Stock Exchange of Thailand Index prediction using Back Propagation Neural Networks

Phaisarn Sutheebanjard
Graduate School of Information Technology
Siam University
Bangkok, Thailand
mr.phaisarn@gmail.com

Wichian Premchaiswadi
Graduate School of Information Technology
Siam University
Bangkok, Thailand
wichian@siam.edu

Abstract—In this paper, we investigate predicting the Stock Exchange of Thailand Index movement. Currently, there are two stock markets in Thailand; the Stock Exchange of Thailand (SET) and the Market for Alternative Investment (MAI). This paper focuses on the movement of the Stock Exchange of Thailand Index (SET Index). The back propagation neural network (BPNN) technology was employed in forecasting the SET index. An experiment was conducted by using data of 124 trading days from 2 July 2004 to 30 December 2004. The data were divided into two groups: 53 days for BPNN training and 71 days for testing. The experimental results show that the BPNN successfully predicts the SET Index with less than 2% error. The BPNN also achieves a lower prediction error when compared with the Adaptive Evolution Strategy, but a higher prediction error when compared with the (1+1) Evolution Strategy.

Keywords-component; Stock Exchange of Thailand; SET index; neural network;

I. INTRODUCTION

Stock exchange index prediction is an interesting and challenging issue for both investors and academics. The stock market is a highly nonlinear dynamic system. Many factors influence the performance of a stock market including interest rates, inflation rates, economic environments, political issues, and many others. The Stock Exchange of Thailand (SET) has its own unique characteristics according to the economic systems that it serves such as the Dow Jones index, the Straits Times index, the Nikkei index, the Hang Seng index, Minimum Loan Rate (MLR), gold price, the value of the Thai Baht and many other as in [1-6]. Therefore, this research used the historical movement of the SET index itself as well as the world's major stock market indices which include the Dow Jones index (New York), the Straits Times index (Singapore), the Nikkei index (Japan), the Hang Seng index (Hong Kong) as well as the domestic Minimum Loan Rate (MLR) and Gold prices as the factors used to predict the SET index.

There are previous works concerning prediction of the Stock Exchange of Thailand index (SET index). They used the technique of neural network [7-9], ARIMA [9] and [2-3]. Neural networks are very efficient adaptive forecasting models because of their excellent performance based on their self learning capability. Unlike other techniques that construct functional forms to represent relationships of data, neural networks are able to learn patterns or relationships from the data itself [7]. The Autoregressive Integrated Moving Average (ARIMA) was introduced by G. Box and G. Jenkins in the early 1970s. This time series analysis can capture complex arrival patterns, including those that are stationary, non-stationary, and seasonal (periodic) ones [10]. The ARIMA approach is elegant in theory but has been of little practical use in business because of its complexity and limited increase in accuracy over less sophisticated methods. The Evolution Strategies approach was introduced by Rechenberg [11]. Evolution Strategies (ES) are algorithms which imitate the principles of natural evolution as a method to solve parameter optimization problems [12-14]. ES is one of the most popular evolutionary algorithms. ES approaches are generally applied to numerical optimization for its real valued representation. In this paper, a back propagation neural network is used to predict the SET index movement and compare the results with other methodologies that have been proposed in the same test period.

II. THE STOCK EXCHANGE OF THAILAND

The Thai stock market in Thailand officially started trading on April 30, 1975. The number of listed companies on the Stock Exchange of Thailand increased from 16 in 1975 to 476 in 2008. And the total market capitalization increased from 1,522.92 million baht at the end of 1975 to 3.57 billion baht at the end of 2008. The index of the Stock Exchange of Thailand is called the SET Index. The SET Index is a composite market capitalization-weighted price index which compares the current market value (CMV) of all listed common stocks with its market value on the base date of April 30, 1975 (Base Market Value or BMV), which was when the stock market was established. The initial value of the SET index on the base date was set at 100 points. The formula of the SET index calculation as shown in (1)

$$\text{SET Index} = \frac{\text{Current Market Value x 100}}{\text{Base Market Value}} \quad (1)$$

The SET index movement is dependent on both global and domestic economic factors [1-6], [15-16]. Since countries are linked together, movement on one stock market can have an impact on other stock markets. Naturally, the

