Applying artificial neural networks (ANNs) to Foreign Exchange modeling

Alex Chang

Overview

The FOREX market lends itself well to being modeled, with previous studies concluding that "rates evolve to fit a trend not completely random" (Vincenzo, 2011). However, current ANNs used to model the Foreign Exchange (FOREX), while useful, are not yet good enough to be used "for profit" (Shahbazi, 2016). By taking into account economic and political variables, such as investment or inflation, a profitable model could be developed. Within this research, the Indian rupee (₹) will be modeled. The rupee was chosen because India is one of the major developing economies of the 21st century and thus a more accurate model of its movements would be of great value.

Independent Variables

The independent variable of this experiment will be the various inputs (economic factors) of the neural network I am creating. Specifically, I will be looking at bank-mandated rates, such as the statutory liquidity ratio and cash reserve ratio, as well as the movements of relevant assets/commodities, such as gold and Indian government bonds. How these factors will be delineated will be explored during the procedure.

Dependent Variable

The dependent variable of this experiment will be the accuracy of the model's predictions. This accuracy will be expressed as a percentage with the mean absolute percentage error (MAPE).

Constants

The constants of this experiment include network depth, currency, and neuron transfer functions. The network depth will be 3 layers deep, the currency will be the Indian Rupee, and the transfer functions will be tan-sigmoid for the hidden layers and linear for the output layers.

Controls

For this experiment, the control will be previous neural networks designed to model the foreign exchange market. The MAPE of these past models will be compared to the MAPE of the current model and any improvement will be assessed.

Assumptions

The efficient market hypothesis (EMH) states that prices, such as exchange rates, follow a random distribution. For this experiment, the EMH is assumed to be false, at least within the context of the FOREX market. The reason this assumption is made is because if the EMH were to be true, then predictive modeling would be futile. It is also being assumed that artificial neural networks are well-suited to financial modeling.

Materials

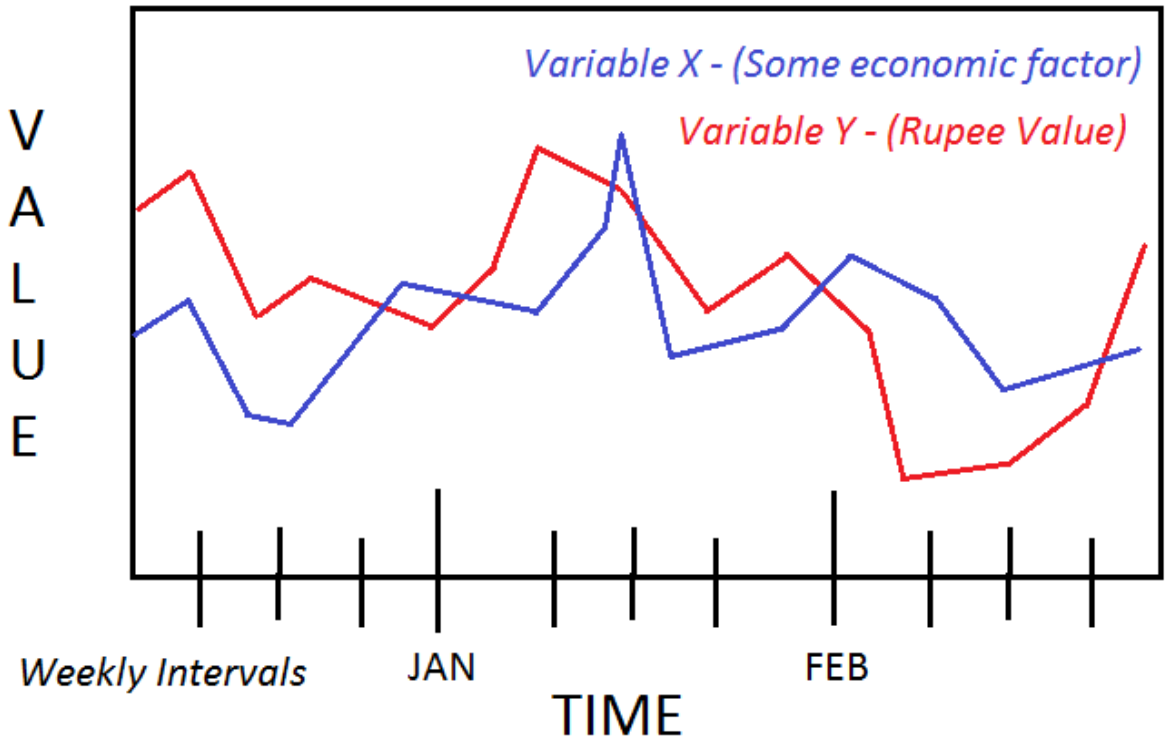
The only material required for this research is a Matlab license, which is $99.00. Matlab was chosen because it is capable of advanced neural network simulation without the need to hard-code each neuron. This will be run off of a school computer.

