An Application of Decision Trees in the Developing of Decision Model for Investing in the Stock Exchange of Thailand

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Abstract

A lot of information for decision making in stock trading needs to be considered from both global and local aspects. To make trading decisions, there are several options for investors such as using their own guidelines or looking for models as a trading guideline. More importantly, trading at the suitable times are the key success factor for profit making. The objective of this study was to develop a decision model for trading stocks. A decision tree was developed by using tree-like model to make decision rules for trading stocks. Historical stock data of the Stock Exchange of Thailand (SET) in the past five years were used to construct a decision tree model. Price per earnings, price per book value, and dividend yield were applied in stock selection. Thereafter the selection process, technical indicators including Simple Moving Average (SMA), Moving Average Convergence Divergence (MACD), Momentum (MOM), Stochastic Oscillator (STO), Relative Strength Index (RSI), Money Flow Index (MFI), Buy-Sell Volume and NVDR Volume were applied to the stock data. The data were preprocessed to classify as buying, selling, and no-signal. The decision tree model indicated that the best performance for classification was “no-signal” followed by “selling” and “buying”, respectively. The root node of decision trees, decision rules, recommendations, and further studies were also discussed in this study.

Key Words: Decision Tree, Stock Trading, Stock Exchange of Thailand (SET)
1. Introduction

As a number of elderly people has gradually increased, Thailand will become an ageing society in the near future. To avoid financial instability in their retirement, Thai people are encouraged to save and invest their money for their retirement saving plans. The concept of financial planning has supported investments in many assets including stocks. As the value of interest rates is normally lower than inflation rates, private and public sectors are promoting concepts of financial planning for increasing higher returns. Thai banks introduce their financial products, while the Stock Exchange of Thailand (SET) provides e-learning and informative materials for new and experienced stock investors. There are many concepts for stock investments. Some investors investigate companies’ assets to estimate intrinsic value of stocks. They decide to buy the stocks when the market prices are lower than the intrinsic value, and sell when the market prices are higher than the intrinsic values. Some investors use the fundamental factors to be criteria for stock investment.

Hemvachiravarakorn and Intara (2009) used the concepts of value investing to examine stocks in the SET from 2004 to 2008. Their criteria in stock selection were: 1) price to book value ratio was less than 1; 2) price per earnings ratio (P/E) was less than 10; and 3) dividend yield was more than 3 percent. In their report, a number of selected stocks in each from 2004 to 2008 were 90, 88, 81, 57 and 62 respectively. Their return on investment were 5.72, 26.11, 73.56, 55.80, and -2.12 percent respectively. The five year average of return on investment of their portfolio was 31.81 percent while that of the SET was -2.12 percent. They claimed that the compounded return on their investment for 5 years was 31.81 percent. However, when economic factors changed, the criteria in stock selections need to be changed accordingly.

Sereewiwatthana (2011) used 15-year stock data from 1996 to 2010 to test the basic screening criteria. He tested the screening rules which the same criteria as the work of Hemvachiravarakorn and Intara (2009) and reported that 15-year geometric mean of returns was 36.69 percent. By ranking stocks from the first screening criteria in accordance with the lowest price to book value ratio, the first 30 stocks were selected to invest and 15-year geometric mean of returns was 43.8 percent. Moreover, when applying Joel Greenblatt’s modification method ranking scores of stocks in terms of the lowest P/E and the highest return on equity (ROE), he found 15-year geometric mean of returns was 66.18 percent. While the 15-year geometric mean of returns of the SET was 2.4 percent. This showed the investment on the SET could result better return rates than deposit interest rates when good criteria or strategies in quality stock selection were applied.

Besides the qualities of stocks in terms of fundamental factors, some investors believe that stock prices reflect everything which included fundamental factors, all related information, and potential profits in the future. Therefore, analyzing price movements, and
volume which called technical analysis is another key concept for buying or selling stocks. Technical indicators have shown in many books and research papers for stock trading. Limwiwatkul (2015) wrote a book, “System Trading”, that strengthened the use of trend lines referred to SMA and MACD for system trading development. Wong, Manzur and Chew (2003) used technical analysis in the timing of buying and selling Singapore’s stocks. They mentioned that the moving average and the Relative Strength Index were frequently used and member firms of Singapore Stock Exchange (SES) had their own trading teams using the technical analysis. These firms could generate substantial profits. In addition, the work of Vasiliou, Eriotis and Papathanasiou (2008) strengthened the work of Wong, Manzur and Chew (2003) by using technical analysis in the Greek Stock Market which resulted in trading profits. They reported the applying of the moving average as a main signal for buying and selling, and the overall of their technical strategies overcome the market. They claimed that it was 13% per year by using buy-and-hold strategy, while the return was 29.25% per year when trading with their moving averages strategy for buy-sell method. They confirmed that the results from their study strongly supported profitability from technical trading rules.

