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AN EXAMINATION OF THE RANDOM WALK MODEL AND TECHNICAL TRADING RULES IN THE MALAYSIAN STOCK MARKET

Lai Ming Ming
Balachandher, K. Guru
Faculty of Management
Multimedia University

Fauzias Mat Nor
Faculty of Business Management
Universiti Kebangsaan Malaysia

This paper examines the predictability of technical trading rules on the daily returns of the Kuala Lumpur Stock Exchange Composite Index for the full-sample period from January 1977 to December 1999 which includes both bullish and bearish periods. The methodology employed includes both the variance ratio test and moving average rules. The results indicate non-randomness of successive price changes. The degree of predictability is supported as the trading rules examined indicate technical attractiveness with the presence of transaction costs.

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Introduction

The possibilities of market inefficiencies and their subsequent profit opportunities which arise after controlling for risk in international and local stock markets are appealing to portfolio managers and investors. If the market is not fully efficient, then, there are possibilities for investors to find good value stocks at low prices. They could then buy these low value stocks and wait for their prices to go up and then sell them thus making abnormal profits. Hence, whatever the investment strategy, investors first need to know whether the stock market is efficient or not. In more technical terms, this would imply asking whether the stock prices follow random walk. Lo and MacKinlay (1988, 1999) reported that stock prices did not completely follow the random walk and some predictable components did exist in stock returns. They provided techniques for detecting forecast ability as well as their statistical and economic significance.

Ariff, Shamsher, and Annuar (1998) pointed out that emerging markets indicated variations in behavior which were less correlated with that of the developed markets. Ratner and Leal (1999) report that emerging equity markets are significantly inefficient. This has given rise to renewed interest in technical analysis, which relies on past prices to predict future prices. This paper contributes to technical analysis research by supplementing the existing literature with insights where associated issues of forecast ability, profitability, and random walk movement of the Kuala Lumpur Stock Exchange Composite Index are integrated and examined. Findings from this study may also advance our understanding and practice of technical trading rules in bullish and bearish markets as well as their implications on the profit potential.

Literature Review

The random walk model first developed by Bachelier (1964) states that changes in stock price between period t + k and period t are independent with zero mean and proportional variance, that is the variance of monthly changes are four times the variance of the weekly changes. Lo and MacKinlay (1989) proposed the variance ratio test for the random walk hypothesis. They applied the test on weekly returns in the New York Stock Exchange and American Stock Exchange which provided evidence to reject the random walk model for the entire sample period of 1962-1985. According to the variance ratio test, the ratio of the variance of the *q*-period returns to the variance of the one-period returns divided by q must be equal to unity under the random walk hypothesis.

Lo and MacKinlay (1989) indicated that the variance ratio test was more powerful than the well-known Dickey-Fuller unit root or the Box-Pierce Q tests. Ayadi and Pyun (1994) also acknowledged that the variance ratio test was more appealing as compared to other traditional tests for random walk. Furthermore, it would be better if the variance ratio tests can be complemented with the multiple variance ratio test which was extended by Chow and Denning (1993). The multiple variance ratio test is simply comparing the maximum absolute value of the Lo and Mackinlay's test statistics namely $Z_j^*(q) = \max |Zj(q)|$ (j = 1 and/or 2) with the Studentized Maximum Modulus (SMM) critical values. The SMM table can be found in Hahn and Hendrickson (1971) and Stoline and Ury (1979).

Pan, Chiou, Hocking and Rim (1991) applied the variance ratio test on daily and weekly returns of five Asian stock markets, namely, Hong Kong, Japan, Singapore, South Korea, and Taiwan from January 1982 to June 1987. The random walk hypothesis was rejected in all the sample countries except Japan. In addition, the variance ratios also indicated evidence of positive autocorrelation for all sample countries except Japan.

In the case of Malaysia, though much empirical research had indicated the weak form of efficiency in the Kuala Lumpur stock market, the results so far have been inconclusive and thus demand investigation. To this extent, it is worth noting that Joy and Jones (1986, p. 51-53) state that weak form tests are not direct tests of technical analysis.

Despite the views on market efficiency, technical analysis is still considered as a viable and efficient approach to individual stock selection and market analysis. Brock, Lakonishok, and Lebaron (1992) examined the predictability of technical trading rules such as the moving average rule and trading range breakout rule in the United States stock market from 1897 to 1986. They found that the buy (sell) signals generated returns, which were higher (or lower) than normal returns. In addition, they found that for both the variable length moving average (VMA) and fixed length moving average (FMA) rules, the conditional mean buy returns were significantly higher than the conditional mean sell returns prior to taking transaction costs. However, Hudson, Dempsey and Keasey (1996) who applied the technical trading rules of Brock et al. (1992) in the United Kingdom (UK) stock market from July 1935 to January 1994 found that the technical trading rules did not generate excess returns after taking transaction costs of 1% per round trip.

Bessembinder and Chan (1995) investigated the trading rules of Brock et al. (1992) in Hong Kong, Japan, Korea, Malaysia, Thailand and Taiwan over the period from 1975-1991. The results indicated very strong forecast ability for the emerging markets of Malaysia, Thailand, and Taiwan. This is consistent with Dawson (1991) and Yong (1991) who found some price patterns in the Malaysian stock market.

Data and Method

The random walk hypothesis and the predictability of technical trading rules in the Malaysian stock market are examined by analyzing the daily data of the Kuala Lumpur Stock Exchange Composite Index (KLSE CI) from 3rd January 1977 to 31st December 1999.

The random walk model is tested by applying the variance ratio and the multiple variance ratio tests on the market returns. Thus the random walk hypothesis can be tested by statistically testing if the variance ratio at

$$\text{lag } q,\ VR(q) = \frac{\sigma_c^2(q)}{\sigma_a^2(q)} = 1. \qquad (1)$$

Where σ_c^2 (q) is an unbiased estimator of $1/q$ of the variance of the q-period returns and σ_a^2 (q) is an unbiased estimator of the variance of the single period returns.

The variance ratio at lag q is then tested for unit value by using two Z-statistics, namely Z(q) and Z*(q) based on the assumptions of homoscedasticity and heteroscedasticity, respectively of the error terms.

