COMPARING NEURAL NETWORK AND AUTOREGRESSIVE MODEL FOR STOCK MARKET PREDICTION

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Thematic Paper
entitled

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COMPARING NEURAL NETWORK AND AUTOREGRESSIVE MODEL FOR STOCK MARKET PREDICTION

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ABSTRACT

The purpose of this thematic paper is to build a forecasting stock market model using an Artificial Neural Network (ANN). The key objective of this thematic paper is to use ANN model to predict the FK value which is an indicator showing an investment signal as to whether to buy, hold, or sell stocks in each period. This thematic paper captured daily historical data from the SET index between May 2002 and September 2010 as an input to ANN for the training and validation process. The forecasting model associates both ANN and the Autoregressive model with 9 degrees of freedom and compares the performance of both models by using a Mean Square Error (MSE) as an indicator. From the results, the ANN model was able to predict the FK value better than the Autoregressive model. Meanwhile, ANN performs better in finding non-linear or non-pattern fluctuated situations like the SET index.

KEY WORDS: ARTIFICIAL NEURAL NETWORK / ANN / FORECASTING / STOCK MARKET

32 pages

การเปรียบเทียตัวแบบโครงข่ายประสาทเทียมและระเบียบวิธีการถดถอยแบบอัตโนมัติสำหรับการคาดการณ์ตลาดหลักทรัพย์

COMPARING NEURAL NETWORK AND AUTOREGRESSIVE MODEL FOR STOCK MARKET PREDICTION

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บทคัดย่อ

สารนิพนธ์ฉบับนี้มีจุดมุ่งหมายเพื่อศึกษาการสร้างโครงข่ายประสาทเทียม ซึ่งเป็นแบบจำลองเลียนแบบลักษณะการทำงานของระบบประสาทมนุษย์ วัตถุประสงค์หลักของสารนิพนธ์นี้คือการใช้ตัวแบบโครงข่ายประสาทเทียมนี้สำหรับการพยากรณ์ค่าเอฟเค ซึ่งเป็นตัวบ่งชี้สัญญาณในการลงทุน ไม่ว่าจะเป็นสัญญาณซื้อ ถือครอง หรือขายหุ้นนั้นในช่วงเวลาต่างๆ สารนิพนธ์นี้ใช้ข้อมูลรายวันของดัชนีตลาดหลักทรัพย์แห่งประเทศไทยตั้งแต่ช่วงเดือนพฤษภาคมปี พ.ศ. 2545 ถึงช่วงเดือนกันยายนปี พ.ศ. 2553 ตัวแบบโครงข่ายประสาทเทียมนี้ผ่านกระบวนการการเรียนรู้ วิเคราะห์ และทดสอบเปรียบเทียบความคลาดเคลื่อนของการทำนายเปรียบเทียบกับตัวแบบระเบียบวิธีการถดถอยแบบอัตโนมัติ โดยใช้ค่าเฉลี่ยของความคลาดเคลื่อนยกกำลังสองเป็นตัววัดเทียบวัดความสามารถ ผลจากการทดสอบและวิเคราะห์ตัวแบบโครงข่ายประสาทเทียมมีความสามารถในการพยากรณ์ค่าเอฟเคได้ดีกว่าระเบียบวิธีการถดถอยแบบอัตโนมัติ ซึ่งเป็นผลยืนยันว่าโครงข่ายประสาทเทียมมีความสามารถในการการจัดการกับการผันผวนและสามารถค้นหารูปแบบความไม่เชิงเส้นของสถิติดัชนีตลาดหลักทรัพย์แห่งประเทศไทยได้ดีกว่า

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CHAPTER I
INTRODUCTION

1.1 Background of Study

Predicting of stock market movement is believed to be a very challenge task. Many researchers try to forecast stock market price and return from various techniques. Most of the studies are based on fundamental analysis and technical analysis which was proven that it is difficult to forecast because there is no exact mathematical model and stock market has many bias factors such as market sentiment, rumor and imitative behavior which lead to an unexpected return and performance of investment portfolio.

To avoid such subjective factors and get a better profitability on investment in the stock market, this research provide an alternative technique of Artificial Neural Network (ANN) applied from human brain concept by observing and training from historical data.

1.2 Significance of study

With wealth management concepts, people turn to invest in diversified financial instruments rather than merely placing their money in a bank account. Stock market is one of the tools to make the high profit, but it bring the high risk as well.

Prediction of stock value becomes a topics focusing for many years. This study can be one of the alternative widely useful tools to help investors on decision making to increase the expected return with acceptable risk in the stock market investment. This research will help the investors taking buy, sell or hold position of stock investment with effective and inexpensive way on an investment target especially for the small investors which may have lower and bias information than institutional investors.

1.3 Scope and Objective of the Study

The scope of study for this research is to applied the ANN concept to analyze and predict the FK value of SET (Stock Exchange of Thailand) index through the historical data by using computer technology and algorithm from MATLAB toolbox to simulate model, train the system and construct the decision-making model to let the investors to see the future trend of index for their investment decision of expected return with higher profitability and lower risk.

In addition, this study will compare the outcome of ANN model with traditional Autoregressive model. The lower error of prediction model, the better model is.

1.4 Benefits

Stock price forecasting models using artificial neural network can help investors to predict the future trend of stock. The study can support investors by providing the correct signal whether to hold, buy or sell the stocks which can save the time for small investors for decision making, instead of doing research on the fundamental for each stock. Not only increase the return of portfolio, but also reduce the total risk of investment from market fluctuation.

Moreover, artificial neural network can be trained from many kinds of input data. It is adaptable and flexible with many situations and applicable for other than stock market such as deliberative market (Future/Option), oil price, gold price etc.

CHAPTER II
LITERATURE REVIEW

2.1 Introduction

There are many techniques or documents for the predicting future trends of stock price movement. Most of the researches are focused on fundamental and technical analysis such as using empirical study on correlations or auto-regressive model with many factors.

However, the real situation it's difficult to find the most suitable model to cover all unpredictable factors of stock market movement. This study will provide the artificial neural network concept to apply for this problem.

Neural network is a powerful modeling tool that is able to capture and represent complex relationships among relevant variables. It can compare existing stock-trading patterns with previous situations, analyze all kind of indicators and eventually "learn" what works and what does not as the program digests more data.

The true power and advantage of neural networks lies in their ability to digest a huge amount of data, find both linear and non-linear relationships from trading patterns, and make deep analytics that can never be accomplished by human analysts at the same time.

Most of the technical analysis that tested the hypothesis relied on linear time series modeling (Black & Scholes, 1973). These linear models focus on historical data. The nature and complexities embedded into the stock market makes it really difficult to forecast a particular market by using a linear relationship. These linear relationships are not capable of identifying dynamic or non linear relationship in the historical data. (Faizul F Noor)

A neural network is a data processing system that simulates the behaviors of biological neural network. With the capability of high-speed calculation, memory, learning and error tolerance, the computer system is a good solution for complicated classification or prediction (Yen, 1999).

