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Do the Technical Indicators Reward Chartists? A Study on the Stock Markets of China, Hong Kong and Taiwan

Wing-Keung Wong, Jun Du* and Terence Tai-Leung Chong

This paper studies the profitability of applying technical analysis that signals the entry and exit from the stock market in three Chinese stock markets-the Shanghai, Hong Kong and Taiwan Stock Exchanges. The Simple Moving Average (MA) and its extensions, Exponential MA, Dual MA, Triple MA, MACD and TRIX for both long and short strategies are examined. Applying the trading signals generated by the MA family to the Greater China markets, significantly positive returns are generated, which outperform the buy-and-hold strategy. The cumulative wealth obtained also surpasses that of the buy-and-hold strategy regardless of transaction costs. In addition, we study the performance of the MA family before and after the 1997 Asian Financial Crisis and find that the MA family works well in both sub-periods and in different market conditions of bull runs, bear markets and mixed markets. That technical analysis can forecast the directions of these markets implies that the three China stock markets are not efficient.

Keywords: *Technical analysis, Moving Average, buy-and-hold strategy*

JEL Classification: *G1, C0*

INTRODUCTION

With China's entry into the World Trade Organization (WTO), Greater China (China, Hong Kong and Taiwan) is poised to become a major economic force through increased integration with global capital markets[2]. In China, Provisional Measures on Administration of Domestic Securities Investments of Qualified Foreign Institutional Investors came into effect on December 1, 2002, wherein overseas financial institutions are allowed to invest in China's

* Corresponding author: Wing-Keung Wong, Department of Economics, Faculty of Arts & Social Sciences, National University of Singapore, 1 Arts Link, Singapore 117570. Tel: (65) 6516-6014, Fax: (65) 6775-2646, e-mail: *ecswwk@nus.edu.sg*

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domestic securities market directly. As China relaxes its restrictions on international capital flows, a pertinent question regarding the stock markets in Greater China is how market participants and traders forecast future market developments. Although many institutional and individual investors rely heavily on technical analysis and most financial consultants and information services provide comprehensive and up-to-date technical analysis information (Froot, *et al.* 1992), there are very few studies on technical analysis about these stock markets. In this paper, we apply statistics from the greater China stock markets, namely the Shanghai Stock Exchange (SSE), the Stock Exchange of Hong Kong (SEHK) and the Taiwan Stock Exchange (TSE), to the most established trend indicators, the simple Moving Averages (MA) and its extensions, Exponential MA, Dual MA, Triple MA, MACD and TRIX[3] to see whether the MAs trading rules yield significantly positive financial returns and whether they perform better than the buy-and-hold (B&H) strategy in long and short trading methods. Our findings show that the MAs perform better than the B&H strategy regardless of the transaction costs. A study of the performance of the Moving Averages before and after the 1997 Asian Financial Crisis has also been conducted. The trading signals generated by the MAs before and after the 1997 Asian Financial Crisis produce significant returns and beat the B&H strategy significantly in bull runs, bear markets and mixed markets. The fact that technical analysis yields significant forecasting power implies that the Greater China stock markets are not efficient.

The paper is organized as follows: Section II gives a brief review of the existing literature. Section III introduces the technical indicators studied in this paper while Section IV discusses the data, hypotheses and the corresponding testing statistics, followed by a brief introduction of the trading costs in the three exchanges. Empirical results are provided in Section V and discussions in the last section.

LITERATURE REVIEW

Technical analysts are often referred to as chartists because they rely almost exclusively on charts for their analyses. In its simplest form, technical analysis uses information about historical price movements, summarized in the form of price charts, to forecast future price trends. This approach to forecasting was first used by the Japanese rice traders in the 1700s, and has been widely used by investors since the late 1800s after the publications of Charles Dow, which laid the foundation for modern technical analysis. Technical analysis is applicable to stocks, indices, commodities, futures or any tradable instrument where prices are influenced by the forces of supply and demand. Price refers to any combination of the open, high, low or close for a given security over a specific time frame. The time frame can be based on intraday (tick, 5-minute, 15-minute or hourly), daily, weekly or monthly price data and may span from a few seconds to many years. In addition, some technical analysts include volume or open interest figures in their studies of price action. (Blume, *et al.*, 1994).

The guiding principle of technical analysis is to identify and exploit the price trends, which are determined by the changing attitudes of investors towards a variety of economic, monetary, political and psychological forces. Most chartists agree that prices trend. However, they also acknowledge that there are periods when prices do not trend. Schwager (1995) notes that markets may witness extended periods of random fluctuation, interspersed with shorter periods of nonrandom behavior. If prices are always random, it would be extremely difficult to make

money using technical analysis. The goal of a chartist is to identify these periods of non-random major trends.

Some empirical studies (see for example, Fama and Blume (1966), Jensen and Benington (1970) and Fong and Yong (2005)) do not see any merits in technical analysis. They suggest that the results from applying technical analysis are consistent with the market efficiency hypothesis. In an efficient market, the current prices reflect all available information including past history and future price changes, so one should not be able to use technical analysis to predict future prices and get abnormal returns. Popular technical trading strategies which use current and past price data only should not be able to beat the market.

On the contrary, there is strong evidence that simple technical analyses have significant forecasting power (Allen and Taylor 1990 and Neftci 1991), for example, Brock, *et al.* (1992) forecast changes in the Dow Jones Industrial Average over a long sample period. For LeBaron (1999), a Financial Economist, technical trading rules can be viewed as another set of moment conditions that can be used either in specification testing or in estimation. Technical trading rules therefore assume a dual role: as a signal of interesting behavior that may have some practical values, and as a data description that economic theorists should be aware of. Lo, *et al.* (2000) examine the prevalence of various technical patterns in the American share prices during 1962-1996 and find that the patterns are recurrent. Even though the study does not prove that the patterns are sufficiently predictable to ensure sufficient profit the authors believe that risks are justified. Recently, Wong, *et al.* (2001) show that the forecasts drawn from the E/P ratio and bond yield would enable investors to escape most of the crashes and capture most of the bull runs. Wong, *et al.* (2003) find that two commonly used indicators: Moving Average and Relative Strength Index can be used to generate significantly positive return in the Singapore stock market. The profitability of technical trading rules in the aforementioned studies diametrically contradicts the notion of an efficient market.

TECHNICAL INDICATORS

Moving Average (MA) is the most commonly used trend-following indicator. There are many studies on the performance of MA but the findings are not consistent. For example, Brock, *et al.* (1992) show that MA significantly outperforms a cash benchmark when applied to the Dow Jones Industrial Average. However, Ready (1997) finds that apart from the earliest sub-period (1970-1974), MA generally underperforms the B&H strategy. More recently, data from Wong, *et al.* (2003) supports the usefulness of the MA. On the other hand, Fong and Yong (2005) examine various MA rules and conclude that no evidence of significant trading profits is found. In this paper, we examine the performance of the Moving Average in the Greater China stock markets by investigating the following MA rules: simple Moving Average (MA), simple Exponential Moving Average (EMA), Dual Moving Average (DMA), Dual Exponential Moving Average (DEMA), and the extensions of MA and/or EMA, the Moving Average Convergence-Divergence (MACD) and Triple Smoothed Exponential Moving Average (*TRIX*).

