



Neural networks performance in exchange rate prediction



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ABSTRACT

Exploration of ANNs for the economic purposes is described and empirically examined with the foreign exchange market data. For the experiments, panel data of the exchange rates (USD/EUR, JPN/USD, USD/GBP) are examined and optimized to be used for time-series predictions with neural networks. In this stage the input selection, in which the processing steps to prepare the raw data to a suitable input for the models are investigated. The best neural network is found with the best forecasting abilities, based on a certain performance measure. A visual graphs on the experiments data set is presented after processing steps, to illustrate that particular results. The out-of-sample results are compared with training ones.

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1. Introduction

Uncertainty is pervasive in everyday life and the forecasting of uncertain parameters is widely recognized to represent a very critical issue in every application context. This consideration is particularly true for the financial field, where wrong forecasts can produce very severe losses.

Prediction of different financial indices based on time series is one of the most urgent research directions in economic sciences nowadays [1]. Recent researches show that the application of computational intelligence methods as a base for predicting models, in particular, neural networks, evolutionary computations, fuzzy logic and others is very crucial due to their principal differences from existing mathematical approaches. For example, neural networks have inherent learning abilities that allow us to effectively capturing the dynamics of nonlinear and complicated features of financial data; their self-training and self-adaptation properties provide a universality of the prediction model within the class of forecasting problems [2]. While the prediction model based on mathematical expression should be re-calculated for every prediction case. Finally, some prediction tasks in economics cannot be predicted by mathematical methods due to a number and diversity of input parameters.

In the last years, more than thousand scientific contributions have been proposed on the application of neural networks (NNs or ANNs) in finance. Gurusen [3] provides a detailed survey of the 25

contributions available in scientific literature on the NNs application in the financial field for the last few years. Their conclusions have confirmed that NN-based solutions outperform other statistical and mathematic approaches in the most cases. The largest number of NN applications in finance is for exchange rate [4], stock price [3] and sales [5] predictions.

The literature indicates that exchange rates are largely unforecastable. The pessimism about the prediction of exchange rate becomes generally accepted after the publication of the seminal paper by Meese and Rogoff [6]. Meese and Rogoff puzzle states that there is no better economic model for exchange rates forecasting during floating exchange rates than the simple random walk. This result was updated later by the same authors, and the conclusions did not change [7]. Nevertheless, Alvarez-Diaz [8] highlights that Meese and Rogoff puzzle rely on the assumption of linearity; therefore, it must not be considered definitive or conclusive due to the possible existence of nonlinear structures in the exchange rates dynamics. Author assumes that the scarce forecasting ability of the structural and univariant approaches are well summarized in the competition conducted by Meese and Rogoff [6], where it was shown that the great majority of linear models could not beat the out-of-sample predictions of a simple random walk.

Subsequently, a number of studies have pursued nonlinear modeling using conventional nonlinear techniques, such as Markov switching models. However, generally the results suggest that conventional nonlinear modeling does not improve exchange rate forecasts. An alternative way to deal with nonlinearities in data is to use neural network (NN) models. In contrast to the abovementioned model-based nonlinear methods, NN models are data driven and are

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thus capable of producing nonlinear models without prior knowledge about the functional forms. NN are also highly flexible as they can approximate any continuous function to any degree of accuracy.

The goal of this paper is to test prediction capacity of neural networks with the exchange rates of EUR/USD, GBP/USD and USD/JPY in daily steps to use them as the methods of the technical analysis of foreign market. The rest of the paper is organized as follows. The neural network used for our experiment is presented in Section 2. The input data preparation for NN training is described in Section 3. The NN models used for prediction are described in Section 4. The results of prediction are presented in Section 5. Section 6 concludes this paper.

