Correlation Prediction between Foreign Stock Exchanges

Chiu-Che Tseng, Han-Chiu Huang, I-Wan Wang*
Department of Computer Science and Information Systems
*Department of Business and Technology
Texas A&M University – Commerce, TX 75429, U.S.A.

Abstract
The stock price effects of cross-listed ADRs (American Depositary Receipts) by Taiwan is discussed in the study in order to see if there is any positive co-relation between the stock prices in those two countries. In the study, we applied the methodology of neural network analysis which is different from the traditional statistical methodology that has been used in fairly extensive empirical studies. The studies are used to examine stock price information from eight Taiwanese companies during 1996 and 2003. After analyzing the numerical information, the result is going to be compared with those in 2004 to estimate the accuracy of prediction and make sure that investors can earn the best return.

Keywords: Neural network, Prediction, Artificial intelligence.

1. Introduction

In the late 20th century, along with the deregulation of financial markets internationally, there is a growing number of private capital flows across the globe. At the same time, the changes have appealed to more companies internationally than ever before who are now eager to list their stocks in the world's largest capital market. Among various vehicles, the primary one has been the American Depositary Receipts (ADRs). For the operational side, listing stocks as ADRs enables those companies to disperse the investment risk; on the financial side, it expands their investor base and possibly raises additional capital.

Neural network is modeled on the human brain in which there are extensively interconnected units (neurouns) that make up a vast network capable of complex pattern recognition. As such, it is composed of many computational elements operating in parallel and arranged in patterns reminiscent of biological neural nets. The purpose of such emulation is to produce artificial systems capable of intelligent computation and pattern recognition similar to those that the human brain routinely performs. From the mid of the 21st century, this newly analytical tools have been applied extensively. Like Rochester (1990), Dutta and Shekar (1988), and Cheng and Titterington (1994) have proved that neural network analysis is one of the more effective methodologies with powerful predictive capability than any other regression models. Besides, as a new methodology compares with those traditional statistical methods, neural network analysis has been shown to be "of great use in diverse real-life application" (Meilich, 1996, p.5).

Since the trading hours of US markets do not coincide with Taiwanese markets, in this study, we apply neural network to analyze the stock price variances of ADRs in the US and those in the Taiwanese stock market in order to see if the ADRs listed in the US market really reflect the real-time information that become available while the US market was open right after the Taiwanese stock market was closed.

2. Relative Works

Among numerous empirical studies, the co-relationship between international stock prices has always been discussed. Jayaraman et al. (1993) show ADR listing to be associated with both positive abnormal returns on the listing day and an increase in the volatility of returns to the underlying stock. Foerster and Karolyi (1999) find that their sample of non-US firms cross-listing on US exchanges, over the period 1976 to 1992, experienced average excess returns of 19% during the year before listing, 1.2% the listing week, and -14% the year following listing.

Moreover, Jiang (1998) uses weekly data, over the sample period January 1980 to September 1994, on ADRs and market indices to conduct co-integration tests and to estimate EC and multifactor models. The study's findings shows that, most of the time, ADRs and stocks issued in its home market are interrelated and do influence each other. As a result, the inter-relationships among international markets do exist.

Nevertheless, despite the existing interrelationships between ADRs and stocks issued in its home country, there were many other science and technical literatures discussed the factors that really affect the price of ADRs and its returns. For instance, Park (1990) uses the data from June 1987 to July 1997 of the ADRs cross-listed by Japanese and England companies. He found that the prices of ADRs are mainly affected by those issued in Japan and England (their home countries) but lightly affected by US market instead. Karolyi and Stulz (1996) uses the daily ADRs data of eight Japanese companies during May 31st , 1988 to May 31st, 1992 as sample. He also found that the ADRs return is barely related to the daily exchange and bond return's impact in the USA. What really matters to the ADRs return are Nikkei index and S&P 500 index in Japan, and they also have positive movement, too.

Even so, there are not many empirical studies which discuss the issue of whether the cross-listed ADR have any influence on the stocks issued in the home country. Whether there are any positive movements between the returns of ADRs and that issued in its home country. In the following section, we are going to apply neural network and do adverse analysis to make contrasts with above studies.

3. Neural Network

Neural networks are software models inspired by biological neural networks. Neural networks are inherently nonlinear. They estimate nonlinear functions well and extract residual nonlinear elements. The networks can at least partially transform the input data if needed. These overcome the limitations of models such as linear regression. Neural network consists of basic units, termed neurons, whose design is suggested by their biological counterparts. These artificial neurons have input paths just as biological neurons have dendrites; they have output paths just as biological neurons have axons. Both artificial and biological neurons also have predispositions which affect the strength of their output. The neuron combines the input signals. In both real and artificial neurons, learning occurs and alters the neurons.

