORECASTING THROUGH ARTIFICIAL NEURAL NETWORKS

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Abstract: Financial forecasting plays a prominent role in finance market because of its commercial applications with respect to high stakes and attractive gains that it provides. The purpose of the study is to develop a new analytical ANN based model for predicting the FER and compare proposed model efficiency with the existing technique. Model was proposed to predict the euro to dollar exchange, pound to dollar exchange and rupee to dollar exchange. It was noticed that outcomes of proposed model performs better and faster to evaluate the FER. There was a slight difference found between real ER and predicted ER. Future work would be carried out to enhance the study area by emerging a new analytical model by adopting ANN along with any other appropriate analytical model or other NN model.

Keywords: neural networks, artificial neural networks (ANN), exchange rate, foreign exchange rate (FER) Hidden Markov Model Foreign Exchange Rate (HMMFER), artificial neural network foreign exchange rate forecasting model (AFERFM), Hidden Markov Model (HMM).

1.1 Introduction:

Forecasting is a significant factor and most prominent activity in markets of finance. It is helpful for numerous players namely policy makers, regulators, investors, practitioners, investors and academia. When forecasting with weak factors it has strong effect in the growth of economy because of its negative influence on global trade and investment adopting a weak model for predicting would result in incorrect judgment [1]. It could support organization to take decision in the upcoming years. Models of forecasting include judgmental, time series (TS) and cause-and-effect (CE). TS forecasting model is a variable that would be sequentially placed. Such variable would posses equal length and time gap [2]. Some of the examples of TS methods are predicting the linear, growth curve, box-Jenkins, exponential smoothing, auto-aggressive moving average and estimating the trend. TS are applied to numerous fields such as workload projections, control of quality and process, budgetary analysis, economic and sales forecasting, yield projects, analyzing the stock market, inventory studies and so on [3]. CE model would determine the form of link and applies prediction for the following variable [4] [5].

ER (Exchange Rates) plays a key role in maintaining the dynamics in market of foreign exchange. Probably forecasting ER would be successful factor in the business and for fund managers. Although, financial market is well-known for its unpredictable nature and volatility however various groups like financial institutions or banks, agency and so on are there for forecasting the ER through unique techniques. Forecasting the ER is a demanding and needed application in the area of TS forecasting [6]. Characteristics of ER are non-stationary chaotic, deterministic and more noisy. Due to such characteristics complete data cannot be gained from prior behaviours of

market of foreign exchange to completely gain the relied between the rates of past and future. Methods which are employed to predict the currency ER involves soft computing, economic and TS methods [7] [8].

Neural networks (NN) are powerful and supportive tools for prediction in the area of artificial intelligence [9-14]. NN are generally non-linear models and if such models are well-trained then it would help in mapping prior and future values in the field of time series and get concealed structures and relationships which guide the data [9][14]. NN are applicable in various fields [15] [16] like filtrating data, phenomena related to economy and finance, forecasting and optimization and producing time-series [10] [13] and more. Artificial NN (ANN) could be applied for predicting the FER (Foreign Exchange Rate) that supports various players in the financial markets. Therefore organizations in the market of overseas exchange could adopt ANN model in determining the ER for future as well as provides a beneficial trading strategy and suitable decision on allocating the assets [17].

1.2 Problem Statement:

FER is a huge problem in finance that is obtaining more focus especially due to its complexity and practical applications. ANN was adopted by various industries for different purposes of real-time applications. ANN was adopted as an alternative and prominent approach to predict FER due to various unique characteristics [14]. Many investigators have developed several models in ANN to forecast FER, all failed to concentrate on forecasting during uncertain and instable market situations. Therefore the proposed research would develop a new analytical ANN model to predict the FER and compare its efficiency with the existing technique namely AFERFM model.