Simple Moving Average

The n-day simple Moving Average (MA) at time t, denoted by $MA_{t,n}$, is given by:

$$MA_{t,n} = \frac{1}{n}\sum_{i=t-n}^{t-1} C_i, \qquad ...(1)$$

where C_i is the closing price at time i. A moving average moves in response to the adding of a new period and the shedding of the oldest period. As the calculation continues, the n-day moving average goes up when the closing price moves upwards as the added value is larger than the dropped value. In a simple MA procedure, a buy signal is generated when the closing price rises above the MA and a sell signal is generated when the close falls below the MA. Because moving averages are lagging indicators, they are trend following. If there exists a clear trend, this method should work well. However, if the market is moving sideways or if there is excessive volatility, there could be a lot of whipsaws (false signals). In such cases, Bollinger Bands and the MA Channels may be better trading tools than the Moving Averages (Leung and Chong, 2003).

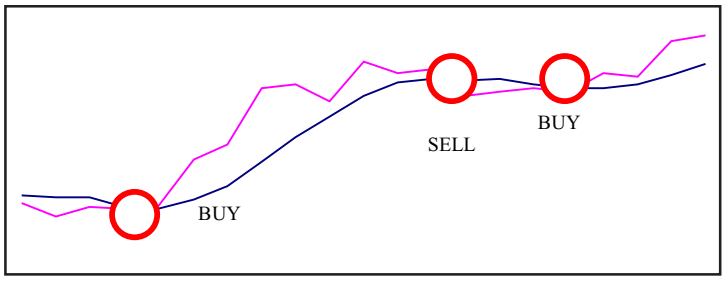
Exponential Moving Average

In order to reduce the lag effect from the 'outdated' data in simple moving averages, the exponential moving averages are developed. The n-day Exponential Moving Average (EMA) at time t, denoted by $EMA^4_{t,n}$, is given by:

$$EMA_{t,n} = \frac{2}{n+1}(C_t - EMA_{t-1,n}) + EMA_{t-1,n}. \qquad ...(2)$$

Exponential moving averages reduce the lag effect from the 'outdated' data by assigning more weight to more recent prices. The smoothing constant 2/ (n+1) in formula (2) works as the weight that applies to the most recent price depending on the length of the moving average. The shorter the exponential moving average, the greater the weight that will be assigned to the most recent price. For example: a 10-period exponential moving average would weigh the most recent price 18.18% and a 20-period exponential moving average would weigh the most recent price 9.52%. EMA will react faster to recent price changes than a simple moving average. The EMA formula works by weighing the difference between the price in the current period and the EMA in the previous period and updating the result of the EMA in the previous period.

Illustration on Moving Average



—— **stock index** —— **MA**

The above diagram shows the formation of the buy and sell signals by MA (either MA or EMA):

Dual Moving Average and Dual Exponential Moving Average

Another commonly used trading rule is the Dual MA (*DMA*)[5], denoted by *DMA*(*n,m*), that consists of two MAs: a 'short' *n*-day *MA*, $MA_{t,n}$, and a 'long' *m*-day *MA*, $MA_{t,m}$, with $m > n$. The rule generates a buy (sell) signal when the short *MA* rises above (falls below) the long *MA*. The common *DMA* rules are 1-5, 1-200, 5-10, 5-20, 5-30 and 5-200. When the *DMA* is formed by two *EMAs*, we call it Dual Exponential Moving Average (*DEMA*), denoted by *DEMA*(*n,m*). They are similar to *DMA,* There are two *EMAs*: a 'short' *n*-day *EMA*, $EMA_{t,n}$, and a 'long' *m*-day *EMA*, $EMA_{t,m}$, with $m > n$. The rule for the *DEMA* signals is the same as that of the *DMA*. The 5-20 day and 5-30 day *DMA* and *DEMA* are examined in this paper.

Moving Average Convergence Divergence (MACD)

Developed by Appel and Hitschler (1980), Moving Average Convergence Divergence (*MACD*) is one of the simplest and most reliable indicators. *MACD* uses moving averages, which are lagging indicators, to detect some trend-following characteristics. These lagging indicators are then turned into a momentum oscillator by subtracting the longer exponential moving average from the shorter exponential moving average. The general formulas are given by:

$$MACD_t = EMA_{t,n} - EMA_{t,m} \quad (m>n),$$

and

$$DIF_t = \frac{2}{h+1} MACD_t + \frac{h-1}{h+1} DIF_{t-1} \qquad ...(3)$$

where $EMA_{t,m}$ and $EMA_{t,n}$ are defined in (2) and $DIF_1 = \text{MACD}_1$.

The most popular formula for the "standard" MACD is the difference between a security's 26-day and 12-day exponential moving averages. This is the formula used in many popular technical analysis programs, and quoted in most publications on technical analysis. Appel and Hitschler (1980) have since tinkered with these original settings to come up with a *MACD* that is better suited for faster or slower securities. Using shorter moving averages will produce a quicker, more responsive indicator, while using longer moving averages will produce a slower indicator that is less prone to whipsaws. The traditional 12/26 *MACD* will be used for illustration in our study. Of the two moving averages that make up *MACD*, the 12-day *EMA* is faster than the 26-day *EMA*. Closing prices are used to form the moving averages. Usually, a 9-day *EMA* of *MACD* is plotted along with both *EMAs* to act as a trigger line. A bullish crossover occurs when *MACD* moves above its 9-day *EMA* and a bearish crossover occurs when *MACD* moves below its 9-day *EMA*.

Triple Exponential Moving Average (TRIX)

The *TRIX* indicator is the rate of change between a triple exponentially smoothed moving average of price. It is a momentum indicator designed to filter out insignificant cycles by presenting a one percentage change of an exponential moving average.

TRIX values oscillate around a zero line. When the values turn up (down), the market is considered bullish (bearish). A moving average of the *TRIX* indicator is often calculated as a signal line. The *TRIX* indicator crossing above (below) the signal line is considered bullish (bearish). The general formula of a moving average of the *TRIX* indicator is defined as:

$$MATRIX_t = \frac{1}{m}\sum_{i=1}^{m} TRIX_{t,i} \qquad ...(4)$$

where

$$TRIX_{t,i} = \frac{2}{i+1}(BX_{t,i} - TRIX_{t-1,i}) + TRIX_{t-1,i}$$

$$BX_{t,i} = \frac{2}{i+1}(AX_{t,i} - BX_{t-1,i}) + BX_{t-1,i}$$

$$AX_{t,i} = \frac{2}{i+1}(C_t - AX_{t-1,i}) + AX_{t-1,i}\,.$$

$TRIX_{1,i}$, $BX_{1,i}$ and $AX_{1,i}$ are defined similarly as in equation (2) and C_t is defined in equation (1).

