EFFECTS OF ASSESS CONDITION ON PROFITABILITY OF TECHNICAL TRADING RULES IN THE STOCK EXCHANGE OF THAILAND

BY

MS. NIMESHA PRIYANGI SENANAYAKE IHALA GAMAGE

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (ENGINEERING AND TECHNOLOGY)
SIRINDHORN INTERNATIONAL INSTITUTE OF TECHNOLOGY
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ENTITLED

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Chairman

Member and Advisor

Member and Co-advisor

Director

(Associate Professor Tanachote Boonvorachote, D.BA.)

(Rujira Chayasiri, Ph.D.)

(Professor Somnuk Tangtermsirikul, D.Eng.)
ABSTRACT

Many researchers have applied technical trading methods to observe the likelihood of profitability from trading stocks in different stock markets around the world. However, when do technical trading indicators outperform the buy and hold strategy is still in doubt. Different factors such as different stock markets and different technical trading indicators play a crucial role in different results for profitability. This paper investigates the profitability of moving average, commodity channel index (CCI) and Bollinger bands indicators performing on 19 stocks, which had been listed consistently from 2007 to 2017 in the Thailand SET50 Index with different asset conditions. Sixteen asset conditions are constructed from volume and volatility of stocks and trading period. According to our study, Bollinger bands bottom reversal and CCI trend reversal trading strategies outperform buy and hold strategy for all asset conditions. However, moving average trading rules perform better than buy and hold strategy for the asset condition with high volatility stock, low volatility of trading period, low volume of stock and low
volume trading period as well as the asset condition with high volatility stock, high volatility of trading period, low volume of stock and low volume trading period.

**Keywords:** Technical analysis, Thai SET50 Index, asset conditions, buy and hold strategy
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1.1 Technical Trading Strategies

Various research studies have proved the difficulty of stock market returns in different degrees. (Yoon & Swales, 1991) (Boyacioglu & Avci, 2010)(Kara, Acar Boyacioglu, & Baykan, 2011) (Farias Nazário, e Silva, Sobreiro, & Kimura, 2017). Nonlinearity and nonstationary of stock market have been subjected it to be a complicated system (Farias Nazário et al., 2017). Many factors such as political events, economic conditions, traders’ expectations, international influence and other environment that may influence stock prices(Ticknor, 2013). Some techniques are existing in present to predict future stock price returns including fundamental and technical analysis (Vanstone & Finnie, 2009).

There are many investigation can be found which can support the EMH, different technical trading rules could not earn profits. (Fang, Jacobsen, & Qin, 2014) got results which support to the EMH using Moving average trading rules.

However, it can be found many successful stories which helps to technical trading predictability. Mainly, Brock et al. 1992 strongly supported for the technical trading strategies using two methods of moving average technical trading rules. Providing strong support for the technical strategies. Moreover,(Parisi & Vasquez, 2000) confirmed Brock et al. 1992 s results using Chilean stock market data from 1987 to 1998. In this investigation same trading rules were used which proved by Brock. Also (Bessembinder & Chan, 1995) (Hudson, Dempsey, & Keasey, 1996), (Gunasekarage & Power, 2001) supported to the evidence.

Not only financial stock markets but also other financial securities such as currency and future markets were supported by technical trading strategies. (Lebaron, 1998), (Dymova, Sevastjanov, & Kaczmarek, 2016) were supported by technical trading strategies for foreign exchange intervention and forex trading.
1.2 Formulating Research Question

(Brock & Lakonishok, 2018) (1992) and (“Hudson et al 1995.pdf,” n.d.) Studies, which published in last decade, give the evidence to rules of technical trade with ability of prediction in terms of USA and UK Indies.

In the Asian markets, (Bessembinder & Chan, 1995) have found that use of technical trading rules creates a positive prediction rate in stock price movement in emerging markets not only including Malaysia and Taiwan but also Thailand. In addition, it has forecast ability in highly developed Hong Kong and Japan markets. Considering South East Asian markets (Indonesia, Malaysia, Singapore, Thailand, and Philippines), (Yu, Narte, Gan, & Yao, 2013) (Tharavanij, Siraprapasiri, & Rajchamaha, 2015) found that technical trading rules outperforms existing rules in prediction of emerging stock markets in South East Asian region.

(Hayes et al., 2014) presents a study of the profitability of technical trading rules as a function of asset state or condition. It uses several common technical trading strategies on 296 stocks over a 15-year period for S&P 500 index. Strategies were run with 1 month rolling time horizons. Stocks were segmented based on volatility and volume. This investigation got successful results for technical trading rules for one of developed market index called S&P500. It shows that, for the ten-year period, trading strategies based on these rules, some asset conditions would have produced a greater return than a simple buy-and-hold strategy, and these results are statistically significant.

This paper examines the predictive ability of the technical trading indicators in the Stock Exchange of Thailand by analyzing daily data on the SET50 index for the period 2007-2017. Most of papers used moving average indicator to predict the stock prices. Because of that, we also used moving average indicator in this paper. In here we followed (Hayes et al., 2014) technique for the one of emerging market in Asia called Stock Exchange of Thailand and applied that technique for SET50 index. In that case, they used volume and volatility parameters to suggest asset conditions. They have found that in some asset conditions, technical trading rules can be profitable than buy and hold strategy such that Bollinger band and CCI strategies performance are well under all asset conditions. This is an investigation of (Hayes et al., 2014) ‘s proposed a technique regarding the asset conditions for S&P 500. Most popular moving average
technical trading rule and (Hayes et al., 2014)’s successful trading indicators (Bollinger band and CCI) are used to check the emerging market Thai SET50 index.

This investigation was chosen to examine the impact of the different indicator on the profitability of the rules and to compare the results of this emerging market Thai SET50 index study with the US S&P500 index findings which give the predictive ability (Hayes et al., 2014) using similar strategies.

1.3 Efficient Market Hypothesis

Discussing Efficient Market Hypothesis (EMH) is very important task before evaluating the profitability of technical analysis. The Efficient Market Hypothesis (EMH) has an important role in the financial industry, with its use worldwide in the related study on the stock prices behaviors. A famous Nobel prized American economist Eugene Fama developed a theory called the Efficient Market Hypothesis in the 1960s in which he assumes efficient markets interpreting Fama’s (1970) theory on efficient as a market with prices which “fully reflect” possible information available.

According to another well-known scientist called Jensen (1978)’s interpretation of efficient market is given as an impossibility to make economic profit in terms of information set. EMH is divided into three forms the weak version, the semi-strong version, and strong version of efficiency according to the Jenen’s definition.

The weak form of efficiency states that today stock prices are the reflection of all past prices of stock. This only allows fundamental analysis to identify undervalued stocks and overvalued stocks. For that reason, investors can make profitable companies only by researching financial statements as contrasting to technical analysis. However, semi-strong version of efficiency ensures incorporation of all public information with security current price. This suggests that no methods including fundamental analysis or technical analysis can be used in returning abnormal profits. Mainly, the strong version of efficiency, which is, also the extreme form of market efficiency available suggests that all information irrespective of its nature of being public or private is given a security price. This not only implicates the negative worthiness of techniques discussed such as technical analysis and fundamental analysis but also in addition proves unprofitable nature with insider information.
Capital Asset Pricing Model (CAPM) can be given as one of the most popular testing conviction of the efficient markets. The CAPM model was first developed by Sharpe (1964), Lintner (1965) and Black (1974). It is considered as a standard equilibrium model in present financial lexicon. The following formula summarizes the CAPM:

$$ r_i = r_f + \beta (r_m - r_f) $$

Where:
- $r_i$ – Expected rate of return
- $r_f$ – Risk free rate
- $r_m$ – Market return
- $\beta$ - Market Risk

1.4 Technical Trading Rules

There are three technical indicators in this study. Firstly, we investigate Moving average (MA), which is the most common and simple technical indicator. Then, we investigate Bollinger bands, and Commodity Channel Index (CCI) because Hayes et al. (2014) shows that these two technical indicators generated exceed profit and outperformed the buy and hold strategies in certain asset conditions.