2. Literature Review:

Kadilar et al [18] carried out a research to forecast the ER series with ANN for high volatile US/Turkish dollar ER series and outcomes indicated that method of ANN had the best accuracy in terms of accuracy to TS models namely ARCH (Auto-regressive conditional heteroschedasticity) and ARIMA. Pradhan and Kumar [19] had deployed ANN model for predicting FER with specific reference to India. ANN model performs coupling international revolutionary topologies of network search, initial heuristic and input series near-optimal weights. Such method enhances the prediction by testing, proper training and cross-validation. It was stated that NN is an advanced method to be adopted for FER. It was suggested that ER's linear unpredictability could be enhanced and non-linearity could be found out by adopting the modeling of NN. Highlight of such model is that the data concealed in ER could be able to extract with the help of ANN.

According to the research by Pacelli et al [20] predicted the trend of ER USD/Euro using ANN model. It was found that developed ANN model could be able to forecast the trend to 3 days of ER US dollar/Euro. Philip et al [21] developed an ANN model to predict FER. In this research, ANNFER forecasting model (AFERFM) was developed for forecasting the FER to correct few issues. It was found that proposed model outperforms well in evaluating the FER. It was noticed that proposed model showed good results in terms of accuracy percentage. When AFERFM performed it was compared with Hidden Markov Model FER forecasting model (HFERFM), projection of FER performs better. Accuracy of AFERFM model was 81.2 per cent. It was indicated that new proposed model gives an enhanced technique to conduct FER forecasting.

Perwej and Perwej [22] examined the prediction of INR (Indian Rupee)/ US dollar currency ER using ANN. Number of hidden and input nodes are the experimental factors of ANN. Both performance of out-of-sample prediction and fitting ability of in-sample with 3 forecast horizons are estimated with 3 criteria MA (Mean Absolute) Error, MA Percentage Errorand RMSE (Root Mean Square

Error). 2 training sample impacts were analyzed with the similar predictive horizons. Goal of this research is to explore the impacts of certain significant factors in NN on fitting the model and predicting the behaviours. Purpose of forecasting is not suitable to estimate the capability of ANN with the sample of training alone. At the same time, there are no widely adopted methods for building best and suitable model for prediction through in-sample data of training. Selecting the architecture of optimal network would be on the basis on the outcomes of test sample. Number of nodes in input plays a significant part in NN and TS forecasting.

Erdogan and Goksu[23] predicted the analysis of Turkish Lira and Euro ER with ANN. Certain factors affect the NN accuracy in the process of implementation. Different structures are constructed by modifying the various neurons, learning algorithms and transfer functions for obtaining higher performance. It compared the accuracy of various architectures of ANN as well as various time horizons. Outcomes are estimated by values of MSE of each and every case and it was identified that ANNs could predict the future Turkish Lira and Europe ER. Pedram and Ebrahimi[24] examined the estimation of model and forecasting the data of ER using ANN. It was noticed that NN could probably estimate continuous function. When comparing the performance of NN with ARIMA, it was noted that NN performs well and errors also reduced gradually. Thus it was concluded that it is probable to evaluate a model for predicting the ER value even by accessing with limited data subset.

3. Research Design:

This research develops a new analytical ANN based model for predicting FER as well as compares its efficiency with the existing technique namely AFERFM. Proposed FER prediction adopted new analytical ANN model with certain specifications of existing HFERFM. HMM involves hidden set states namely M, output alphabet represented as U, probabilities of output or emission E, probabilities of transition P and probabilities of initial state as α. Instead of observing present state, each state gives an outcome with a specific probability C. Particularly the states M and outputs E are perceived, so HMM had tripled and represented as (P, M, α).

Hidden states E ={Ej; j=1, 2, 3,…….N}---------- 3.1

Subsequently Probabilities of Transition state P = {pik = S (Etak r +1|Ej at r)} ----------3.2.

Where, S (h| b) is denoted as probability of condition of a given b, r=1, R= time and ej in E.

Observations D = {dv}, v= 1, 2, 3, --------N ---------- 3.3.

Probabilities of emission G = {gjk = gj (dv) = S (dv | ej) }, where dv in D.

Where, G is referred as probability and that probability output dvisgiven as the current state of ej.

Probabilities of initial state α = {kj = k (dv at B =1) }---------- 3.4.

Such model is performed by total parameters set: μ = {P, M, α}.

These Canonical problems have to be resolved in HMM.