DATA AND METHODOLOGY

The data used in our study are the daily closing values of the Shanghai A-share Index (SAI)[6] from January 2, 1992 to December 31, 2004, the Hang Seng Index (HSI) and the Taiwan Stock Exchange Index (TWII) from January 1, 1988 to December 31, 2004, extracted from Datastream[7]. The entire study period is almost 13 years for SAI and is 17 years for HSI and TWSEI. As shown in Figures 1A to 1C, in the sub-period before the 1997 Asian Financial Crisis, Shanghai and Taiwan were mixed markets which contained several bull runs and bear markets while Hong Kong was in a bull run. In the sub-period after the 1997 Asian Financial Crisis, Shanghai and Hong Kong were mixed markets while Taiwan was a bear market. Our study captures the performance of the MA family in the Greater China stock markets in most, if not all, of the market conditions.

The closing prices of the indexes are used to compute the daily returns, r_t, such that $r_t = 100*Ln\,(C_t\,/C_{t-1})$ where C_t is the closing price of the index at day t. In order to utilize the moving average indicator, MA_t (either *MA*, *EMA*, *DMA*, *DEMA*, *MACD*, or *TRIX*), we assume that investors will buy (sell) when the MA_t indicates a buy (sell) signal, say at time t and sell (buy) when the MA_t indicates a sell (buy) signal, say at time $t + n_t$ and form the long (short) trading strategy. Then the aggregate return S_{t,n_t} will be

$$S_{t,n_t} = \sum_{i=1}^{n_t} r_{t+i}\ . \qquad ...(5)$$

Figure 1A: Time Series Plot of Shanghai a share Index

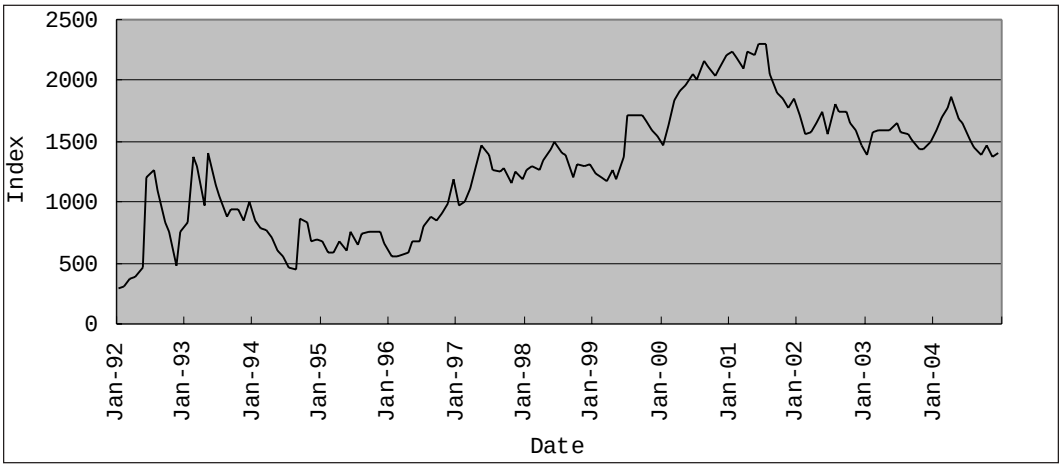


Figure 1B: Time Series Plot of Hang Seng Index

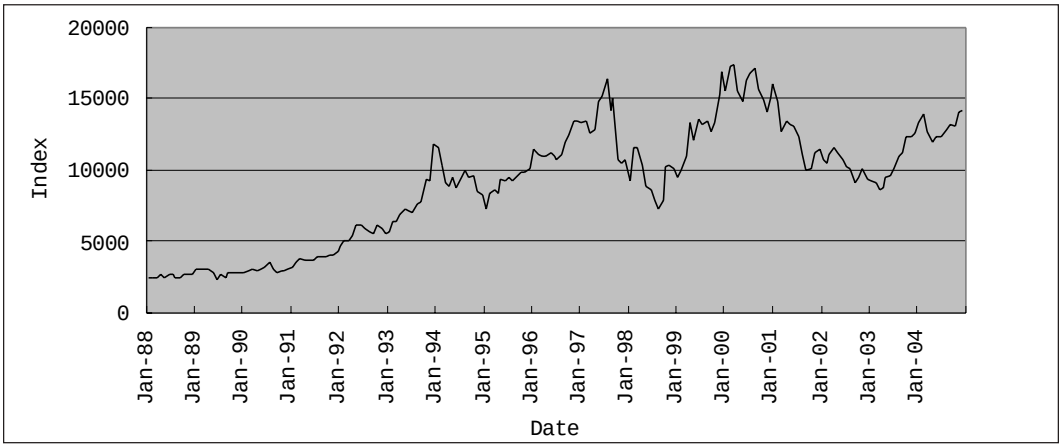
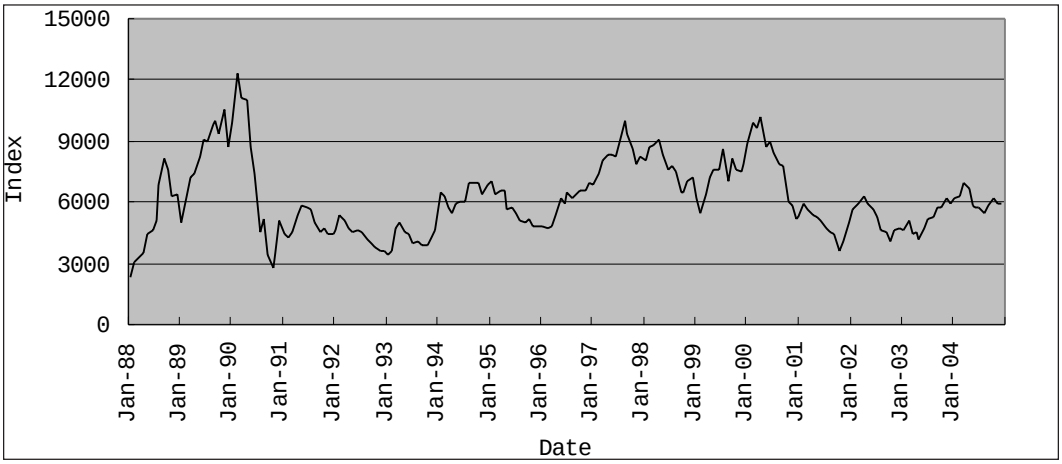