The initial design and basic structure of a neural network are both similar to the structure of a neuron of human brain. The system enables the assignment of different weights to the input value, based on their importance. The weighted value are then summed up and converted through a transfer function incorporated in the neuron, thereby arriving at an output value. However, neural network required a big amount of data or an observation of the system training process. The mechanism is as follows:

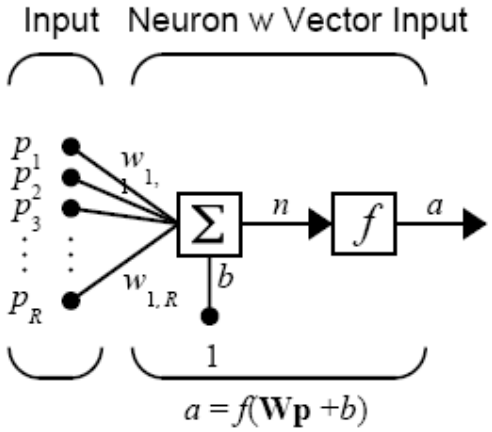

Figure 2.1: Processing Unit of the Neural Network

Source: MATLAB neural network toolbox

2.2. Related Researches on Artificial Neural Network

Neural networks have been extensively applied to the calculation and prediction of stock prices in recent years due to an potential of computer technology. For example, Tsai et al. (1999), tried to predicted the best timing for investment.

Many literatures are available on application of ANN in modeling the stock market returns. Researchers have tested the accuracy of ANN in predicting the stock market index return of most developed economies across the globe.

Kimoto et al. (1990) also constructed their forecasting model based on the Nikki Stock Price Index. The model turned out to be effective in predicting the Japanese stock price, and contributed to an excessive investment return.

Fernando et al. (2000) used the BPN to construct his forecasting model for Madrid Stock Exchange General Indices. The result of his empirical study also

showed that the model is an effective forecasting model for the Madrid Stock Exchange General Indices and helped to achieve better investment return.

Tsong-Wuu Lin, adopt the neural network approach to analyze the Taiwan Weighted Index and the S&P 500 in the States. Consequently, find that the trading rule based on artificial neural network generates higher returns than the buy-hold strategy.

Hindi A Al-Hindi, Neural Network Approach to Forecasting Stock Price of Saudi Companies, Neural network results demonstrate the effectiveness on weekly forecasting stock prices of Saudi companies which result in better investment decision. Each network has two neurons in the input layer, five neurons in the hidden layer and on neuron in the output layer.

Birgul Egeli, used artificial neural networks to predict Istanbul Stock Exchange (ISE) market index value by inputting the previous day's index value, previous day's TL/USD exchange rate, previous day's overnight interest rate and 5 dummy variables each representing the working days of the week. Artificial neural networks have better performances than moving averages.

CHAPTER III
RESEARCH AND METHODOLOGY

3.1 Data Source

The analysis collected the data from daily index of Stock Exchange of Thailand (SET) over the period of May, 2002 to September, 2010. The values were taken from www.settrade.com indicated information of Open Index, Closing Index, Day-high Index and Day-low Index.

3.2 Developing model using: Neural Network Model

The research used a back-propagation network model for the neural network which has 3 Layers: Input layer, Output layer and Hidden layers.

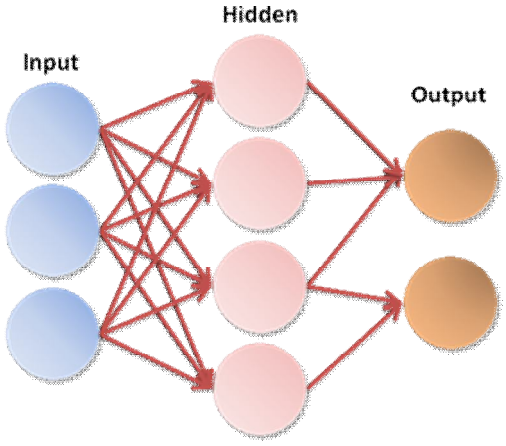

Figure 3.1: Simple neural network structure

High level steps on building ANN model starts from preparing input data such as stock market index. Then, we will proceed further on the pre-processing process to make data readiness such as calculating daily return rate, data normalization to make the data align within the same range. Finally, it is the post-processing such as finding error of the network, compare network performance etc.

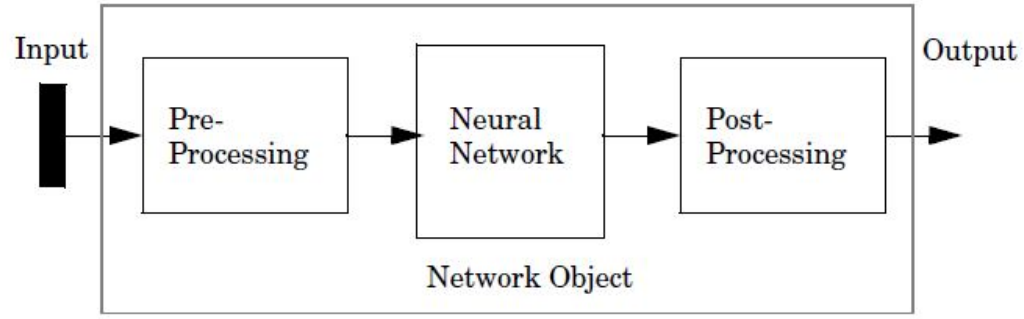

Figure 3.2: Neural network processes

Source: MATLAB neural network toolbox

3.2.1 Input Layer

In this research, we input investment return into the neural network for the preceding nine days (R_{t-1}, R_{t-2}, R_{t-3},…, R_{t-9}) (Fernando et al., 2000).

The calculation formula is as follows:

$$R_t = \frac{P_t}{P_{t-1}} \qquad (3.1)$$

Where

R_t = Return of investment on Day t

P_t , P_{t-1} = Price of Day t and Day t-1

Before further execution, we require pre-processing before input the data into the network to avoid the impact different range of each input. The input value be normalized to the specified range of "0-1" (Yen, 1999). The formula for normalization is as follows:

$$Y = \frac{X - Xmin}{Xmax - Xmin} \qquad (3.2)$$

Where:

X = Raw data before normalization

X_{min} = Minimum value of raw data prior to normalization

X_{max} = Maximum value of raw data prior to normalization

3.2.1 Output Layer

Adopting the FK indicator for decision making (Zhang, 1993), value of FK value is in range between 0 and 1. When stock price is rising, value of FK will move toward 1, on the other hand, it will move toward 0 when stock price is reducing. FK is the General Index for investor to indicate current stock position and timing for trading.