- Given are the parameters in the model, in which probability has to be computed with particular output sequence. Such issue could be resolved by backward and forward algorithms.
- Given parameters in the model, determine the most probable sequence of concealed states which are emerged as the given output sequence. This would be resolved by viterbi algorithm and posterior decoding.
- Given sequence of output, determine the state transition set as well as output probabilities resolved by BWA. Proposed work adopted BWM.

Baum-Welch algorithm (BWA):

A set of noticed sequence N^1, N^2, N^3…….. is considered as input.

Algorithm initialization would be chosen by parameters of arbitrary model

$\pi^{'} = A_{bc}, G_b$ () : data = $\sum_s D (N^r \backslash \pi^{'})$

Repeat

{$\pi = \pi^{'}$, S= $S^{'}$

For each and every sequence, N^r

{

Estimate γ (G, b) for N^r using backward algorithm

Estimate α (G, b) for N^r using backward algorithm

Estimate the dedication of N^r to G using

$A_{bc} = \sum_r 1/ g (N^r) \sum g (g, b) A_{bc} D_a (N^r_{g+1})$ γ (g +1, b)

Estimate the dedication of β^r to G using

$G_a = \sum_r 1/ g (\alpha^r) \sum \{g \backslash N^r s = \beta\} \beta(r, b) \gamma (g, b)$

$A_{bc} = A_{bc} / \sum_j A_{bc}$; $G_j (\beta) = G_j (\beta) / \sum_g G_j (\beta)$

data = $\sum_r G (N^r / r_{bc}, G_j ())$

}

Until the transformation in data is less than specific threshold

BWM would know the data parameters and implicitly determines the motive. This research adopts viterbi algorithm to estimate the motive for states of every input data.

4. Discussion:

ANN based model was deployed for two major purposes. 1st section focuses on the deployment of ANN based model to predict the stock market with specific reference from euro to dollar exchange and 2nd section focuses on the implementation of ANN based model to predict the stock market with specific reference from rupee to dollar exchange. In this research proposed research ANN based model is deployed for all 3 data types such as rupee to dollar, pound to dollar and euro to dollar.

Proposed model was explained through code and screenshots.

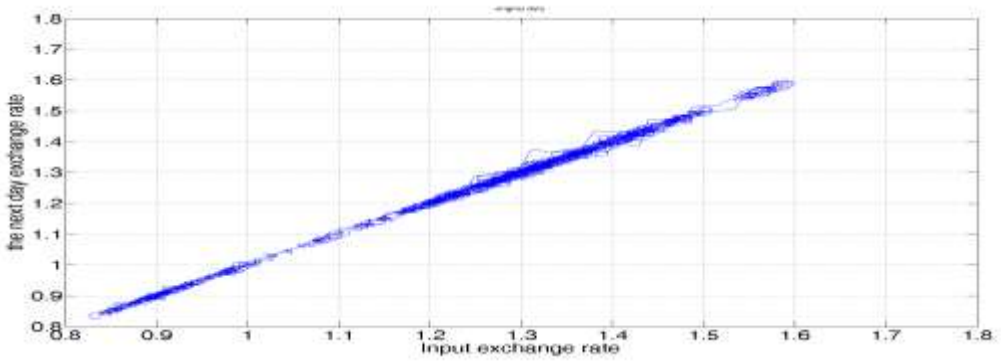

Figure 4.1: Input ER and next day ER for euro to dollar exchange

This figure explains about the original input ER data and next day ER from euro to dollar exchange. X- Axis represents the input exchange rate and Y-Axis represent next day exchange rate