978-0-7695-4042-9/10 $26.00 © 2010 IEEE
DOI 10.1109/ICCNT.2010.21

The Thai stock market has unique characteristics, so the factors influencing the prices of stocks traded in this market are different from the factors influencing other stock markets [1]. An example of the factors that influence the Thai stock market are foreign stock indexes, the value of the Thai Baht, the price of oil, the price of gold, the Minimum Loan Rate (MLR) and many others [2], [4-6], [15-16]. Some researchers used these factors to forecast the Stock Exchange of Thailand (SET) index such as Tantinakom [15] who used trading value, trading volume, interbank overnight rate, inflation, net trading value of investment, value of the Thai Baht, price earnings ration, the Dow Jones index, the Hang Seng index, the Nikkei index, the Straits Times index and the Kuala Lumpur Stock Exchange Composite index. In 2000, Khumpoo [6] used the Dow Jones index, the price of gold, the Hang Seng index, the exchange rate of the Japanese yen and the Thai baht, the Minimum Loan Rate (MLR), the Nikkei index, the price of oil, the Straits Times Industrial index and the Taiwan weighted index. In 2004, Chotasiri [5] used the interest rate of Thailand and the USA, the exchange rate of USD, JPY, HKD and SKD, the stock exchange indices of USA, Japan, Hong Kong and Singapore, the consumer price index, and the price of oil. In 2005, Chaereonkithuttakorn [4] used the United States stock indices including the Nasdaq index, the Dow Jones index and the S&P 500 index. In 2005, Rimcharoen et al. [2] used the Dow Jones index, the Nikkei index, the Hang Seng index, the price of gold and the Minimum Loan Rate (MLR). In 2007, Worasucheep [16] used the Minimum Loan Rate (MLR), the exchange rate of the Thai Baht and the US dollar, daily effective over-night federal fund rates in the USA, the Dow Jones index and the price of oil. In 2008, Chaigusin, et al. [7] used the Dow Jones index, the Nikkei index, the Hang Seng index, the price of gold, the Minimum Loan Rate (MLR) and the exchange rate of the Thai Baht and the US dollar. The common factors that researchers used to predict the SET index are summarized in table I.

In 2005, Rimcharoen, et al. [2] used the Adaptive Evolution Strategies technique to predict the Stock Exchange of Thailand index for the period from January 2003 to December 2004. The economic factors used in their experiment were the Dow Jones index, the Nikkei index, the Hang Seng index, the price of gold and the MLR. The experimental results showed that their method can be used to forecast the Stock Exchange of Thailand index with an error of less than 3%. The Function used by Rimcharoen, et al. is shown in (2).

$$\begin{aligned} SET_{(t)} = {} & 2.3645 + 5.5208\sin^3[0.3138_{(t-1)}] - \\ & 1.5430 hangseng_{(t-1)} / -5.2054 mlr_{(t-1)} + \\ & 2.8360\cos^2[0.6246_{(t-1)}] * 4.6811\sin[0.3651_{(t-1)}] - \\ & 1.5380\cos^3[0.7522_{(t-1)}] - 1.1618\cos^3[0.7724_{(t-1)}] + \\ & 3.3228\sin^3[1.5317_{(t-1)}] - 2.4620\cos[0.6676_{(t-1)}] * \\ & 2.3144 mlr_{(t-1)} \end{aligned} \quad (2)$$

where (t) is today and (t-1) is yesterday.

In 2009, Sutheebanjard and Premchaiswadi [3] applied the (1+1) Evolution Strategies method to predict the SET index during the period from January 2003 to December 2004 and January 2005 to December 2006. The four factors used in the prediction function were the Dow Jones index, the Nikkei Index, the Hang Seng index and the MLR as shown in (3). The experimental results showed that the prediction function of Sutheebanjard and Premchaiswadi predicted the SET index with less than 2% error for both periods.

$$\begin{aligned} SET_{(t)} = {} & 0.86 SET_{(t-1)} + 0.021008 \times \\ & ((0.632529 DJ_{(t-1)} + 0.317615 \mathrm{N}K_{(t-1)} + \\ & 0.156434 HS_{(t-1)}) / 0.509522 MLR_{(t-1)}) \end{aligned} \quad (3)$$

TABLE I. IMPACT FACTORS TO STOCK EXCHANGE OF THAILAND INDEX PREDICTION

	Tantinakom 1996 [15]	**Khumyoo 2000 [6]**	**Chotasiri 2004 [5]**	**Chaereonkithuttakorn 2005 [4]**	**Rimcharoen el al. 2005 [2]**	**Worasucheep 2007 [16]**	**Sutheebanjard and Premchaiswadi 2009 [3]**
Nasdaq Index				x			
Dow Jones Index	x	x	x	x	x	x	x
S&P 500 Index				x			
Nikkei Index	x	x	x		x		x
Hang Seng Index	x	x	x		x		x
Straits Times Index	x	x	x				
USD		x	x			x	
JPY		x	x				
HKD			x				
SKD			x				
Gold price		x			x		
Oil price		x	x			x	
MLR		x			x	x	x