After testing for random walk in the Malaysian stock market, the predictability of two technical trading rules, namely, the variable length moving average (VMA) rule and the fixed-length moving average (FMA) rule are examined. In both the VMA and FMA rules, a buy (sell) signal is generated when a short-term moving average exceeds (falls below) the long-term moving average (see Figure 1). In this paper, the short term moving average is represented by the five-day moving average to reflect the five (5) trading days per week

and T + 5 rolling settlement system in Malaysia. This is then compared with the long-term moving averages of 60-days (3 months), 120-days (6 months), and 180-days (9 months). In addition, a one percent band[1] around the long-term moving average is used to generate six variations of each rule, namely (5,60,0), (5,120,0), (5,180,0), (5,60,0.01)[2], (5,120, 0.01), and (5,180,0.01).

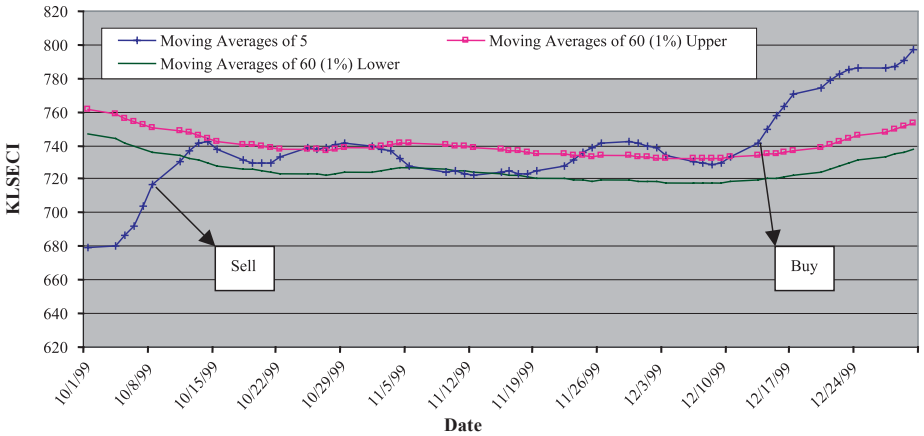

Figure 1: The Short and Long-term Fixed Moving Averages (5, 60, 0.01) of KLSE CI from October to December 1999

In the VMA rule, a buy or sell signal will be generated each day and the buy (sell) signal will be executed on day (t) when the short term moving average on day (t-1) exceeds (falls below) the long-term moving average on day (t-1). However, when a one percent band is introduced, a buy (sell) signals is initiated only when a short-term moving average exceeds (falls below) the long-term moving average by at least one percent. If the short-term moving average falls in between the upper and lower band of the long-term moving average, no signal or a neutral signal will be generated.

The FMA rules used in this study are similar to the VMA rules except that for the FMA rules, once a signal is generated, it will be held for a certain period to estimate the holding period returns. The selection of the holding period is arbitrary and we choose the same 10-day holding period of Brock et al. (1992) to reflect ten (10) trading days. Any signals within these holding periods will be ignored. After the 10-day period, the FMA rule will generate new signals. The same 10-day holding period rule will be followed and the cumulative returns of 10-day will be calculated.

In measuring the profit resulting from the application of the technical trading rules and the buy-and-hold strategy, the "double-or-out" framework used by Brock et al. (1992) and Bessembinder and Chan (1998) is applied. In this framework an investor is assumed to borrow at the risk free interest rate and double the equity investment when a buy signal is generated. On the other hand, the investor will sell the shares and invest in the risk free interest rate when a sell signal is generated. The average yield of the 3-month Malaysian

Treasury bill is used as proxy for the risk free interest rate. In addition, the borrowing and lending rates are assumed to be equal and the risk during the buy and sell periods are assumed to be the same. Thus, the profit generated as a result of the buy signals would be computed as follows:

$$\text{Profit } (\pi) = ((\text{mean return}^{3} \times \text{trade per year}^{4}) - (\text{risk free interest rate}^{5})) \quad (2)$$

The profit or cost savings earned for not being in the market when a sell signal is generated is computed as follows:

$$\text{Profit } (\pi) = ((\text{risk free interest rate}) - (\text{mean return} \times \text{trade per year})) \quad (3)$$

Hence, the profits or extra returns earned by using the technical trading rules before accounting for transaction cost is the combination of the profits from the buy signals and the cost savings of the sell signals. However, in an environment with transaction costs, in line with Bessembinder and Chan (1995), the concept of the breakeven transaction costs is used to calculate the profits earned as follows:

$$\pi \text{ (After transaction cost)} = \pi \text{ (Before transaction cost)} - C * (N_b + N_s) \quad (4)$$

Where N_b and N_s are respectively the number of buy and sell signals generated in a year and C represents the percentage round trip transaction cost.

The viability of the moving average rules are first evaluated by testing to determine if the mean returns generated are significantly different from zero. The returns generated by the moving average technical trading rules are then compared with the mean returns derived from the buy and hold strategy.

It should be pointed out that both the random walk model and the technical trading rules are investigated over the full sample period and four non-overlapping sub-periods. The four sub-periods are selected in such a manner as to reflect the political and economic developments in Malaysia.

The first sample period from 3rd January 1977 to 31st December 1981 reflects the early period of the security industry in Malaysia after the separation of the Stock Exchange of Malaysia and Singapore and the establishment of the Securities Industry Act (1973). The second sub-period from 4th January 1982 to 30th December 1987 represents the period when the National Unit Trust fund was established as well as the growth period of the Malaysian Securities industry[6]. The third sub-period from 4th January 1988 to 31st December 1993 represents a period of major restructuring and liberalization[7] of the securities industry as well as the bullish period in the Malaysian stock market. (Tan, 1997, p.154). Finally, the fourth sub-period from 3rd January 1994 to 30th December 1999 starts with the removal of the restrictive registration concerning institutional investors and the continuation of the consolidation and development of the security industry[8]. This period also encompasses the Asian financial crisis and is reflective of a bearish period in the Malaysian stock market.