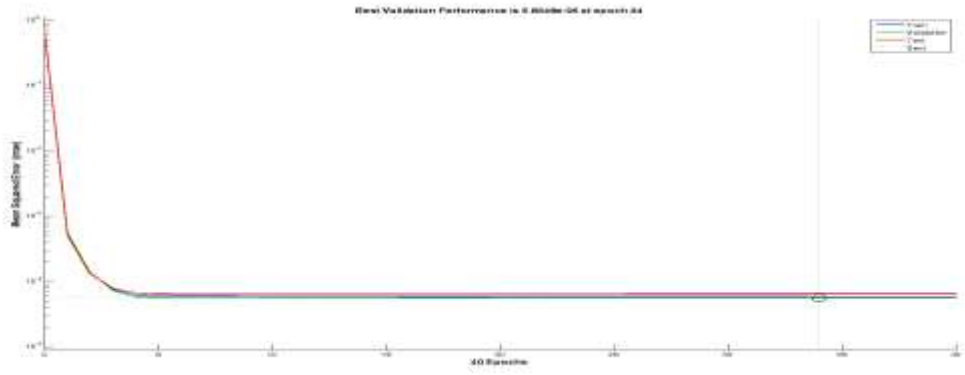

Figure 4.2: Training results of exchange rate

The above figure presents the training results from euro to dollar ER. X-axis represents Epochs and Y-Axis represents mean squared error. It was noticed that performance of best validation was identified at 5.6346e-05 at epoch 34.

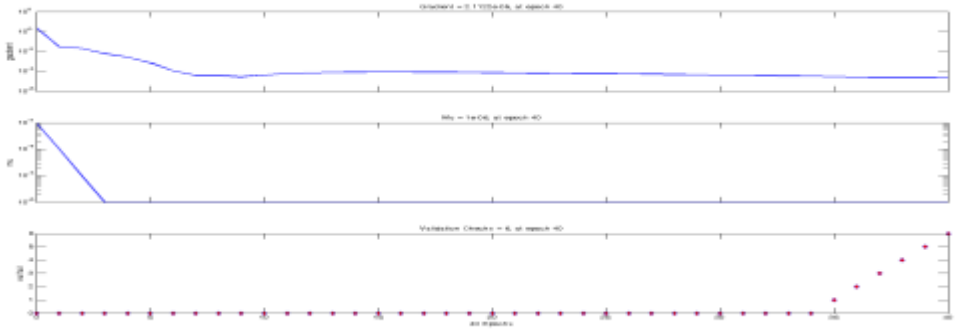

Figure 4.3: Training errors in the NN

The above screenshot shows the errors in the NN. Gradient errors, Mu errors and validation checks were seen at 2.112e06 at epoch 40, DB at epoch 40 and 6 at epoch 40 respectively.

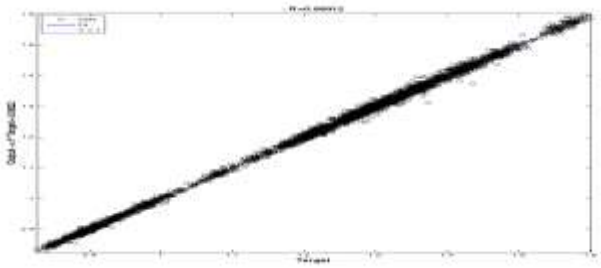

Figure 4.4: The regression of neural networks

Figure 4.4 represents the NN regression. Regression was found at 0.99912.

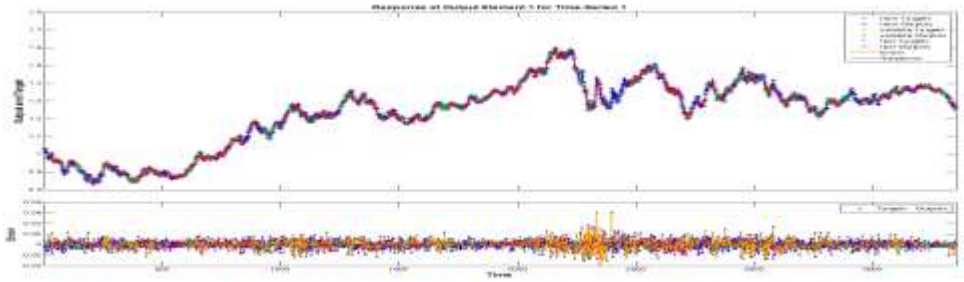

Figure 4.5: Response time of NN

Figure 4.5 indicates the response time of NN. This figure explains the output response for TS. Blue, green and red colour * symbol denotes training targets, validation targets, test targets respectively. Blue, red and green colour+ symbol represents the train outputs, test outputs and validate outputs. Orange colour line represents the NN errors. Black colour line denotes the output element response.

