FORECASTING THE JORDANIAN STOCK PRICES USING ARTIFICIAL NEURAL NETWORK

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ABSTRACT
Artificial Neural Network (ANN) technique was used in forecasting the Jordanian stock prices. The algorithm was developed using a feedforward multi layer neural network; the network was trained using backpropagation algorithm. Software was developed by using MATLAB to simulate the performance and efficiency of the algorithm. Simulation was conducted for seven Jordanian companies from service and manufacturing sectors. The companies were sampled from different categories which vary according to the degree of stock stability. The results were accurate and acceptable for Jordanian brokers. The use of ANN provides fast convergence, high precision and strong forecasting ability of real stock prices.

INTRODUCTION

Stock market is an exchange where secured trading is conducted by professional stockbrokers; it is one of the main indicators to the financial performance. In addition, stock market represents an essential part of the economy in the developing countries. Apparently, it is significant for shareholders and investors to estimate the stock price and select the best trading opportunity accurately in advance. This brings high return and reduces potential loss to investors. Jordanian stock market faces continuous fluctuating values due to the political, economical, and psychological factors. Furthermore, this market witnesses a noticeable sharp growth in the last few years. Thus, it is imperative for the Jordanian stockbrokers to employ new analysis tools.

Traditional methods for stock price forecasting are based on the statistical methods, intuition, or on experts' judgment. Time series analysis, Arema / Arma model are usually used for forecasting the stock prices. However, their performance depends on the stability of the prices, as more political, economical, and psychological impact-factors get into the picture, the problem becomes non linear, and need a more heuristic or nonlinear methods like ANN, Fuzzy logic, or Genetic Algorithms (Greene, 2003, InvestorWords, 2005).

Hassoun (1995) defines ANN as " parallel computational models comprised of densely interconnected adaptive processing units, they are viable computational models for a wide range of problems including pattern classification, speech synthesis and recognition, adaptive interfaces, function approximation, image compression, associative memory, clustering, forecasting and prediction, combinatorial optimization, nonlinear system modeling, and control". ANN can outperform other methods of forecasting due to its remarkable ability to derive meaning from complicated or imprecise data, it had been used successfully to extract complex patterns and trends (Stergiou and Siganos, 1996). Literature shows that ANN can be used in prediction, classification, data association, data conceptualization, and data filtration (Anderson and McNeil, 1992).

A lot of research had been conducted for using ANN in stock prices forecasting, as Steiner and Wittkemper (1997) had developed a portfolio optimization model that was built based on ANN embedded in the nonlinear dynamic capital market model. An economic approach to the analysis of highly integrated financial markets and econometric methods had been developed by Poddig and Rehkugler (1996). Donaldson and Kamstra (2000) proposed a methodology for forecasting future stock prices and return volatilities for fundamentally valuing assets such as stocks and stock options. Sheng proposed a neural network-driven fuzzy reasoning system for stock price forecast, his experimental result shows that the fuzzy neural network has fast convergence, a high precision, and strong function approximation ability which make it suitable for real stock price prediction.

ANN MATHEMATICAL MODEL:

One layer ANN that has L cells, all fed by the same input signals $x_j(t)$, and producing one output per neuron $y_l(t)$ can be modeled as (Lewis, et al., 1999):

$$y_l = f(\sum_{j=1}^{n} v_{lj} x_j + v_{l0}); \ l = 1,2,..., \ L. \tag{1}$$

The summing function can be replaced by a function that finds the average, the largest, the smallest, the ORed values, or the ANDed values (Anderson and McNeil, 1992).

Most ANN's consist of more than one layer, where the second layer input is the first layer output and so on. For the forecasting model of stock prices, the network consists of two or three layers depending on the degree of stock prices stability of the case study. There were 13 inputs to the network which are the stock prices for the first 13th working days of the month while the network output was the price for the 14th working day of the month.

SIMULATION RESULTS

To test the efficiency and effectiveness of the model a software program was developed using MATLAB. Seven Jordanian companies from different sectors were used as case studies. For each company, a full year was used for training the network; each month was used as a different pattern. The data starting from February 2002 and ending with January 2003 was used for the training, the validation was done by using another year which starts with February 2003 and ends with January 2004.

