

# **Random Walk down the SET, Can We Really Beat the Market Using Simple Technical Analysis?<sup>1</sup>**

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## **Abstract**

This study examines the potential benefit of employing the most commonly used technical trading strategies on the Thai stock market. The study is based on the Stock Exchange of Thailand (SET) Index over the period of April 1975 to April 2006. Two hundreds and eighty eight different moving average and eighty different trading range break trading models are assessed. The findings reveal the predictive ability of technical trading rules. In the presence of transaction costs which are measured through our new method, results show that both variable-length and fixed-length moving average rules generate extra returns as compared to the buy-and-hold strategy. The trading-range-break rules, even though have return predictability, in some cases underperform the buy-and-hold strategy due to an inability to generate enough return to compensate for the commission fee.

## **1. Introduction**

Nowadays, all major brokerage firms in the Thai stock market give advices to their clients regarding when to buy or to sell stocks. These advices are mainly based on the analysis known as "Technical Analysis". Technical analysis covers a class of trading techniques analyzing pattern of past prices in order to predict future prices. The forecasting power of technical analysis still remains controversial in the literatures. Several studies evidence benefits of using technical analysis, whereas the other suggests the opposite. Mostly, these researches are conducted on the world major stock exchanges. Few researchers studied on the Thai stock market and found those simple trading strategies, net of transaction costs, could generate extra return over the buy-and-hold strategy. They found evidence of pattern or trend of stock prices in the Stock Exchange of Thailand (SET). Their findings are against the weak-form market efficiency hypothesis: the random-walk, which suggests that stock prices randomly move without pattern.

These researches, however, can be considered premature because the period of study is not sufficiently long, and more importantly, does not cover the 1997 market crash. In general, price patterns are the result of speculative forces, which in turn, cause stock market bubbles. For Thailand, after the market crash, price patterns or trends could disappear. If this is the case, technical commentary on Thai stocks published by the brokerage firms would yield no benefit. Their comments, then, should be based on another competing ground of stock analysis, the fundamental analysis. On the other hand, if the trend still exists, it suggests possibility for investors to earn extra profit.

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In this paper, our objective is to provide more recent evidence on this issue. We investigate whether the most frequently used trading rules - moving average and trading range break - can beneficially signal the time to enter into and to exit from the SET. Specifically, we investigate whether these trading strategies can generate significantly positive return; and test whether there exists the difference in returns given by buy signals and those given by sell signals.

Our study differs from previous studies in many aspects. It is carried over longer period of time. Our data is also more recent and explicitly covers period after the 1997 market crash. Moreover, we use an in depth investigation in which we employ as many rules as possible. Most importantly, we introduce a new measurement of brokerage commission fees that reflect the actual transaction costs, hence a more precisely measurement of the profits.

We present a review of previous researches in the next section. In section 3, technical trading rules commonly used by market practitioners are introduced and discussed. A discussion on the data and the methodology employed in this study is in section 4. The empirical results are reported and discussed in section 5. Finally, the conclusions of this study are presented in section 6.

## 2. Literature Review

If stock prices follow a random walk their movements are unpredictable, given historical prices. As a result, technical analyses would yield no merit for investors to earn extra return. However, predictability does not necessarily imply market inefficiency as long as no extra return is generated by investor who possesses such predictability. Empirical studies focusing on this issue are still in controversial. Early researches by Roberts (1959), Fama and Blume (1966), and Jensen and Benington (1970) find that technical trading rules cannot be successfully used in the U.S. equity markets, supporting the weak-form of market efficiency. In contrast, Brock et al. (1992) and Sweeney (1986) show that even simple technical trading rules are able to predict future returns in the US equity market and in the currency market. Hudson et al. (1996) and Ready (1997) find that the technical trading rules of Brock et al. (1992), even though having power to predict series of returns, yield no significant gains after transaction costs are factored in.

For emerging markets, Aggarwal and Rivoli (1989), Cadsby and Ratner (1992), and Agrawal and Tandon (1994) identify seasonalities and evidence seasonal effects on stock returns. Urrutia (1995) also rejects the random-walk hypothesis for Latin American markets. Harvey (1995b) utilizes a pricing model to address return predictability in emerging markets. He contends that emerging market returns seem to be predictable when international and local risk factors are used. These finding is supported by Ratner and Leal (1999) who test trading rules in the emerging markets of Latin America and Asia. Their results show that technical trading strategies may be profitable in Taiwan, Thailand, and Mexico. Similarly, Bessembinder and Chan (1995) investigate equity market of six Asian countries including Hong Kong, Japan, Korea, Malaysia, Thailand and Taiwan over the period 1975-1991. By using trading rules of Brock et al (1992), they evidence the strongest return predictability of technical analysis in the emerging markets of Malaysia, Thailand, and Taiwan.

### 3. Technical Trading Rules

Among technical trading rules used by market practitioners, Variable-length moving average (VMA), Fixed-length moving average (FMA), and trading range breakout (TRB) rules are among the most popular ones. In this section, we provide description and motivation of these trading rules.

#### A. Moving Averages (MA)

The moving average rules generate a signal (either buy or sell) by comparing a short-term moving average of stock price to a long-term moving average. When the recent demand is higher than the long-run average, or in other words, the short-term moving average (calculated over  $S$  days) exceeds the long-term moving average (calculated over  $L$  days, where  $L > S$ ), a buy signal (at time  $t$ ) is emitted:

$$\frac{\sum_{s=1}^S P_{t-s-1}}{S} > \frac{\sum_{l=1}^L P_{t-l-1}}{L} \quad (1)$$

where  $P_t$  is the stock price at time  $t$ .

In contrast, when the current demand is below the long-run average, hence the short-term moving average is lower than the long-term moving average, a sell signal is emitted:

$$\frac{\sum_{s=1}^S P_{t-s-1}}{S} < \frac{\sum_{l=1}^L P_{t-l-1}}{L} \quad (2)$$

The periods of short-term and long-term averages can be selected arbitrarily, hence the name Variable-length moving average (VMA). According to Bessembinder and Chan (1995), the most popular rule is 1-200, where the short average is one day and the long average is 200 days. In this paper, we also test other variations using 1, 2, and 5 day(s) as short-term average and using 50, 100, 150, and 200 days as long-term average. Under this setting, VMA rules classify all days into either buys or sells.