Many researchers show that moving average can generate profit in stock markets. Brock et al. (1992) and Hudson et al. (1996) evidence that moving average trading rules can generate profit in the market index in the USA and the UK. In addition, Ratner and Leal (1999) investigate ten different MA trading rules on a several indices of Asian and Latin American stock markets. The results show that the average returns of technical trading rules in Taiwan, Thailand and Mexico are profitable with the transaction cost. Later, Gunasekarage and Power (2001) demonstrate that moving average trading rules perform well in the market index of four South Asian stock markets: the Bombay Stock Exchange, the Colombo Stock Exchange, the Dhaka Stock Exchange and the Karachi Stock Exchange. Metghalchi et al. (2007) test two moving average technical trading rules for the Austrian stock market. Results indicate that moving average rules do have the predictive ability and could recognize recurring-price patterns for profitable trading. Results also support that the technical trading rules can outperform the buy-and-hold strategy. (Marshall, Qian, & Young, 2009) consider popular moving average and trading break out rules on the individual US stocks over
the period 1990 to 2004. The result is robust to different time-periods and different markets (NYSE and NASDAQ). They suggest that these trading rules are more profitable on small, illiquid stocks. However, they could not have strong results.

Lento and Gradojevic (2007) suggest that Bollinger band can earn excess returns and determine the profitability of technical trading rules on the S&P/TSX 300 Index, the Dow Jones Industrial Average Index, NASDAQ Composite Index, and the Canada/U.S. spot exchange rate. Moving average cross over rules, filter rules, Bollinger Bands, and trading range break out rules are tested. Bollinger bands underperform relative to the buy and hold strategy. After adjusting the transaction costs, the filter rules and Bollinger Bands are not found to be profitable. Stubinger et al. (2018) aim to capture the Mean return behavior with a simple trading rule based on Bollinger bands. The moving average and standard deviation are calculated for the 20 days. The upper (lower) band is obtained by adding (subtracting) k-times the standard deviation to (from) the moving average. Stubinger et al. (2018) use k=1, whatever whose aim is achieving a higher trading frequency compared with k = 2.

According to Lambert (1983), Commodity Channel Index (CCI) can be used as a versatile indicator, which gives new trends or warn of extreme conditions. CCI is developed to identify cyclical turns in commodities. However, the indicator can be applied to indices, ETFs, stocks and other securities. In general, CCI used to measure the current price level relative to an average price level over a given time period. However, Hayes et al. (2014) suggest that Bollinger bands and CCI able to perform as well as the buy and hold strategy under the asset conditions tested. However, this paper is evaluate to the use of the Bollinger bands trading rules.

1.4.1 Moving Average

Moving average (MA) trading rule can be introduced as the simplest and the most popular technical trading indicator in technical analysis. MA gives the average value over a given time period which is known as a trend indicator. To apply the moving average technical trading rules, an investor should buy (sell) at the closing price of the trading day immediately after the short-term moving average exceeds (falls below) the long-term moving average. In general, these rules are identified by short-term, long-term, and bandwidth. Short and long are the lengths of periods for the short-term and
long-term moving averages respectively. The bandwidth is the percentage difference between the short-term and long-term moving averages required to generate a signal. The introduction of a band reduces the number of buy and sell signals by eliminating a signal when the short-term moving average is relatively close to the long-term moving average (Parisi and Vasquez, 2000). If the short-term moving average is inside the band, no signal is generated. If the band is zero, the rule classifies all days into either buy or sell signal.

The simple moving average (SMA) of $i^{th}$ stock on day $t$ with the defined number of time-period $n$ is defined as:

$$SMA_{t,n}(P_t) = \frac{1}{n} \sum_{j=t-n+1}^{t} P_{t,j}$$

$$= (P_{t,t} + P_{t,t-1} + \cdots + P_{t,t-n+2} + P_{t,t-n+1})/n$$

Where: $P_{i,t}$ is the closing price of $i^{th}$ stock at day $t$.

In this study, two moving average trading rules are 50 days and 200 days with 1% bandwidth. Closing price is used as short-term moving average.

**Trading Rule 1: 50 day Moving Average**

1.1. If short period (1 day) average crosses from above (below) the long period (50 day) by more than 1 %, then make sell (buy) signals

1.2. If the short period (1 day) crosses the long period (50 day) moving average, then close any open position.

**Trading Rule 2: 200 day Moving Average**

2.1. If short period (1 day) average crosses from above (below) the long period (200 day) by more than 1 %, then make sell (buy) signals.
2.2. If the short period (1 day) crosses the long period (200 day) moving average, then close any open position.

1.4.2. Bollinger Bands

Bollinger bands are the tool for technical analysis, which later earned popularity with the volatility nature of possessing it as a decision maker for trading by John Bollinger. Standard deviation is an effective method to set bandwidth level with various volatility measurement initial tests. Bollinger is an intelligent solution in terms of sensitivity to extreme deviation with respect to standard deviation. Thus, Bollinger bands exhibit extreme reaction to large moves in asset prices with a quick response.

(Nørskov et al., 2002) focuses on central tendency of the data and considers a simple moving average to capture it by developing the bands above and below the respective value by a constant and later multiplying the resultant solution by moving standard deviation.

The defaults values used in Bollinger bands are for a calculation of 20 days with approximate trading days number of two added or removed from standard deviation. It is however necessary to maintain low number of values of standard deviation to set the bandwidth value if the calculation time-period is of small value. In addition, if the calculation period is of high length, the bandwidth has the necessity to be widened. For a sample size of 30 or greater values, ±2 standard deviations should contain about 95% of the data.

Thus, the calculation estimates sufficiently robust with a sample size of less than value 30. Trading stocks at the time of fall outside the bands is simple but an effective trading method in terms of trading stocks. For example, if a price falls outside the positive band, Short/long position is then with three target exit areas: (1) upper band, (2) middle band or (3) lower band. Trading rules 1 and 2 give the double bottoms and bottom reversal of the Bollinger bands.

Trading Rule 3 Bollinger Band Double Bottoms

Ref. code: 25615922040885AXY
3.1 If the stock has had two consecutive local minimums, cut the lower band at least twice, and the remaining stock prices which between local minimums should below the moving average then make the open position.

3.2 If the stock price cuts the upper Bollinger band then make the close the position.

**Trading Rule 4 Bollinger Band Bottoms Reversal**

4.1 If the stock has been below the lower band for at least two consecutive days and the price has increased from the previous day but remains below the lower band then make the open position.

4.2 If the stock price cuts the upper Bollinger band then make the close position.

1.3.3. **Commodity Channel Index (CCI)**

The Commodity Channel Index (CCI) is an indicator developed by Donald (Falls, 1980) and it was featured in Commodities magazine ensuring the identity of a new trend and warning system with extreme conditions. The idea originally developed by Lambert in which CCI identified as a cyclical turns in commodities. However, the indicator successfully applies not only to indices but also to various other requirements including ETFs, stocks and other securities.

Over a considered time-period, CCI is able to measure the current price level of stocks with respect to an average price level. In general, the value of CCI is relatively high while the prices of stocks are above the average by great amount and low with prices below the average. This allows CCI as a tool to detect the level of overbought and oversold stock values.

In the process of calculation of the Commodity Channel Index (CCI), trading price calculates first. Trading price (TP) is the average of the high, low and closing price a particular trading day.

After that, the 20-day moving average of TP is calculated. Then the Mean Deviation (MD) of 20-day MA of TP has to be calculated. Then CCI calculates as follows.
TP = \frac{(High + Low + Close)}{3}

\text{Mean Deviation} = \frac{\sum_{i=0}^{19} TP_{t-i} - \overline{TP}_{20\text{day MA}}}{20}

CCI = \frac{TP - \overline{TP}_{20\text{day MA}}}{0.015 \times \text{Mean Deviation}}

Where: \( t \) is the current time and MA is the simple moving average.

Then CCI can catch the large variations in trading price. That means it is more likely to see the large deviation of TP from the previous days TP if high, low and closing price close together. When we talk about the large variations in trading price, CCI gives the trend and trend reversal early. Large positive values represent the strong strength of prices above its average. An also high negative value represents the weakness of prices below its average. So it can be used to find the strong overbought and strong oversold signals. In this case, ±100 and ±200 values boundaries can be used as a trading rule.