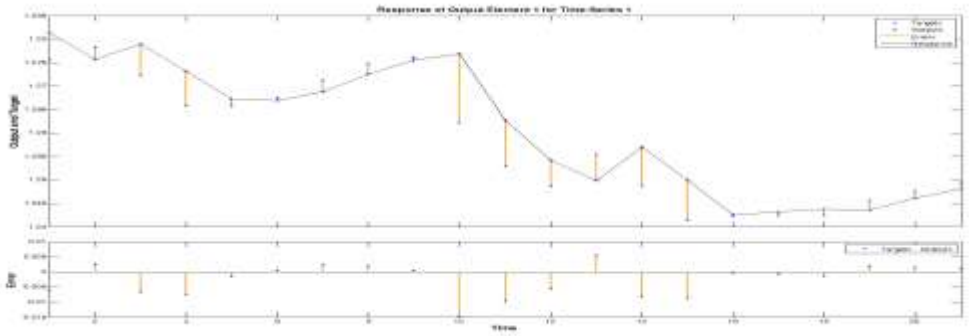

Figure 4.6: The time series prediction in the neural networks

This figure explains the forecasting for output element 1 response for TS 1. Blue colour * symbol indicates targets in NN. Blue colour + symbol denote outputs in NN. Orange colourline represents the errors found in the NN. Response in TS was represented by dotted line.

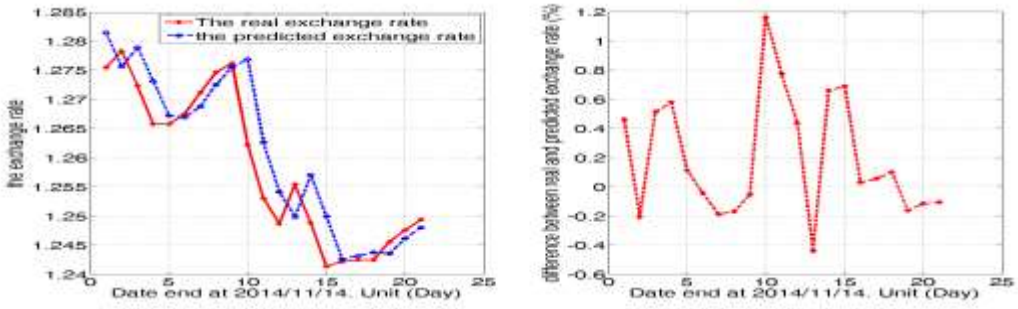

Figure 4.7: The real exchange and predicted results in the neural networks

Figure 4.7 indicates the real and predicted ER outcomes in NN. 1st graph indicates the graph of real ER and predicted ER. In 1st graph, red colour represents real ER. Blue colour represents predicted ER. 2nd graph describes the difference between predicted and real ER.

This section discusses about the deployment of ANN for predicting stock market from rupee to dollar exchange.

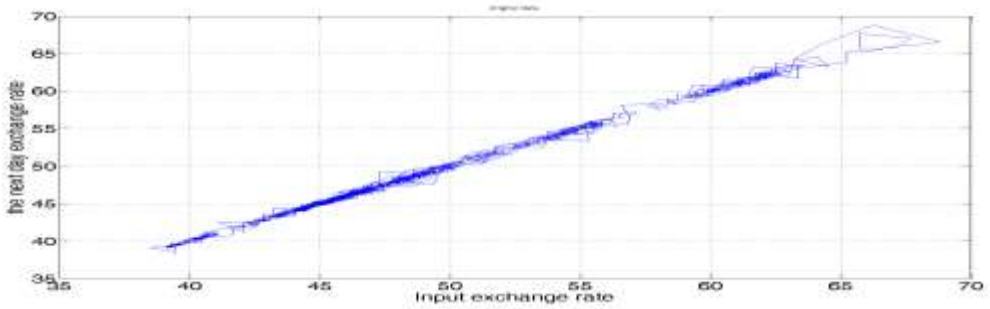

Figure 4.8: Input ER and next day ER for rupee to dollar exchange

This figure represents the original data of input ER and next day ER from rupee to dollar exchange.