Analyses and Discussion

Variance Ratio Test Results

The summary statistics of market index returns reported in Table 1 indicate non-normality of returns computed on a weekly and monthly basis. The results of Jacque- Bera normality test rejects the null hypothesis of normality for the changes in the log price indices on a daily, weekly, and monthly basis. The values of skewness and kurtosis indicate that the distributions are not normal. The distribution of the weekly and monthly index returns are characterized by leptokurtosis. Furthermore, the ARCH (AutoRegressive Conditional Heteroscedasticity) test detected successive periods of volatility followed by successive periods of stability.

The auto-correlation of market index returns exhibited the presence of significant positive dependency of log price changes on a weekly basis. However, the serial correlation tests failed to produce significant negative autocorrelation on monthly basis.

Table 1: Summary Statistics of the Kuala Lumpur Stock Exchange Composite Index (KLSE CI) from January 1977 to December 1999)

	Daily Returns	Weekly Returns	Monthly Returns
Mean	0.0378	0.1802	0.7945
Standard Deviation	1.5959	3.4978	8.8205
Skewness	-0.3206	-0.6808	-0.6232
Kurtosis	31.2302	8.5146	2.9286
Jacque-Bera Normality Test	229439**	3679.95**	110.93**
ARCH Test	1413.26**	20.018*	4.788**
Number of Observations	5656	1200	276

Lag	Autocorrelation	T-stat	Autocorrelation	T-stat	Autocorrelation	T-stat
1	0.0950	7.3077**	0.1060	3.6552**	0.1120	1.8667
2	0.0310	2.3846*	0.0950	3.2759**	0.1500	2.5000*
3	0.0260	2.0000*	0.0750	2.5862**	-0.1180	-1.9667*
4	-0.0450	-3.4615**	0.0100	0.3793	-0.0570	-0.9500
5	0.0630	4.8462**	0.0660	2.2759*	-0.0290	-0.4833
6	-0.0320	-2.4615*	0.0040	0.1379	-0.0830	-1.3833
7	-0.0050	-0.3846	0.0970	3.3448**	0.0890	1.4833
8	0.0050	0.3846	0.0190	0.6552	-0.0080	-0.1333
9	0.0300	2.3077	0.0730	2.5172*	0.0600	1.0169
10	0.0330	2.5385*	0.0200	0.6897	0.0690	1.1696
11	0.0370	2.8462**	-0.0710	-2.4483*	0.0340	0.5769
12	0.0030	0.2308	0.0240	0.8276	-0.0460	-0.7797
13	-0.0050	-0.3846	-0.0640	-2.2069*	-0.0390	-0.6610
14	0.0430	3.3077**	-0.0320	-1.1034	-0.0580	-0.9831
15	0.0010	0.0769	-0.0050	-0.1724	-0.0330	-0.5690
16	-0.0100	-0.7692	-0.0100	-0.3448	-0.0530	-0.9138

* denotes $p < 0.05$, ** denotes $p < 0.01$

Table 2 reports the variance ratios and the Z-statistics for lags of 2 days to 24 days, 2 weeks to 52 weeks, and 2 months to 24 months on the daily, weekly, and monthly returns, respectively. The variance ratios are all greater than one indicating positive serial correlation in daily, weekly and monthly market returns. Furthermore, the variance ratios increased with increase in the number of lags but the Z-statistic declined with increasing of number of lags. Overall, the random walk hypothesis was rejected under the assumption of homoscedasticity, particularly on daily and weekly returns only. This is consistent with the results of Richardson and Stock (1989) and Chow and Denning (1993) who also failed to reject the random walk hypothesis for monthly market index returns.

Table 2: Variance Ratios of KLSE CI Return from 1977 to 1999

	Lag	Variance Ratio	Homoscedasticity Z(q)	Hereroscedasticity Z*(q)
Daily	2	1.0948	7.1334**	1.7005
	4	1.1862	7.4877	1.7830
	6	1.2168	6.5958**	1.5724
	8	1.2307	5.8667**	1.3986
	10	1.2464	5.4886**	1.3084
	12	1.2792	5.6013**	1.3353
	14	1.3085	8.1787**	1.3529
	16	1.3407	5.8212**	1.3877
	18	1.3637	5.8272**	1.3891
	20	1.3836	5.8058**	1.3841
	22	1.3311	4.7612**	1.1350
	24	1.3541	4.9127**	1.1587
Weekly	2	1.1297	4.4897**	3.0973**+
	4	1.2922	5.4086**	3.5253**
	8	1.5218	6.1078**	3.9811**
	12	1.7114	6.5701**	4.2824**
	16	1.7776	6.1250**	3.9873**
	24	1.7912	4.9996**	3.2587**+
	32	1.7717	4.1944**	2.7304**+
	52	1.8921	3.7640**	2.4535*+
Monthly	2	1.1182	1.9605*+	1.5305
	4	1.2827	2.5059	1.9562
	6	1.2645	1.7742	1.3851
	8	1.2350	1.3174	1.0285
	10	1.2442	1.1995	0.9365
	12	1.2995	1.3247	1.0342
	18	1.2604	0.9198	0.7181
	24	1.1331	0.4029	0.3148

Z(q) and Z*(q) denotes the homoscedasticity and heteroscedasticity test statistics. The variance ratio are statistics different from 1.

*denotes $p < 0.05$, **denotes $p < 0.01$

+ denotes an inference error in which variance ratio is statistical significant from 1.0 according to the standard normal distribution but is insignificantly different from 1.0 under the Studentised Maximum Modulus (SMM) distribution as indicated in Stoline and Ury (1979) critical value of 3.031 and 3.493 at the 5% and 1% level.