In neural networks, the neuron input path has a signal on it , and the strength of the path is characterized by a weight . The neuron forms a sum of the path weight times the input signal over all paths and the node bias . The output is usually a sigmoid shaped logistic function of the sum. Mathematically, the sum is expressed as:

$$\text{sum} = \Sigma w_i x_i + Q$$

And it is transformed into the output with the sigmoid-shaped logistic function:

$$Y = 1/(1 + e^{-\text{sum}})$$

Sigmoid-shaped curve approaches a minimum and maximum value at the asymptotes. It is common for this curve to be called a sigmoid when it ranges between 0 and 1, and a hyperbolic tangent when it ranges between -1 and 1. Mathematically, the exciting feature of these curves is that both the function and its derivatives are continuous. This option works fairly well and is often the transfer function of choice.

Learning occurs through the adjustment of the path weights and node bias. The most common method used for the adjustment is called back propagation. In this method, the weights are adjusted to minimize the squared difference between the model output and the desired output. The adjustments are usually based on a gradient descent algorithm. These and the other Neural Network models do not necessarily correspond to the methods used in the biological neural networks.

4. Training Model

4.1 Data Normalization

By applying Brain Maker neural network, daily data during the month of January in 1996 to the month of June in 2004 of eight Taiwanese companies which have cross-listing their stocks in the US stock market as American Deposit Receipt (ADR) are being applied as sample. The data during 1996 to 2003 will be analyzed via Brain Maker. After training, the analytical result would be used to compare with the existed data in 2004 (during January to June) of Taiwanese stock variation.

Before training, the data should be normalized and changed into the statistics which could be recognized by Brain Maker. The following are formula and terms used in the training:

Stock Variation: (Close price – Open price) / Open price * 100% = Stock Variation

Input: The first five days of ADRs' variation during 1996 to 2003. (The day of data collection is included.)

Output: The real stock variation of intraday in Taiwanese stock market.

First of all, data of eight companies are gathered for the neural network to study. We are using past results to predict future results. The data of ADRs previous five days including the day of data collection are used as input and one data of the fifth day of Taiwanese stocks are used as output. In order to make comparisons, the data will be trained reversely that the data of previous five days of Taiwanese stocks are used as input and the data on the fifth day of ADRs are used as output.

4.2 Learning Setting

When applying neural network analysis, we have to adjust the learning rate. The correct setting for the learning rate is application-dependent and is typically chosen by experiment; it may also be time-varying, getting smaller as the algorithm progresses. However, too low a learning rate makes the network learn very slowly. Too high a learning rate makes the weights and error function diverge and, therefore, there is no learning at all. After setting, we have to train the network. Training examples are divided into inputs and target outputs. We set the learning rate to exponential learning rate which starts at 1.000 and the reduction at 0.900. Also, we set the neurons transfer function to sigmoid. Brain Maker keeps adjusting the network's connections until the network has learned the correct result for each input.

4.3 Training Process

Designing neural network is largely a matter of identifying which data are input and what you want to predict, assess, classify, or recognize. The network tries to learn each example in turn, calculating output based on the input which is provided. If the network output doesn't match the target output, we have to correct the network by changing its internal connections. This trial-and-error process continues until the network reaches the specified level of accuracy. Once the network is trained and tested, new input information could be given, and it will produce a prediction.

4.4 Test and Run the Network

The data of eight companies in 2004 are used to test the network and make comparisons with the analytical result. To be sure that we have a good network, the data which has never seen by neural work before must be shown and we have to check the results again. At last, we have to run the network, and show the neural network new input data and read the results.

5. Summary and Conclusion

5.1 Neuron and Connections

In the Figure1, it shows the task of neural network models and determines the relationships between the input (the data of Taiwanese stock market from previous five days including the day of data collection) and the output (the predicted data of ADRs on the fifth day) by building network structures among them using the hidden layers and hidden nodes

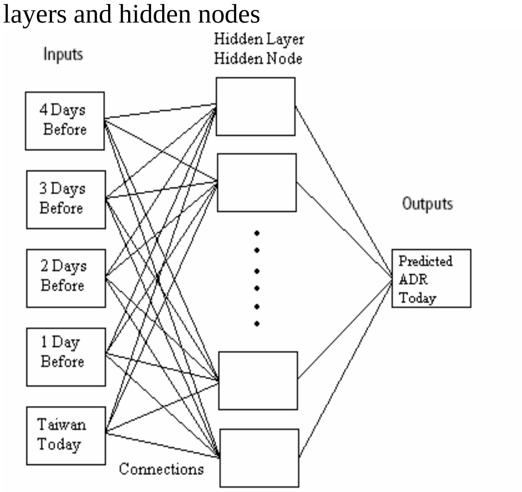

Figure 1 Using Taiwan Stock previous 5 days variation as input and today ADRs variation as output.