Fixed-length moving average (FMA) rules are similar to VMA rules except that for FMA rules, once the signal is initially emitted, it will be held for a certain period. Any signal within this holding period will be ignored. After the holding period, new signal is then again generated (using conditions (1) and (2)) and held. For the FMA rules, signals are generated every period, instead of everyday. Thus, it results in fewer transactions. Note that the selection of number of days for the signal holding-period is arbitrary. Five, Ten, Twenty, and Thirty days of holding period are chosen for this study.

### B. Trading Range Breakout (TRB)

Trading Range Breakout rules compare the current stock price to the recent local minimum and local maximum, so called the support and the resistance levels, respectively. As suggested in Brock et al (1992), technical analysts believe that many investors are willing to sell stock when price reaches its expected maximum. As a result, their selling will cause resistant pressure to price not to rise above the previous peak. However, if the price penetrates the previous peak, it suggests a newly higher expected maximum; hence the buy signal is emitted:

$$P_t > \text{Max}[P_{t-1}, P_{t-2}, P_{t-3}, \dots, P_{t-T}] \quad (3)$$

Similarly, many investors are willing to buy stock when price is at expected minimum. Therefore, we can expect that price will adversely move if the price falls below the previous minimum or the support level. A sell signal is then emitted:

$$P_t < \text{Min}[P_{t-1}, P_{t-2}, P_{t-3}, \dots, P_{t-T}] \quad (4)$$

In accordance with the moving average rules, we implement the TRB rules by determining previous maximum (or minimum) prices on the past 50, 100, 150, and 200 days.

## 4. Data and Methodology

### A. Data

We use the daily closing prices of the Thai SET index from April 30, 1975 to April 28, 2006, a total of 31 years. The full sample is also divided into 3 sub-periods of 11, 11 and 9 years. Note that the last sub-period is intended to represent the period after the Thai financial crisis in 1997.

The daily return for signal generated at the end of day  $t$  (identically, at the beginning of day  $t+1$ ) is computed from daily closing prices, and is expressed as:

$$r_t = \ln \left[ \frac{SET_{t+1}}{SET_t} \right] \quad (5)$$

where  $SET_t$  is the closing value of the SET index for day  $t$ .

The average daily return generated by buy signal, or the average daily buy return,  $\bar{r}_{buy}$ , is computed as:

$$\bar{r}_{buy} = \frac{\sum_{t=1}^N r_t \times I_t^{buy}}{N_{buy}} \quad (6)$$

where  $N$  is the number of days in sample period;  $N_{buy}$  is the number of days for buy signal; and  $I_t^{buy}$  is the indicator function whose value is one for a buy signal observed at the end of day  $t$ , and zero otherwise. The average daily return generated by sell signal, or the average daily sell return, is also computed in a similar manner and denoted by  $\bar{r}_{sell}$ .

In this study, we test the following hypotheses:

Hypothesis 1:

$H_0$ : The average returns generated by buy signal equal to the average returns generated by the buy-and-hold strategy (or the unconditional mean).

$H_1$ : The average returns generated by buy signal are not equal to the average returns generated by the buy-and-hold strategy (or the unconditional mean).

Hypothesis 2:

$H_0$ : The average returns generated by sell signal equal to the average returns generated by the buy-and-hold strategy (or the unconditional mean).

$H_1$ : The average returns generated by sell signal are not equal to the average returns generated by the buy-and-hold strategy (or the unconditional mean).

Hypothesis 3:

$H_0$ : The average returns generated by buy signal equal to the average returns generated by sell signal.

$H_1$ : The average returns generated by buy signal are not equal to the average returns generated by sell signal.

To test these hypotheses, we adopt the t-statistics used by Brock et al. (1992) which assume equal variances of the two populations. The t-statistics used to test the first two hypotheses, namely the difference between mean buy (sell) returns and unconditional mean returns, are

$$\frac{\bar{r}_I - \bar{r}}{\sqrt{\left( \frac{Var}{N} + \frac{Var}{N_I} \right)}} \quad (7)$$

where  $\bar{r}_I$  and  $N_I$  are the average return and number of signals for the buys and sells, and  $\bar{r}$  and  $N$  are the unconditional mean and number of observations.  $Var$  is the estimated variance for the entire sample.

Another t-statistic used to test the third hypothesis on the difference between mean buy and mean sell returns are

$$\frac{\bar{r}_{buy} - \bar{r}_{sell}}{\sqrt{\left( \frac{Var}{N_{buy}} + \frac{Var}{N_{sell}} \right)}} \quad (8)$$

### B. Profits Measurement

To compare our results to those of Brock et al. (1992) and Bessembinder and Chan (1995), we measure the profit from applying technical trading rules over the buy-and-hold strategy, by employing their framework of “double or out” strategy. Under this trading strategy, when the buy signal is emitted, an investor who is assumed to have a long position in stocks will borrow, at the daily interest rate  $i_t$ , to double his/her equity investment. When sell signal is emitted, the investor will sell all the shares and invest the proceeds in the money market. In some cases, when no signal is emitted, the investor will simply hold his/her long equity position. The pre-transaction cost return<sup>3</sup> earned by technical trading ( $TR$ ) can then be computed as follows: on buy day,  $TR_t = 2r_t - i_t$ ; and on sell day  $TR_t = i_t$ . The return on the day no signal is emitted is return of the long equity position,  $TR_t = r_t$ . Using this setting, total return of using technical trading rules can be expressed as:

$$\sum TR_t = [(2r_t - i_t) \times N_{buy}] + [i_t \times N_{sell}] + [r_t \times N_{none}] \quad (9)$$

where  $N_{none}$  is the number of days no signal is emitted.

Since the daily interest rate data over our long sample period is not available, we approximate the total return of using technical trading rules by assuming that investors borrow and lend at the same interest rate, and that  $N_{buy}$  is equal to  $N_{sell}$ <sup>4</sup>. As a result, the total return of using technical trading rule is simplified as:

$$\sum TR_t = [2r_t \times N_{buy}] + [r_t \times N_{none}] \quad (9')$$

The profit or extra return ( $\pi$ ) can then be measured as the difference between the terminal value per a currency unit initially invested obtained under technical trading rule ( $TVTR_t$ ) and that obtained under buy-and-hold strategy ( $TVBH_t$ ), net of transaction costs.