Data Collection

Data for this experiment will be downloaded from the Reserve Bank of India's (RBI) Data Warehouse. Specifically, weekly USD/INR rates will be collected from https://rbi.org.in/scripts/ReferenceRateArchive.aspx. Weekly dollar index rates (DXY) will be retrieved from https://fred.stlouisfed.org/series/DTWEXB/downloaddata. Most economic variables I'll be looking at will be included within the RBI's weekly statistical supplement: https://rbi.org.in/Scripts/BS_ViewWss.aspx. Historical precious metal rates can be retrieved from: http://www.perthmint.com.au/investment_invest_in_gold_precious_metal_prices.aspx.

Procedure

1. First, I will identify and delineate the major economic/political variables I'll be looking at. For optimization purposes, I will be looking specifically at variables with a weekly or daily frequency. Since there are literally hundreds of different economic variables which I could use, I will be employing a simple probability distribution to identify which variables are significant. To do this, I will be comparing the movement of each variable to the value of the rupee. For ease of comparison, the direction of variable movement will be condensed into a boolean. An upward movement will become true; a downward movement will become false. Shown below is an example of one such comparison, along with a table of the associated boolean values.

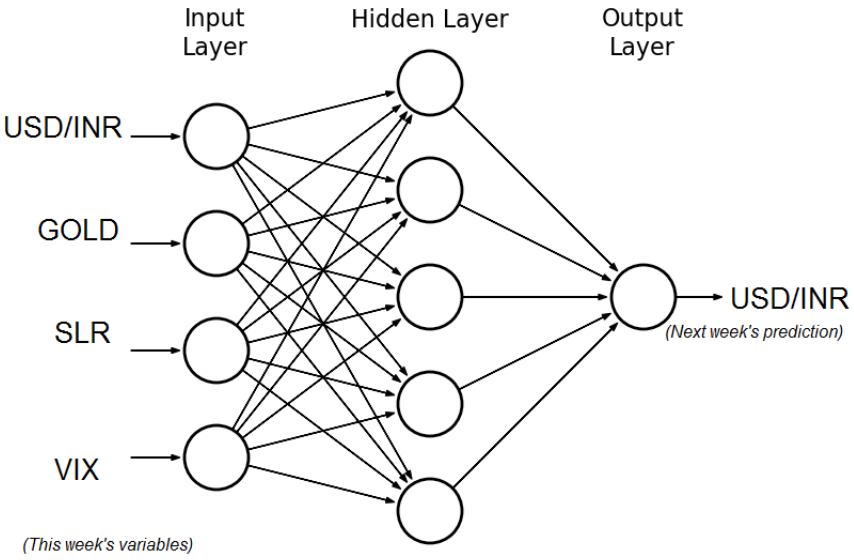


Week (n)	Variable X	Rupee Value
1	True	True
2	False	False
3	False	True

By comparing the directions of each variable over many intervals, I can create a probability distribution of the correlation. If this distribution surpasses a threshold of 60%, then I will choose to include that particular variable within my neural network. Ideally, if I incorrectly choose to include a variable, then my mistake will be weeded out during training.

2. I will incorporate each of the variables I have identified into a larger neural network. This will be done by instantiating the input layer of that network with the identified variables. The initial topology of this network will be based on the previous work of Tamal Chaudhuri. Through backpropagation training, the individual impact of each variable on currency value will be

deduced and incorporated into the model. A visualization of an example network is shown below



3. Through repeated backpropagation training with historical data, the model will be optimized. The training ratio being used is 70-15-15. In other words, 70% of network time is spent on training, 15% is spent on validation testing, and 15% is spent on testing the model against real data. Matlab's Neural Network Toolbox can perform each step automatically, as long as it is given the proper parameters.
4. The results of the neural network will be recorded in terms of MAPE. If the MAPE is relatively high, this would indicate an inaccurate model. To improve accuracy, the model will be retrained and the topology will be adapted until the MAPE becomes acceptable. If neither retraining nor topological adjustments are effective, then the input variables will be revisited.
5. The output data can be displayed on a graph, with one line representing the actual exchange rate and another line representing the exchange rate prediction of the model. The closer the two lines are to each other indicates higher model accuracy.

References

Chaudhuri, T. D., & Ghosh, I. (2016, July 3). Artificial Neural Network and Time Series Modeling Based Approach to Forecasting the Exchange Rate in a Multivariate Framework. *Journal of Insurance and Financial Management, 1*(5), 92-123. Retrieved September 12, 2016.

Evans, C., Pappas, K., & Xhafa, F. (2013). Utilizing artificial neural networks and genetic algorithms to build an algo-trading model for intra-day foreign exchange speculation. *Mathematical and Computer Modelling, 58*(5-6), 1249-1266. doi:10.1016/j.mcm.2013.02.002

Shahbazi, N., Memarzadeh, M., & Gryz, J. (2016). Forex Market Prediction Using NARX Neural Network with Bagging. *MATEC Web of Conferences MATEC Web Conf., 68*, 19001. doi:10.1051/matecconf/20166819001

United States of America, Federal Reserve, New York. (2009). *Overview of the OTC Foreign Exchange Market*. Retrieved September 18, 2016.

Vicenzo P. & Vitoantonio B. (May 2011) An Artificial Neural Network Model to Forecast Exchange Rates. Journal of intelligent learning, 3, 57-69, Retrieved November 20th, 2016