Figure 1C: Time Series Plot of the Taiwan Stock Exchange Index



Without loss of generality, we denote S_{t,n_t} as S_t. Suppose we have the buy (sell) signals at t_1, t_2, …, t_m, we let $\Lambda = \{t_1, t_2, \ldots, t_m\}$ and define Ω to be the set of all these trading returns such that $\Omega = \bigcup_{i\in\Lambda} I_i$ where $\{I_i\}$ are disjoint sets of returns generated by the i^{th} buy (sell) signals[8]. We also let $n = N(\Omega)$ be the number of elements in the set Ω. We let r_Ω be the vector of all returns in Ω and let 1_Ω be the nx1 vector of one. Assume mean vector and covariance matrix of r_Ω are μ_Ω and Σ_Ω respectively. If Ω is the set of all the daily returns generated by buy signals, we use $r_\Omega^{long}, \mu_\Omega^{long}, \sum_\Omega^{long}$ and n_{long} to correspond to r_Ω, μ_Ω, $\sum_\Omega$ and n respectively. Similarly, if Ω is the set of all the daily returns generated by sell signals, we use the symbols r_Ω^{short}, μ_Ω^{short}, $\sum_\Omega^{short}$ and n_{short} respectively. r_Ω^{long} is the vector of daily returns for the long strategy generated by the indicator MA_t while r_Ω^{short} is the vector of daily returns for the short strategy generated by the indicator. We further define μ_{long} and μ_{short} to be the population means of daily returns generated by the buy and sell signals respectively. The hypothesis

$$H_{01} : \mu_{long} = 0 \text{ against } H_{11} : \mu_{long} > 0 \qquad ...(6)$$

is used to test whether the return is profitable for the long strategy. On the other hand, the hypothesis

$$H_{02} : \mu_{short} = 0 \text{ against } H_{12} : \mu_{short} < 0 \qquad ...(7)$$

is used to test whether the return is profitable for the short strategy. Statistic applied to test whether the buy and sell signals generated by the family of *MA* yield significantly positive returns for both the long and short strategies are:

$$T = \frac{1_\Omega^T r_\Omega}{\sqrt{1_\Omega^T \hat{\Sigma}_\Omega 1_\Omega}}^{9} \qquad ...(8)$$

$$\bar{r} = 1_\Omega^T r_\Omega / n$$

where $\bar{r}$, r_Ω and E_Ω are $\bar{r}_{long}, r_\Omega^{long}$ and Σ_Ω^{long} respectively if it is used to test (6) and are $\bar{r}_{short}$ r_Ω^{short} and Σ_Ω^{short} respectively if it is used to test (7). The test statistic T will be approximately distributed as $N(0,1)$ if μ (μ_{long} and μ_{short}) is 0. We do not assume r_Ω to be multivariate-normally distributed as n is very large in our study, T will approach the standard normal distribution by virtue of the Central Limit Theorem. Thus, the profit generated by using the MA_t is significantly greater than zero if

$$\begin{cases} T > z_\alpha & \text{in a long position} \\ T < -z_\alpha & \text{in a short position} \end{cases}, \qquad ...(9)$$

where z_α is the critical value such that $\alpha = P(Z > z_\alpha)$ and Z follows the standardized normal distribution.

Nonetheless, it is well-known that the daily return is not i.i.d. (independent and identical distributed) nor is normal (see, for example, Fama 1965, Fama and French 1988). One may refer to Lo and MacKinlay (1990) for the violation of the normality assumption and Conrad and Kaul (1988) for the violation of the independence assumption for daily returns. To take care of the possibility that the Central Limit Theorem does not work well in our study, we employ a bootstrap technique (Hall 1992) in our analysis for checking. The results obtained from the bootstrap approach are very close to the results obtained by assuming the statistic T to approach the standard normal distribution. Thus, we only report the results obtained by the latter.

To check whether any of the moving average approaches significantly outperform the *B&H* strategy, we let $\bar{r}_{BH}$ and μ_{BH} be the sample and population means of daily returns respectively for the *B&H* strategy and use $\bar{r}$ and *n* defined in (8). Recall that $\bar{r}$ is equal to $\bar{r}_{long}$ if Ω is generated by the buy signals and equal to $\bar{r}_{short}$ if Ω is generated by the sell signals. Let *m* (μ_{long} and μ_{short}) be the mean and σ^2 (σ^2_{long} and σ^2_{short}) be the variance of $\bar{r}$ ($\bar{r}_{long}$ and $\bar{r}_{short}$) respectively. Then, we have $\sigma^2 = 1^T_\Omega \Sigma_\Omega 1_\Omega / n$ where $1^T_\Omega \Sigma_\Omega 1_\Omega$ is defined in (8). To check whether any of the moving average approaches significantly outperform the *B&H* strategy, it is necessary to test whether the return, μ_{long} , generated by the long strategy using the *MA* family is significantly greater than the return, μ_{BH} , using the *B&H* strategy. That is to test the hypothesis

$$H_{03} : \mu_{long} = \mu_{BH} \text{ against } H_{13} : \mu_{long} > \mu_{BH}. \qquad ...(10)$$

Similarly, the hypothesis

$$H_{04} : \mu_{short} = \mu_{BH} \text{ against } H_{14} : \mu_{short} < \mu_{BH}. \qquad ...(11)$$

is used to test whether the return, μ_{short} , generated by the short strategy using the *MA* family is (significantly) greater than the return, μ_{BH} , obtained from using the *B&H* strategy. We let $R = (\bar{r}, \bar{r}_{BH})^T$ and Σ be the variance matrix of R , and introduce the following test statistic to test whether a long or short strategy using the buy and sell signals generated by the MA family outperforms significantly the *B&H* strategy:

$$T' = \frac{a^T R}{\sqrt{a^T \Sigma a}} \qquad ...(12)$$

where $a = (1, -1)^T$.

The statistic *T'* should approach the standard normal distribution by virtue of the Central Limit Theorem as sample size is very large in our study. The possibility that the Central Limit

Theorem does not work well in our study, we employ a bootstrap technique (Hall, 1992) for checking purpose. As the results obtained from the bootstrap approach are very close to the results obtained by assuming *T'* to approach the standard normal distribution, we only report the latter results.

The statistics *T* and *T'* will be applied to the entire period as well as the sub-periods before and after the 1997 Asian Financial Crisis. In the sub-period before the 1997 Asian Financial Crisis, China and Taiwan were mixed markets which contained several bull runs and bear markets while Hong Kong was in a bull run. After the 1997 Asian Financial Crisis, China and Hong Kong were mixed markets while Taiwan was a bear market. The statistics will test whether the buy and sell signals generated by the family of MA produce significant profits and surpass the *B&H* strategy for these market scenarios.

Besides evaluating the performance of these technical analysis rules and the *B&H* strategy, we have also set up a portfolio with an initial amount of $1 million local currency for both investment approaches so that comparison can be made at the end of the entire period.

As trading costs will affect the results from technical analysis, it is necessary to factor them in. Excluding the fixed costs, Table 1 lists the costs imposed on equity trading in the SSE, SEHK and TSE markets.

Table 1
Transaction costs in SSE(A), SEHK and TSE.

	SSE (A)	*SEHK*	*TSE*
Commission	<=0.3%	freely negotiable	<=0.1425%
Transaction Levy	N.A.	0.005%	0.3% (One side)
Investor Compensation Levy	N.A.	0.002%	N.A.
Stamp Duty	0.2%	0.1%	N.A.
Transfer Fee	0.1%	HK$2.50 (Fixed)	N.A.
Total (approx.)	<=0.6%	>=0.107%	<=0.2925%

The cost of transaction varies from country to country and in general the cost has dropped significantly. In addition, the commission rate varies with the market players. Retail investors pay higher rate while large institutional investors, such as mutual funds pay less. Broking firms with seats in the Stock Exchange practically do not have to pay any commission, although they do have to pay out a considerable sum to buy the seat. The transaction cost in SEHK is about 0.1% for big investors and institutional investors. We have compared the MA strategy and *B&H* strategy with zero cost as well as 0.1% transaction cost in this paper.