Denote USD is the exchanges rates of the Thai Baht and the US dollar
JPY is the exchanges rates of the Thai Baht and Japanese Yen
HKD is the exchanges rates of the Thai Baht and Hong Kong dollar
SKD is the exchanges rates of the Thai Baht and Singapore dollar

III. ARCHITECTURE OF ARTIFICIAL NEURAL NETWORK

The theory of neural network computation provides interesting techniques that mimic the human brain and nervous system. A neural network is characterized by a pattern of connections among the various network layers, the numbers of neurons in each layer, the learning algorithm, and the neuron activation functions. The neural networks techniques can approximate any nonlinear continuous function without a priori assumptions about the nature of the generating process. They also have good self-learning ability. With such flexible function approximations, they are powerful tools for pattern recognition, classification, and forecasting.

Artificial neural networks are one of the technologies that have made significant progress in studying the stock market movement forecasting. The back propagation technique is one of the most widely used algorithms to train neural networks. The training is based on a simple concept. If the network gives a wrong answer, then the weights are corrected so that the error is lessened and as a result, future responses of the network are more likely to be correct. Therefore, the back propagation neural network has been used by many researches to predict the stock market movement [17-19].

A three layered back propagation neural network was used in this study. There are seven nodes in the input layer, four nodes in the hidden layer and one node in the output layer. The historical data of the critical factors that were used in the input layer are as follow:

- The SET index (Thailand)
- The Dow Jones index (New York)
- The Straits Times index (Singapore)
- The Nikkei index (Japan)
- The Hang Seng index (Hong Kong)
- The domestic Minimum Loan Rate (MLR)
- The domestic Gold prices

IV. EXPERIMENTAL RESULTS

The experimental data were obtained from the following two sources: the SET index, the Dow Jones index, the Straits Times index, the Nikkei index, the Hang Seng index, Minimum Loan Rate from the Bank of Thailand and gold price data from Gold Trader Association.

The time series investigated in the experiment covered the period from 2 July 2004 to 30 December 2004. It contained 124 days of data. The data were divided into two groups: 53 days for training and 71 days for testing. The test data period used in this experiment was the same as [2-3].

This research used the Mean Squared Error (MSE) and the Mean Absolute Percentage Error (MAPE) to measure the error, which is the difference between the forecasted value and actual value. MSE is one of many ways to quantify the amount by which an estimator differs from the actual value of the quantity being estimated. MSE measures the average of the square of the error. The error is the amount by which the estimator differs from the quantity to be estimated. MAPE expresses the error as a percentage. MAPE is commonly used in quantitative forecasting methods because it produces a measure of relative overall fit. The absolute values of all the percentage errors are summed up and the average is computed. The function of MSE and MAPE are shown in (4) and (5) respectively.

$$MSE = \frac{1}{n}\sum_{t=1}^{n}\left(g_{(t)} - f_{(t)}\right)^2 \tag{4}$$

where $g_{(t)}$ is an actual value.
$f_{(t)}$ is a forecasted value
n is the number of data points.

$$MAPE = \frac{\sum_{t=1}^{n}\left|\frac{g_{(t)} - f_{(t)}}{g_{(t)}}\right|}{n} \times 100 \tag{5}$$

where $g_{(t)}$ is an actual value.
$f_{(t)}$ is a forecasted value
n is the number of data points.

The empirical study results show that the back propagation neural network (BPNN) returns an MSE of 243.68 and a MAPE of 1.96% on the test data. The experimental results were also compared with the Adaptive Evolution Strategies and the (1+1) Evolution Strategies as shown in table II.

TABLE II. ERROR COMPARISON

Method	MSE	MAPE (%)
Adaptive ES [2]	-	2.46
(1+1) ES [3]	55.49	0.88
BPNN	243.68	1.96

V. CONCLUSION

This research used the back propagation neural network (BPNN) to forecast the Stock Exchange of Thailand index (SET Index) movement with an error rate of less than 2%. The BPNN also achieved a lower prediction error when compared with the Adaptive Evolution Strategies technique. But the BPNN had a higher prediction error when compared with the (1+1) Evolution Strategies method. But the (1+1) Evolution Strategies requires determining the prediction function before the forecasting task.