Although using the same trading strategy, our study has two main differences from previous studies. First, Bessembinder and Chan (1995) define the terminal value by ignoring the compounding effect. They simply multiply the product of currency unit invested by one plus the sum of daily returns. To illustrate, we use the example of the SET index during a selected time period. The SET index on April 30, 1975 and April 28, 2006 are 100 and 768.29 respectively. Moreover, the sum of daily return over this period is 203.90 percent. According to Bessembinder and Chan (1995), buy-and-hold investor who had invested one baht on April 30, 1975 would end up with 3.039 baht wealth on April 28, 2006, instead of 7.6829 baht. To take into account the effect of compounding, the terminal values per a currency unit initially invested obtained under technical trading rule,

<sup>3</sup> In this paper, return is defined as a percentage of currency unit initially invested.

<sup>4</sup> Our results suggest that the number of days buy signals are generated are very close to the number of days sell signals are generated. Thus, the spread between borrowing and lending rates will not bias our total return measure.

$$TVTR_t = \exp(\sum TR_t) \quad (10)$$

and the terminal values per a currency unit initially invested obtained under buy-and-hold strategy,

$$TVBH_t = \exp(\sum r_t) \quad (11)$$

The profit from applying technical trading rules over the buy-and-hold strategy,

$$\pi = TVTR_t - TVBH_t - C \quad (12)$$

where  $C$  denotes the total transaction costs<sup>5</sup>.

The second difference of our study from previous researches is of the presence of the transaction costs. Traders would incur transaction costs as they follow technical trading rules. Brock et al. (1992) and Bessembinder and Chan (1995) assume that transaction costs as percentage of currency unit initially invested, not as percentage of equity market value being transacted, are constant over the study period. Their measure therefore underestimates actual transaction costs since the equity values normally increase overtime. In this study, we relax this assumption by computing the commission fees that actually incur. The transactions occur when new signals are initially emitted. Moreover, for investors who employ “double or out” trading strategy, their costs are doubled in case of VMA and FMA rules. This is because they change from holding two positions to none or vice versa. The total transaction costs over the sample period of the VMA and FMA rules can therefore be computed as:

$$C = 2 \times \sum_{t=1}^N \left[ \frac{SET_t}{SET_1} \times I_t^{New} \times \text{Commission fee} \right] \quad (13)$$

where  $SET_t$  is the closing index of day  $t$ ;  $\text{Commission fee}$  is a percentage one-way brokerage commission fee; and  $I_t^{New}$  is the indicator function whose value is one for a day in which new signal is initially emitted, and zero otherwise.

Unlike, VMA and FMA rules in which buy or sell signal is generated everyday, TRB rules sometimes generate no signal. As mentioned earlier, an investor responds to the no-signal by simply holding his/her long equity position, not by borrowing to double the position as when buy signal is emitted, or not by selling all position as when sell signal is emitted. In case of TRB rules, therefore, the transaction cost for double-or-out investor is not always doubled as in case of VMA and FMA rules. More specifically, when a no-signal initially occurs; an investor changes either from

<sup>5</sup> To be consistent with the profit measure, transaction cost is also computed as a percentage of currency unit initially invested. Moreover, in this study transaction cost is limited to only the brokerage commission fee.

holding two equity positions or having no position to holding one position. Similarly, when initially emitted buy or sell signal follows the previous no-signal, an investor change from holding one position to either holding two positions or hold none. Commission fee, in these cases, will be for transaction of only one position, instead of two. The computation of transaction cost in Equation (13) is thus modified as:

$$C = \sum_{t=1}^N \left[ \frac{SET_t}{SET_1} \times (2I_t^{New} - I_t^{None} - I_t^{Followed}) \right] \times \text{Commission fee} \quad (13')$$

where  $I_t^{New}$  is the indicator function whose value is one for a day in which new signal, including buy or sell or no-signal, is initially emitted, and zero otherwise;  $I_t^{None}$  is the indicator function whose value is one for a day in which no-signal is initially emitted, and zero otherwise;  $I_t^{Followed}$  is the indicator function whose value is one for a day in which an initially emitted buy or sell signal follows the previous no-signal, and zero otherwise.

## 5. Empirical Results

### A. Sample Statistics

Table 1 reports summary statistics for the full sample and three subsamples for 1-, 10-day returns on the SET series. In all panels, average return is highest for subperiod immediately before the Thailand financial crisis in 1997, and is lowest for period immediately after. Volatility appears to increase overtime, and is largest for the subperiod following the crisis. Serial correlations are surprisingly high. In all subperiods, Ljung-Box statistics show that each return series are significantly serially correlated with one percent significant level. This suggests a potential benefit of employing technical trading rules to generate extra profit.

**Table 1**  
**Summary Statistics**

This table reports summary statistics for daily and 10-day returns from 30/04/1975 - 28/04/2006 and 3 nonoverlapping subperiods. Returns are measured as log differences of the level of the SET index. 10-day returns are cumulative returns on nonoverlapping periods.  $\rho(i)$  is the estimated autocorrelation at lag  $i$  for each series. Numbers marked with \* (\*\*) are significant at the 5% (1%) levels for a two-tailed test based on Ljung-Box Statistic.

Panel A: Daily Returns

	04/1975 - 04/2006	04/1975 - 04/1986	05/1986 - 04/1997	05/1997 - 04/2006
$N$	8083	2870	2869	2342
Mean	0.00025	0.00009	0.00057	0.00006
SD	0.01429	0.00842	0.01551	0.01799
$\rho(1)$	0.15751**	0.27896**	0.16858**	0.11434**
$\rho(5)$	0.02277**	0.03881**	0.01611**	0.02334**

**Table 1**  
**Summary Statistics**

Panel B: 10-day Returns				
	04/1975 - 04/2006	04/1975 - 04/1986	05/1986 - 04/1997	05/1997 - 04/2006
Mean	0.00255	0.00096	0.00582	0.00089
SD	0.05412	0.03500	0.05951	0.06507
$\rho(1)$	0.93256**	0.94248**	0.93186**	0.92724**
$\rho(5)$	0.57570**	0.60596**	0.54373**	0.58745**

**B. The Moving-Average Strategy**

As described earlier in section 3, the moving average trading rules generate signals by comparing short and long moving averages. When the short moving average is above (below) the long, the buy (sell) signal is emitted. For example, (2, 50) indicates that the short moving averages are calculated using two-day period, while the fifty-day period is used to calculate the long-moving averages. Under this setting, these moving average rules emit either buy or sell signals every day, and are referred to as the “variable-length moving average” (VMA).