EMPIRICAL RESULTS

To get a clear idea of how the markets reward, we first depict in Table 2 the basic statistic description of the returns of the three markets for the entire period as well as for the two sub-periods.

Table 2
Descriptive Statistics of Returns of the Stock Markets

	Period	n	Mean ($\bar{r}_{BH}$)	S.D.	t	Skewness	Kurtosis
Shanghai	1992-2004	3391	0.0445	2.9147	0.8899	6.0755	139.7251
A-share	1992-1996	1303	0.0905	4.3115	0.7575	4.8670	74.3974
Index	1997-2004	2088	0.0159	1.4833	0.4889	-0.0530	6.8513
	1988-2004	4435	0.0411	1.6244	1.6835	-0.8744	21.0561
Hang Seng	1988-1996	2347	0.0752	1.4430	2.5247	-2.6364	41.5131
Index	1997-2004	2088	0.0027	1.8063	0.0682	0.1823	10.2161
Taiwan	1988-2004	4434	0.0216	1.9858	0.7295	-0.0608	2.8053
Stock Ex.	1988-1996	2347	0.0463	2.2095	1.0149	-0.0802	2.5628
Index	1997-2004	2087	-0.0058	1.6996	-0.1567	-0.0416	2.1492

As the daily mean return shown in the table is actually the average return of the *B&H* strategy, the *t*-value could be used to test whether the *B&H* strategy could generate significant profit for the three markets in the entire period as well as in the sub-periods. Except for the sub-period of 1997-2004 in the Taiwan stock Exchange, all the daily means returns are positive, indicating that B&H generates positive returns for the three markets in nearly all periods. However, except for the period 1988-1996 in Hang the Seng Index, all the *t*-values are not significantly different from zero at the 5% level, implying that B&H does not generate significant profit. This suggests that investors should look for alternative strategies. Our study of the *MA* family with the results shown in Tables 3 to 6 is one of the best alternatives.

Tables 3A to 3C report the average daily return $\bar{r}_{long}$ and the corresponding test statistic, *T*, generated by the long strategy from the MA family, including MA(5), MA(10), MA(20), DMA(5,20), DMA(5,30), EMA(5), EMA(10), EMA(20), DEMA(5,20), DEMA(5,30), MACD and TRIX, in the Shanghai A-share Index for the entire period from 1992 to 2004 and for the two sub-periods before and after the 1997 Asian Financial Crisis. The difference, $\bar{r}_{long} - \bar{r}_{BH}$, between the average daily return generated by the MA family from the long strategy and the average daily return generated by the *B&H* strategy and the corresponding test statistic (*T'*) are reported in the right panel of the tables. In addition, the total number of holding days generated by the MA family is also reported in the tables. All the variables are defined in Equations (8) and (12). Similarly, Tables 4A to 4C report the same variables for investing in the Hang Seng Index while Tables 5A to 5C for the Taiwan Stock Exchange Index.

In Table 3A, we find that the average daily returns ($\bar{r}_{long}$) produced by the long strategy from the *MA* family are all positive, ranging from 0.08% to 0.60%, highly significant at the 1% level for all rules except for *TRIX*. Rejecting H_{01} in (6), we conclude that all the *MA* rules except *TRIX* generate more profitable returns for the long strategy for the Shanghai A-share Index for the entire period. In addition, the difference, $\bar{r}_{long} - \bar{r}_{BH}$, between the average daily return generated by any *MA* rule and the *B&H* strategy are all positive, ranging from 0.04% to 0.56%, highly significant at the 1% level for all rules except the *TRIX* rule. Rejecting H_{03} in (10), we conclude that all *MA* rules except the *TRIX* perform significantly better than the *B&H* strategy for the Shanghai A-share Index for the entire period.

From Table 4A and Table 5A, similar conclusions can be drawn for the Hong Kong and the Taiwan stock markets. The *MA* rules, except the *TRIX* rule, generate more profitable

Table 3A
Results of Adopting Different Rules for Shanghai A-share Index from 1992 to 2004

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	*T*	$\overline{r}_{long} - \overline{r}_{BH}$	*T'*	*N*	$\overline{r}_{short}$	*T*	$\overline{r}_{short} - \overline{r}_{BH}$	*T'*
MA (5)	2011	0.5826	8.03***	0.5381	7.42***	2037	-0.4953	-8.64***	-0.4507	-7.86***
MA (10)	1863	0.4989	6.56***	0.4544	5.97***	1918	-0.3745	-6.22***	-0.3300	-5.48***
MA (20)	1685	0.3994	5.75***	0.3549	5.11***	1860	-0.3112	-5.03***	-0.2667	-4.31***
DMA (5,20)	1622	0.2061	3.11***	0.1616	2.44***	1819	-0.1304	-2.01**	-0.0858	-1.32*
DMA (5,30)	1572	0.1560	2.39***	0.1114	1.71**	1819	-0.0841	-1.30*	-0.0395	-0.61
EMA (5)	2032	0.6032	8.46***	0.5587	7.83***	2050	-0.4927	-8.68***	-0.4481	-7.90***
EMA (10)	1887	0.5501	7.24***	0.5056	6.65***	1975	-0.4011	-6.83***	-0.3565	-6.07***
EMA (20)	1793	0.4724	5.95***	0.4279	5.39***	1893	-0.3075	-4.81***	-0.2629	-4.12***
DEMA (5,20)	1578	0.2544	3.67***	0.2098	3.02***	1816	-0.1715	-2.63***	-0.1270	-1.95**
DEMA (5,30)	1573	0.2086	3.13***	0.1641	2.46***	1784	-0.1409	-2.13**	-0.0963	-1.46*
MACD	1728	0.3057	3.79***	0.2611	3.24***	1875	-0.1638	-2.81***	-0.1193	-2.05**
TRIX	1759	0.0812	1.07	0.0366	0.48	1629	-0.0051	-0.08	0.0394	0.60

** p < 1%, ** p < 5% * p < 10%.

Table 3B
Results of Adopting different Rules for Shanghai A-share Index from 1992 to 1996