(neurons) that resemble the human thinking process.

In the Figure2, it shows the task of neural network models and determines the relationships between the input (the data of ADRs from previous five days including the day of data collection) and the output (the predicted data of Taiwanese stock market on the fifth day) by building network structures among them using the hidden layers and hidden nodes (neurons) that resemble the human thinking process.

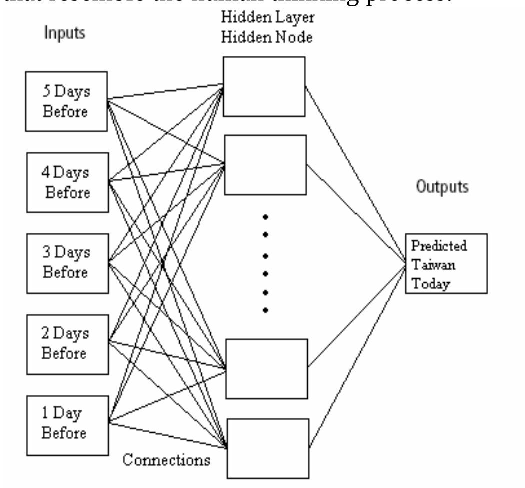

Figure 2 Using ADRs previous 5 days variation as input and today Taiwan's variation as output.

5.2 Result

When the network is trained to the satisfaction, the current input data and the network will make a prediction of output (the variation of stock price). The following shows the accuracy rate of prediction acquired from training..

Take MXICY (Macronix International CO., LTD.) for example, my network predicts that there are 71 trading days which have the same moving trend as some of those within 114 trading days. The result shows that the neural network can achieve precision of up to 62.28% (71/114) in an uptrend or a downtrend.

We believe and the data shows that the ADRs co-related with stock prices listed in Taiwanese stock market. However, by training the neural network, we found that the accuracy rate of using Taiwanese stock prices to predict ADRs' is even much higher than training them in the opposite way. The stock prices in the home country do play the main role to affect those cross-listed in foreign market if any other factors are not concerned.

6. References

[1] Anant K., S., Dennis E., L. (1st Qtr., 1996). Valuation Effects of Foreign Company Listings on U.S. Exchanges. Journal of International Business Studies, 27(1), p.67-88.

[2] Brad, W., Manavendra, M. (Nov., 1996). Understanding Neural Networks as Statistical Tools. The American Statistician. 50(4), p.284-293.

[3] Connor, D. (May, 1988). Data Transformation Explains the Basics of Neural Networks. EDN. p.138-144.

[4] David E., Mehdi, S. (2001). American depositary receipts: An analysis of international stock price movements. International Review of Financial Analysis, 10, p.323-363.

[5] Foster, B., Collopy, F., and Ungar, L. (1992). Neural Network Forecasting of Short, Noisy Time Series. Computers and Chemical Engineering. 16(12), p.293-297.

[6] Geng, C., Man, L., W. Implementing neural networks for decision support in direct marketing.International Journal of Market Research. 46(2).

[7] Hagan, M. T., Demuth, H. B., and Beale, M. (1996). Neural Network Design. (Thomson Learning, Vikas Publishing House, New Delhi, India).

[8] John F, V., Michael, L., Roland, C., Philippe, V., and Y. Alex, T. (2nd Qtr., 2000). Using Neural Network Analysis to Uncover the Trace Effects of National Culture. Journal of International Business Studies, 31(2). p.223-238.

[9] Mark E., W., William J., Crowder. (1998). COINTEGRATION, FORECASTING AND INTERNATIONAL STOCK PRICES. Global Finance Journal. 9(2).

[10] Niklas, A., Jan, A. (2002). Testing for cointegration between international stock prices. Applied Financial Economics. 12, p.851-861.

[11] Ripley, B. D. (1994). Neural Networks and Related Methods for Classification. Journal of the Royal Statistical Society B. 56(3), p.409-456.

[12] Rao, S. C., Srikant, R.R. (2004). Tool wear monitoring – an intelligent approach. Proceeding s of the Institution of Mechanical Engineers – Part B – Engineering Manufacture. 218(8), p905, 8p.

[13] Tim, H., Marcus, O. C., and William, R. (Jul., 1996). Neural Network Models for Time Series Forecasts. Management Science. 42(7).