Table 3: Variance Ratios of Weekly KLSE CI Returns from 1977 to 1999

Ranking Period	Lag	Variance Ratio	Homoscedasticity Z(q)	Heteroscedasticity Z*(q)
7 Jan 1997 to	2	1.1407	2.2694**+	1.5736
31 Dec 1981	4	1.4125	3.5553**	2.4653*+
	8	1.7143	3.8936**	2.6999**+
	12	1.9729	4.1845**	2.9017**+
	16	2.0555	3.8665**	2.6812**+
	32	1.6105	1.5434	1.0703
	52	1.2165	0.4255	0.2952
	104	0.8196	-0.2489	-0.1728
7 Jan 1982 to	2	1.2612	4.6141**	2.4936*+
31 Dec 1987	4	1.5216	4.9250**	2.6617**+
	8	1.7718	4.6087**	2.4910*+
	12	1.8996	4.2386**	2.2915*+
	16	1.9618	3.8598**	2.0871*+
	32	2.1012	3.0493**+	1.6497
	52	2.2768	2.7483**+	1.4895
	104	1.3886	0.5872	0.3203
8 Jan 1988 to	2	1.0367	0.6477	0.4342
31 Dec 1993	4	1.1232	1.1636	0.7807
	8	1.1543	0.9214	0.6188
	12	1.2485	1.1707	0.7866
	16	1.2665	1.0693	0.7187
	32	1.1161	0.3214	0.2162
	52	1.0903	0.1944	0.1310
	104	1.8936	1.3502	0.9146
7 Dec 1994 to	2	1.2105	3.7188**	2.9381**+
30 Dec 1999	4	1.1444	1.3638	1.1947
	8	1.4019	2.3996*+	2.1051*+
	12	1.6305	2.9705**+	2.6082**+
	16	1.6793	2.7259**+	2.3951*+
	32	1.5790	1.6034	1.4112
	52	1.9582	2.0624*+	1.8176
	104	1.5581	0.8432	0.7458

Z(q) and Z*(q) denotes the homoscedasticity and heteroscedasticity test statistics. The variance ratio are statistics different from 1.
*denotes $p < 0.05$, **denotes $p < 0.01$
+ denotes an inference error in which variance ratio is statistical significant from 1.0 according to the standard normal distribution but is insignificantly different from 1.0 under the Studentised Maximum Modulus (SMM) distrribution as indecated in Ury (1979) critical value of 3.031 and 3.493 at the 5% and 1% level.

The variance ratio test of the weekly market index returns[9] for the four non-overlapping periods as shown in Table 3 are all greater than one, thus exhibiting positive serial correlation. The results documented evidence of deviations from random walk in all the four sub-periods except the third sub-period from 8th January 1988 to 31st December 1993

The possible explanation for the randomness might be due to the financial services liberalization efforts[10] which had transformed the market into weak form efficient. Nonetheless, the randomness was not sustainable and subsequently partially disappeared indicating by the high critical value of multiple variance ratio in the fourth sub-period[11].

The random walk hypothesis was further examined during the bullish and bearish periods in the history of the Malaysian stock market. The bullish[12] period spanned from 2nd January 1992 to 31st December 1993, whereas the bearish period[13] was from 1st July 1997 to 2nd July 1999. The results of the bullish and bearish periods are presented in Table 4.

Table 4: Variance Ratios of KLSE CI Daily Returns During Bullish and Bearish Periods

	Lag	Variance Ratio	Homoscedasticity Z(q)	Heteroscedasticity Z*(q)
Bullish	2	1.2571	5.7200**	4.3519**
Period	4	1.3782	4.4981**	3.4223**+
(2nd Jan 1992	6	1.3936	3.5423**+	2.6952**+
to 31st Dec 1993)	8	1.3979	2.9929**+	2.2772*+
	10	1.4103	0.7035**+	2.0571*+
	12	1.4167	2.4729*+	1.8817
	14	1.4376	2.3815*+	1.8125
	16	1.4705	2.3783*+	1.8105
	18	1.5072	2.4040*+	1.8305
	20	1.5325	2.3836*+	1.8154
	22	1.5336	2.2693*+	1.7288
	24	1.5320	2.1599*+	1.6458
	Lag	**Variance Ratio**	**Homoscedasticity Z(q)**	**Heteroscedasticity Z*(q)**
Bearish	2	1.0108	0.2408	0.0824
Period	4	1.0557	0.6622	0.2267
(1st July 1997	6	1.0064	0.0577	0.0198
to 2nd July 1999)	8	0.9864	-0.1025	-0.0351
	10	0.9655	-0.2274	-0.0779
	12	0.9764	-0.1400	-0.0479
	14	0.9889	-0.0602	-0.0206
	16	1.0188	0.0952	0.0326
	18	1.0576	0.2729	0.0934
	20	1.0890	0.3985	0.1364
	22	1.1265	0.5379	0.1841
	24	1.1616	0.6562	0.2247

Z(q) and Z*(q) denotes the homoscedasticity and heteroscedasticity test statistics. The variance ratio are statistics different from 1.

*denotes $p < 0.05$, **denotes $p < 0.01$

+ denotes an inference error in which variance ratio is statistical significant from 1.0 according to the standard normal distribution but is insignificantly different from 1.0 under the Studentised Maximum Modulus (SMM) distribution as indicated in Stoline and Ury (1979) critical value of 3.061 and 3.787 at the 5% and 1% level.

It is interesting to note that the random walk hypothesis was rejected during the bullish period. On the other hand, the Kuala Lumpur Stock Exchange Composite Index was found to follow a random walk during the bearish period. This is consistent with Mansor and Lim (1995) who reported that investors in the Malaysian stock market resorted to fundamental analysis and long-term investment strategies during bearish periods and speculative activities during bullish periods with the aim of making short-term capital gains.

Predictability of the Moving Average Rules

The results reported in Table 5 provide evidence to reject the hypothesis that the VMA rules generate zero returns. Over the full sample period from 1977 to 1999, the VMA rules generated more buy than sell signals. In addition the average returns of the buy signals were significantly positive. The VMA rules particularly the 60-days VMA rule was found to earn significantly higher returns compared to the buy-and-hold strategy.

Overall the predictability of the variable moving averages appear to be pervasive with the 60-days rule generating the highest returns.

The results as reported in Table 6 provide some evidence to reject the hypothesis that the FMA rules generate zero returns. Similar to the VMA rules the buy signals generated positive returns whereas the sell signals generated negative returns. In addition the FMA rules also generated more buy than sell signals. Furthermore, the FMA rules were also found to generate significantly higher returns compared to the buy-and-hold strategy at the 5% level. Once again, the 60-day FMA rule was found to generate significantly higher profits compared to the buy-and-hold strategy.