To measure the CCI, Trading price (TP) should be calculated as the first step. TP is the average value of high, low and close price. High price is the maximum price of stock in a given day. As well as Low price is the minimum price of stock. Close price is the end of day price of a stock per given day. After that, 20-day moving average of TP is calculated. Then the mean deviation of TP is the average absolute difference of the TP and 20-day moving average of TP. If stocks are more volatile, then the mean deviation will be a high value. Finally, CCI is the difference between the current day TP and the 20-day moving average of TP divided by mean deviation

Therefore, CCI easily finds the large variation of TP. It can be happen when high, low and close prices do not have variation too much. In other words, CCI can be used to find the future trends and trend reversal early.

\textbf{Trading Rule 5 CCI Trend Reversal}

5.1 When CCI is greater than 100 take short position
5.2 When CCI is less than -100 take long position
5.3 When CCI crosses 0 close the positon
Trading Rule 6 CCI Extreme Trend Reversal

6.1 When CCI is greater than 200 take short position

6.2 When CCI is less than -200 take long position

6.3 When CCI crosses 0 close the position
CHAPTER 2
REVIEW OF LITERATURE

2.1 Review of Literature

The Efficient Market Hypothesis (EMH) is one of the main pillars of modern finance. The study of the EMH concludes that the stock exchange is efficient if stock prices always fully reflect all available information in a market (Fama, 2010; Park and Irwin, 2007). EMH is also explained by Park and Irwin (2007) as an efficient market with respect to information set if it is impossible to make economic profits by trading on the basis of information set. In efficient market, price changes are random and returns are independent from successive one period (Mills, 1997; Sova et al., 2012). The efficient market hypothesis was supported by many of early empirical studies. Those empirical studies, which investigated the efficient market hypothesis, were based on tests of whether different trading rules could earn profits. Ratner and Leal (1998) examined the ten emerging equity markets in Latin America and Asia from 1982 to 1995 for ten Variable Length Moving Average (VMA) technical trading rules. After having trading costs for each rule, trading rules are compared to the buy and hold strategy. Study found that within ten markets in the world, Taiwan, Thailand and Mexico markets are profitable and supported the EMH. Gunasekarage and Power (2001) examined the four emerging South Asian capital markets and examined the implications of the results for the EMH. The findings indicate that technical trading rules have predictive ability in these markets.

Since Asian stock markets have unique characteristics, investors may be able to gain profits when they trade in these markets. Based on the results from Bessembinder and Chan (1995), Asian stock markets consist of few large companies with small number of ownership. Thus, insider-trading behavior is prominent and the requirements of financial disclosures are less regulated. Risso (2009) stated that emerging stock markets are inefficient compared to the existing developed markets. In Asian stock markets, Bessembinder and Chan (1995) have found that the technical trading rules are successful in predicting stock price movement in emerging stock markets such as Malaysia, Thailand and Taiwan. These emerging stock markets have forecast ability in relative to developed stock markets such as Hong Kong and Japan stock markets.
Considering South East Asian markets (Singapore, Malaysia, Thailand, Indonesia and Philippines), Yu et al. (2013) and Tharavanij et al. (2015) found that technical trading rules have strong predictive power in the emerging stock markets in the South East Asian region. Zhu et al. (2015) found that traditional technical trading rules are effective without considering transaction cost in Shanghai Securities Composite Index (SSCI) from May 21, 1992 through June 30, 2013 and China Securities Index 300 (CSI 300) from April 8, 2005 through June 30, 2013. However, simple trading rules are not effective when considering transaction cost.

The core of the studies on technical analysis is the profitability of technical trading rules. In the past, large stock markets were studies such as US stock market (Brock et al., 1992; Lo et al., 2000; Tian et al., 2003; Lento et al., 2007; Marshall et al., 2009), UK stock markets (Hudson et al., 1996; Chong et al., 2008), Australian markets (Marshall and Cahan, 2005; Metghalchi et al., 2007), and Singapore stock market (Wong et al., 2003).

Brock et al. (1992) used simple moving average trading rules and trading-range break to show profitable results on these technical trading rules. Hudson et al. (1996) followed Brock et al. (1992)’s study on the profitability of technical trading rules in US stock market, and they found that technical trading rules also generate excess returns in UK stock market. Lo et al. (2000) proposed smoothing techniques to identify the regularities in the stock prices from noisy data in order to evaluating the efficacy of technical indicators. They suggest that automated algorithms and traditional patterns can help to improve technical analysis. Tian et al. (2003) expanded technical trading rules from 26 rules (Brock et al., 1992; Bessembinder & Chan, 1995) to 412 rules . In their results, technical trading rules did not perform well in the US stock market; however, technical trading rules give positive results in Chinese stock market. Wong et al. (2003) tested moving average (MA) and relative strength index (RSI) technical trading rules on Singapore stock market without transaction cost. They suggest that members of the stock exchange of Singapore can earn excess profits due to the exemption of transaction cost. Marshall and Cahan (2005) applied three momentum technical trading rules on Australian stock market. They suggest that 52-week high momentum rule is highly profitable on Australian stock market comparing to US stock market. In addition, Metghalchi et al. (2007) found that moving average has predictive
power in Australian stock market, and technical trading rules outperform the buy and hold strategy. Lento et al. (2007) used moving average cross-over, filter rules, Bollinger bands, and trading range brake out rules to determine profitability on S&P/TSX 300 Index, the Dow Jones Industrial Average Index, NASDAQ Composite Index, and the Canada/U.S. spot exchange rate. Mixed results are shown in this study; they cannot conclude that technical trading rules generate excess returns in all securities. The filter rules and Bollinger bands could not be profitable with the transaction cost. Chong et al. (2008) investigated Moving Average Convergence Divergence (MACD) and Relative Strength Index (RSI) for 60-year data in UK stock markets and found the evidence to support profitability on technical trading rules. Marshall et al. (2009) found that technical trading rules are rarely profitable in US stock market from 1990 to 2004; however, they found that smaller and less-liquid stocks could earn excess returns.

In addition, relatively small stock markets, which are excluded Asian stock markets, are studied. Chen and Metghalchi (2012) investigated various technical trading rules in Brazilian stock markets. They concluded that technical trading rules could not beat buy and hold strategy based on t-test. Gerritsen (2016) who evaluates technical trading rules in the Netherland stock market concludes that technical trading rules cannot generate abnormal returns on investment by examining more than 5000 technical trading rules from 2004 to 2010.
CHAPTER 3
METHODOLOGY

3.1 Experimental Procedure and Data

The main purpose of this study is to verify two hypothesis given below. To verify those hypotheses, the daily closing prices and the daily trading volumes within ten-year period are used for technical trading strategies in the Thai stock exchange. This paper uses SET50 index in the Thai stock exchange. Further, it selects 19 stocks in the SET50 index that were listed in continuously within 10-year period. 2007-2017 period is used for this investigation.

3.2 Research Hypothesis

Hypothesis 1:
Technical trading rules are affected by asset conditions.

Hypothesis 2:
The technical trading strategies can be performed better than the buy and hold strategy within short time horizon for specific stock conditions.

To verify these hypotheses, the daily closing price and the daily trading volume from 19 stocks, which were continuously listed from 2007 to 2017 in the Thailand SET50 Index, are used in this study. If there were enough evidences to support both hypotheses above, investors would be aware of the impacts of asset conditions when they trade. This paper uses six technical trading rules from three technical trading indicators, and we use sixteen asset conditions proposed by Hayes et al. (2014).

Asset conditions are the combination of four categories listed below.

1. Volatility of the Stock
2. Volatility of the Trading Period
3. Volume of the Stock
4. Volume of the Trading Period
3.3 Assets Conditions or Market Conditions

Assets conditions are focused on two parameters that are volatility and trading volume. Each stock is categorized by using these two parameters, volatility and trading volume. In addition, each month is categorized by using volatility and trading volume. Volatility measures the price variations. It is computed as the standard deviation of absolute returns of the closing price.