The advantage of a neural network is its ability to model a nonlinear process without a priori knowledge about the nature of the process. A neural network can be trained with available data to model an arbitrary system. The trained network is then used to predict movements in the future therefore it is not necessary to determine the prediction function before the forecasting task.

REFERENCES

[1] S. Chaigusin, C. Chirathamjaree, and J. Clayden, "Soft computing in the forecasting of the stock exchange of Thailand (SET)," Management of Innovation and Technology, 2008. ICMIT 2008. 4th, 2008.

[2] S. Rimcharoen, D. Sutivong and P. Chongstitvatana, "Prediction of the Stock Exchange of Thailand Using Adaptive Evolution

Strategies," Tools with Artificial Intelligence, 2005. ICTAI 05. 17th 2005.

[3] P. Sutheebanjard and W. Premchaiswadi, "Factors Analysis on Stock Exchange of Thailand (SET) Index Movement," The 7th International Conference on ICT and Knowledge Engineering, ICTKE2009, Bangkok, Thailand, December, 2009.

[4] K. Chaereonkithuttakorn, "The Relationship between the Stock Exchange of Thailand Index and the Stock Indexes in the United States of America," Master Thesis in Economics, Chiang Mai University, Chiang Mai, Thailand. 2005.

[5] S. Chotasiri, "The Economic Factors Affecting the Fluctuation of The Stock Exchange of Thailand Index," Master Thesis in Economics, Chiang Mai University, Chiang Mai, Thailand, 2004.

[6] C. Khumyoo, "The Determinants of Securities Price in the Stock Exchange of Thailand," Master Thesis in Economics, Ramkhamhaeng University, Bangkok, Thailand, 2000.

[7] S. Chaigusin, C. Chirathamjaree and J. Clayden, "The Use of Neural Networks in the Prediction of the Stock Exchange of Thailand (SET) Index," Computational Intelligence for Modelling Control & Automation. 2008.

[8] S. Pattamavorakun, and S. Pattamavorakun, "Determination the Number of Hidden Nodes of Recurrent Neural Networks for River Flow and Stock Price Forecasting," International Conference on Software Engineering Research, Management and Applications 5th, 2007.

[9] J. Tunsenee, "Accuracy Comparison in Securities Price Forecasting Between Neural Networks Model and EGARCH-M ARIMA Model," Master Thesis in Economics, Chiang Mai University, Chiang Mai, Thailand, 2006.

[10] P. Meesad and T. Srikhacha, "Universal Data Forecasting with an Adaptive Approach and Seasonal Technique,' Computational Intelligence for Modeling, Control and Automation, 2006 and International Conference on Intelligent Agents, Web Technologies and Internet Commerce, 2006.

[11] I. Rechenberg, "Evolutionsstrategie: Optimierung technischer Systeme nach Prinzipien der biologischen Evolution," Dr.-Ing. Thesis, Technical University of Berlin, Department of Process Engineering, 1971.

[12] T. Back, F. Hoffmeister and H.P. Schwefel, "A Survey of Evolution Strategies," Proceeding of the Fourth Conference on Genetic Algorithm, 1991.

[13] H.G. Beyer and H.P. Schwefel, "Evolution Strategies-A Comprehensive Introduction," Natural Computing. Vol. 1, Issue 1, 2002.

[14] S. Rimcharoen and P. Chongstitvatana, "An Adaptation of Evolutionary Strategies for Forecasting the Exchange Rate," The 8th Annual National Symposium on Computational Science and Engineering, 2004.

[15] T. Tantinakom, "Economic Factors Affecting Stock Exchange of Thailand Index," Master Thesis in Economics, Chiang Mai University, Chiang Mai, Thailand, 1996.

[16] C. Worasucheep, "A New Self Adaptive Differential Evolution: Its Application in Forecasting the Index of Stock Exchange of Thailand," Evolutionary Computation, 2007. CEC 2007, 2007.

[17] N. L. D. Khoa, K. Sakakibara and I. Nishikawa, "Stock price forecasting using back propagation neural networks with time and profit based adjusted weight factors," SICE-ICASE International Joint Conference, October 2006.

[18] C.T. Lee and Y.P. Chen, "The efficacy of neural networks and simple technical indicators in predicting stock markets," International Conference on Convergence Information Technology, 2007.

[19] P. R. Charkha, "Stock price prediction and trend prediction using neural networks," Firth International Conference on Emerging Trends in Engineering and Technology, 2008.