In this research, the thresholds for buy and sell are at 0.2 and 0.8. If FK value is lower than 0.2, it is the signal to "Buy". If FK value is higher than 0.8, it is the signal to "Sell". Finally, if FK value is between 0.2 and 0.8, it is the signal to "Hold"

Table 3.1: FK value output and its signal

FK Value	Signal
0-0.2	Buy
0.2-0.8	Hold
0.8-1	Sell

FK value is the modified K indicator with below formula:

$$FK_N^{J,K} = \frac{C_N - MIN_{i=N-J}^{N+K}(L_i)}{MAX_{i=N-J}^{N+K}(H_i) - MIN_{i=N-J}^{N+K}(L_i)} \qquad (3.3)$$

Where:

$FK_N^{J,K}$ = *FK value on the* N_{th} *trading day*

C_N = *Closing index on* N_{th} *trading day*

L_i = *The day low on the* i_{th} *trading day*

H_i = *The day high on the* i_{th} *trading day*

$MAX^{N+K}_{i=N-J}(H_i)$ = *Max value of the day high's during period from* $N\text{-}J_{th}$ *to* $N+K_{th}$

$MIN^{N+K}_{i=N-J}(L_i)$ = *Min. value of the day low's during period from* $N\text{-}J_{th}$ *to* $N+K_{th}$

3.2.1 Hidden Layer

3.2.1.1 Find appropriated number of Hidden Layer

Require trial and error on how many hidden layer, by starting from no hidden layer at all which output will be similar to the linear regression analysis. After that, try at one or two more hidden layer which normally got the best converging effect. Based on experience gained in research process, we chose one hidden layer process which is sufficient in normal situation (Li, 2003).

3.2.1.2 Find appropriated number of Neuron

There is no precise theory or formula to determine the most suitable number of neurons for each hidden layer in the network. It is normally determined through the trial and error method. Increasing on the number of neurons will reduce an error and the converging speed would be slow down. On the other hand, when the number of neurons processed exceeded a specific level, it is likely that the network is over-trained.

There is 3 recommended methods to select number of Neuron.

1) First method: *(*Refenes et al., 1994)

Number of Neurons for the Hidden-Layer = sqrt(input * output)

Sqrt(9*1) = 3

2) Second method: *(*Refenes et al., 1994)

Number of Neurons for the Hidden Layer = (input + output)/2

(9+1)/2 = 5

3) Third methond: Equal to *4 (Refer to Fernando et al., 2000)*

3.2.1.2 Transfer function

Selecting the best transfer function is once again done by a process of trial and error. In this research, we chose the “Hyperbolic Tangent Function” and “Log-Sigmoid Function” as the transfer functions for the neural network.

1) Hyperbolic-Tangent Sigmoid Transfer Function: Output value is between -1 and 1.

$$f(n) = \frac{e^{n} - e^{-n}}{e^{n} + e^{-n}} \quad (3.4)$$

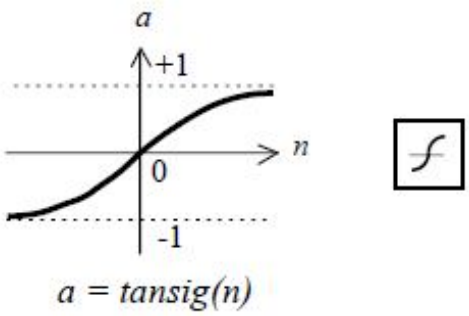

Figure 3.3: Hyperbolic-Tangent Sigmoid Transfer function

Source: MATLAB neural network toolbox

2) Log-Sigmoid Transfer Function: Output value is between 0 and 1.

$$f(n) = \frac{1}{1 + \exp^{-n}} \quad (3.5)$$

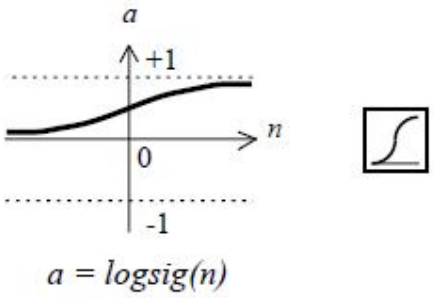

Figure 3.4: Log-Sigmoid Transfer function

Source: MATLAB neural network toolbox

Function as the transfer functions for the neural network. Through different experimental set-up in the hidden layer number, number of neurons and transfer function, we endeavor to construct 3 models for solving complicated problems as in table 3.2.

Table 3.2: Structure of the neural network used for the experiment

ANN Structure
9-[3]-1
9-[4]-1
9-[5]-1
9-[10-5]-1
9-[6-3]-1

From figure 3.5 below, it shows the high level picture of the ANN model that have more than 1 hidden layers called "Multiple-layer neural network"

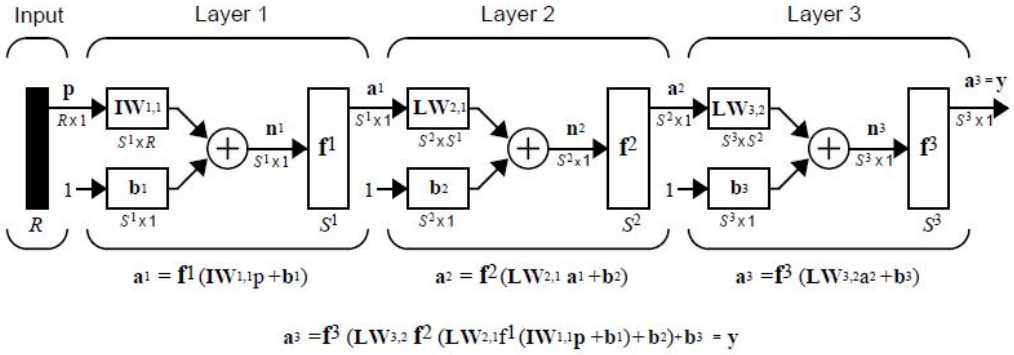

Figure 3.5: Multiple-layer neural network

Source: MATLAB neural network toolbox

3.4 Neural Network Training

The process of training the neural network involves iteratively presenting it the input data. "Levernberg-Marquardt" algorithm in MATLAB is selected to be used in the research. It is a default algorithm which is the fastest back-propagation algorithm in the toolbox.

3.5 Performance and Benchmarking

The objective of the training is to minimize a defined error function, which implies that the neural network fit the input data, given the expected results as outputs. In this research, we used MSE (Mean Squared Error) to be the reference of an error function

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(F_i - A_i)^2 \tag{3.3}$$

Where MSE = Mean Square Error

n = Number of validated observations

F = Forecasted value

A = Actual Value

i = Observation i^{th} date

CHAPTER IV
EMPIRICAL RESULTS

4.1 Introduction

This chapter shows the empirical results from the study using the methodology specified in previous chapter. All of them are developed using a MATLAB application, which are artificial neural network and autoregressive models built up to predict the FK value. The results are expected to artificial neural networks will have better performance than the normal process or autoregressive models. The ANN should predict the FK value with lower autoregressive model. Meanwhile, ANN can predict the FK value with more accuracy than autoregressive model

For this research, we used SET index data from the period of May 1992 to September 2010 as a reference to train and test the result of ANN model compared with AR model. The capture data include the data during the period of bullish (2nd Quarter, 2003 to 1st Quarter 2004 and 2nd Quarter 2009 to 3rd Quarter 2010), bearish (2nd Quarter, 2008 to 1st Quarter, 2009) and stable (2nd Quarter 2004 to 1st Quarter 2007)