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	*T*	$\overline{r}_{long} - \overline{r}_{BH}$	*T'*	*N*	$\overline{r}_{short}$	*T*	$\overline{r}_{short} - \overline{r}_{BH}$	*T'*
MA(5)	697	1.0513	5.44***	0.9608	4.97***	783	-0.8135	-6.32***	-0.7230	-5.61***
MA(10)	625	0.9758	4.66***	0.8853	4.23***	761	-0.5945	-4.51***	-0.5040	-3.82***
MA(20)	557	0.7454	3.95***	0.6550	3.47***	732	-0.4878	-3.52***	-0.3973	-2.87***
DMA(5,20)	534	0.4547	2.52***	0.3642	2.02**	705	-0.2439	-1.62*	-0.1534	-1.02
DMA(5,30)	518	0.2994	1.71**	0.2089	1.19	699	-0.1686	-1.12	-0.0781	-0.52
EMA(5)	750	1.0514	5.89***	0.9609	5.38***	796	-0.8063	-6.36***	-0.7158	-5.65***
EMA(10)	701	0.9624	5.07***	0.8720	4.60***	777	-0.6359	-4.89***	-0.5454	-4.19***
EMA(20)	661	0.8650	4.33***	0.7745	3.87***	747	-0.4773	-3.30***	-0.3868	-2.67***
DEMA(5,20)	502	0.5362	2.74***	0.4457	2.28**	706	-0.2831	-1.89**	-0.1926	-1.29*
DEMA(5,30)	507	0.3865	2.12**	0.2960	1.62*	696	-0.2280	-1.50*	-0.1376	-0.90
MACD	638	0.6048	2.95***	0.5144	2.51***	719	-0.3167	-2.41***	-0.2262	-1.72**
TRIX	671	0.2037	1.10	0.1132	0.61	604	-0.0662	-0.42	0.0243	0.16

*** p < 1%, ** p < 5% * p < 10%.

Table 3C
Results of Adopting different Rules for Shanghai A-share Index from 1997 to 2004

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	*T*	$\overline{r}_{long} - \overline{r}_{BH}$	*T'*	*N*	$\overline{r}_{short}$	*T*	$\overline{r}_{short} - \overline{r}_{BH}$	*T'*
MA(5)	1314	0.3340	8.14***	0.3182	7.76***	1254	-0.2965	-6.42***	-0.2807	-6.08***
MA(10)	1238	0.2582	6.06***	0.2423	5.69***	1157	-0.2299	-4.71***	-0.2140	-4.39***
MA(20)	1128	0.2286	5.09***	0.2127	4.74***	1128	-0.1966	-4.09***	-0.1807	-3.76***
DMA(5,20)	1088	0.0841	1.94**	0.0682	1.57*	1114	-0.0585	-1.25	-0.0427	-0.91
DMA(5,30)	1054	0.0855	1.90**	0.0696	1.55*	1120	-0.0313	-0.68	-0.0155	-0.34
EMA(5)	1282	0.3410	8.17**	0.3251	7.79***	1254	-0.2936	-6.47***	-0.2777	-6.12***
EMA(10)	1186	0.3064	6.99***	0.2905	6.63***	1198	-0.2487	-5.29***	-0.2329	-4.96***
EMA(20)	1132	0.2432	5.38***	0.2273	5.03***	1146	-0.1968	-4.16***	-0.1809	-3.83***
DEMA(5,20)	1076	0.1229	2.75***	0.1070	2.39***	1110	-0.1006	-2.08**	-0.0847	-1.75**
DEMA(5,30)	1066	0.1241	2.71***	0.1082	2.36***	1088	-0.0851	-1.78**	-0.0692	-1.45*
MACD	1090	0.1306	2.96***	0.1147	2.60***	1156	-0.0687	-1.46*	-0.0528	-1.13
TRIX	1088	0.0056	0.13	-0.0103	-0.23	1025	0.0308	0.65	0.0467	0.98

*** p < 1%, ** p < 5% * p < 10%.

Table 4A
Results of Adopting different Rules for Hang Seng Index from 1988 to 2004

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	*T*	$\overline{r}_{long} - \overline{r}_{BH}$	*T'*	*N*	$\overline{r}_{short}$	*T*	$\overline{r}_{short} - \overline{r}_{BH}$	*T'*
MA(5)	2896	0.3972	14.51***	0.3561	13.01***	2498	-0.3424	-9.46***	-0.3015	-8.32***
MA(10)	2752	0.3153	11.55***	0.2744	10.05***	2269	-0.2826	-7.06***	-0.2416	-6.03***
MA(20)	2697	0.2394	8.80***	0.1983	7.29***	2156	-0.2070	-5.01***	-0.1659	-4.01***
DMA(5,20)	2621	0.1105	4.03***	0.0695	2.53***	2064	-0.0524	-1.26	-0.0113	-0.27
DMA(5,30)	2693	0.0816	3.08***	0.0406	1.53*	1954	-0.0018	-0.04	0.0392	0.89
EMA(5)	2891	0.3900	14.17***	0.3489	12.68***	2420	-0.3516	-9.33***	-0.3105	-8.24***
EMA(10)	2786	0.3342	12.30***	0.2932	10.79***	2265	-0.3174	-7.93***	-0.2763	-6.90***
EMA(20)	2793	0.2520	9.46***	0.2109	7.92***	2112	-0.2393	-5.56***	-0.1982	-4.61***
DEMA(5,20)	2727	0.1336	4.99***	0.0925	3.46***	1950	-0.0913	-2.04**	-0.0503	-1.12
DEMA(5,30)	2809	0.1178	4.54***	0.0767	2.96***	1816	-0.0776	-1.63*	-0.0365	-0.77
MACD	2411	0.1779	6.15***	0.1369	4.73***	2343	-0.1015	-2.70***	-0.0604	-1.61*
TRIX	2865	0.0437	1.60*	0.0027	0.10	1615	0.0467	1.00	0.0877	1.88

*** p < 1%, ** p < 5% * p < 10%.

Table 4B
Results of Adopting different Rules for Hang Seng Index from 1988 to 1996

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	T	$\overline{r}_{long} - \overline{r}_{BH}$	T'	N	$\overline{r}_{short}$	T	$\overline{r}_{short} - \overline{r}_{BH}$	T'
MA(5)	1595	0.3712	12.48***	0.2960	9.95***	1255	-0.3003	-6.43***	-0.2253	-4.82***
MA(10)	1526	0.3013	9.72***	0.2263	7.29***	1119	-0.2448	-4.66***	-0.1696	-3.23***
MA(20)	1496	0.2313	7.35***	0.1561	4.96***	1065	-0.1627	-3.03***	-0.0875	-1.63*
DMA(5,20)	1453	0.1282	3.91***	0.0530	1.61*	1020	-0.0171	-0.31	0.0581	1.06
DMA(5,30)	1506	0.0962	2.95***	0.0210	0.64	955	0.0347	0.61	0.1099	1.93
EMA(5)	1599	0.3644	12.28***	0.2892	9.75***	1206	-0.2986	-6.07***	-0.2234	-4.54***
EMA(10)	1541	0.3134	10.13***	0.2382	7.70***	1118	-0.2664	-5.11***	-0.1912	-3.66***
EMA(20)	1575	0.2335	7.62***	0.1583	5.17***	1018	-0.2001	-3.56***	-0.1249	-2.22**
DEMA(5,20)	1540	0.1370	4.28***	0.0618	1.93**	929	-0.0634	-1.07	0.0118	0.20
DEMA(5,30)	1640	0.1145	3.69***	0.0392	1.26	811	-0.0283	-0.43	0.0469	0.72
MACD	1283	0.2062	6.34***	0.1310	4.03***	1212	-0.0751	-1.57*	0.0001	0.00
TRIX	1761	0.0732	2.09**	-0.0020	-0.06	607	0.1074	1.90**	0.1826	3.24***