**Table 2**  
**Test Results for the Variable-Length Moving Average (VMA) Rules**

This table reports test results for daily return data from 30/04/1975 - 28/04/2006. Trading rules are identified as (short moving average, long moving average). N(Buy) and N(Sell) are the number of buy and sell signals emitted during the sample. Buy and Sell are the average returns on buy days and sell days, respectively. Buy-Sell is the difference between average returns on buy days and sell days. The t-values (reported in parentheses) test the difference of the mean buy and mean sell from the unconditional 1-day average return, and buy-sell from zero. Test results of a selected trading rule for subperiods are reported in Panel B.

Panel A: Full Sample						
Period	Rule	N(Buy)	N(Sell)	Buy	Sell	Buy-Sell
04/1975 - 04/2006	(1, 50)	4285	3749	0.00146 (4.42087)	-0.00111 (-4.83264)	0.00256 (8.01378)
	(1, 100)	4206	3778	0.00119 (3.39831)	-0.00077 (-3.65029)	0.00196 (6.10427)
	(1, 150)	4283	3651	0.00086 (2.14765)	-0.00041 (-2.38872)	0.00127 (3.92861)
	(1, 200)	4432	3452	0.00065 (1.36620)	-0.00019 (-1.61355)	0.00084 (2.58055)
	(2, 50)	4281	3753	0.00137 (4.11610)	-0.00101 (-4.49350)	0.00238 (7.45614)
	(2, 100)	4190	3794	0.00116 (3.27560)	-0.00072 (-3.49969)	0.00189 (5.86758)
	(2, 150)	4271	3663	0.00081 (1.96513)	-0.00035 (-2.17688)	0.00116 (3.58709)

**Table 2**  
**Test Results for the Variable-Length Moving Average (VMA) Rules**

Period	Rule	N(Buy)	N(Sell)	Buy	Sell	Buy-Sell
	(2, 200)	4435	3449	0.00065 (1.34321)	-0.00018 (-1.58803)	0.00083 (2.53855)
	(5, 50)	4295	3739	0.00126 (3.70280)	-0.00089 (-4.06120)	0.00215 (6.72382)
	(5, 100)	4178	3806	0.00103 (2.80938)	-0.00058 (-2.98955)	0.00161 (5.02202)
	(5, 150)	4255	3679	0.00081 (1.97551)	-0.00035 (-2.17658)	0.00116 (3.59582)
	(5, 200)	4429	3455	0.00056 (1.02816)	-0.00007 (-1.21306)	0.00063 (1.94097)
	Average			0.00098	-0.00055	0.00154
Panel B: Subperiods						
04/1975 - 04/1986	(1, 50)	1443	1379	0.00104 (3.30273)	-0.00087 (-3.47158)	0.00191 (5.86716)
05/1986 - 04/1997	(1, 50)	1642	1227	0.00204 (2.86868)	-0.00129 (-3.45542)	0.00333 (5.47586)
05/1997 - 04/2006	(1, 50)	1200	1142	0.00154 (2.23161)	-0.00147 (-2.29900)	0.00301 (3.92358)

In Panel A of Table 2, test results from moving average strategies for the full sample are presented. Columns 5 and 6 report the average daily returns during buy and during sell periods, respectively. All average buy (sell) returns are greater (lower) than the unconditional mean return. For all ten trading rules, the average one-day buy return is 0.098 percent or about 35 percent per annum, which is about four times larger than the unconditional one-day return of 0.025 percent. For the sells, all the sell returns are negative. The average one-day sell return for ten trading rules is -0.055 percent or about 20 percent per annum. At 5 percent significance level, 9 of the 12 two-tailed *t* tests reject the null hypotheses 1 and 2 that returns on buy and on sell days equal the unconditional returns. The tests are unable to reject these hypotheses for the rules using two hundred-day period in calculation of the long moving average.

As shown in column 7, all the buy-sell differences are positively significant, rejecting the null hypothesis 3 - the equality of buy and sell returns. The number of buy and sell signals generated are also reported in column 3 and 4. For each of the trading rules, buy signals are slightly more emitted than sells suggesting a speculative behavior of market participants.

In Panel B of Table 2, test results for all three subperiods are very consistent with those for the full sample reported above. Due to limitation of space, only results for (1, 50) are presented.

As suggested by Brock et al. (1992), the negative returns on sell days, especially when sell days count for a significant fraction of all trading days, imply that returns are predictable. This predictability can reflect either changes in expected return or market inefficiency. Although expected returns are possible to vary, none of the

existing equilibrium models can explain negative returns over such a large fraction of trading days.

As a variant of the VMA rule in which signals are emitted every trading day, the fixed-length moving average (FMA) rules generate signals every fixed holding period. The fixed holding period of 5, 10, 20, and 30 days are examined; however, to save space, only results for the 10-day FMA rules are reported in Table 3. For all the tests and for all four holding periods, the average buy (sell) returns are positive (negative) and the buy-sell differences are positive. However, the t-statistics are lower and less significant when the fixed holding period increases. As shown in the last column of Table 3, at the 5 percent significance level, 10 out of the 12 tests for the 10-day FMA rules indicate that buy-sell differences are positively significant. The same results are found for only 6 out of 12 tests for the 30-day FMA rules.

Overall, the test results for the FMA rules for the full sample are consistent with those for the VMA rules in which (1) returns on buy (sell) days are positive (negative), (2) sell days count for a large fraction of all trading days, and (3) the difference between buy and sell returns are generally positive.

Test results for FMA rules for all three subperiods are also reported in Panel B of Table 3. The results reveal some striking evidences that return predictability reduces after the 1997 financial crisis; as the t-tests for (1, 50), for all four fixed holding periods, are unable to reject null hypotheses 1 and 2.