Based on the VMA and FMA test results for the four non-overlapping sub periods presented in Tables 7 and 8, it is worth noting that both these technical trading rules were found to generate significantly positive returns only in sub-period 1 (year 1977-1981) and sub-period 3 (year 1988-1993). However, the results provide evidence to reject the hypothesis of mean equality between the technical trading rules and the buy-and-hold strategy in all four sub-periods. The overall test results are in line with Brock et al. (1992) and Bessembinder and Chan (1995 and 1998) in which the technical trading rules have been found to generate abnormal profits.

Conclusions

The behavior of stock market index and dependency of successive price changes are of considerable interest for investors. In this context, the findings indicate absence of a random walk in the KLSE, thus implying potential for technical trading rules to generate above average returns. This is in fact verified by the predictability of the FMA and VMA rules examined in this study and the significantly positive returns generated by these rules even in the presence of trading costs. In addition, both these rules were found to generate returns, which are significantly higher than the unconditional mean return of the

Table 5: Test Results of Variable Length Moving Averages (VMA) Rules

				VMA-Full Sample						
Period	**Test**	**N(Buy)**	**N(Sell)**	**Buy**	**Sell**	**Buy > 0**	**Sell > 0**	**Buy-Sell**	**Profit(b)**	**Profit(a)**
1977-1999	5,60,0	3445	2152	0.1226 (6.1391)[1]** (2.459)[2]*	-0.0945 (-2.0760)[1]* (-3.2722)[2]**	0.5628	0.4740	0.2171 (4.9504)[3]**	13.20461[B] -3.6803[S] 16.8849[1]	11.9888
	5,60,0.01	3109	1848	0.1311 (6.1590)** (2.6188)**	-0.1187 (-2.2778)* (-3.6600)**	0.5664	0.4637	0.2498 (5.3290)**	12.5620 -4.3789 16.9409	12.6046
	5,120,0	3469	2068	0.1012 (4.9563)** 1.8422	-0.0477 (-1.0400) (-2.0849)*	0.5624	0.4734	0.1489 (3.3585)**	10.1026 0.8693 9.2333	4.3896
	5,120,0.01	3320	1908	0.1050 (5.1250)** (1.9250)	-0.0728 (-1.4541) (-2.6170)**	0.5636	0.4680	0.1778 (3.8767)**	9.9908 -0.8782 10.8690	6.2957
	5,180,0	3470	2007	0.0811 (3.8876)** (1.2579)	2.1262 (44.8000)** (50.3611)**	0.5591	0.4723	-2.0451 (-45.6916)**	7.0723 190.6945 -183.6223	-188.4134
	5,180,0.01	3367	1879	0.0856 (4.0245)** (1.3751)	-0.0508 (-1.0151) (-2.0850)*	0.5601	0.4667	0.1364 (2.9675)**	7.3652 1.0083 6.3569	1.7678
	Average			0.1044	0.2903					

Notes:
[1] The student t-statistic ratio which tests the hypothesis that the mean returns generated by technical trading rules is zero. The second row of the each test present t-statistic values in parenthesis.
[2] The t-statistic ratio that tests the mean returns generated by technical trading rules equal to the returns Derived by the buy-and-hold strategy. The third row of the each test present t-statistic values in parenthesis.
[3] The t-statistic ratio of the difference between the returns of the buy and sell signals.
N(Buy) refers to the number of buy signals generated during the sample period.
N(Sell) refers to the number of sell signals generated during the sample period.
* denotes $p < 0.05$, ** denotes $p < 0.01$.
Buy > 0 is the fraction of returns of the buy which are more than zero.
Sell > 0 is the fraction of returns of the sell signal which are more than zero.
Profit(b) refers to the average annual profit before transaction cost.
Profit(a) refers to the average annual profit after transaction cost.
[B] denotes profit for buy signals, [S] denotes profit for sell signals. [T] denotes total profit for buy and sell signals.

Table 6: Test Results of Fixed Moving Averages (FMA) Rules

				FMA-Full Sample						
Period	**Test**	**N(Buy)**	**N(Sell)**	**Buy**	**Sell**	**Buy > 0**	**Sell > 0**	**Buy-Sell**	**Profit[(b)]**	**Profit[(a)]**
1977-1999	5,60,0	348	212	1.2044 (5.3819)[1]** (2.7348)[2]**	-0.9437 (-1.8936)[1] (-3.4507)[2]**	0.6006	0.4340	2.1480 (4.5044)[3]**	13.0621[B] -3.5378[S] 16.6000[1]	16.1101
	5,60,0.01	311	184	1.1745 (4.9192)** (2.4998)*	-1.0525 (-1.8943) (-3.4879)**	0.5981	0.4402	2.2270 (4.3747)**	10.7216 -3.2597 13.9813	13.5483
	5,120,0	350	204	0.8512 (3.2172)** (1.5709)	-0.4209 (-0.9035) (-2.047)*	0.5686	0.4755	1.2721 (2.6385)**	7.7934 1.4274 6.3660	5.8814
	5,120,0.01	333	188	0.9074 (3.3565)** (1.7165)	-0.4042 (-0.8089) (-1.9267)	0.5706	0.4787	1.3116 (2.6267)**	7.9776 1.8566 6.1210	5.6652
	5,180,0	347	201	0.8141 (3.1412)** (1.4419)	-0.3974 (0.8210) (-1.9728)*	0.5735	0.4677	1.2115 (2.4971)*	7.1219 1.6870 5.4349	4.9556
	5,180,0.01	337	187	0.8141 (3.0584)** (1.4222)	-0.6534 (-1.2773) (-2.5344)*	0.5697	0.4492	1.4676 (2.9403)**	6.7684 -0.1524 6.9207	6.4624
	Average			0.9610	-0.6453			1.6063		

Notes:
[1] The student t-statistic ratio which tests the hypothesis that the mean returns generated by technical trading rules is zero. The second row of the each test present t-statistic values in parenthesis.
[2] The t-statistic ratio that tests the mean returns generated by technical trading rules equal to the returns Derived by the buy-and-hold strategy. The third row of the each test present t-statistic values in parenthesis.
[3] The t-statistic ratio of the difference between the returns of the buy and sell signals.
N(Buy) refers to the number of buy signals generated during the sample period.
N(Sell) refers to the number of sell signals generated during the sample period.
* denotes $p < 0.05$, ** denotes $p < 0.01$.
Buy > 0 is the fraction of returns of the buy which are more than zero.
Sell > 0 is the fraction of returns of the sell signal which are more than zero.
Profit[(b)] refers to the average annual profit before transaction cost.
Profit[(a)] refers to the average annual profit after transaction cost.
[B] denotes profit for buy signals, [S] denotes profit for sell signals. [T] denotes total profit for buy and sell signals.