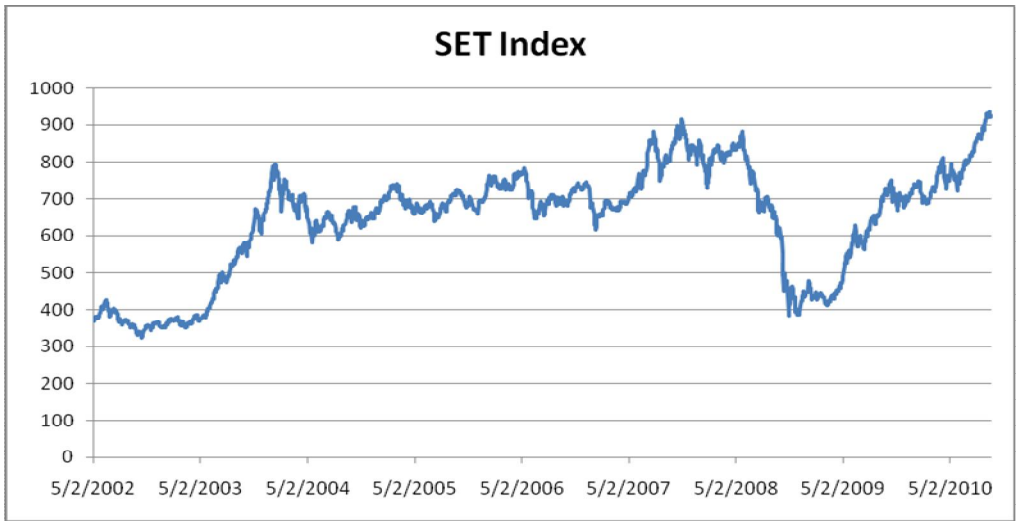

Figure 4.1: SET Index from May 2002 to September 2010

Source: www.settrade.com

During the bull market or bear market, it is easy for investors to make profit from the investment because they can know the future trend of the index easily. However, during the side-way period that the SET index keeps stable, it is more difficult to make profit for investors. Thus, FK value become more important for investor to make more profit than the buy & hold stategy. FK value can be used as a guildeline for investors because it show the signal for that period whether to buy, sell or hold the stocks. As mentioned in chapter3, if the FK value is higher than 0.8, it is time to 'Sell' the stocks. If the FK value is lower than 0.2, it is time to 'Buy' the stock. If the FK value is between 0.2 and 0.8, it is time use the 'Hold' stategy.

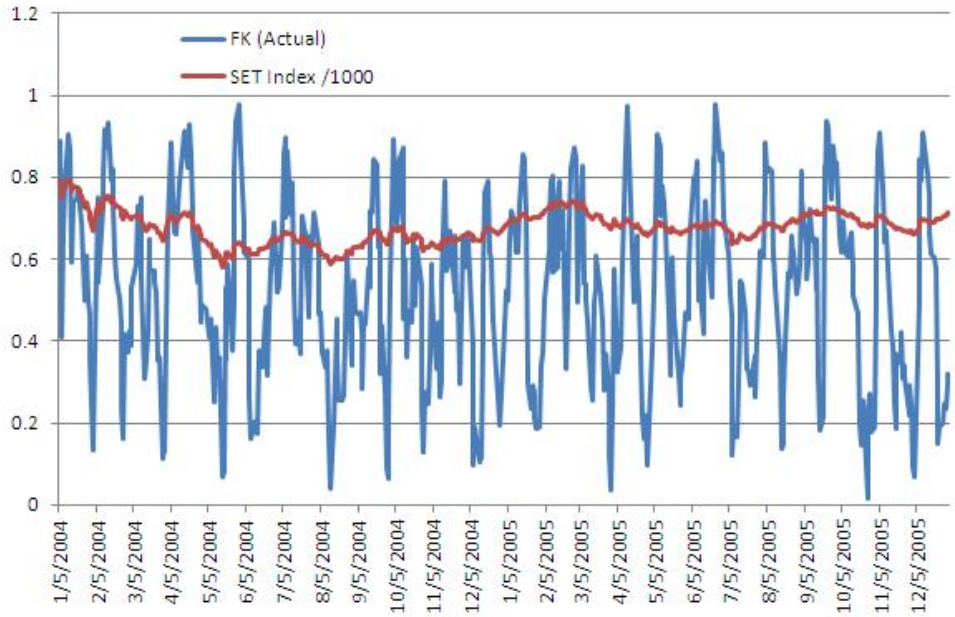

Figure 4.2: Comparing SET Index and FK value (2004-2005)

From the Figure 4.2 above, it shows that the FK value is very useful tool for the investment strategy. However, the formula of FK value requires the future value of the closing, day-high and day-low index as the inputs which mean FK value is very useful for the historical data, but it is not practical to be used for SET index predictor. Thus, we need to find the model to predict the FK value to be closer to the actual FK.

4.2 Results of Implementation

4.2.1 Artificial Neural Network Model

From the methodology in chapter 3, we used the Matlab program to stimulate the ANN model separated into 5 network structure running for 100 times for each type of network. From Table 4.1, it shows an output for MSE compare for each type of ANN model. MSE minimum is the minimum value of 100 simulations. Meanwhile, MSE average is the average value of 100 simulations.

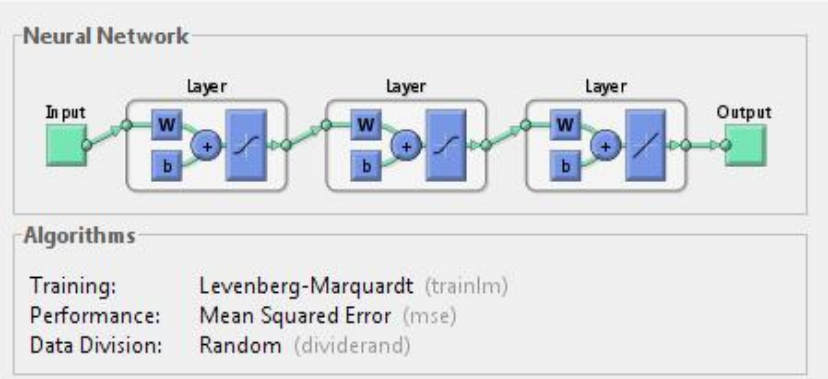

Figure 4.3: Artificial Neural Network Model

Source: Captured from MATLAB

We found that the ANN structure 9-10-5-1 has the lowest MSE Minimum and ANN 9-6-3-1 has lowest MSE Average. From the result it seems that the ANN structure which have 2 hidden layers ANN model (9-10-5-1 and 9-6-3-1) may have a better performance than 1 hidden layer ANN model type (9-3-1, 9-4-1 and 9-5-1).