Figure 3.1 Asset Conditions

Figure 3.2 and Figure 3.3 show the volatility changes in the market for 2007 to 2017. We consider 2007-2014 as one time-period and 2015-2017 as another time-period since within 2007 to 2017 first six months data of 2015 is not available. Here we used Yahoo Finance data. However, they could not give the data from June 2014 to January 2015. Therefore, we have to separate our data set as two data set. One subset is 2007 to 2014 and another sub set is 2015 to 2017.

According to the Figure 3.2 and 3.3, SET50 Index is a volatile index within the period of 2007-2014 and 2015-2017 respectively. Nevertheless, volatility does not have
a trend within the time. Thus, volatility parameter is considered for stock and time-period.

**Figure 3.2** Average SET50 19 stocks daily absolute volatility 2007-2014.

**Figure 3.3** Average SET50 19 stocks daily absolute volatility 2015-2017.

A stock is considered a highly volatile stock if its median daily volatility, over the entire 10 year period, is in the top 50% for all stocks. Other stock is considered as low volatility stocks. Furthermore, stocks are considered as one-month volatility periods. In this case, each stock is segmented into the volatility of one-month time-period. Some
months have high volatilities and others have low volatilities. To classify high volatility months and low volatility months, median volatility is used. Extreme outliers can be limited using the median volatility. If mean is used then large abnormal price fluctuations can be affected to the volatilities. Finally, if time-periods have volatility that is in top 50%, it is defined as high volatility time-periods and others are defined as low volatility time-periods.

Figure 3.4 and Figure 3.5 show the average daily volume of Thai SET50 19 stocks for 2007 – 2014 and 2015 – 2017 respectively. Same as average SET50 19 stocks daily absolute volatility plots, below plots are created. According to these plots, average SET50 19 stocks daily volume has increased over the past 10 year. However, increase is non-linear and thus, the daily volume is de-trended.

\[ y = 4264.9x - 1\times10^8 \]

**Figure 3.4** Average SET50 19 stocks daily volume 2007-2014.
Figure 3.5 Average SET50 19 stocks daily volume 2015-2017

Figure 3.5, 3.6 and 3.7 below illustrates the daily volume of the SET50 Index in three different years, which demonstrate a linear change in volume over a year. To determine high volume stocks for a given year, the researchers take the median of the daily trade volume of each stock. The previously mentioned approach is used; high volume stocks have a median daily volume in the top 50% of all stocks. However, unlike volatility, volume is recalculated on a yearly basis. Therefore, a stock can be considered a high volume stock for one year and a low volume stock in another year.

Figure 3.6 Average SET50 19 stocks daily volume 2008.
Figure 3.4 and figure 3.5 show that average SET50 19 stocks daily volume has a trend. However, this trend is non-linear. Figure 3.6, figure 3.7 and figure 3.8 show that volume is assumed to have linear change throughout the year. The third asset condition is the volume of the stock. The median daily volume of each stock is calculated to determine high or low volume of the stock for a given year. As same as the calculation of volatility of the stock, high volume stocks have median daily volume in top 50% of all stocks within a year. However, unlike volatility, volume is calculated by year basis. Therefore, a stock can be considered as high volume stock in one year and low volume stock in another year.

According to the fourth asset condition of volume of the trading period, daily volume is de-trended. Each stock in each year is made by linear regression. Then daily volume is subtracted from linear regression estimation. Later, adjusted volume summed...
up within each month. It is calculated as if the summation is positive it is considered as high volume trading period and summation is negative that month is considered as low volume trading period.

Considering combination of four categories of basic asset condition, sixteen asset conditions are made. Each category can be either High (H) or Low (L). The asset conditions are listed in an abbreviated format. For example, H|L|H|L represents a high volatility stock, low volatility trading period, high volume stock and low volume trading period.

Furthermore, this investigation conceded the three basis point transaction cost to enter and leave the market. Also all six technical trading strategies are independently calculated from the buy and hold.

The Pseudo Sharpe ratio is used to find the best market conditions within each strategy. The Pseudo Sharpe ratio is the ratio between mean return and the standard deviation. The Pseudo Sharpe ratio can have a high positive value when the mean return has relatively high positive value comparing to the standard deviation or the standard deviation has relatively low value comparing to the mean return. The Pseudo Sharpe ratio is zero when mean return is less than zero.

For each asset condition, a Tukey’s test is run for overall strategies to determine if any strategy has a statistically higher return than the buy and hold strategy. Additionally, interaction tables are generated to determine the better trading strategies, which outperforms the buy and hold within each asset conditions. The next section presents the results of the analysis.
CHAPTER 4
RESULTS AND DISCUSSION

Asset conditions are the combination of four categories; Volatility of the stock, Volatility of the trading period, Volume level of the stock and Volume level of the trading period. Each category has High and Low represented as H and L. According to that, sixteen asset conditions were created. (Hayes et al., 2014) In every table, they are listed as an abbreviated format. As an example, H|L|H|L represents a high volatility, low volume stock in a high volatility, low volume trading period.

4.1 Results of Mean Returns

Table 4.1 gives the mean return values for buy and hold strategy and six trading strategies. If we consider about the buy and hold strategy, it has some negative mean returns. It happens because of SET50 index variation. SET50 Index does not have a highly up trend within the considered time-period of 10 years and SET50 index is a volatile index. Because of these reasons, B&H can have a negative mean returns. CCI Reversal Rule, Bollinger Band Double Bottom and Bollinger Band Bottom Reversal Rules give the positive mean returns for all sixteen-asset conditions. Furthermore, CCI extreme reversal, Moving average 50 day and Moving average 200 day rules give positive mean returns for the specific asset conditions. Both Moving average trading rules give positive mean returns only for H|L|L|L, H|H|L|L and H|H|L|H asset conditions.
Table 4.1 SET50 Index Mean Returns 2007-2017.

<table>
<thead>
<tr>
<th>AC</th>
<th>B&amp;H</th>
<th>CCI_100</th>
<th>CCI_200</th>
<th>BB_BR</th>
<th>BB_DB</th>
<th>MA_50</th>
<th>MA_200</th>
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<tbody>
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<td>0.1127</td>
<td>-0.0496</td>
<td>0.0226</td>
<td>0.1548</td>
<td>-0.0661</td>
<td>-0.0253</td>
</tr>
<tr>
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</tr>
<tr>
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<td>-0.1106</td>
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</tr>
<tr>
<td>L[L]</td>
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<tr>
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<td>H[L]</td>
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<td>0.1450</td>
</tr>
<tr>
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<td>0.0688</td>
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<td>-0.0754</td>
</tr>
</tbody>
</table>

4.2 Results of Standard Deviation

Table 4.2 represents the standard deviation values for the buy and hold strategy and the six trading strategies. According to the table, Buy and Hold gives the less standard deviation values compared to the other standard deviation values of trading strategies. B&H gives lower standard deviation values comparing to other rules. Standard deviation values of six trading strategies have same high standard deviation around 0.5. The trading rules have higher standard deviation returns.
### Table 4.2 SET50 Index Standard Deviation of returns 2007-2017.

<table>
<thead>
<tr>
<th></th>
<th>AC</th>
<th>B&amp;H</th>
<th>CCI_100</th>
<th>CCI_200</th>
<th>BB_BR</th>
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<th>MA_50</th>
<th>MA_200</th>
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### 4.3 Results of Pseudo Sharpe Ratio

Table 4.3 shows the Pseudo Sharpe ratio values. The Pseudo Sharpe ratio is given as the ratio between mean returns and the standard deviation. This is also called as reward risk ratio. If it represents higher value, it has a less risk value. The reward ratio value can be either positive or zero. It is positive when mean return is positive and it is zero when mean return is negative. In Table 4.3, each column has either zero or positive values. That means some asset conditions give higher Pseudo Sharpe Ratio and other asset conditions give lower Sharpe ratio values. Some strategies have a larger Sharpe ratio values than the buy and hold strategy. This indicates that under these asset conditions, strategies return more reward for the same amount of risk. Pseudo Sharpe Ratio cannot be considered as a statistical test. However, it can be used to measure the relative risk between two strategies. Additionally, Sharpe ratio values for all strategies are less than one because of high variance.
Table 4.3 Pseudo Sharpe Ratio 2007-2017.