Different training functions, activation functions, number of layer, and number of neurons were tried till the error converged to the set value which is 10^{-6}. The performance function used was the mean square error (MSE). MSE is the average squared error between the network outputs and the target. The weights and biases of the network were automatically initialized to small random numbers by the software.

Case 1: Arab Engineering Industry

The training was done using one step secant backpropagation, a two layers network was used with Hyperbolic tangent sigmoid activation function for the first layer and hard limit activation function for the second layers, the first layer consists of 14 neurons and the second layer consists of one neuron. The network was trained using the stock prices for this company during the year starting February 2002 and ending January 2003, the network was able to train the data with a MSE of $9.7245*10^{-7}$ in only 11 epochs. To put things into perspective, the output of the network was plotted against the target as shown in Fig. 1, after the network passed the validation stage; the network was used to forecast the prices for the year starting from February 2003 until January 2004. Fig. 2 reveals the forecasted prices against the actual prices, as shown in the figure the forecasted price is very close to the actual one.

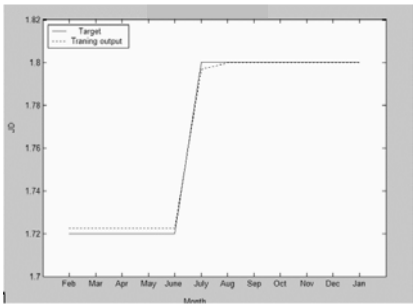

Figure 1: Training output against the target for Arab Engineering Industry Company.

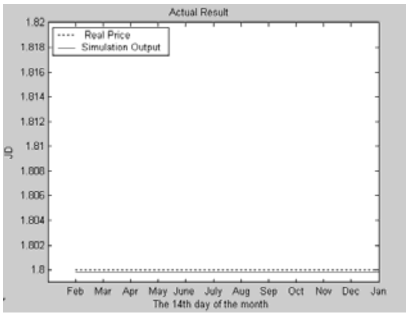

Figure 2: Forecasted prices against the actual prices for the Arab Engineering Industry Company.

Case 2: NUTRIADAR (Jordanian Drug Company)

The same training function was used, however, this time three layers contain (14,10,1) neurons respectively was needed to converge to a small training error, the first and second layers used positive linear transfer activation function, while the third layer used a hard limit transfer activation function. The company stock prices exhibits a noticeable variation between the days of each month, which make the forecasting job more difficult. The network was able to train the data in 1000 epochs that took only 30 seconds. The output of the network is plotted against the target as shown in Fig. 3, the figure prove that the network output matches the actual prices, after the network passed the validation stage, the network was used to forecast the prices for the year starting from February 2003 until January 2004. Fig. 4 reveals the forecasted prices against the actual prices. This time the forecasted price was slightly different than the actual prices, however, the gap did not exceed .08 JD (1 JD=$1.40).

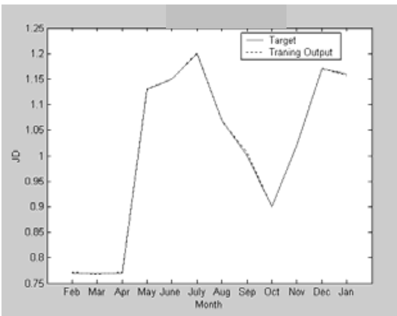

Figure 3: Training output against the target for the Nutriadar Company.

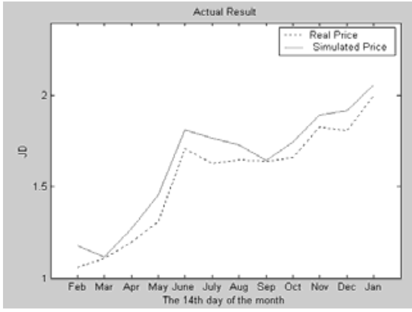

Figure 4: Forecasted prices against the actual prices for the Nutriadar Company.

The rest of the seven case studies were very close to the ones presented before where the network was able to train the data very quickly and produce a very good forecast, except for one case that will be presented next.

Case 3: Jordan Petroleum Refinery

A three layers ANN was used consist of (14,7,1) neurons respectively, the training was done using one step secant backpropagation, the first and second layers used positive linear activation function, while the third layer used hard limit activation function. The stock prices for this company during the year starting February 2002 and ending January 2003 are very volatile and varies substantially from one month to month and even during the same month. The training mean square error reaches 10^{-3} within 90 second in 1000 epochs.