Table 7: Test Results of Variable Moving Average Rules

Period	Test	N(Buy)	N(Sell)	Buy	Sell	Buy > 0	Sell > 0	Buy-Sell	Profit[b]	Profit[a]
1977-1981	5,60,0	913	246	0.1740 (5.1058)[1]** (1.1156)[2]	-0.0633 (-0.5236)[1] (-2.0314)[2]*	0.6024	0.5691	0.2373 (2.6565)[3]**	27.8509 0.8087 27.0422	22.3784
	5,60,0.01	851	182	0.1767 (5.0212)** (1.1418)*	-0.1207 (-0.7502) (-2.3677)*	0.6075	0.5659	0.2974 (2.9286)**	26.1542 -0.4709 26.6251	22.4683
	5,120,0	933	933	0.1547 (4.4822)** (0.7654)	-0.0483 (-0.6724)** (-2.9855)*	0.6013	0.1018	0.2030 (3.5247)**	24.9420 -5.0816 30.0236	22.5149
	5,120,0.01	916	154	0.1572 (4.5215)** (0.8078)	-0.0263 (-0.1450) (-1.3121)	0.6004	0.5844	0.1835 (1.6941)	24.8777 3.1142 21.7635	17.4578
	5,180,0	897	142	0.1270 (3.4247)** (0.2516)	0.0907 (0.4878) (-0.2043)	0.5953	0.5986	0.0363 (0.3231)	18.8681 6.5008 12.3673	8.1864
	5,180,0.01	889	133	0.1349 (3.6229)** (0.3942)	0.1185 (0.6288) (0.0461)*	0.5973	0.6015	0.0164 (0.1417)	20.0622 7.0761 12.9861	8.8736
	Average			0.1541	-0.0082					

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Cont'd Table 7: Test Results of Variable Moving Average Rules

1982-1987	5,60,0	694	722	0.1082 (2.4362)[1]* (1.8729)[2]	-0.1274 (-1.8528)[1] (-1.4552)[2]	0.5375	0.4501	0.2356 (2.8648)[3]**	7.9894 -10.7984 18.7878	14.0395
	5,60,0.01	634	644	0.1332 (2.8620)** (2.1553)*	-0.1430 (-1.8891) (-1.6130)	0.5426	0.4472	0.2762 (3.1908)**	9.5459 -10.8173 20.3631	16.0776
	5,120,0	694	662	0.0844 (1.7440) (1.5376)	-0.1027 (-1.4347) (-1.0714)	0.5432	0.4396	0.1870 (2.2251)*	5.2272 -6.7979 12.0251	7.4780
	5,120,0.01	659	610	0.1124 (2.4385)* (1.8970)	-0.1291 (-1.6906) (-1.3964)	0.5493	0.4279	0.2415 (2.7781)**	7.8120 -8.5974 16.4094	12.1540
	5,180,0	644	652	0.0673 (1.1836) (1.2650)	-0.0670 (-1.0146) (-0.5748)	0.5528	0.4417	0.1343 (1.5618)	2.6924 -2.7456 5.4381	1.0921
	5,180,0.01	617	611	0.0758 (1.2867) (1.3603)	0.0781 (-1.1206) (-0.711)	0.5592	0.4304	0.1538 (1.7419)	3.2602 -3.4182 6.6784	2.5605
	Average			0.0969	-0.1079					

* denotes $p < 0.05$, ** denotes $p < 0.01$

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Cont'd Table 7: Test Results of Variable Moving Average Rules

Period	Test	N(Buy)	N(Sell)	Buy	Sell	Buy > 0	Sell > 0	Buy-Sell	Profit[b]	Profit[a]
1988-1993	5,60,0	1048	371	0.1380 (4.3485)[1]** (0.6612)[2]	0.0130 (0.1848)[1] (-1.4068)[2]	0.5763	0.5337	0.1250 (1.7940)[3]	17.9065 7.0025 10.9040	6.1456
	5,60,0.01	918	298	0.1395 (3.9815)** (0.6652)	-0.0104 (-0.1263) (-1.6063)	0.5806	0.5034	0.1499 (1.9490)	16.8059 4.0127 12.7932	8.7155
	5,120,0	1031	328	0.1126 (3.4622)** (0.1154)	0.0275 (0.3650) (-1.1329)	0.5664	0.5305	0.0851 (1.1645)	14.8203 6.0320 8.7883	4.2311
	5,120,0.01	968	277	0.1130 (3.3100)** (0.1218)	0.0069 (0.07983) (-1.3288)	0.5661	0.5054	0.1061 (1.3506)	13.7036 4.8479 8.8557	4.6808
	5,180,0	1033	266	0.1175 (3.6355)** (0.2198)	0.0460 (0.5259) (-0.7972)	0.5721	0.5113	0.0715 (0.9018)	15.6983 6.5687 9.1296	4.7736
	5,180,0.01	1020	249	0.1162 (3.6000)** (0.1925)	0.0520 (0.5701) (-0.6986)	0.5696	0.5141	0.0642 (0.7878)	15.2319 6.6892 8.5428	4.2874
	Average			0.1228	0.0225					

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Cont'd Table 7: Test Results of Variable Moving Average Rules