<table>
<thead>
<tr>
<th>AC</th>
<th>B&amp;H</th>
<th>CCI_100</th>
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4.4 Results of Tukey Test of Grouping

Table 4.4 gives the Turkey pairwise comparison results between the buy and hold strategy and each trading strategy. The numbers in the cells represent groups of strategies whose returns are not statistically different. The order of mean return represents by the number in an increasing order starting from one. Value 1 represents the highest mean return and value 2 is the next highest mean return and so on. Some trading strategy has a statistically higher return than the buy and hold strategy using a 95% confidence interval. For example, in H|L|L|L market condition, all trading strategies have a statistically higher return than the buy and hold strategy. Thus, we conclude that trading strategies outperform the buy and hold strategy in H|L|L|L market condition. Furthermore, we can conclude that CCI trend reversal outperform the buy and hold strategy for all asset conditions. In addition, Bollinger band double bottom trading strategy outperform buy and hold strategy for all asset condition accept H|H|L|H.
Table 4.4 Tukey’s test groupings 2007-2017.

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Appendix A gives the number of asset conditions in each stock of SET50 for 2007-2017. These results classify which asset condition is suitable for each stock. Some stocks have high/low volatility and high/low volume relatively to other stocks. In addition, this gives the high/low volatility months and high/low volume months for each stock relatively to other months.

Appendix B gives the Matlab codes which is created for technical trading strategies. Moving Average 50 day, Bollinger band bottom reversal, Bollinger band Double bottom and CCI reversal codes are included in the Appendix.
CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The results of this study suggest that trading rules are affected by asset conditions. In addition, the CCI trend reversal and Bollinger band double bottom trading strategies outperform a buy and hold strategy for all most all asset conditions except H|H|L|H for Bollinger band double bottom. Moving average trading rules perform better than buy and hold strategy for some specific asset conditions. In addition, CCI extreme reversal and Bollinger band bottom reversal outperform buy and hold strategy for specific asset conditions. Taking the overall results, this investigation conclude that Bollinger band and CCI technical strategies are profitable than comparing the buy and hold strategy for Thai SET50 index. This confirm the Hypothesis 2 that the technical trading strategies can be performed better than a buy and hold strategy within the short time horizon (one month time-period) for specific stock conditions.

Financial investors. Addition, these findings can be helped to give the reasons why still practitioners are used Bollinger band and CCI technical trading strategies in the financial markets.

In this study gives how the technical trading strategy performed in a given assets condition. In addition, to use this method, traders should know the assets conditions in future time-periods. So that, a future study should be a forecasting assets conditions for next month time-period. That means using volatility and volume estimators, future stocks can be determined as a function of assets conditions to apply this trading rule or buy and hold strategy. Furthermore, other estimators can be consider for the future studies than volume and volatility. It can be helpful to forecast the better profits for the investors.

This study gives that technical trading strategies are profitable for a given asset conditions comparing with buy and hold strategy. So that, it confirms Hypothesis 1 that a technical trading strategy’s performance is influenced by asset conditions. According to the results, Commodity channel Index can be given as the most profitable trading strategy for SET 50 index.
These findings can be used in the Stock exchange of Thailand. Therefore, practitioners can use optimal asset conditions for their investments. In addition, these findings can be helped to give the reasons why still practitioners are used technical trading strategies in the financial markets.

Mainly, using three strategies, 100% of asset conditions give CCI trend reversal is the best with comparing buy and hold strategy. In addition, 32% of asset conditions in the strategies are best comparing buy and hold strategy. As a conclusion, CCI can be given the most robust technical trading strategy for SET50 Index. Because of, CCI perform better as buy and hold strategy for given all assets conditions. Furthermore, under certain assets conditions these strategies exceed the buy and hold returns. Therefore, it confirm hypothesis two as well as hypothesis one.

5.2 Recommendation

The CCI trend reversal and Bollinger band double bottom trading strategies outperform the buy and hold strategy for all asset conditions except H|H|L|H asset condition for Bollinger band double bottom. However, CCI extreme reversal and Bollinger band bottom reversal outperform buy and hold strategy for some asset conditions. Moving average trading rules perform better than the buy and hold strategy for H|L|L|L and H|H|L|L asset condition. Thus, the technical trading strategies outperform the buy and hold strategy within the short time horizon for specific stock conditions. The results of this study can guide people to understand the reasons to use moving average, Bollinger bands and CCI technical trading strategies in the financial markets. This study gives an insight on how the technical trading strategies perform in a given asset conditions. Since investors have to know the current asset condition in order to be profitable in using the technical trading rules, the future work of this research would be to forecast the asset condition of the current trading period.

In this study gives how the technical trading strategy performed in a given assets condition. In addition, to use this method, traders should know the assets conditions in future time-periods. So that, a future study should be a forecasting assets conditions for next month time-period. That means using volatility and volume estimators, future stocks can be determined as a function of assets conditions to apply CCI trading rule or buy and hold strategy.
REFERENCES


Costa, T. R. C. C., Nazário, R. T., Bergo, G. S. Z., Sobreiro, V. A., & Kimura,


### APPENDIX A

## ASSET CONDITIONS

### Table 6 Number of assets conditions

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Ref. code: 25615922040885AXY
cci extreme reversal

% import the data
filename = 'advanc.bk.xlsx';
[ndata, text, alldata] = xlsread(filename);
price = ndata(:,4);
x1 = size(price);    % price modify = price;

% preallocation
date = zeros(1,x1);
cci = zeros(1,x1);
cost = zeros(1,x1);
Revenue = zeros(1,x1);
a = zeros(1,x1);
MDV_TP = zeros(1,x1);

for z=1:x1
   date(z)=datenum(alldata(z,1), 'mm/dd/yyyy');
end

month_trading = month(date);
TP = (ndata(:,2)+ndata(:,3)+ndata(:,4))/3;
TP_avg = tsmovavg(TP, 's', 20, 1);

for a=20:x1-20
   MDV_TP(a) = (abs(TP_avg(a)-TP(a))+abs(TP_avg(a)-TP(a-1))+... 
               abs(TP_avg(a)-TP(a-2))+abs(TP_avg(a)-TP(a-3))+abs(TP_avg(a)-TP(a-4))+... 
               abs(TP_avg(a)-TP(a-5))+abs(TP_avg(a)-TP(a-6))+abs(TP_avg(a)-TP(a-7))+... 
               abs(TP_avg(a)-TP(a-8))+abs(TP_avg(a)-TP(a-9))+abs(TP_avg(a)-TP(a-10))+... 
               abs(TP_avg(a)-TP(a-11))+abs(TP_avg(a)-TP(a-12))+abs(TP_avg(a)-TP(a-13))+... 
               abs(TP_avg(a)-TP(a-14))+abs(TP_avg(a)-TP(a-15))+abs(TP_avg(a)-TP(a-16))+... 
               abs(TP_avg(a)-TP(a-17))+abs(TP_avg(a)-TP(a-18))+abs(TP_avg(a)-TP(a-19)))/20;
end

for y=20:x1-20
   CCI(y) = (TP(y)-TP_avg(y))/(0.015*MDV_TP(y));
end

count=0;
for q=1:x1-1
   if month_trading(q)~= month_trading(q+1)
   count = count + 1;
   end
end
count = count+1;
end
end

index = zeros(1,x1);

for q=1:x1-1
    
    if month_trading(q+1)~= month_trading(q)
        index(q)= 1;
    else
        index(q)=0;
    end
end

P=find(index);
% dimension (y2=size of month change)
[y1,y2] = size(find(index));

% For A, buy = -1, open = 0, sell = 1
for r=1:y2-1
    for q=P(r):P(r+1)
        %if month_trading(q)== month_trading(q)