Comparing between 1 hidden layer ANN model, it seems that a higher of neuron in hidden layer will have a better performance because ANN model type 9-5-1 have the lowest MSE average value, while 9-3-1 have the highest MSE average.

Table 4.1: Outcome from of Artificial Neural Network

ANN Structure	No. of Simulation	MSE Minimum	MSE Average
9-[3]-1	100	0.0345	0.0348
9-[4]-1	100	0.0338	0.0346
9-[5]-1	100	0.0339	0.0345
9-[10-5]-1	100	0.0336	0.0346
9-[6-3]-1	100	0.0337	0.0344

From figure 4.3 below, it shows the trend of the FK value that is the output of ANN model (9-10-5-1) comparing with the Actual FK from the manual mathematics calculation. We found that the trend of the FK value is very close to the actual FK value.

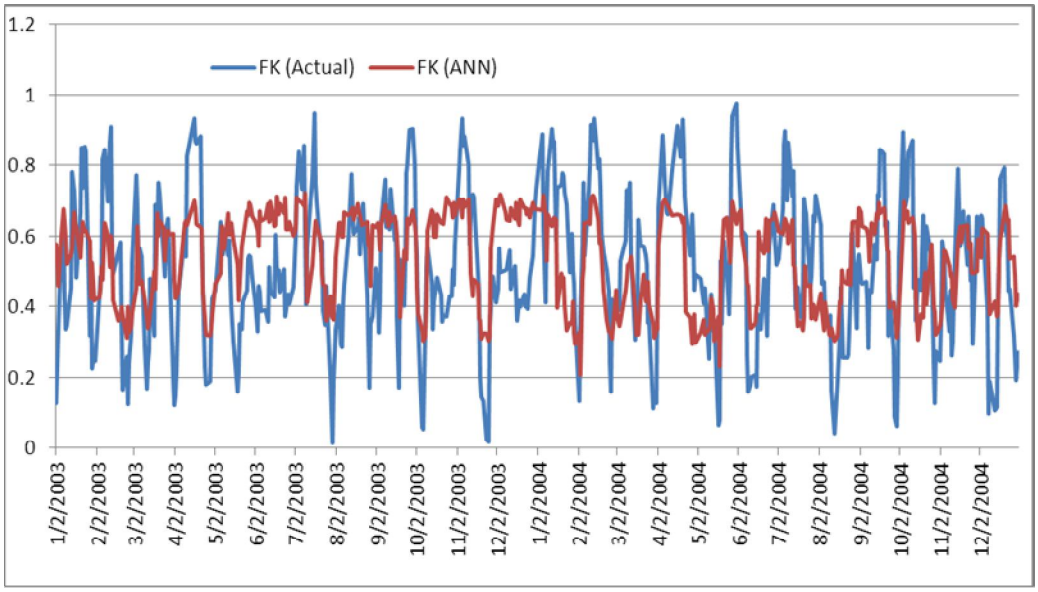

Figure 4.4: Comparing actual FK value and predicted FK from ANN model

4.2.2 Autoregressive Model

To current predict the FK value, we simulate the Autoregressive model in order to compare the performance with the ANN model that we created pervious section. The model is shown in equation 4.1 below. This Autoregressive is built up similarly like ANN model use using 9 daily return rate with lagged period as the input data.

$$FK_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 R_{t-2} + \beta_3 R_{t-3} + \ldots + \beta_9 R_{t-9} + \varepsilon \qquad (4.1)$$

From the running simulation using the Matlab program, we get the the beta coefficient, T-Stat, F-Stat and the MSE of Autoregressive function as in Table 4.2 below.

Table 4.2: Parameters and Coefficients from Autoregressive Model

AR Model	Beta Value	T-Stat	F-Stat	MSE
β_0	-1.5991	-18.0496	85.06474	0.0367
β_1	0.774768	13.87461		
β_2	0.692342	12.37523		
β_3	0.563281	10.05406		
β_4	0.500603	8.941638		
β_5	0.443965	7.93004		
β_6	0.286873	5.124141		
β_7	0.253548	4.526933		
β_8	0.123633	2.209592		
β_9	0.036228	0.649017		

In figure 4.5 below, it shows the relationship and the trend of the actual FK and the predicted FK from ANN model (9-10-5-1) and Autoregressive model. Both models can predicted the trend of FK value, but the ANN model can predict it better than Autoregressive model.

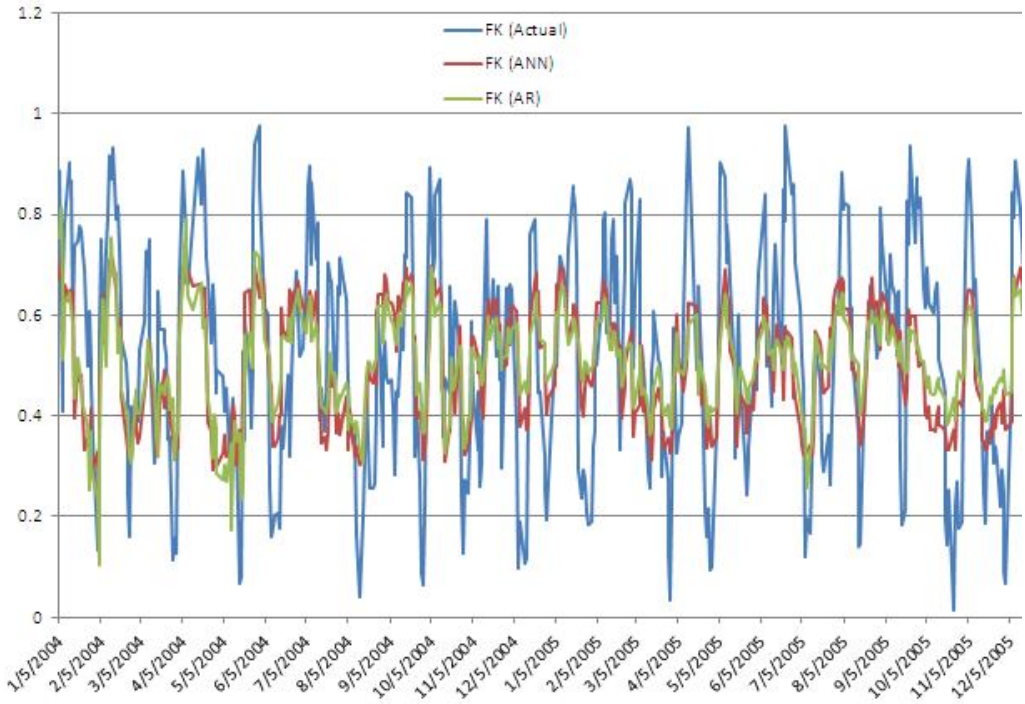

Figure 4.5: Compare actual FK value with ANN and AR model

4.3 Interpretation of Results

After constructing each model using parameter sets defining in section 4.2, the differences between forecasting value and actual value as a mean squared error (MSE) are captured as a performance indicator.