1994-1999	5,60,0	694	728	0.1196 (1.5002)[2]	-0.1339 (2.3811)[1]* (-1.0520)[2]	0.5274 (-1.3385)[1]	0.4354	0.2535 (2.1981)[3]*	7.9235 -10.3442 18.2677	13.4992
	5,60,0.01	622	647	0.1275 (2.3644)* (1.5203)	-0.1604 (-1.4387) (-1.2685)	0.5289	0.4297	0.2878 (2.3578)*	8.6829 -12.7630 21.4459	17.1906
	5,120,0	672	690	0.0752 (1.4651) (1.0451)	-0.1051 (-1.002) (-0.7748)	0.5223	0.4362	0.1803 (1.5302)	3.8953 -7.5514 11.4467	6.8795
	5,120,0.01	642	650	0.0497 (0.9661) (0.7802)	-0.0989 (-0.8923) (-0.6692)	0.5202	0.4446	0.1486 (1.2283)	0.7881 -6.1815 6.9697	2.6371
	5,180,0	683	619	0.0321 (0.6783) (0.6220)	-0.0944 (-0.8008) (-0.6149)	0.4978	0.4410	0.1265 (1.0487)	-0.8755 -5.2100 4.3345	-0.0315
	5,180,0.01	637	574	0.0308 (0.6198) (0.5949)	-0.1350 (-1.0692) (-0.9786)	0.4945	0.4303	0.1659 (1.3257)	-1.2563 -8.3870 7.1307	3.0698
	Average			0.0725	-0.1213					

*denotes $p < 0.05$, **denotes $p < 0.01$

Notes: The (men and standard deviation) of daily returns of the KLSE C1 for full sample period and four sub-period 1977-1981, 1982-1987, 1988-1993, 1994-1999 under the buy-and-hold strategy are (0.0378, 1.5961); (0.1133, 1.2436); (-0.0251, 1.5472); (0.1072, 1.1534) and (-0.0304, 2.1739) respectively.

Table 8: Test Results of Fixed Length Moving Average Rules

Period	Test	N(Buy)	N(Sell)	Buy	Sell	Buy > 0	Sell > 0	Buy-Sell	Profit[b]	Profit[a]
1977-1981	5,60,0	94	22	1.5657 (4.0078)[1**] (0.9278)[2]	-0.1763 (-0.1337)[1] (-1.3881)[2]	0.7447	0.6818	1.7420 (1.6801)[3]	25.5119 3.1477 22.3641	21.8973
	5,60,0.01	85	20	1.5639 (3.6600)** (0.8815)	-0.1802 (-0.1245) (5.4101)**	0.7294	0.7000	1.7440 (-2.3261)*	22.6620 3.2029 19.4591	19.0366
	5,120,0	94	16	1.4034 (3.4233)** (0.5815)	0.2746 (0.1620) (-0.7773)	0.7340	0.6875	1.1289 (0.9535)	22.4612 4.8021 17.6591	17.2164
	5,120,0.01	91	15	1.5951 (4.0399)** (0.9756)	0.4957 (0.2760) (5.1205)**	0.0659	0.7333	1.0993 (-26131)**	25.1065 5.4107 19.6958	19.2692
	5,180,0	90	14	1.3720 (3.2471)** (0.5041)	0.2403 (0.1258) (-0.7568)	0.7444	0.7143	1.1317 (0.8998)	20.7725 4.5964 16.1761	15.7576
	5,180,0.01	90	13	1.3766 (3.2567)** (0.5138)	0.1915 (0.0928) (5.1627)**	0.7444	0.6923	1.1851 (-2.6349)*	20.8560 4.4214 16.4346	16.0201
	Average			1.4794	0.1409					

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Cont'd Table 8: Test Results of Fixed Length Moving Average Rules

1982-1987	5,60,0	71	71	0.9388 (1.6794)[1] (1.5666)[2]	-1.1762 (-1.4053)[1] (-1.2276)[2]	0.5211	0.3944	21151 (2.0228)[3*]	6.5792 -9.3882 15.9674	15.4912
	5,60,0.01	62	64	1.4112 (2.4135)* (2.0532)*	-1.1558 (-1.2646) (9.5031)**	0.5806	0.4063	2.5670 (-2.4391)*	10.0522 -7.7983 17.8505	17.4279
	5,120,0	69	67	0.5726 (0.7649) (1.0681)	-0.7303 (-0.9810) (-0.6211)	0.5362	0.3731	1.3029 (1.2193)	2.0544 -3.6251 5.6795	5.2234
	5,120,0.01	68	61	0.6991 (0.9298) (1.2245)	-0.6796 (-0.8494) (7.9796)**	0.5441	0.3934	1.3787 (-0.0433)	3.3933 -2.3783 5.7716	5.3390
	5,180,0	65	65	0.6580 (0.8515) (1.1463)	-0.6630 (-0.9015) (-0.5268)	0.5538	0.3538	1.3210 (1.2088)	2.5984 -2.6516 5.2500	4.8140
	5,180,0.01	61	62	0.6470 (0.7883) (1.0983)	-0.7770 (-1.0204) (7.7297)**	0.5410	0.3548	1.4240 (0.3683)	2.0472 -3.4985 5.5458	5.1333
	Average			0.8211	-0.8636					

*denotes $p < 0.05$, ** denotes $p < 0.01$

Cont'd Table 8: Test Results of Fixed Length Moving Average Rules

Period	Test	N(Buy)	N(Sell)	Buy	Sell	Buy > 0	Sell > 0	Buy-Sell	Profit[b]	Profit[a]
1988-1993	5,60,0	102	40	1.2544 (3.1665)1** (0.4180)[2]	0.5377 (0.6359)[1] (-0.7893)[2]	0.6275	0.6250	0.7167 (0.9074)[3]	15.1259 9.7831 5.3427	4.8666
	5,60,0.01	92	31	1.3246 (3.0852)** (0.5527)	0.0524 (0.0523) (5.8540)**	0.6304	0.6129	1.2723 (-1.6524)	14.1126 6.4692 7.6434	7.2310
	5,120,0	103	33	1.0608 (2.5031)* (-0.0286)	0.4802 (0.5724) (-0.7957)	0.6214	0.6061	0.5806 (0.6856)	12.0125 8.8398 3.1726	2.7166
	5,120,0.01	96	28	0.9991 (2.2536)* (-0.1660)	0.5593 (0.5647) (5.1594)**	0.6042	0.5714	0.4399 (-0.9854)	9.7876 8.8085 0.9792	0.5634
	5,180,0	102	28	1.0756 (2.5914)** (0.0055)	0.8533 (0.8814) (-0.2722)	0.6373	0.5714	0.2223 (0.2461)	12.0864 10.1805 1.9059	1.4699
	5,180,0.01	102	27	1.0798 (2.6011)** (0.0153)	0.9236 (0.9212) (5.0306)**	0.6373	0.5926	0.1562 (-1.1094)	12.1587 10.3548 1.8038	1.3713
	Average			1.1324	0.5677					