        % case A = 0
        % long position
        if(A(q) == 0) && (CCI(q)<-200)
            A(q+1) = -1;
            Cost(q)= -1*(price_modify(q)+(0.01*price_modify(q)));
        elseif (A(q) == 0) && (CCI(q)>=-200) && (CCI(q)<0)
            A(q+1) = 0;
        elseif (A(q) == 0) && (CCI(q)<=200) && (CCI(q)>=0)
            A(q+1) = 0;

        % short position
        elseif (A(q) == -1) && (CCI(q)<-200)
            A(q+1) = 0;
            Revenue(q)= 1*(price_modify(q)-(0.01*price_modify(q)));
        elseif (A(q) == -1) && (CCI(q)>=-200) && (CCI(q)<0)
            A(q+1)=-1;
        elseif (A(q) == -1) && (CCI(q)>0) && (CCI(q)<=200)
            A(q+1) = 0;
            Revenue(q) = 1*(price modify(q)-(0.01*price_modify(q)));
        elseif (A(q) == -1) && (CCI(q)>200)
            A(q+1) = 0;
Revenue(q) = price_modify(q) - (0.01*price_modify(q));

% Case A = 1

elseif (A(q) == 1) && (CCI(q) < -200)
    A(q+1) = 0;
    Cost(q) = -1*(price_modify(q) + (0.01*price_modify(q)));

elseif (A(q) == 1) && (CCI(q) >= -200) && (CCI(q) < 0)
    A(q+1) = 0;
    Cost(q) = -1*(price_modify(q) + (0.01*price_modify(q)));

elseif (A(q) == 1) && (CCI(q) <= 200) && (CCI(q) >= 0)
    A(q+1) = 1;

elseif (A(q) == 1) && (CCI(q) > 200)
    A(q+1) = 1;
else
    disp('false1')
end

%last element of matrix, need to close position
if q==P(r+1)
    if A(q) == -1
        A(q) = 0;
        Revenue(q) = price_modify(q) - (0.01*price_modify(q));
    elseif A(q) == 1
        A(q) = 0;
        Cost(q) = -1*(price_modify(q) + (0.01*price_modify(q)));
    elseif A(q) == 0
        A(q) = 0;
    else
        disp('false2')
    end
end
end

%Preallocation
%sum_Revenue = zeros(1,count);
%sum_Cost = zeros(1,count);
sum_revenue=zeros(1,y2);
sum_cost=zeros(1,y2);

for z=1:y2-1
    T1=0;

Ref. code: 25615922040885AXY
T2=0;

for d=P(z):P(z+1)
    T1 = T1+Revenue(d);
    T2 = T2+Cost(d);
end

sum_revenue(z)=T1;
sum_cost(z)=T2;
end

% Compute formula
% Result
result1=zeros(y2,1);

for z=1:y2
    result1(z)=(sum_revenue(z)+sum_cost(z))/(-1*sum_cost(z));
    %result1(z)=(sum_revenue(z)+sum_cost(z));
    if sum_cost(z)==0
        % result1(z)=double('NA');
        XX = str2double('NA');
        result1(z)=XX;
    end
end

% Date
result2 = datestr(date(P+1), 'mm/dd/yy');

% Combine result1 and result2
YY = date(P+1)';
datecol = 1;
YY(:,datecol) = YY(:,datecol) - datenum('30-Dec-1899');
result=cat(2,YY, result1);

Bollinger Band Double Bottom

% Import the data
filename = 'TOP.BK.xlsx';
[ndata, text, alldata] = xlsread(filename);
price = ndata(:,4);
x1=x2 = size(price);
price_modify=price;
sell_signal=zeros(1,x1);
buy_signal=zeros(1,x1);

% Preallocation
date=zeros(1,x1);
for z= 1:x1  
    date(z)=datenum(alldata(z,1), 'mm/dd/yyyy'); 
end  

month_trading = month(date);  

% Construction of Bollinger bands  
[mid,uppr,lowr] = bollinger(price,20,1,2);  
%bollinger(tsobj,wsize,wts,nstd)  
dis_CloseBolling = [mid,uppr,lowr,price];  
%plot(dis_CloseBolling)  

% Construction of the buying/selling signals.  
[Maxima,MaxIdx] = findpeaks(-price);  
Minima=-Maxima;  
MinIdx=MaxIdx;  
B=price(MinIdx(1):MinIdx(2));  
%C=mid(MinIdx(1):MinIdx(2));  
cv = numel(MinIdx)-1;  
count=0;  
for q=2:(x1)  
    if month_trading(q)~= month_trading(q-1)  
        count = count+1;  
    end  
end  

Cost=zeros(1,x1);  
Revenue=zeros(1,x1);  
sum_Revenue = zeros(1,count);  
sum_Cost = zeros(1,count);  
A = zeros(1,x1);  
index = zeros(1,x1);  
index1= zeros(1,cv);  
for q=1:x1-1  
    if month_trading(q+1) ~= month_trading(q)  
        index(q)= 1;  
    else  
        index(q)=0;  
    end  
end  

date_MinIdx=date(MinIdx);  
month_MinIdx=month(date_MinIdx);  
for q=1:cv  
    if month_MinIdx(q+1) ~= month_MinIdx(q)  
        index1(q)= 2;  
    else  
        index1(q)=0;  
    end  
end
P = find(index);
P1 = find(index1);

con3 = zeros(1, x1);

for i = 1:cv
    if price(MinIdx(i)) < mid(MinIdx(i)) && price(MinIdx(i + 1)) < mid(MinIdx(i + 1))
        q = MinIdx(i):MinIdx(i + 1);
        if price(q) < mid(q)
            con3(q) = 1;
        else
            con3(q) = 0;
        end
    end
end

% dimension (y2=size of month change)
[y1, y2] = size(find(index));

% For A, buy = -1, open = 0, sell = 1
for r = 2:y2-1
    for q = P(r):P(r+1)
        % case A = 0
        % long position
        if A(q) == 0 && con3(q) == 1 && con3(q + 1) == 1
            A(q + 1) = -1;
            Cost(q) = -1 * (price_modify(q) + (0.01 * price_modify(q)));
        elseif A(q) == 0 && con3(q) == 1 && con3(q + 1) == 0
            A(q + 1) = 0;
        elseif A(q) == 0 && con3(q) == 0 && con3(q + 1) == 0
            A(q + 1) = 0;
        elseif A(q) == 0 && con3(q) == 0 && con3(q + 1) == 1
            A(q + 1) = 0;
        % short position
        elseif A(q) == 0 && price(q) > uppr(q)
            A(q + 1) = 1;
            Revenue(q) = 1 * (price_modify(q) - (0.01 * price_modify(q)));
        elseif A(q) == 0 && price(q) <= uppr(q)
            A(q + 1) = 0;
    end
end
% Case A = -1

elseif A(q)==-1 && con3(q)==0 && con3(q+1)==0
A(q+1)=-1;

elseif A(q)==-1 && con3(q)==1 && con3(q+1)==0
A(q+1)=-1;

elseif A(q)==-1 && con3(q)==0 && con3(q+1)==1
A(q+1)=-1;

elseif A(q)==-1 && con3(q)==1 && con3(q+1)==1
A(q+1)=-1;

elseif A(q)==-1 && price(q)>uppr(q)
A(q+1)=0;
Revenue(q)= 1*(price_modify(q)-(0.01*price_modify(q)));  

elseif A(q)== -1 && price(q)<=uppr(q)
A(q+1) = -1;