Table 4.3: Performance comparison between ANN and Autoregressive Model

ANN Structure	Comparison MSE ANN Minimum and Autoregressive	Comparison MSE ANN Average and Autoregressive
9-[3]-1	-5.99%	-5.18%
9-[4]-1	-7.90%	-5.72%
9-[5]-1	-7.63%	-5.99%
9-[10-5]-1	-8.45%	-5.72%
9-[6-3]-1	-8.17%	-6.27%

From the empirical study, we found that the ANN model has a better performance than normal Autoregressive model with percentage in table 4.3 above. On average, ANN structure 9-6-3-1 shows the best performance with lowest MSE average which is lower than Autoregressive model for 6.27%. On the best performance of ANN after simulate for 100 times, ANN structure 9-10-5-1 get the best performance with the lowest MSE minimum which 8.17% lower than Autoregressive model. Both ANN structure 9-6-3-1 and 9-10-5-1 are the ANN 2-hidden layers type, we can see the trend that the ANN 2-hidden layers type has a better performance than ANN 1-hidden layer type like ANN structure 9-3-1, 9-4-1and 9-5-1.

Although ANN models with 1-hidden layer have a lower performance than ANN with 2-hidden layers, they still have a better performance than the normal Autoregressive model. ANN with 9-3-1, 9-4-1 and 9-5-1 structure have a lower MSE than the Autoregressive model for 5.18%, 5.72% and 5.99% respectively on average. We can see the trend that the higher number for neuron in the hidden layer, the better performance of the ANN model.

CHAPTER V
CONCLUSION

5.1 Research Conclusion

Nowadays, computer based stock forecasting system play more important role for predicting stock trends. ANN model is one of the most common and accurate model as an alternative tool beside the normal fundamental and technical analysis

From the empirical result in chapter IV tested on ANN model with 5 type of structure and compared with Autoregressive model using SET closing index with 9 days lagged as a input data to predict the FK value. We found that the ANN model can predict the FK value better than the traditional Autoregressive model.

Comparing among the ANN model in deference types, we found that the 2-hidden layer structure type will have a better performance than 1-hidden layer structure type. Comparing among ANN single hidden layer structure, we found that the more neuron on hidden layer, the more accuracy on the prediction.

5.2 Limitation of Analysis

There are 3 main factors as a limitation of this research which bring the higher error or reduce the accuracy of the prediction of the selected model.

5.2.1 High Fluctuation of SET Index

The limitation of this study is the high fluctuation of SET index like other market emerging countries. Compared with other mature market like US which have more than 10,000 companies registered on S&P index, SET index have only about 500 companies which can be induced by some business sector like energy and bank sector. Moreover, SET index is a very small market in global or regional scale, so that it can be easily speculated any mutual fund or hedge fund from both internal and external country. The fund flow from mutual fund can induce the SET index very

easily. Lastly, about 60-70% of trading values in SET are from individual investors which is opposite of other mature market that majority of trading value are from mutual fund. Individual investors may have a lower power and knowledge than the mutual fund which is managed by well-trained or experienced fund manager.

5.2.2 Sampling Period

ANN model require the training data as much as possible so that it can be learned on all kind of situation of the market like bull, bear and stable market period. A longer validation period with more sampling data of index can help to reduce an error of the forecasting in ANN model

5.2.3 Other Factors

The SEC (Securities and Exchange Commission) who control the SET market is still not control well enough on the stock speculation or the insider trading. Moreover, some policy on the SET market is still not stable changing by government or political issue. For example, during December 2006, a new measure deploy for SET market reduced the SET index about 15% in one day.

5.4 Further Research

5.3.1 Add more independent input factors

In this research, the ANN and Autoregressive models predict the FK value by using only the 9 days lagged data of the closing SET index. Therefore, the further research can use other factor as a input data for the forecasting such as GDP, oil price, gold price, inflation rate, foreign exchange rate, government bond yield, US index and daily volume trading etc.

5.3.2 Integrate with other trading model & Predict Return Rate

Other recommendation for the further research is to bring the predicted FK value to be the guideline of the timing strategy to know when is the right time to buy, sell or hold the stock. Then, integrate the trading strategy of this research with other strategy like portfolio management to know the final return rate and compare

with other traditional investment strategy such as dollar cost average, buy & hold strategy.

5.3.3 Changing inputted data & performance indicator

We can to improve and validate the model of this research by trying to input the longer period of data and change the input data from SET index to other market index especially for the mature market (i.e. US DowJone Index, HK Hang-Seng Index, UK FTSE Index, Japan Nikkei Index etc.) Meanwhile, performance indicator beyond MSE can also be changed to another appropriated one for stock market.

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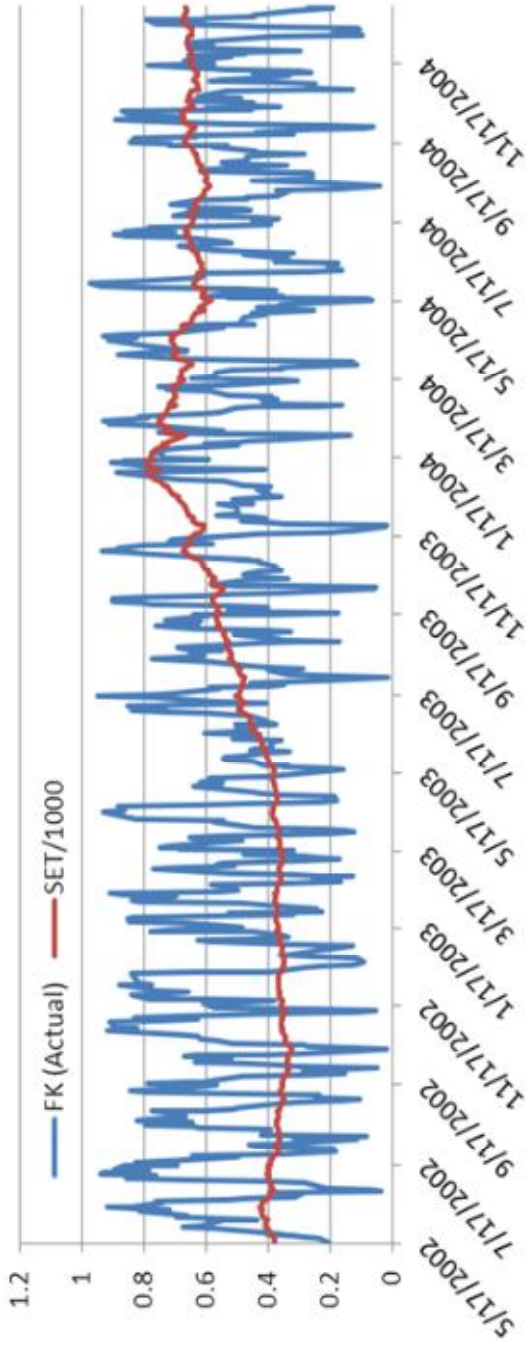
APPENDICES

APPENDIX A

SET Index (2002-2010)