The output of the network against the target is shown in Fig. 5. As shown in the figure the network output slightly differs from the target, although it exhibits the same pattern. The network was used to forecast the prices of the year starting from February 2003 until January 2004. The forecasted prices against the actual prices are shown in Fig. 6. The network was able to produce a very good forecast for the first four months (February-June), after June the actual prices fall from 15 JD's to 4 JD's. As shown in the figure the forecasted prices fall too at the same time but with different amplitude (from 14 to 1 JD) then it follow the same pattern of the actual price but with a difference of less than 2 JD's. Further investigation into this case reveals that the company broke the shares which caused the prices to drop.

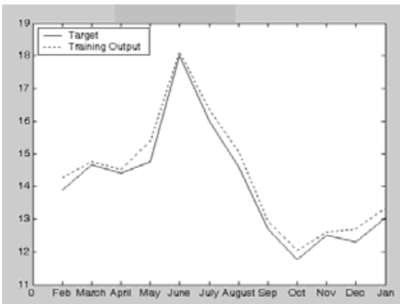

Figure 5: Training output against the target for Jordan Petroleum Refinery Company.

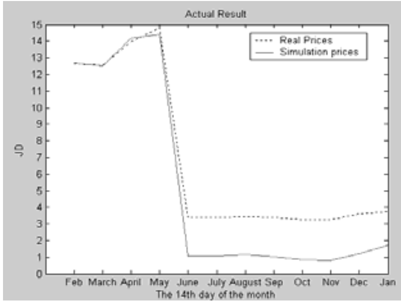

Figure 6: Forecasted prices against the actual prices for Jordan Petroleum Refinery Company.

DISCUSSION

The results obtained from the software were accurate for six out of seven cases, thus, ANN can be used for forecasting stock prices.

In the last case, the network did not give a good forecast but it was able to detect the pattern of the change in prices. Even when the actual stock prices change dramatically for assignable causes, the network was able to detect that and the forecast change at the same month and even with the same pattern as the actual data. Therefore, ANN can give a good indication about the trends of stock prices.

MODEL EVALUATION BY STOCKBROKERS

The model was evaluated by stockbrokers through the use of a questionnaire that was distributed in Amman Stock Market. The questionnaire was designed so that it can be filled in no more than two minutes. The questionnaire first presents the forecasting results obtained from the network and then asked the participant to answer seven multiple choice questions, which focus on the techniques currently used by the broker, and whether he/she would be willing to use the network in the future, only seven responses were returned.

In response to a question: “Would you depend on ANN technique, and by how much percent?”, four out of the seven participants stated that they will depend on ANN technique by 75%, two of them stated that they will depend on ANN technique by only 25%, and one participant stated that he will depend on ANN technique by 50 %.

In response to another question: “Do you believe that this technique will be applicable to any company regardless of the range of stability of its stock prices?”, four participants decided that the ANN technique will be applicable 100% for any company. Two of the participants believed that ANN will be applicable 50% for any company, and one participant believed that it is only 25% applicable for any company.

CONCLUSIONS

A forecasting model for stock prices was developed using ANN. The model was developed using a feedforward neural network with two to three layers. The network was trained using one step secant backpropagation. The activation functions used were hyperbolic tangent sigmoid, positive linear and hard limit transfer function. Simulation software developed by MATLAB was used to evaluate the network performance on seven Jordanian companies sampled from service and manufacturing sectors. The companies selected have different degree of stock prices stability. The network was trained on the data of year 2002. The network was able to produce the output within a MSE of 0.00228871-$9.75237*10^{-8}$ from the target. The network performance was evaluated by using the stock prices of the year 2003. The network output was very close to the actual data, except for one case, for which the company broke it's shares in the middle of the year, however, even in that case the network output drops dramatically to values close but not exactly the same as the ones of the actual data. The results of the network were further evaluated via a questionnaire sent to stockbrokers from Amman stock market. The returned responses indicated an average reliability measure of 75% in using the model for forcasting. Additionally, the responses indicated that this technique is 100% applicable for any company.

The model significance stems from the fact that stock market represents an essential part of the economy in the developing countries. The ANN model can help stockbrokers to forecast the stock prices and select the trading chance that will maximizes their profits more accurate than the available methods.

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