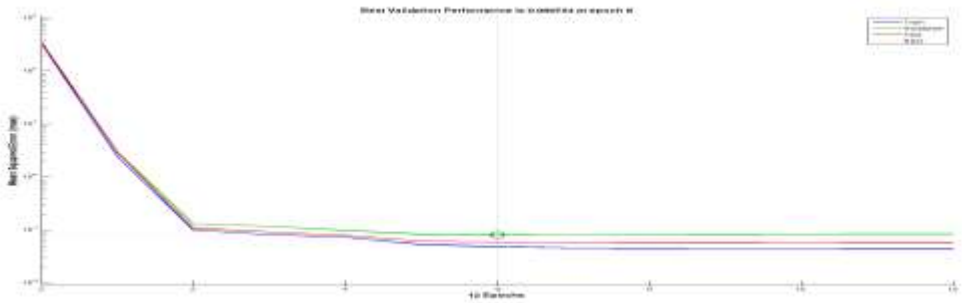

Figure 4.9: Training results of ER

This screenshot represents the training results of rupee exchange to dollar. It was noticed that best validation performance was seen at 0.080754 at epoch 5.

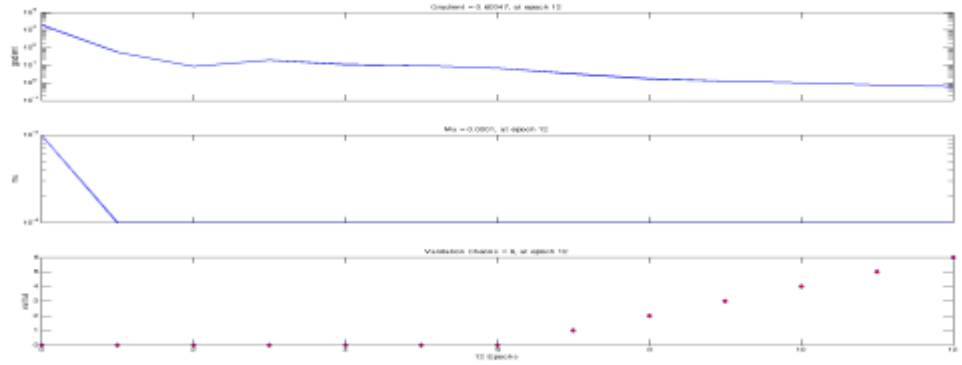

Figure 4.10: Training errors in the NN

Figure 4.10 represents the errors found in the training in NN. Gradient errors, Mu errors and validation checks were seen at 0.60927 at epoch 12, 0.0001 at epoch 12 and 6 at epoch 12 respectively.

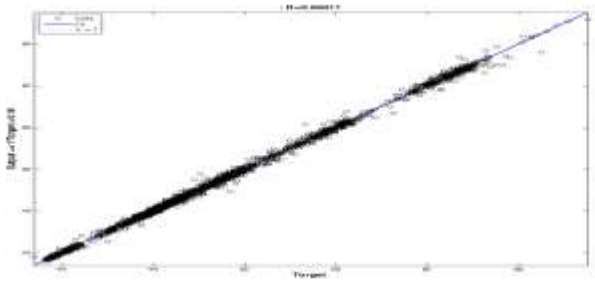

Figure 4.11: The regression of NN

This screenshot shows the NN regression. Regression was found at 0.99911.

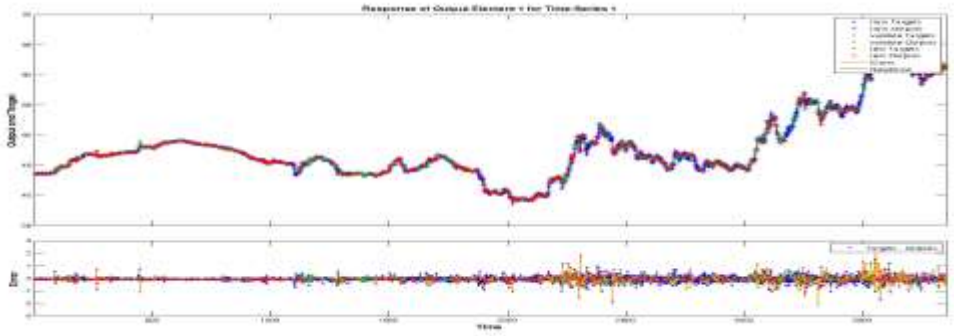

Figure 4.12: The response time of neural networks

This screenshot represents the response of element of output 1 for TS.