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Cont'd Table 8: Test Results of Fixed Length Moving Average Rules

1994-1999	5,60,0	70	73	0.8664 (1.5223)[1] (1.4390)[2]	-1.0298 (-1.0862)[1] (-0.9130)[2]	0.5857	0.4247	1.8962 (1.7065)	4.2013 -6.6219 10.8232	10.3437
	5,60,0.01	65	66	1.0103 (1.7196) (1.5598)	-1.3018 (-1.2573) (-1.1955)	0.6000	0.4091	2.3121 (1.9919)*	5.0381 -8.4123 13.4504	13.0111
	5,120,0	66	71	0.2971 (0.5063) (0.7178)	-0.5852 (-0.6007) (-0.3500)	0.5152	0.5070	0.8823 (0.7768)	-2.6384 -1.0177 -1.6207	-2.0801
	5,120,0.01	64	66	0.4346 (0.7248) (0.8694)	-0.6462 (-0.6256) (-0.4110)	0.5313	0.5000	1.0809 (0.9275)	-1.2709 -1.2015 -0.0694	-0.5054
	5,180,0	70	61	0.2921 (0.5323) (0.7321)	-0.9338 (-0.8308) (-0.7271)	0.5429	0.4590	1.2259 (1.0536)	-2.4992 -3.5862 1.0870	0.6477
	5,180,0.01	67	56	0.4054 (0.7243) (0.8535)	-1.1686 (-0.9650) (-0.9576)	0.0448	0.4464	1.5740 (1.3088)	-1.3800 -5.0003 3.6204	3.2079
	Average			0.5510	-0.9442					

*denotes $p < 0.05$, **denotes $p < 0.01$

Notes: The (mean and standard deviation) of 10-day returns of the KLSE CI for full sample period and four sub-period 1977-1981, 1982-1987, 1988-1993, 1994-1999 under the buy-and-hold strategy are (0.3776, 5.4734); (1.1309, 4.3776); (-0.2470, 6.2298); (1.0732, 4.2337); and (-0.3027, 6.6423) respectively.

buy and hold strategy. In this context the 60-day VMA and FMA rules were found to be the most profitable.

Notes

1. It is noted that the introduction of a band by percentage is to eliminate 'whiplash' signals as highlighted by Brock et al. (1992), particularly when short-term and long-term moving averages are very close.
2. The first term within the parenthesis represents the short term moving average, the second term the long term moving average, and the last term the percentage band around the long term moving average.
3. Mean return refers to the return earned for each rule in the sample period.
4. Trade per year refers to average buy or sell signals generated per year. It is computed as the total buy (sell) signals divided by the number of years involved., i.e. 23 years in this study.
5. The risk free interest rate is measured by $= 2 \times \left([1+ \frac{(\text{Face value}/\text{Price})^{365/90} - 1}{100})\right]^{1/2} - 1) \times 100\%$ based on 100 the respective 3-month Malaysian treasury bill in full-period sample and 4 sub-periods samples.
6. "The collapse of a big Singapore company, Pan-El, forced the Kuala Lumpur Stock Exchange (KLSE) to suspend trading between the days 2-4 December 1985. The Pan El crisis was an important event because it prompted the government to step in to restructure the stockbroking industry" (Tan, 1997, p. 114).
7. See Dobson, W., & Jacquet, P. (1998). Financial Services Liberalization in the WTO: Case Studies (Malaysia) [Online]. Available: http://207.238.152.36/CATALOG/casestudies/DOBSON/dobmlsia.htm (access date: 26 June 2001).
8. Tan (1997, p. 161) indicated that "in 1995, major liberalization measures for the financial market were trading in 200 units was instituted; broking houses were allowed to operate Unit Trust Schemes; Regulated short selling, and securities borrowing and lending were allowed.
9. The variance ratio test required a sample size of at least 256 observations to have reasonable power against other alternative tools, the weekly market returns are appropriate in this case.
10. The financial services liberalization included the introduction of the Banking and Financial Institutions Act in 1989 which provided the main features of the laws governing the financial institutions, large inflows of foreign direct investment, the introduction of computerized trading system in 1992, and the deregulation of interest rates that promoted the efficiency of the domestic capital market (Dobson and Jacquet, 1998).
11. Malaysian has implemented the capital control measures since 1st September 1998 that aimed at ending speculation on the Ringgit. This was seen as an important step towards the revitalization of the economy. The Ringgit controls involve: 1) restrictions on external account transactions by non-residents; 2) tightening of rules on overseas investments by Malaysians; 3) trade settlements by Malaysian exporters and importers; and 4) export and import of the ringgit by the travelers (Yap, 1999).

12. The year "1993 was an outstanding year on many counts. The year experienced a bullishness never before experienced in the history of the Kuala Lumpur Stock Exchange. Sixty eight Malaysian stocks were included in the Morgan Stanley's Europe, Australia-Asia and Far East (EAFE) Index and in the world index in May 1993 helped attract foreign funds and provided further impetus to the local market" (Tan, 1997 p.154). Furthermore, in his commemorative book of KLSE, Tan (1997) indicated that the January to July 1993 was noted as "Bull run" and August to December 1993 was viewed as "Super Bull run" of Kuala Lumpur Stock Exchange.
13. Since July 1997, the currencies of all three second-tier Southeast Asian newly industrialized countries had fallen precipitously, with the stock markets responding in tandem (Jomo, 1998, p.1)." The period in the mid 1997 to mid 1999 were considered as financial crisis period and economic downturn in Malaysia.

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