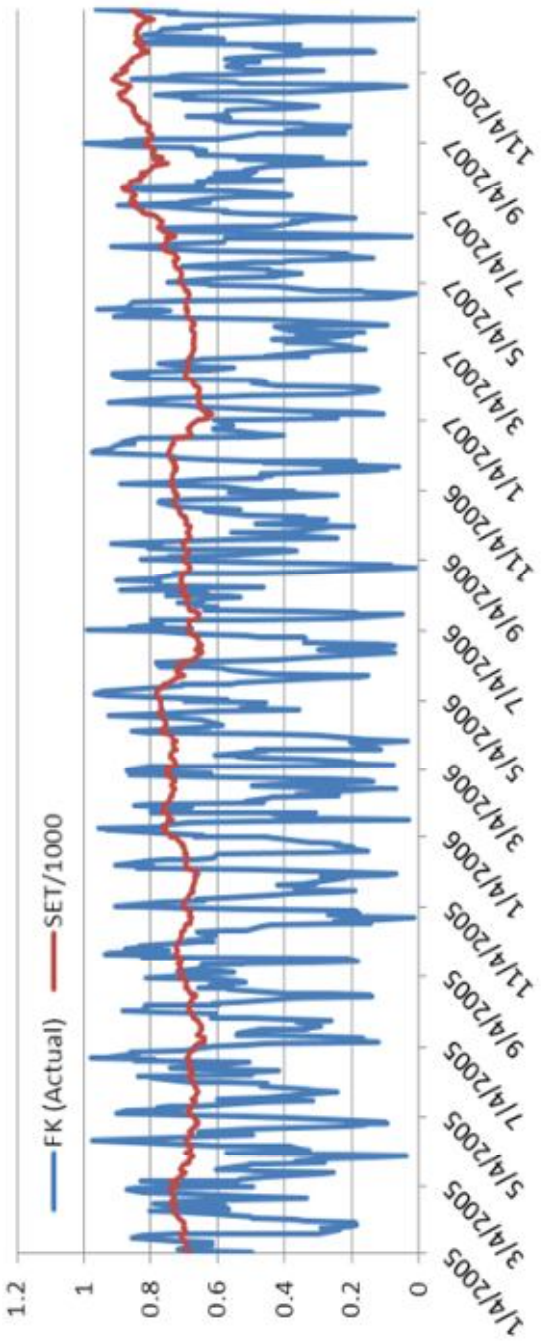
APPENDIX B

SET Index and FK Value Actual (2002-2004)



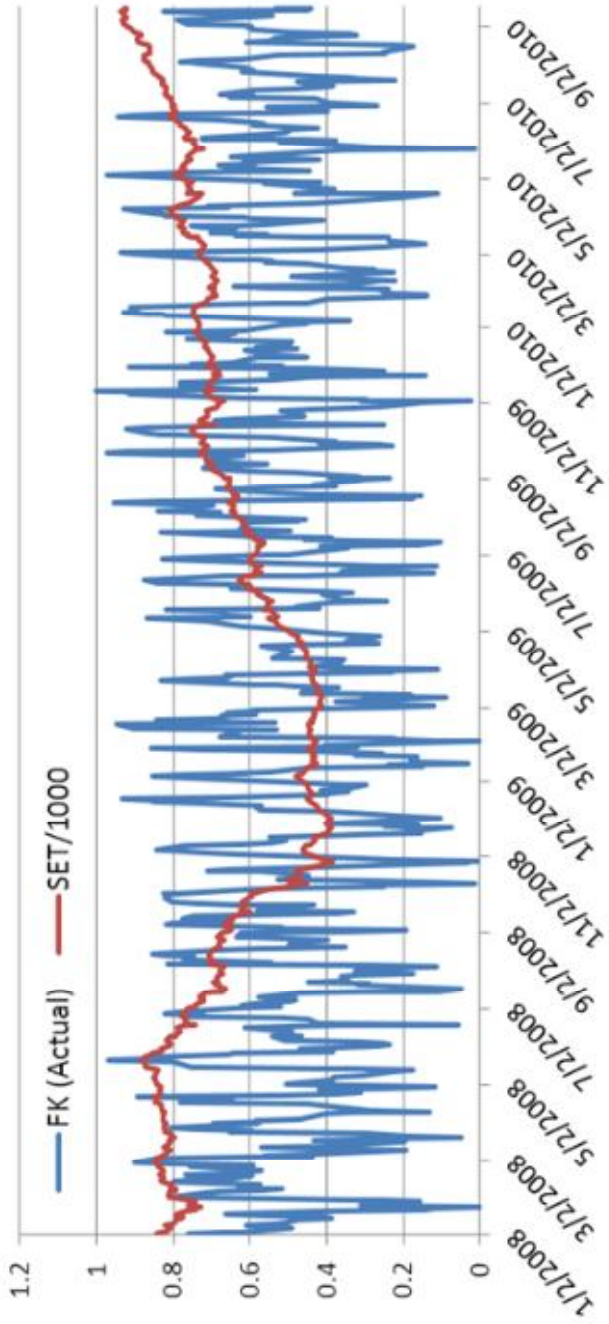
APPENDIX C

SET Index and FK Value Actual (2005-2007)