The following figure explains the error's auto-correlation in NN

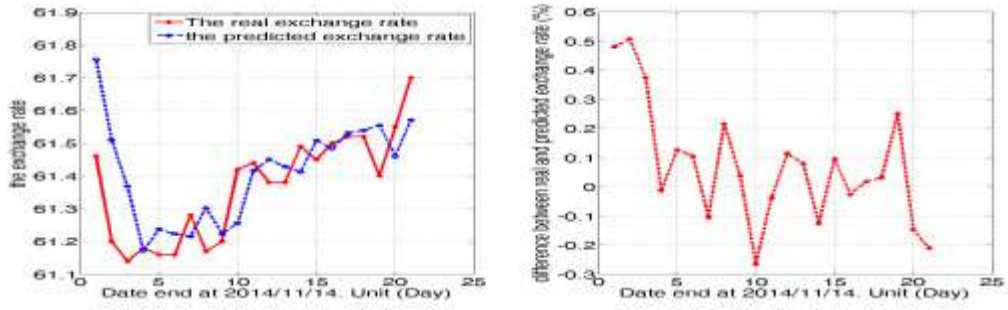

Figure 4.13: The real exchange and predicted results in the neural networks

This figure indicates two plotted graphs. 1st graph denotes real ER and predicted ER outcomes. Red colour line represents real ER. Blue colour dotted line denotes the predicted ER. 2nd graph indicates the difference between real ER and predicted ER. It was found that there is only slight difference in real ER and predicted ER for euro ER to dollar ER and rupee ER to dollar ER.

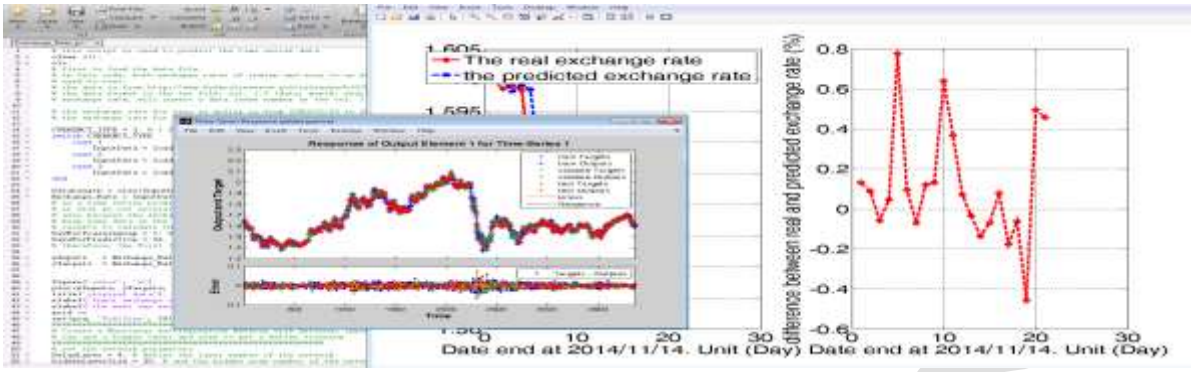

Figure 4:14 Pounds to Dollar

Above figure denotes the outcomes of pound rates to dollar ER. 1st graph explains the graph of real ER and predicted ER. 2nd graph explains the difference between the real and predicted outcomes. Top graph represents the outcomes of pounds to dollar ER on the basis of response time with TS.