*** p < 1%, ** p < 5% * p < 10%

Table 4C
Results of Adopting different Rules for Hang Seng Index from 1997 to 2004

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	T	$\overline{r}_{long} - \overline{r}_{BH}$	T'	N	$\overline{r}_{short}$	T	$\overline{r}_{short} - \overline{r}_{BH}$	T'
MA(5)	1301	0.4290	8.79***	0.4263	8.74***	1243	-0.3849	-6.95***	-0.3822	-6.90***
MA(10)	1226	0.3328	6.99***	0.3301	6.94***	1150	-0.3195	-5.30***	-0.3168	-5.25***
MA(20)	1201	0.2494	5.32***	0.2467	5.26***	1091	-0.2503	-4.00***	-0.2476	-3.96***
DMA(5,20)	1168	0.0886	1.92**	0.0859	1.87**	1044	-0.0869	-1.38*	-0.0842	-1.34*
DMA(5,30)	1187	0.0631	1.45*	0.0604	1.39*	999	-0.0367	-0.55	-0.0340	-0.51
EMA(5)	1292	0.4216	8.53***	0.4189	8.47***	1214	-0.4042	-7.09***	-0.4015	-7.04***
EMA(10)	1245	0.3601	7.63***	0.3574	7.57***	1147	-0.3671	-6.07***	-0.3644	-6.02***
EMA(20)	1218	0.2759	5.93***	0.2732	5.87***	1094	-0.2757	-4.28***	-0.2730	-4.24***
DEMA(5,20)	1187	0.1292	2.85***	0.1265	2.79***	1021	-0.1168	-1.76**	-0.1141	-1.72**
DEMA(5,30)	1169	0.1225	2.74**	0.1198	2.68***	1005	-0.1174	-1.73**	-0.1147	-1.69**
MACD	1128	0.1458	2.94**	0.1431	2.89***	1131	-0.1297	-2.22**	-0.1270	-2.17**
TRIX	1104	-0.0033	-0.07	-0.0060	-0.14	1008	0.0101	0.15	0.0128	0.19

*** p < 1%, ** p < 5% * p < 10%

Table 5A
Results of Adopting different Rules for Taiwan Stock Exchange Index from 1988 to 2004

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	*T*	$\overline{r}_{long} - \overline{r}_{BH}$	*T'*	*N*	$\overline{r}_{short}$	*T*	$\overline{r}_{short} - \overline{r}_{BH}$	*T'*
MA(5)	2862	0.5111	14.56***	0.4893	13.94***	2546	-0.4692	-11.0***	-0.4474	-10.5***
MA(10)	2731	0.3996	11.24***	0.3778	10.63***	2330	-0.3705	-7.97***	-0.3487	-7.50***
MA(20)	2559	0.3143	8.81***	0.2926	8.20***	2268	-0.3030	-6.44***	-0.2812	-5.98***
DMA(5,20)	2509	0.1303	3.70***	0.1086	3.09***	2184	-0.1176	-2.50***	-0.0959	-2.04**
DMA(5,30)	2424	0.1393	3.86***	0.1176	3.26***	2195	-0.1093	-2.33***	-0.0876	-1.87**
EMA(5)	2833	0.5221	14.85***	0.5004	14.23***	2524	-0.4758	-10.9***	-0.4540	-10.4***
EMA(10)	2739	0.4340	12.28***	0.4123	11.66***	2370	-0.4008	-8.74***	-0.3791	-8.27***
EMA(20)	2589	0.3335	9.46***	0.3118	8.84***	2284	-0.3122	-6.58***	-0.2905	-6.12***
DEMA(5,20)	2463	0.2045	5.73***	0.1827	5.12***	2188	-0.1879	-3.92***	-0.1661	-3.47***
DEMA(5,30)	2400	0.1785	4.98***	0.1567	4.37***	2183	-0.1732	-3.65***	-0.1515	-3.19***
MACD	2502	0.1927	5.11***	0.1710	4.54***	2249	-0.1839	-4.10***	-0.1621	-3.62***
TRIX	2309	0.0435	1.14	0.0217	0.57	2166	-0.0033	-0.07	0.0184	0.40

*** p < 1%, ** p < 5% * p < 10%.

Table 5B
Results of Adopting different Rules for Taiwan Stock Exchange Index from 1988 to 1996

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	*T*	$\overline{r}_{long} - \overline{r}_{BH}$	*T'*	*N*	$\overline{r}_{short}$	*T*	$\overline{r}_{short} - \overline{r}_{BH}$	*T'*
MA(5)	1541	0.5797	10.96***	0.5334	10.09***	1302	-0.5479	-8.27***	-0.5016	-7.57***
MA(10)	1488	0.4423	8.23***	0.3960	7.37***	1192	-0.4030	-5.54***	-0.3567	-4.91***
MA(20)	1358	0.3858	6.98***	0.3395	6.15***	1190	-0.3500	-4.92***	-0.3037	-4.27***
DMA(5,20)	1347	0.1992	3.67***	0.1529	2.82***	1129	-0.1565	-2.20**	-0.1102	-1.55*
DMA(5,30)	1303	0.2044	3.63***	0.1581	2.81***	1139	-0.1258	-1.77**	-0.0795	-1.12
EMA(5)	1529	0.5764	10.84***	0.5301	9.97***	1299	-0.5344	-7.86***	-0.4881	-7.18***
EMA(10)	1477	0.4850	9.05***	0.4387	8.19***	1235	-0.4569	-6.50***	-0.4106	-5.84***
EMA(20)	1393	0.3996	7.36***	0.3534	6.51***	1179	-0.3479	-4.75***	-0.3017	-4.12***
DEMA(5,20)	1330	0.2585	4.69***	0.2122	3.85***	1128	-0.2121	-2.89***	-0.1658	-2.26***
DEMA(5,30)	1316	0.2130	3.86***	0.1667	3.02***	1118	-0.1854	-2.55***	-0.1391	-1.91**
MACD	1367	0.2313	4.01***	0.1850	3.21***	1146	-0.2118	-3.06***	-0.1655	-2.39***
TRIX	1237	0.0636	1.08	0.0173	0.29	1131	0.0224	0.32	0.0687	0.98

*** p < 1%, ** p < 5% * p < 10%.

Table 5C
Results of Adopting different Rules for Taiwan Stock Exchange Index from 1997 to 2004