% Case A = 1

elseif A(q)== 1 && con3(q)==1 && con3(q+1)==0
A(q+1) = 0;
Cost(q)= -1*(price_modify(q)+(0.01*price_modify(q)));  

elseif A(q)==1 && con3(q)==0 && con3(q+1)==0
A(q+1) = 1;

elseif A(q)==1 && con3(q)==0 && con3(q+1)==1
A(q+1) = 1;

elseif A(q)==1 && con3(q)==1 && con3(q+1)==1
A(q+1) = 1;

elseif A(q)== 1 && price(q)>uppr(q)
A(q+1) = 1;

elseif A(q)==1 && price(q)<uppr(q)
A(q+1) = 1;

end

if q==P(r+1)
   if A(q) == -1;
      A(q) = 0;
end

Ref. code: 2561592204885AXY
Revenue(q) = price_modify(q) - (0.01 * price_modify(q));

elseif A(q) == 1;
  A(q) = 0;
  Cost(q) = -1 * (price_modify(q) + (0.01 * price_modify(q)));

elseif A(q) == 0;
  A(q) = 0;
end

end

%last element of matrix, need to close position
end

% Preallocation
sum_revenue = zeros(1, y2);
sum_cost = zeros(1, y2);

for z = 1:y2-1
  T1 = 0;
  T2 = 0;

  for d = P(z):P(z+1)
    T1 = T1 + Revenue(d);
    T2 = T2 + Cost(d);
  end

  sum_revenue(z) = T1;
  sum_cost(z) = T2;
end

% Compute formula
% Result
result1 = zeros(y2, 1);

for z = 1:y2
  result1(z) = (sum_revenue(z) + sum_cost(z)) / (-1 * sum_cost(z));
  if sum_cost(z) == 0
    % result1(z) = double('NA');
    XX = str2double('NA');
    result1(z) = XX;
  end
end

% Date
result2 = datestr(date(P+1), 'mm/dd/yy');

% Combine result1 and result2
YY = date(P+1);
datecol = 1;
YY(:,datecol) = YY(:,datecol) - datenum('30-Dec-1899');
result=cat(2,YY, result1);

% Make a base file name that has a number embedded in it.
baseFileName = sprintf('KDJs1_%s', filename);

Moving Average 50 day

% Import the data
filename = 'AOT.BK.xlsx';
[ndata, text, alldata] = xlsread(filename);
price = ndata(:,4);
[x1,x2] = size(price);
i=50;
price_modify=price;

% Preallocation
date=zeros(1,x1);
for z= 1:x1
    date(z)=datenum(alldata(z,1), 'mm/dd/yyyy');
end
month_trading = month(date);

% Construction of the 3 SMA for 1, 50 and 100 periods.
SMA.sma_1 = tsmovavg(price,'s',1,1);
SMA.sma_i = tsmovavg(price,'s',i,1);
SMA.signals = SMA.sma_1-SMA.sma_i;

% Construction of the buying/selling signals.
% SIGNALS.buy_1_50= (SMA.sma1 - SMA.sma50>0.01);
% SIGNALS.sell_1_50 = (SMA.sma1 -SMA.sma50<0.01);
SIGNALS=SMA.signals;

count=0;
for q=2:(x1)
    if month_trading(q)~= month_trading(q-1)
        count = count+1;
    end
end

Cost=zeros(1,x1);
Revenue=zeros(1,x1);
sum_Revenue = zeros(1,count);
sum_Cost = zeros(1,count);
A = zeros(1,x1);
index = zeros(1,x1);
for q=1:x1-1
    if month_trading(q+1)~= month_trading(q)
        index(q)= 1;
    else
        index(q)=0;
    end
end

P=find(index);

% dimension (y2=size of month change)
[y1,y2] = size(find(index));

% For A, buy = -1, open = 0, sell = 1
for r=1:y2-1
    for q=P(r):P(r+1)

        % if month_trading(q)== month_trading(q)
        % case A = 0
        % long position
        if (A(q) == 0) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)>0 && SIGNALS(q)<0
            A(q+1) = -1;
            Cost(q)= -1*(price_modify(q)+(0.01*price_modify(q)));
        elseif (A(q) == 0) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)<0 && SIGNALS(q)<0
            A(q+1) = 0;
        elseif (A(q) == 0) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)>0 && SIGNALS(q)>0
            A(q+1) = 0;
        elseif (A(q) == 0) && (SIGNALS(q)>=-0.01) && (SIGNALS(q)<=0.01)
            A(q+1) = 0;
        end
        elseif (A(q) == 0) && (SIGNALS(q)>0.01) && SIGNALS(q-1)<0 && SIGNALS(q)<0
            A(q+1) = 1;
            Revenue(q)= 1*(price_modify(q)-(0.01*price_modify(q)));
        elseif (A(q) == 0) && (SIGNALS(q)>0.01) && SIGNALS(q-1)>0 && SIGNALS(q)>0
            A(q+1) = 0;
        elseif (A(q) == 0) && (SIGNALS(q)>0.01) && SIGNALS(q-1)<0 && SIGNALS(q)<0
A(q+1) = 0;

% Case A = -1

elseif (A(q) == -1) && (SIGNALS(q)>0.01) && SIGNALS(q-1)<0 && SIGNALS(q)>0
  A(q+1) = 0;
  Revenue(q) = 1*(price_modify(q)-(0.01*price_modify(q)));

elseif (A(q) == -1) && (SIGNALS(q)>0.01) && SIGNALS(q-1)>0 && SIGNALS(q)>0
  A(q+1) = -1;

elseif (A(q) == -1) && (SIGNALS(q)>0.01) && SIGNALS(q-1)<0 && SIGNALS(q)<0
  A(q+1) = -1;

elseif (A(q) == -1) && (SIGNALS(q)<=-0.01) && (SIGNALS(q)<=0.01)
  A(q+1) = -1;

elseif (A(q) == -1) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)<0 && SIGNALS(q)<0
  A(q+1) = -1;

elseif (A(q) == -1) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)>0 && SIGNALS(q)>0
  A(q+1) = 1;

elseif (A(q) == -1) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)<0
  A(q+1) = -1;

% Case A = 1

elseif (A(q) == 1) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)<0 && SIGNALS(q)<0
  A(q+1) = 1;
  Cost(q) = -1*(price_modify(q)+(0.01*price_modify(q)));

elseif (A(q) == 1) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)>0 && SIGNALS(q)>0
  A(q+1) = 1;

elseif (A(q) == 1) && (SIGNALS(q)<-0.01) && SIGNALS(q-1)<0
  A(q+1) = 1;

elseif (A(q) == 1) && (SIGNALS(q)>=-0.01) && (SIGNALS(q)<=0.01)
  A(q+1) = 1;
elseif (A(q) == 1) && (SIGNALS(q)>0.01) && SIGNALS(q-1)<0 && SIGNALS(q)>0
    A(q+1) = 1;
elseif (A(q) == 1) && (SIGNALS(q)>0.01) && SIGNALS(q-1)>0 && SIGNALS(q)>0
    A(q+1) = 1;
elseif (A(q) == 1) && (SIGNALS(q)>0.01) && SIGNALS(q-1)<0 && SIGNALS(q)<0
    A(q+1) = 1;
end
if q==P(r+1)
    if A(q) == -1
        A(q)= 0;
        Revenue(q)= price_modify(q)-(0.01*price_modify(q));
        elseif A(q) == 1
        A(q)=0;
        Cost(q)= -1*(price_modify(q)+(0.01*price_modify(q)));
        elseif A(q) == 0
        A(q+1)=0;
    end
end
end
%Preallocation
sum_revenue=zeros(1,y2);
sum_cost=zeros(1,y2);
for z=1:y2-1
    T1=0;
    T2=0;
    for d=P(z):P(z+1)
        T1 = T1+Revenue(d);
        T2 = T2+Cost(d);
    end
    sum_revenue(z)=T1;
    sum_cost(z)=T2;
end
% last section of month
%  T3=0;
%  T4=0;
% for d1=P(y2):x1
%   T3 = T3+Revenue(d1);
%   T4 = T4+Cost(d1);
% end
%
% sum_revenue(y2)=T3;
% sum_cost(y2)=T4;

% Compute formula
% Result
result1=zeros(y2,1);

for z=1:y2
    result1(z)=(sum_revenue(z)+sum_cost(z))/(-1*sum_cost(z));
    if sum_cost(z)==0
        % result1(z)=double('NA');
        XX = str2double('NA');
        result1(z)=XX;
    end
end

% Date
result2 = datestr(date(P+1), 'mm/dd/yy');

% Combine result1 and result2
YY = date(P+1)';

datecol = 1;
YY(:,datecol) = YY(:,datecol) - datenum('30-Dec-1899');
result=cat(2,YY, result1);