### C. *The Trading Range Break Strategy*

With the TRB rule, a buy (sell) signal is generated when the index level moves above (below) the resistance (support) level. Resistance and support levels are computed by local maximums and local minimums over the preceding 50, 100, 150, and 200 days. Similar to the FMA rule, once the signal is emitted, it will be held for a certain period. However, unlike the VMA and FMA rules in which either buy or sell signals are emitted every trading day; TRB rule may generate no signal on some trading days. Test results for each of the TRB rules using 5-, 10-, 20-, and 30-day holding periods are investigated. To save space, we reported only results for the 10-day TRB rules in Table 4. Among three trading strategies studied, TRB rules appear to have lowest predictability power. Average returns on sell days are positively significant in some cases. As shown in the last column of Table 4, only 10 out of 16 tests reject the null hypothesis that buy-sell differences equal to zero.

Table 3

**Test Results for the 10-Day Fixed-Length Moving Average (FMA) Rules**

This table reports test results for daily return data from 30/04/1975 - 28/04/2006. Trading rules are identified as (short moving average, long moving average). N(Buy) and N(Sell) are the number of buy and sell signals emitted during the sample. Buy and Sell are the cumulative returns for fixed 5-day period after buy and sell signals are emitted, respectively. Buy-Sell is the difference between average cumulative 5-day returns over buy periods and sell periods. The t-values (reported in parentheses) test the difference of the mean buy and mean sell from the unconditional 10-day mean return, and buy-sell from zero. Test results of a selected trading rule for subperiods are reported in Panel B.

Panel A: Full Sample						
Period	Rule	N(Buy)	N(Sell)	Buy	Sell	Buy-Sell
04/1975 - 04/2006	(1, 50)	431	372	0.01172 (2.73861)	-0.00794 (-3.02201)	0.01966 (4.98887)
	(1, 100)	415	383	0.01004 (2.18591)	-0.00534 (-2.30648)	0.01538 (3.89053)
	(1, 150)	423	370	0.00851 (1.71516)	-0.00388 (-1.87585)	0.01239 (3.10992)
	(1, 200)	449	339	0.00545 (0.78409)	-0.00060 (-0.94607)	0.00605 (1.49840)
	(2, 50)	430	373	0.01194 (2.80019)	-0.00813 (-3.07964)	0.02007 (5.09211)
	(2, 100)	416	382	0.00976 (2.10200)	-0.00506 (-2.22540)	0.01482 (3.74765)
	(2, 150)	427	366	0.00776 (1.49732)	-0.00314 (-1.65996)	0.01090 (2.73430)
	(2, 200)	444	344	0.00592 (0.92309)	-0.00113 (-1.09477)	0.00704 (1.74756)
	(5, 50)	425	378	0.01064 (2.40207)	-0.00641 (-2.59798)	0.01705 (4.33018)
	(5, 100)	415	383	0.00915 (1.92067)	-0.00437 (-2.02661)	0.01351 (3.41846)
	(5, 150)	426	367	0.00757 (1.43907)	-0.00289 (-1.58998)	0.01046 (2.62325)
	(5, 200)	439	349	0.00657 (1.11549)	-0.00185 (-1.30041)	0.00842 (2.09226)
	Average			0.00875	-0.00423	0.01298
Panel B: Subperiods						
04/1975 - 04/1986	(1, 50)	146	137	0.00800 (1.87661)	-0.00628 (-1.97332)	0.01428 (3.33428)
05/1986 - 04/1997	(1, 50)	170	116	0.01653 (1.82550)	-0.00966 (-2.35367)	0.02620 (3.61938)
05/1997 - 04/2006	(1, 50)	120	114	0.00901 (1.16898)	-0.00815 (-1.20964)	0.01716 (2.05994)

#### D. Terminal Wealth and Profit

Tables 5 to 8 report the average terminal wealth of investment following technical trading strategies, comparing to that following the buy-and-hold strategy. The terminal wealth is computed as the average annualized value of one currency unit invested over the full sample period, as well as over the subperiods. Profits are also reported in the last column of each table. Profit is computed by the difference between terminal wealth of technical strategy and that of buy-and-hold strategy, and net of brokerage commission fees which is calculated based on 0.5 percent standard rate for a round-trip transaction in Thailand.

**Table 4**  
**Test Results for the 10-Day Trading Range Break (TRB) Rules**

This table reports test results for daily return data from 30/04/1975 - 28/04/2006. Trading rules are identified as number of preceding days used in computing of local minimums and maximums. N(Buy) and N(Sell) are the number of buy and sell signals emitted during the sample. Buy and Sell are the cumulative returns for fixed 5-day period after buy and sell signals are emitted, respectively. Buy-Sell is the difference between average cumulative 5-day returns over buy periods and sell periods. The t-values (reported in parentheses) test the difference of the mean buy and mean sell from the unconditional 5-day mean return, and buy-sell from zero. Test results for subperiods are reported in Panel B.

Panel A: Full Sample						
Period	Rule	N(Buy)	N(Sell)	Buy	Sell	Buy-Sell
04/1975 - 04/2006	50	85	61	0.02107 (2.97058)	-0.00957 (-1.67802)	0.03064 (3.34729)
	100	72	44	0.01996 (2.57454)	-0.00388 (-0.77034)	0.02383 (2.27901)
	150	64	33	0.02322 (2.87958)	0.00349 (0.08024)	0.01973 (1.67952)
	200	57	28	0.02277 (2.64632)	0.00270 (-0.01133)	0.02007 (1.58226)
Panel B: Subperiods						
04/1975 - 04/1986	50	23	24	0.02812 (3.61484)	-0.01623 (-2.35926)	0.04435 (4.40560)
	100	17	20	0.03799 (4.26676)	-0.01784 (-2.38571)	0.05583 (4.90629)
	150	16	15	0.03861 (4.16726)	-0.01014 (-1.24963)	0.04875 (3.90500)
	200	13	12	0.04096 (3.95851)	-0.00528 (-0.67545)	0.04624 (3.30641)
05/1986 - 04/1997	50	48	17	0.01100 (0.54458)	-0.00720 (-0.87491)	0.01820 (1.07483)
	100	39	17	0.00424 (-0.16287)	-0.00720 (-0.87491)	0.01144 (0.65586)
	150	31	5	0.00325 (-0.23390)	0.00761 (0.06279)	-0.00435 (-0.15055)