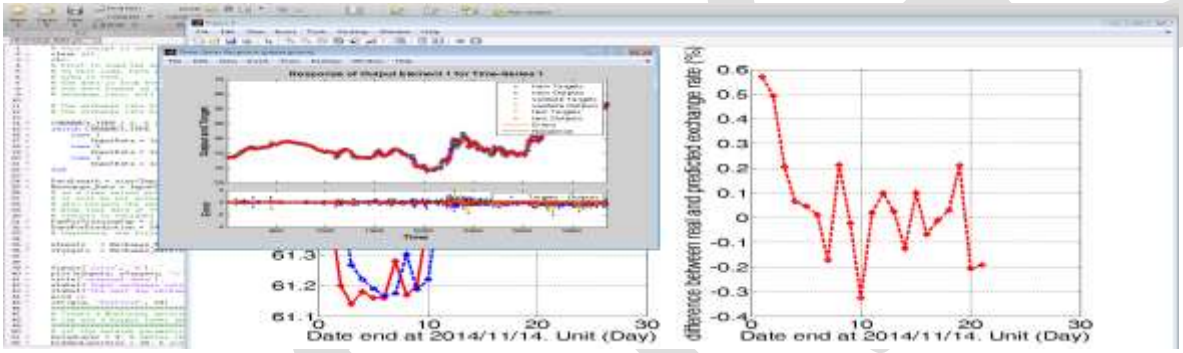

Figure 4.16: Rupee to Dollar

This figure explains the outcomes of rupee to dollar exchange. 1st graph explains the graph of real ER and predicted ER. Top graph represents the outcomes of rupee to dollar ER on the basis of response time with TS. 2nd graph explains the difference between the real and predicted outcomes.

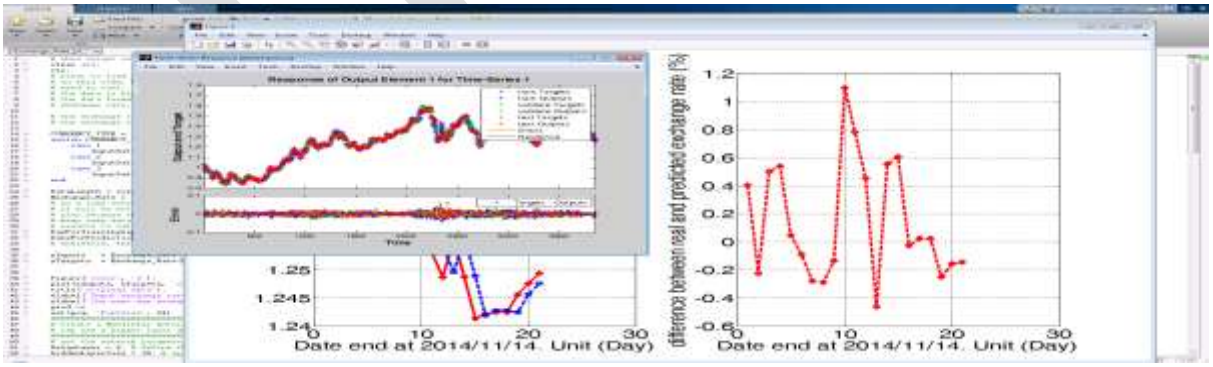

Figure 4.17: Euro to Dollar

This figure explains the outcomes of Euro to dollar exchange. First graph explains the graph of real exchange rate and predicted exchange rate. Second graph explains the difference between the real and predicted outcomes. Further, top most graphs represent the outcomes of euro to dollar ER on the basis of response time with TS.

5. Conclusion and Future Work:

The proposed ANN based model was emerged for predicting the stock market with respect to pound to dollar exchange, euro to dollar exchange and rupee to dollar exchange. From the above analysis, it was observed that outcomes of forecasting looks good and variance between forecasted outcome and real ER is noticed as less than 0.7 per cent. It was confirmed that outcomes of proposed analytical ANN based model for predicting FER performs faster and better in evaluating the FER. Proposed model developed for predicting FER could ensure FER for provided data and also gives better accuracies percentage. When the performance of proposed model for predicting FER is compared with existing models of FER models for prediction, it was found that proposed method performs better. It is possible to enhance the study area by emerging a new analytical model by adopting ANN along with any other appropriate analytical model or other NN model.

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