There are many research evidences that profitability is higher than the returns from the stock markets by using fundamental or technical strategies. These strategies increase the opportunities for new and experienced investors in making profits. Either using fundamental factors or technical indicators for trading strategies, the key success factors are to trade at a suitable time for buying and selling decisions. In this study, decision rules for trading stocks was developed by applying fundamental factors for selections and technical indicators are applied to the selected stocks.

2. Methodology

Historical daily data from 2010 to 2015 were retrieved from the Stock Exchange of Thailand (SET) via the efin Stock Pick Up program (2015 version), a version used in 2015. The criteria of fundamental factors for stock selection were Price per Earnings ratio (P/E), Price Book Value ratio (P/B) and dividend yield. These three factors were scored ranging from the best to the worst, after that summation was applied. The best stock from each industry was selected if the stock price movements had any chances for making profits in 10 percent within 20 day-periods. Past 5-year historical data of June were selected since annual financial statements of most listed companies in the SET were published. UPF and GYT were selected for the period of June 2010 to April 2011, KYE was selected from June 2011 to April 2012, TTL and GYT were selected for the period of June 2013 to April 2014, and SFP was selected for June 2014 to April 2015. The historical daily data of these selected stocks were applied to technical indicators including Simple Moving Average (SMA), Moving average convergence divergence (MACD), Stochastic Oscillator (STO), Relative Strength Index
(RSI), Momentum (MOM), Money Flow Index (MFI), and Volume. To cover the two aspects of technical trading, the movement of stock prices and the changes of volume were reflected from the selected technical indicators. The technical indicators related to the movements of prices of stocks such as SMA, MACD, STO, RSI, MOM. The buy volume, sell volume and NVDR volume were used as volume related indicators. Besides, the technical indicators that combined the movement of stock prices and the changes of volume, as well as, MFI, were also used in this study. The historical daily data were classified into three groups, buying, selling and no-signal (or no-action). The classification was made by the profits in 10 percent within 20 day-periods. From the historical daily data retrieved from 2010 to 2015, the total 999 instances were separated into three groups which were buying, selling and no-signal. The numbers of instances in the three groups were 159, 207, and 633 respectively.

To create tree-like decision model, decision tree approach was applied. Weka was used as a tool for this research as many research used. For example, Thamsombat (2011) used decision tree to develop a decision model with Weka for the selection of Internet packages in mobile phone. Al Jarullah (2011) used decision tree approach to extract hidden patterns from medical diagnosis diabetes and Weka was selected as a tool. A decision tree composed of a root node, internal nodes, leaf nodes and branches, paths or splits. To make decision, it started from root node to move along branches through some selected internal nodes until reached to a leaf node, which is the decision. To create a decision tree, based on probability and historical data, the Entropy and Information Gain (IG) were calculated to make the paths of decisions. The Entropy was used to measure the differences of data set. It showed the less different of the instances in the data set, if the Entropy was low (Pacharawongsakda, 2014). While the IG, basically calculated from reduction of the Entropy of a parent node from the computation that use probability and Entropy of partitions or splits. 10-fold cross-validation was used to measure the performance of the decision tree.

3. Findings

There were 10 attributes, except a target attribute, used for generating decision model from Weka. These attributes were the following.

1. close price > 20-day SMA (close>sma20)
2. close price of day t > close price of day t-1 (close pos/neg)
3. slope of 20-day SMA classified to positive, negative, or unchanged (m+/−)
4. the change of slope of 20-day SMA from negative to positive (m_change)
5. the slope of 20-day SMA increased (m_up/down)
6. Buy and Sell Volume of day t compare to Buy and Sell Volume of day t-1 ( vol+/−)
7. Buy Volume of day t compare to Buy Volume of day t-1 (BuyVol +/-)
8. Sell Volume of day t compare to Sell Volume of day t-1 (SellVol +/-)
9. NVDR Volume of day t compare to NVDR Volume of day t-1 (NVDR +/-)

10. Momentum changes (MOM +/-)

The tree-like decision model from decision tree approach was in figure 1. Correctly classified instances were 696 instances out of 999 instances, which were 66.67 percent.

**Figure 1a: Decision Tree**

![Decision Tree Diagram](image)

The decision tree composed of 32 nodes. The numbers of internal nodes and leaf nodes were 13 and 18 respectively. Consequently, the number of decision rules generating from the tree-like decision model was 18 rules according to the number of leaf nodes.

1. If close price is greater than 20-day SMA then the trading signal is “no_action”.

2. If the slope of 20-day SMA is stable then the trading signal is “no_action”.

3. If the slope of 20-day SMA is positive and the change of the slope is positive then the trading signal is “no_action”.