2. Literature overview

The ANNs as a tool in the exchange rate prediction is used quite rarely due to the popularity of the statistical methods and the lack of the experts in the field of artificial intelligence among those who practice economic forecasting. However, there are several major pros of ANN usefulness that distinguish them from the other existed prediction methods. The most powerful feature of artificial neural network technology is solving nonlinear problems that other classical techniques do not deal with. The ANN technology does not require assumption about data distribution and missing, noisy and inconsistent data do not possess any problems. Another important aspect of the ANN is its ability to learn from the data. Moreover, according to Lam [9] neural networks are numeric in nature, which is especially suitable for processing numeric data such as financial information and economic indicators. Because numeric data must be converted into nominal values before they can be used as input to symbolic manipulation techniques, there are the problems of losing information, inappropriate data intervals, and different conversion methods leading to different mining results. Neural networks, on the other hand, can accept numeric data directly as input for mining purpose. Thinyane and Millin [10] in their article describe the creation, optimization and testing of an intelligent technical trading tool. According to their conclusions ANNs prove to be good signal amalgamators, with overtraining being their only downfall. Having said that, they also find that the more complex the ANN, the more specialized the resulting system; generating increasing profits on the training sets. This specialization however, cause a decrease in profits in the test sets, as the resulting system is not finding general optimums, but rather unique and highly profitable solutions limited to the training set. Thus the least complex ANN turn out to be the most profitable, as it is unable to specialize as highly, and is thus a more general solution.

An evidence that ANNs outperform a sort of non-linear approaches in terms of out-of-sample prediction accuracy is investigated and confirmed by the number of economists such as Önder et al. [11] who make the comparison between neural networks implementation and the other time series techniques. Based on empirical analysis the authors find that neural networks are universal functions approximation and they can model any continuous and nonlinear function with desired accuracy, and do not have any assumption about input or residual probability distribution as regression analyze.

There exist studies that have employed artificial neural networks (ANNs) models. During the last several years, ANNs have been applied successfully in many fields, mainly in biology, physics, and statistics and increasingly are being used in economics as well as in economic modeling. Among those who investigated neural networks and their implication for forecasting of financial markets were Kuan and White [12], as well as Swanson and White [13] who prove usefulness of neural networks in

economic time series., Qi and Madala [14] show its usefulness for the stock market, and Gencay [15] for exchange rate forecasting.

Santos et al. [16] in their work use series of first difference of 15 min, 60 min and 120 min log-returns from 01/01/2002 to 01/01/2003 and daily and weekly log-returns from 01/01/2000 to 01/01/2004 of the Brazilian exchange rate (R\$/US\$). The most important result is that ANNs performed better than linear models in all series. Another empirical experiment in favor of ANN is done by Ozkan [17] who compares the prediction performances of artificial neural networks, which he finds as an effective tool of prediction, and the monetary model, which is one of the methods to predict exchange rates. In his study exchange rates of Turkish Lira against US Dollar and Euro are predicted. Results of this study show that ANN, which is recently being used for the prediction problems, reached a high level prediction performance. Dunis and Huang, [18] applies MLP to a 1-day-ahead forecasting and trading task of the EUR/USD exchange rate using the ECB fixing series with only autoregressive terms as inputs. As it turns out, the MLP model clearly outperforms the traditional models in both out-of-sample periods in terms of annualized return. Bissoondeal et al. [19] evaluate the exchange rate forecasting performance of neural network models against the random walk, autoregressive moving average and generalized autoregressive conditional heteroskedasticity models. They warn that there are no guidelines available that can be used to choose the parameters of neural network models and therefore, the parameters are chosen according to what the researcher considers to be the best. In spite of these disadvantages in the paper their results still show that in general, neural network models perform better than the traditional time series models in forecasting exchange rates.

I agree with the disadvantages of ANN called by the researches mainly with the subjectivity in the selection of hidden layers, neurons, etc. Nevertheless, in most cases the implementation of ANN with experienced users as well as special programming environment gives quite good prediction results. It brings us to the idea to use the ANNs mainly the MLP in the experiment with the forecasting of exchange rates of three currency pairs. The originality of the research is in comparison the forecasting capacity of the ANN not with other methods like it is done in the most papers but with different currencies (EUR/USD, GBP/USD and USD/JPY in daily, monthly and quarterly steps was predicted). In the other words, in this paper the idea that it is possible to apply one proposed neural network model (with the example of MPL) to the prediction of the different exchange rates for the different periods is considered as a novelty of the research.

3. Description of used neural network model

The multi-layer perceptron is used as a model to predict exchange rates. This kind of neural network has the advantage of being simple and provides nice generalized properties.

The output value y of three-layer perceptron (Fig. 1) can be formulated as

$$y = F_3 \left(\sum_{i=1}^N w_{i3} h_i - T \right) \quad (1)$$

where N is the number of neurons in the hidden layer, w_{i3} is the weight of the synapse from neuron i in the hidden layer to the output neuron, h_i is the output of neuron i , T is the threshold of the output neuron and F_3 is the sigmoid activation function (3) of the output neuron.

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