**Table 4**  
**Test Results for the 10-Day Trading Range Break (TRB) Rules**

Period	Rule	N(Buy)	N(Sell)	Buy	Sell	Buy-Sell
05/1997 - 04/2006	200	27	5	0.00373 (-0.18049)	0.00761 (0.06279)	0.00611 (-0.13282)
	50	22	21	0.03295 (2.27871)	-0.02544 (-1.80222)	0.05839 (3.01132)
	100	17	13	0.03242 (1.98968)	-0.02123 (-1.20815)	0.05365 (2.29089)
	150	13	12	0.04024 (2.18613)	-0.01839 (-1.01202)	0.05863 (2.30435)
	200	13	11	0.04024 (2.18613)	-0.01949 (-1.02748)	0.05974 (2.29435)

Table 5 shows profits of the VMA rules. Excluding of the commission fee, all 48 VMA strategies create higher terminal wealth than the buy-and-hold strategy. Moreover, when commission fee is incorporated, 40 VMA strategies still generate extra profits than the buy-and-hold strategy. The highest profit of 52.85 percent is generated using (5, 50) strategy in the subperiod before the crisis.

**Table 5**  
**Profits of the Variable-Length Moving Average (VMA) Trading Strategies**

This table reports terminal wealth and annualized profits of the VMA trading strategies employed on daily return data from 30/04/1975 - 28/04/2006. Trading rules are identified as (short moving average, long moving average). “TR Wealth” and “BH Wealth” are the average terminal wealth of one currency unit invested for one year following trading strategies and buy-and-hold strategy, respectively. “TR-BH” is the difference between TR Wealth and BH Wealth. “Commission” is the commission cost of employing trading rule. “Profit” is the increment wealth gaining from trading rule over buy-and-hold strategy and net of commission fee. Profits for subperiods are reported in Panel B.

Panel A: Full Sample						
Period	Rule	TR Wealth	BH Wealth	TR-BH	Commission	Profit
04/1975 - 04/2006	(1, 50)	1.49580	1.06980	0.42600	0.27519	0.15080
	(1, 100)	1.38230	1.07061	0.31169	0.19013	0.12156
	(1, 150)	1.26713	1.07198	0.19515	0.21477	-0.01962
	(1, 200)	1.20515	1.07462	0.13053	0.26201	-0.13148
	(2, 50)	1.46170	1.06980	0.39190	0.21555	0.17635
	(2, 100)	1.36856	1.07061	0.29795	0.14281	0.15514
	(2, 150)	1.24922	1.07198	0.17724	0.16822	0.00902
	(2, 200)	1.20313	1.07462	0.12852	0.19698	-0.06846
	(5, 50)	1.41843	1.06980	0.34863	0.13951	0.20911
	(5, 100)	1.32140	1.07061	0.25079	0.09755	0.15324
	(5, 150)	1.24938	1.07198	0.17740	0.11284	0.06455
	(5, 200)	1.17393	1.07462	0.09932	0.14589	-0.04658

**Table 5**  
**Profits of the Variable-Length Moving Average (VMA) Trading Strategies**

Panel B: Subperiods						
Period	Rule	TR Wealth	BH Wealth	TR-BH	Commission	Profit
04/1975 - 04/1986	(1,50)	1.31507	1.02853	0.28654	0.06381	0.22273
	(1, 100)	1.29296	1.03082	0.26214	0.04292	0.21922
	(1, 150)	1.26821	1.03534	0.23287	0.03726	0.19561
	(1, 200)	1.26428	1.04317	0.22111	0.02495	0.19616
	(2,50)	1.27675	1.02876	0.24799	0.05459	0.19340
	(2, 100)	1.27535	1.03085	0.24449	0.03654	0.20795
	(2, 150)	1.26647	1.03559	0.23088	0.03093	0.19994
	(2, 200)	1.26612	1.04281	0.22331	0.01786	0.20544
	(5,50)	1.24786	1.02891	0.21895	0.03674	0.18221
	(5, 100)	1.26243	1.03058	0.23185	0.02599	0.20586
	(5, 150)	1.26093	1.03526	0.22567	0.01786	0.20781
	(5, 200)	1.25894	1.04326	0.21568	0.01397	0.20171
	05/1986 - 04/1997	1.84123	1.17557	0.66566	0.34615	0.31951
	(1, 100)	1.71681	1.17353	0.54327	0.20077	0.34250
	(1, 150)	1.45650	1.17289	0.28361	0.24522	0.03839
	(1, 200)	1.28487	1.17341	0.11145	0.32356	-0.21211
05/1997 - 04/2006	(2,50)	1.87508	1.17460	0.70048	0.26839	0.43209
	(2, 100)	1.76375	1.17336	0.59039	0.14314	0.44725
	(2, 150)	1.42842	1.17284	0.25557	0.19717	0.05840
	(2, 200)	1.27189	1.17339	0.09851	0.25158	-0.15308
	(5,50)	1.86198	1.17485	0.68713	0.15855	0.52858
	(5, 100)	1.67754	1.17328	0.50426	0.08851	0.41574
	(5, 150)	1.46126	1.17275	0.28850	0.13475	0.15375
	(5, 200)	1.24829	1.17343	0.07486	0.18036	-0.10550
	(1,50)	1.50641	1.01851	0.48790	0.04299	0.44491
	(1, 100)	1.25007	1.01901	0.23107	0.03702	0.19405
	(1, 150)	1.13203	1.01817	0.11387	0.03546	0.07841
	(1, 200)	1.09848	1.01796	0.08052	0.03204	0.04849
	(2,50)	1.40057	1.01730	0.38328	0.03366	0.34962
	(2, 100)	1.18531	1.01847	0.16684	0.02907	0.13777
	(2, 150)	1.10182	1.01795	0.08386	0.02641	0.05745
	(2, 200)	1.10271	1.01825	0.08446	0.02239	0.06207
	(5,50)	1.30128	1.01723	0.28405	0.02541	0.25864
	(5, 100)	1.11950	1.01776	0.10174	0.02210	-0.07964
	(5, 150)	1.07772	1.01794	0.05978	0.01781	0.04196
	(5, 200)	1.03777	1.01791	0.01987	0.01808	0.00179

Similar results are also drawn for the FMA strategies. When commission fee is not incorporated, 237 out of 240 FMA rules generate greater terminal wealth. Yet, 224 rules still yield profit when commission fee is taken into account. As shown in Table 6, most FMA rules overperform the buy-and-hold strategies as they can produce increment returns.