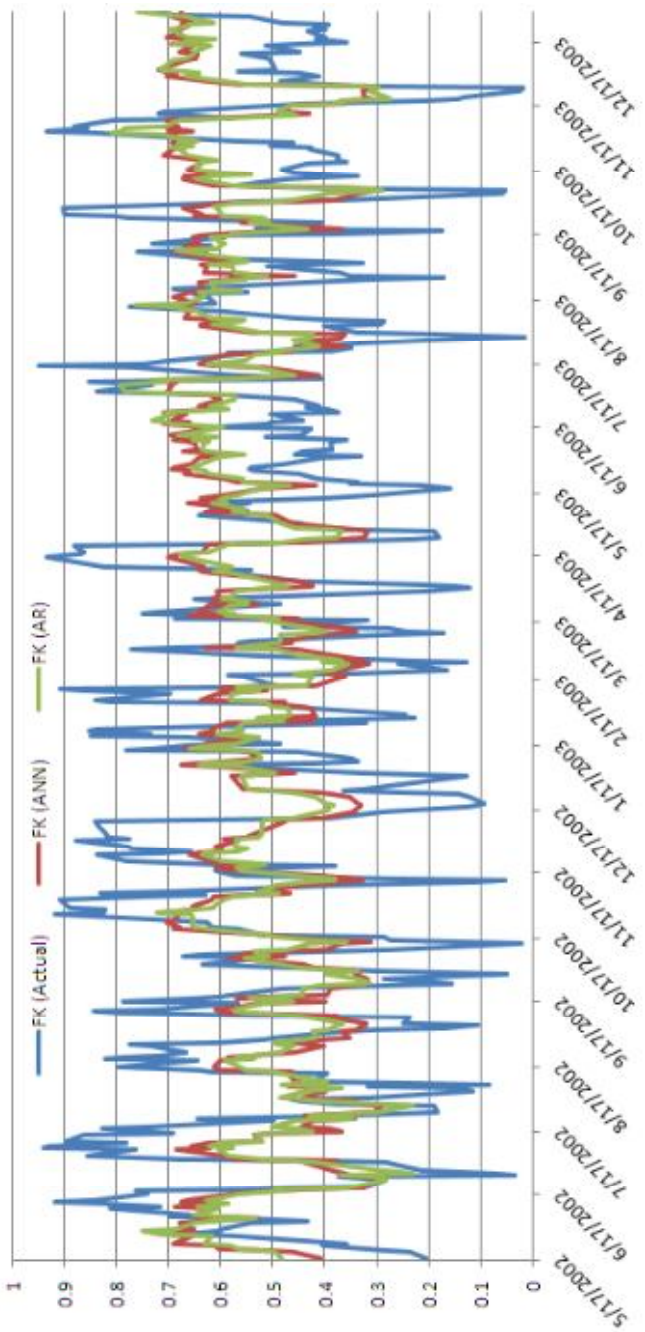
APPENDIX D

SET Index and FK Value Actual (2008-2010)



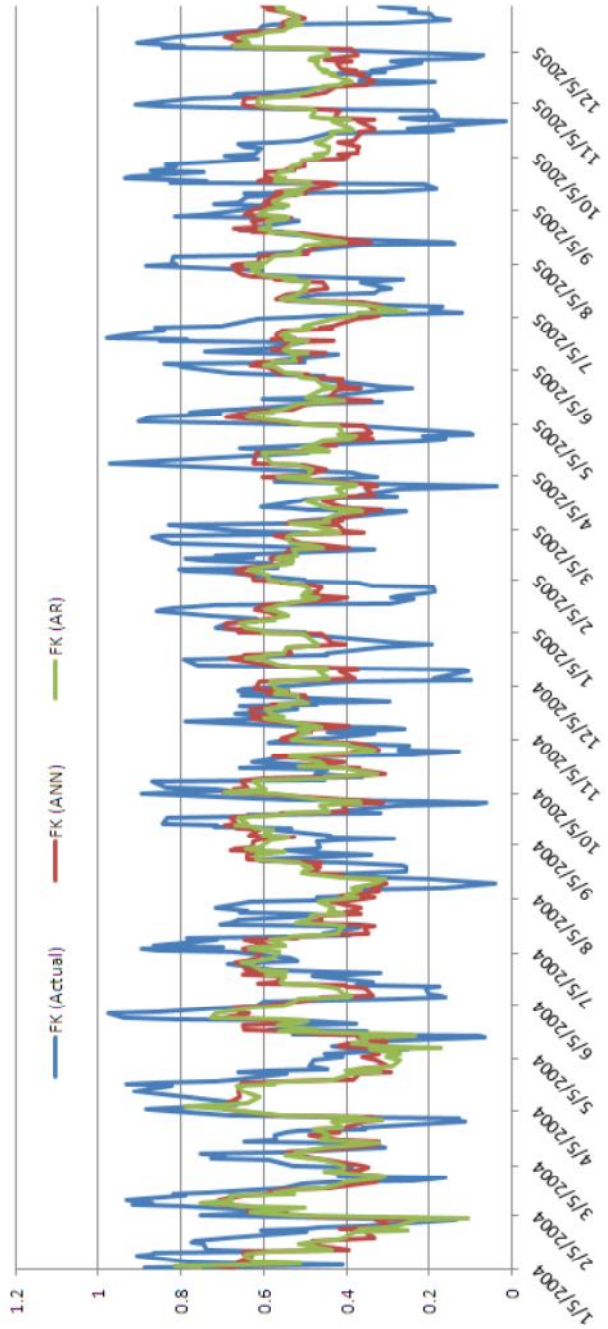
APPENDIX E

Actual FK with ANN and AR model (2002-2003)



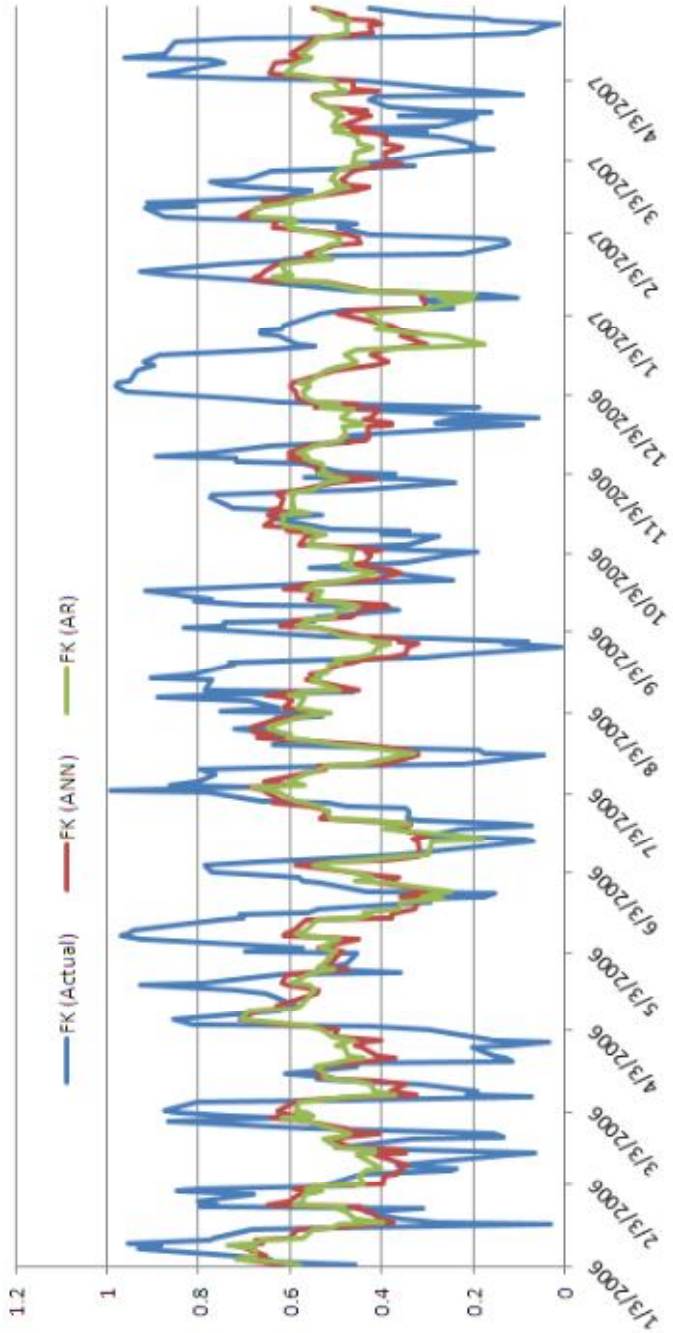
APPENDIX F

Actual FK with ANN and AR model (2004-2005)



APPENDIX G

Actual FK with ANN and AR model (2006-2007)



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