---

Bollinger Band Bottom Reversal

% Import the data
filename = 'ADVANC.BK.xlsx';
[ndata, text, alldata] = xlsread(filename);
price = ndata(:,4);
x1,x2 = size(price);
price_modify=price;
sell_signal=zeros(1,x1);
buy_signal=zeros(1,x1);

% Preallocation
date=zeros(1,x1);

for z= 1:x1
    date(z)=datenum(alldata(z,1), 'mm/dd/yyyy');
end

month_trading = month(date);

% Construction of Bollinger bands
[mid,uppr,lowr] = bollinger(price,20,1,2);
dis_CloseBolling = [mid,uppr,lowr,price];
%plot(dis_CloseBolling)

count=0;
for q=2:(x1)
  if month_trading(q)== month_trading(q-1)
    count = count+1;
  end
end

Cost=zeros(1,x1);
Revenue=zeros(1,x1);
sum_Revenue = zeros(1,count);
sum_Cost = zeros(1,count);
A = zeros(1,x1);
index = zeros(1,x1);

for q=1:x1-1
  if month_trading(q+1)== month_trading(q)
    index(q)= 1;
  else
    index(q)=0;
  end
end
P=find(index);

% dimension (y2=size of month change)
[y1,y2] = size(find(index));

% For A, buy = -1, open = 0, sell = 1
for r=1:y2-1
  for q=P(r):P(r+1)
    % case A = 0
    % long position
    if A(q) == 0 && price(q-1)< price(q) &&...
      price(q-1)< lowr(q-1) && price(q)< lowr(q)
      A(q+1) = -1;
      Cost(q)= -1*(price_modify(q)+(0.01*price_modify(q)));
    elseif A(q) == 0 && price(q-1)< price(q) &&...
      price(q-1)< lowr(q-1) && price(q)>= lowr(q)
      A(q+1) = 0;
    elseif A(q) == 0 && price(q-1)>= price(q) &&...
      price(q-1)>= lowr(q-1)
      A(q+1) = 0;
    elseif A(q) == 0 && price(q-1)< price(q) &&...
      price(q-1)< lowr(q-1)
      A(q+1) = 0;
    elseif A(q) == 0 && price(q-1)>= price(q)
      A(q+1) = 0;
    elseif A(q) == 0 && price(q-1)< price(q) &&...
      price(q-1)< lowr(q-1)
\[
\text{price}(q-1) < \text{lowr}(q-1) \land \text{price}(q) < \text{lowr}(q)
\]
\[
A(q+1) = 0;
\]

% short position
\[
\text{elseif } A(q) == 0 \land \text{price}(q) >= \text{uppr}(q)
\]
\[
A(q+1) = 1;
\]
\[
\text{Revenue}(q) = 1 \times (\text{price}_\text{modify}(q) - (0.01 \times \text{price}_\text{modify}(q)));
\]

\[
\text{elseif } (A(q) == 0) \land \text{price}(q) < \text{uppr}(q)
\]
\[
A(q+1) = 0;
\]

% Case A = -1
\[
\text{elseif } A(q) == -1 \land \text{price}(q-1) < \text{price}(q) \land \ldots
\]
\[
\text{price}(q-1) < \text{lowr}(q-1) \land \text{price}(q) < \text{lowr}(q)
\]
\[
A(q+1) = -1;
\]

\[
\text{elseif } A(q) == -1 \land \text{price}(q-1) < \text{price}(q) \land \ldots
\]
\[
\text{price}(q-1) < \text{lowr}(q-1) \land \text{price}(q) >= \text{lowr}(q)
\]
\[
A(q+1) = -1;
\]

\[
\text{elseif } A(q) == -1 \land \text{price}(q-1) >= \text{lowr}(q-1)
\]
\[
A(q+1) = -1;
\]

\[
\text{elseif } A(q) == -1 \land \text{price}(q-1) >= \text{price}(q)
\]
\[
A(q+1) = -1;
\]

\[
\text{elseif } A(q) == -1 \land \text{price}(q) >= \text{uppr}(q)
\]
\[
A(q+1) = 0;
\]
\[
\text{Revenue}(q) = 1 \times (\text{price}_\text{modify}(q) - (0.01 \times \text{price}_\text{modify}(q)));
\]

\[
\text{elseif } A(q) == -1 \land \text{price}(q) < \text{uppr}(q)
\]
\[
A(q+1) = -1;
\]

% Case A = 1
\[
\text{elseif } A(q) == 1 \land \text{price}(q-1) < \text{price}(q) \land \ldots
\]
\[
\text{price}(q-1) < \text{lowr}(q-1) \land \text{price}(q) < \text{lowr}(q)
\]
\[
A(q+1) = 0;
\]
\[
\text{Cost}(q) = -1 \times (\text{price}_\text{modify}(q) + (0.01 \times \text{price}_\text{modify}(q)));
\]

\[
\text{elseif } A(q) == 1 \land \text{price}(q-1) < \text{price}(q) \land \ldots
\]
\[
\text{price}(q-1) < \text{lowr}(q-1) \land \text{price}(q) >= \text{lowr}(q)
\]
\[
A(q+1) = 1;
\]

\[
\text{elseif } A(q) == 1 \land \text{price}(q-1) < \text{price}(q) \land \ldots
\]
\[
\text{price}(q-1) >= \text{lowr}(q-1)
\]
\[
A(q+1) = 1;
\]

\[
\text{elseif } A(q) == 1 \land \text{price}(q-1) >= \text{price}(q)
\]
\[
A(q+1) = 1;
\]
elseif (A(q) == 1) && price(q) >= uppr(q)
    A(q+1) = 1;

elseif (A(q) == 1) && price(q) > uppr(q)
    A(q+1) = 1;
end

if q == P(r+1)
    if A(q) == -1;
        A(q) = 0;
        Revenue(q) = price_modify(q) - (0.01*price_modify(q));
    elseif A(q) == 1;
        A(q) = 0;
        Cost(q) = -1*(price_modify(q) + (0.01*price_modify(q)));
    elseif A(q) == 0;
        A(q) = 0;
    end
end

end

end

% last element of matrix, need to close position

% Preallocation
sum_revenue=zeros(1,y2);
sum_cost=zeros(1,y2);

for z=1:y2-1
    T1=0;
    T2=0;
    for d=P(z):P(z+1)
        T1 = T1 + Revenue(d);
        T2 = T2 + Cost(d);
    end

    sum_revenue(z)=T1;
    sum_cost(z)=T2;
end

% last section of month
% T3=0;
% T4=0;
% for d1=P(y2):x1
%     T3 = T3+Revenue(d1);
%     T4 = T4+Cost(d1);
% end
% sum_revenue(y2)=T3;
% sum_cost(y2)=T4;

% Compute formula
% Result
result1=zeros(y2,1);

for z=1:y2
    result1(z)=(sum_revenue(z)+sum_cost(z))/(-1*sum_cost(z));
    if sum_cost(z)==0
        % result1(z)=double('NA');
        XX = str2double('NA');
        result1(z)=XX;
    end
end

% Date
result2 = datestr(date(P+1),'mm/dd/yy');

% Combine result1 and result2
YY = date(P+1)';
datecol = 1;
YY(:,datecol) = YY(:,datecol) - datenum('30-Dec-1899');
result=cat(2,YY, result1);

% xlswrite('new_log.xls', result);
% xlswrite(filename, result);
% Make a base file name that has a number embedded in it.
baseFileName = sprintf('KDJs1_%s', filename);
% Combine it with the folder to get the full path of the file.
fullFileName = fullfile(KDJ_s1_results, baseFileName);
% Now write it out to an Excel workbook.
%csvwrite(baseFileName, result);
BIOGRAPHY

Name
Ms. Nimesha Priyangi SenanayakeIhala Gamage

Date of Birth
October 24, 1987

Education
2008: Bachelor of Science (Mathematics)
Faculty of Science
University of Ruhuna
Sri Lanka

2017: Master of Science (Engineering Technology)
Thammasat University
Thailand

Ref. code: 25615922040885AXY