Table 6

**Profits of the 10-day Fixed-Length Moving Average (FMA) Trading Strategies**

This table reports terminal wealth and annualized profits of the 5-day FMA trading strategies employed on daily return data from 30/04/1975 - 28/04/2006. Trading rules are identified as (short moving average, long moving average). "TR Wealth" and "BH Wealth" are the average terminal wealth of one currency unit invested for one year following trading strategies and buy-and-hold strategy, respectively. "TR-BH" is the difference between TR Wealth and BH Wealth. "Commission" is the commission cost of employing trading rule. "Profit" is the increment wealth gaining from trading rule over buy-and-hold strategy and net of commission fee. Profits for subperiods are reported in Panel B.

Panel A: Full Sample						
Period	Rule	TR Wealth	BH Wealth	TR-BH	Commission	Profit
04/1975 - 04/2006	(1, 50)	1.38542	1.07008	0.31534	0.11778	0.19757
	(1, 100)	1.30855	1.07092	0.23763	0.08121	0.15642
	(1, 150)	1.26138	1.07229	0.18909	0.07701	0.11208
	(1, 200)	1.17085	1.07493	0.09592	0.11219	-0.01627
	(2, 50)	1.39253	1.07008	0.32245	0.11978	0.20267
	(2, 100)	1.29928	1.07092	0.22836	0.08105	0.14731
	(2, 150)	1.23832	1.07229	0.16603	0.07519	0.09084
	(2, 200)	1.18472	1.07493	0.10979	0.10505	0.00473
	(5, 50)	1.33881	1.07009	0.26872	0.12191	0.14680
	(5, 100)	1.27754	1.07092	0.20662	0.07899	0.12763
	(5, 150)	1.23118	1.07229	0.15890	0.07465	0.08425
	(5, 200)	1.20457	1.07493	0.12964	0.09695	0.03269

  

Panel B: Subperiods						
Period	Rule	TR Wealth	BH Wealth	TR-BH	Commission	Profit
04/1975 - 04/1986	(1,50)	1.23650	1.02829	0.20821	0.03135	0.17686
	(1, 100)	1.23433	1.03073	0.20360	0.02086	0.18274
	(1, 150)	1.25739	1.03436	0.22304	0.01335	0.20969
	(1, 200)	1.23567	1.04159	0.19408	0.01248	0.18160
	(2,50)	1.23768	1.02828	0.20940	0.02904	0.18036
	(2, 100)	1.23433	1.03073	0.20360	0.02086	0.18274
	(2, 150)	1.26100	1.03435	0.22665	0.01199	0.21466
	(2, 200)	1.23982	1.04156	0.19826	0.01097	0.18729
	(5,50)	1.22353	1.02830	0.19523	0.03063	0.16460
	(5, 100)	1.25541	1.03069	0.22472	0.01889	0.20582
	(5, 150)	1.26228	1.03436	0.22792	0.00979	0.21813
	(5, 200)	1.24301	1.04156	0.20145	0.01239	0.18906
05/1986 - 04/1997	(1,50)	1.66702	1.16602	0.50099	0.14243	0.35856
	(1, 100)	1.55021	1.16602	0.38418	0.08505	0.29913
	(1, 150)	1.38523	1.16602	0.21921	0.09383	0.12538
	(1, 200)	1.25476	1.16602	0.08873	0.13401	-0.04527
	(2,50)	1.70230	1.16602	0.53627	0.12869	0.40758
	(2, 100)	1.55021	1.16602	0.38418	0.08505	0.29913
	(2, 150)	1.38708	1.16602	0.22105	0.08466	0.13639
	(2, 200)	1.27883	1.16602	0.11281	0.12900	-0.01619
	(5,50)	1.70357	1.16602	0.53754	0.13138	0.40616
	(5, 100)	1.56157	1.16602	0.39554	0.08535	0.31019
	(5, 150)	1.44723	1.16602	0.28120	0.08893	0.19227
	(5, 200)	1.28963	1.16602	0.12361	0.12927	-0.00566

**Table 6**  
**Profits of the 10-day Fixed-Length Moving Average (FMA) Trading Strategies**

Panel B: Subperiods						
Period	Rule	TR Wealth	BH Wealth	TR-BH	Commission	Profit
05/1997 - 04/2006	(1,50)	1.27168	1.01711	0.25456	0.02004	0.23453
	(1, 100)	1.16148	1.01711	0.14437	0.01361	0.13076
	(1, 150)	1.12874	1.01711	0.11163	0.01304	0.09859
	(1, 200)	1.04608	1.01711	0.02897	0.01324	0.01573
	(2,50)	1.21182	1.01711	0.19470	0.01994	0.17476
	(2, 100)	1.09455	1.01711	0.07744	0.01363	0.06380
	(2, 150)	1.10011	1.01711	0.08300	0.01188	0.07112
	(2, 200)	1.06509	1.01711	0.04798	0.01327	0.03471
	(5,50)	1.16959	1.01711	0.15248	0.01991	0.13257
	(5, 100)	1.10445	1.01711	0.08733	0.01450	0.07283
	(5, 150)	1.07687	1.01711	0.05975	0.01139	0.04836
	(5, 200)	1.06949	1.01711	0.05238	0.01499	0.03739

For the TRB rules, 62 out of 64 strategies being tested overperform the buy-and-hold strategy in term of terminal wealth created. Net of commission fee, 41 rules return positive profit. In this paper, we report only profits for the 10-day TRB strategies in Table 7. Over the long investment horizon, Panel A shows that TRB rules mostly create loss. However, as we divide investment horizon into shorter periods, results are somewhat interesting. As illustrated in the last column of Panel B, TRB rules create losses only for subperiod when market is in the upward direction, or in a bubble economy. For subperiod after the crisis, TRB rules create large range of profits from 8 to 14 percent.