4. If the slope of 20-day SMA is positive and the change of the slope is negative then the trading signal is “no_action”.

5. If the slope of 20-day SMA is positive; the change of the slope is stable and close price is equal to the 20-day SMA then the trading signal is “no_action”.

6. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is less than the 20-day SMA; and close price is decreased then the trading signal is “no_action”.

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7. If the slope of 20-day SMA is positive; the change of the slope is stable and close price is less than the 20-day SMA; close price is increased; and the buy volume is decreased then the trading signal is “no_action”.

8. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is less than the 20-day SMA; close price is increased; and the buy volume is increased then the trading signal is “selling”.

9. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; and the NVDR volume is increased then the trading signal is “selling”.

10. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is increased; and the slope of 20-day SMA is increased then the trading signal is “selling”.

11. If the slope of 20-day SMA is positive; the change of the slope is stable and close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is increased; and the slope of 20-day SMA is decreased; and the sell volume is decreased then the trading signal is “selling”.

12. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is increased; and buy volume is increased then the trading signal is “no_action”.

13. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is increased; and the slope of 20-day SMA is decreased; and the sell volume is increased; and buy volume is decreased then the trading signal is “selling”.

14. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is decreased; the sell volume is increased; and close price is increased then the trading signal is “no_action”.

15. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is decreased; and the sell volume is increased; and close price is decreased then the trading signal is “selling”.

16. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is decreased; and the sell volume is decreased; and the slope of 20-day SMA is decreased then the trading signal is “selling”.

17. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is decreased; and
the sell volume is decreased; the slope of 20-day SMA is increased; and the MOM is increased then the trading signal is “buying”.

18. If the slope of 20-day SMA is positive; the change of the slope is stable; close price is greater than the 20-day SMA; the NVDR volume is decreased; the volume is decreased; and the sell volume is decreased; the slope of 20-day SMA is increased; and the MOM is decreased then the trading signal is “buying”.

As seen from the rules above, the rule number 9, 10, 11, 13, 15, 16, and 18 resulted a selling signal, and rule number 17 was only one rule for buying signal, while the rest guided to wait and see. In terms of trading the buying and the selling signals are the key for decisions that the investors are waiting for.

**Table 1: Confusion Matrix**

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>&lt;- classified as</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>550</td>
<td>74</td>
<td>9</td>
<td>a = no_action</td>
</tr>
<tr>
<td>b</td>
<td>57</td>
<td>140</td>
<td>10</td>
<td>b = Sell</td>
</tr>
<tr>
<td>c</td>
<td>123</td>
<td>30</td>
<td>6</td>
<td>c = Buy</td>
</tr>
</tbody>
</table>

From confusion matrix table 1, the most accurate of the classification from the decision tree model was “no signal or no_action” followed by “selling” and “buying” respectively.

As seen from figure 1, the most important key for decision was slope of 20-day SMA. This implied that if the slope of 20-day SMA of a stock was not be positive, “wait and see” was the best decision. From the decision tree, the decision of the close price compared to the 20-day SMA was the root node of sub-tree, also the key of decision. This study showed the decision tree that had the most effective in making decision. Therefore, some technical indicators were not included in this decision tree such as RSI, MACD and STO. This could presume that using many technical indicators and waiting them to signal the timing for stock trading may not be made decision better.

4. Conclusion, Discussions, and Recommendations

This study aimed to develop decision support model for trading stocks. The tree-like decision model was created by using the historical daily stock data. The stocks from the SET were selected according fundamental factors included Price per Earnings ratio (P/E), Price Book Value ratio (P/B) and dividend yield. Then the historical data of selected stocks were applied technical indicators. The technical indicators were applied to the historical data of selected stocks included Simple Moving Average (SMA), Moving Average Convergence Divergence (MACD), Momentum (MOM), Stochastic Oscillator (STO), Relative Strength Index (RSI), Money Flow Index (MFI), Buy-Sell Volume and NVDR Volume. The decision model created from decision tree using Weka as a tool. The suitable factors from decision tree for considering in stock trading were SMA, Buy and Sell Volume, Buy Volume, Sell Volume...
NVDR Volume and Momentum. Besides close price, the SMA was one of the key factors for timing the movement of the stock price for trading. This finding supported the work of Wong, Manzur and Chew (2003) in terms of the technical indicators that frequently used. In addition, this work strengthened the work of Vasiliou, Eriotis and Papathanasiou (2008) in applying of the moving average as a main signal for buying and selling.

In considering the historical daily data for this study, the selected stocks limited the ranges of the price movement to at least ten percent profit within 20 days. Therefore, if the stock prices were slightly and slowly increased, the stocks were not selected. The number of instances for buying was small. In addition, related fees for trading were not taken into consideration in this study.

References