**Table 7**  
**Profits of the 10-Day Trading Range Break (TRB) Strategies**

This table reports terminal wealth and annualized profits of the 5-day TRB trading strategies employed on daily return data from 30/04/1975 - 28/04/2006. Trading rules are identified as number of preceding days used in computing of local minimums and maximums. "TR Wealth" and "BH Wealth" are the average terminal wealth of one currency unit invested for one year following trading strategies and buy-and-hold strategy, respectively. "TR-BH" is the difference between TR Wealth and BH Wealth. "Commission" is the commission cost of employing trading rule. "Profit" is the increment wealth gaining from trading rule over buy-and-hold strategy and net of commission fee. Profits for subperiods are reported in Panel B.

Panel A: Full Sample

Period	Rule	TR wealth	BH wealth	TR-BH	Commission	Profit
04/1975 - 04/2006	50	1.15452	1.06938	0.08515	0.07978	0.00536
	100	1.12740	1.07042	0.05697	0.06509	-0.00812
	150	1.12024	1.07178	0.04846	0.05173	-0.00328
	200	1.11759	1.07438	0.04320	0.04973	-0.00652

**Table 7**  
**Profits of the 10-Day Trading Range Break (TRB) Strategies**

Panel B: Subperiods						
Period	Rule	TR wealth	BH wealth	TR-BH	Commission	Profit
04/1975 - 04/1986	50	1.04422	1.00989	0.03433	0.02412	0.01021
	100	1.04410	1.01087	0.03323	0.02026	0.01297
	150	1.03761	1.01216	0.02545	0.01851	0.00694
	200	1.03430	1.01461	0.01969	0.01520	0.00449
05/1986 - 04/1997	50	1.23706	1.16602	0.07104	0.12653	-0.05549
	100	1.19692	1.16602	0.03090	0.11313	-0.08223
	150	1.17270	1.16602	0.00668	0.05674	-0.05006
	200	1.17268	1.16602	0.00666	0.04877	-0.04211
05/1997 - 04/2006	50	1.16985	1.01711	0.15273	0.01231	0.14043
	100	1.11501	1.01711	0.09790	0.00837	0.08953
	150	1.10474	1.01711	0.08763	0.00698	0.08065
	200	1.10399	1.01711	0.08687	0.00670	0.08018

In Table 8, we report the average profits of all trading strategies tested in this study. For the full sample, VMA and FMA rules generate extra profits over the buy-and-hold strategy, while the TRB rules generate losses. The average profits of the VMA and the FMA rules are 6.45 percent and 9.98 percent, respectively. While the average loss of the TRB rule is -1.03 percent.

For the subperiods, VMA and FMA rules perform very well in each subperiod. The lowest average profits of 14.62 percent for VMA rule and 6.37 percent for FMA rule are of subperiod 3, the period after the crisis. The TRB rules generate profit in all subperiods, except for subperiod 2, the period before the crisis. Even though having return predictability as evidenced by higher terminal wealth created, in some cases TRB rules underperform the buy-and-hold strategy due to an inability to generate enough return to compensate for the commission fee.

**Table 8**  
**Average Profits of the Trading Strategies**

This table reports average annualized profits of trading strategies employed on daily return data from 30/04/1975 - 28/04/2006, as well as those of 3 nonoverlapping subperiods. Profit is measured as the percentage increment wealth gaining from trading rule over buy-and-hold strategy and net of commission fee.

Rule	1975 - 2006	1975 - 1986	1986 - 1997	1997 - 2006
VMA	0.06447	0.20317	0.18880	0.14623
5-day FMA	0.09214	0.18067	0.17972	0.11518
10-day FMA	0.10723	0.19113	0.20564	0.09293
20-day FMA	0.10499	0.19880	0.18437	0.06351
30-day FMA	0.09491	0.19171	0.08059	0.06365
Average FMA	0.09982	0.19058	0.16258	0.08382
5-day TRB	-0.03636	0.05355	-0.11581	0.03977
10-day TRB	-0.00314	0.00865	-0.05747	0.09770
20-day TRB	-0.01057	0.00651	-0.00199	0.07487
30-day TRB	0.00890	0.00818	0.02232	0.02764
Average TRB	-0.01029	0.01922	-0.03824	0.06000
Overall Average	0.04695	0.11582	0.07624	0.08016

## 6. Conclusions

This study investigates return predictive ability of the most commonly used technical analysis techniques, namely VMA, FMA, and TRB rules. Our investigation is based on the Stock Exchange of Thailand (SET) index over the period of April 30, 1975 to April 28, 2006, a total of 31 years, with and without trading costs environment. We find that, on average, (1) returns on buy (sell) days are positive (negative), (2) sell days count for a large fraction of all trading days, and (3) the difference between buy and sell returns are generally positive. Moreover, in the presence of the trading cost, most of the technical trading strategies being tested also generate extra profits over the buy-and-hold strategy.

Our results support the finding of Brock et al. (1992) and Bessembinder and Chan (1995) in which the using of information on historical prices to signal the time to enter and to exit a stock market can generate extra returns. This finding implies the weak-form market inefficiency of the Stock Exchange of Thailand (SET). However, the finding does not provide sufficient evidence to conclude that SET is inefficient as a whole. The technical trading rules tested in the study should be conducted on industrial indices and individual stocks as well.

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# วารสารเศรษฐศาสตร์ มหาวิทยาลัยเชียงใหม่

Chiang Mai University Journal of Economics

## ใบบอกรับเป็นสมาชิก

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ข้าพเจ้า.....  
อยู่บ้านเลขที่..... ถนน.....  
ตำบล..... อำเภอ/เขต.....  
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มีความประสงค์จะบอกรับเป็น “สมาชิกวารสารเศรษฐศาสตร์ มหาวิทยาลัยเชียงใหม่”  
มีกำหนด.....ปี ในอัตรา 195.- บาท ต่อปี  
ทั้งนี้ ตั้งแต่ฉบับที่..... ปีที่.....  
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(.....)

ผู้บอกรับเป็นสมาชิก

...../...../.....

(กรุณาส่งเช็คหรือธนาณัติสั่งจ่ายในนามของ นางสินีนาฏ ธรรมณี)