Rule	*Long*					*Short*				
	N	$\overline{r}_{long}$	*T*	$\overline{r}_{long} - \overline{r}_{BH}$	*T'*	*N*	$\overline{r}_{short}$	*T*	$\overline{r}_{short} - \overline{r}_{BH}$	*T'*
MA(5)	1321	0.4310	9.71***	0.4369	9.84***	1244	-0.3868	-7.37***	-0.3926	-7.49***
MA(10)	1243	0.3485	7.87***	0.3543	8.01***	1138	-0.3363	-5.89***	-0.3422	-5.99***
MA(20)	1201	0.2335	5.40***	0.2393	5.54***	1078	-0.2510	-4.17***	-0.2568	-4.26***
DMA(5,20)	1162	0.0505	1.19	0.0564	1.33	1055	-0.0761	-1.26	-0.0819	-1.35*
DMA(5,30)	1121	0.0636	1.51*	0.0695	1.65**	1056	-0.0916	-1.52*	-0.0975	-1.62*
EMA(5)	1304	0.4586	10.38***	0.4644	10.51***	1225	-0.4137	-7.76***	-0.4195	-7.87***
EMA(10)	1262	0.3744	8.48***	0.3802	8.61***	1135	-0.3398	-5.91***	-0.3456	-6.02***
EMA(20)	1196	0.2566	6.01***	0.2624	6.14***	1105	-0.2741	-4.62***	-0.2799	-4.71***
DEMA(5,20)	1133	0.1411	3.30***	0.1469	3.43***	1060	-0.1622	-2.67***	-0.1680	-2.76***
DEMA(5,30)	1084	0.1365	3.22***	0.1423	3.36***	1065	-0.1605	-2.66***	-0.1663	-2.76***
MACD	1135	0.1463	3.21***	0.1521	3.34***	1103	-0.1548	-2.75***	-0.1606	-2.85***
TRIX	1072	0.0202	0.44	0.0261	0.57	1035	-0.0314	-0.54	-0.0373	-0.64

*** p < 1%, ** p < 5% * p < 10%

returns for the long strategy in both the Hang Seng Index and Taiwan Stock Exchange Index in the entire period. The same inference can be drawn in that the *MA* rules (except *TRIX* rule) generate significantly better returns than the *B&H* strategy in the long strategy for both the Hang Seng Index and Taiwan Stock Exchange Index for the entire period.

Tables 3A, 4A and 5A also show the performance of the short strategy generated by the MA family for the Shanghai, Hong Kong and Taiwan stock markets in the entire period. The tables show that the average daily return, $\bar{r}_{short}$, produced by adopting the short strategy are all negative in the three markets, with all but one significant in the Shanghai and Taiwan stock markets and all but three significant in Hong Kong stock market. The comparison of the short strategy by the *MA* family and the *B&H* strategy favor the short strategy by the *MA* family in all the three stock markets. The difference, $\bar{r}_{short} - \bar{r}_{BH}$, between the average daily return generated by the short strategy of any *MA* rule and the *B&H* strategy are negative for almost all rules, with all but one in the Taiwan stock market, all but two in China market and all but five in Hong Kong market significantly negative. It can be concluded that except for the *TRIX* rules, the *MA* rules generate more profit and perform better than the *B&H* strategy for all the three stock markets in the entire period. Even though the *TRIX* rule which is not better than the *B&H* strategy, is not significantly worse and still generates profit for all three markets.

Next, we turn to examine the performance of the *MA* family in the two sub-periods: pre- and post-Asian Financial Crisis in the Shanghai A-share Index, Hang Seng Index and Taiwan Stock Exchange Index. Figures 1A to 1C show that before the Crisis, China and Taiwan were mixed markets which contained several bull runs and bear markets while Hong Kong was in a bull run; after the Crisis, Shanghai and Hong Kong were mixed markets while Taiwan was a bear market. This facilitates the test for different market conditions.

Tables 3B, 4B and 5B show the results of our study of the pre-crisis period. The average daily returns ($\bar{r}_{long}$) produced by using the long strategy generated from the *MA* family are all significantly positive in all the three markets, except for the application of the *TRIX* rule in the Shanghai and Taiwan stock markets. The difference, $\bar{r}_{long} - \bar{r}_{BH}$, between the average daily return generated by the long strategy of the *MA* rules and the *B&H* strategy are almost all positive for the Shanghai, Hong Kong and Taiwan stock markets, with all but two significantly positive for the Shanghai stock market, all but three for Hong Kong stock market and all but one for Taiwan. Thus, we reject both H_{01} in (6) and H_{03} in (10) and conclude that in the pre-crisis period, most *MA* rules for the long strategy generate a higher profit and outperform the *B&H* strategy in all the three markets. The same conclusion can be drawn for the short strategy.

The results in Tables 3C, 4C and 5C support the same conclusion. All *MA* rules for both the long strategy and short strategy generate more profit and outperform the *B&H* strategy for all the three markets in the entire period, before and after the 1997 Asian Financial Crisis.

Tables 3A to Table 5C all show that the MA rules outperform the B&H strategy. However, the results in these tables could not give us a clear picture of how much more one could make by adopting these trading strategies. To make the analysis complete, we set up a portfolio with an initial wealth of $1 million and compute the accumulated wealth generated by the MA strategies in the long strategy, in which short sell is allowed and zero and 0.1% transaction costs are imposed. For comparison, the same portfolio is set up for the B&H strategy. The results are shown in Tables 6A to 6C and Figures 2 to 4[16].

Table 6A
Wealth of Adopting Different Rules in Shanghai A-share Index from 1992 to 2004

Rules	*Wealth (0% Cost)*	*Wealth (0.1% Cost)*	*Wealth (0% Cost and No short)*	*Wealth (0.1% Cost and No short)*
B&H	4.52	4.51	4.52	4.51
MA(5)	340	163	51.50	35.67
MA(10)	161	101	35.12	27.79
MA(20)	55.86	42.55	13.39	11.69
DMA(5,20)	23.61	19.96	7.83	7.2
DMA(5,30)	6.09	5.35	3.62	3.39
EMA(5)	801	401	94.37	66.76
EMA(10)	424	265	63.67	50.28
EMA(20)	112	83.57	35.74	30.82
DEMA(5,20)	14.18	12.33	6.12	5.70
DEMA(5,30)	10.35	9.29	5.01	4.75
MACD	29.31	23.15	18.07	16.06
TRIX	2.66	2.57	3.82	3.75

Table 6B
Wealth of Adopting Different Rules in Hang Seng Index from 1992 to 2004

Rules	*Wealth (0% Cost)*	*Wealth (0.1% Cost)*	*Wealth (0% Cost and No short)*	*Wealth (0.1% Cost and No short)*
B&H	3.31	3.3	3.31	3.3
MA(5)	60.45	28.8	16.86	11.65
MA(10)	32.94	25.14	13.36	10.69
MA(20)	9.7	7	6.43	5.46
DMA(5,20)	3.45	3.14	2.67	2.21
DMA(5,30)	2.23	2.06	1.32	1.13
EMA(5)	53.21	27.14	16.46	11.76
EMA(10)	59.62	37.07	16.44	12.97
EMA(20)	10.55	7.35	6.63	5.53
DEMA(5,20)	2.55	2.12	3.13	2.85
DEMA(5,30)	4.88	4.25	4.32	4.03
MACD	3.16	2.43	3.87	3.40
TRIX	0.85	0.82	1.51	1.48

Table 6C
Wealth of Adopting different Rules in Taiwan Stock Exchange Index from 1992 to 2004

Rules	*Wealth (0% Cost)*	*Wealth (0.1% Cost)*	*Wealth (0% Cost and No short)*	*Wealth (0.1% Cost and No short)*
B&H	1.33	1.32	1.33	1.32
MA(5)	13.45	6.21	4.83	3.28
MA(10)	16.12	9.95	5.47	4.3
MA(20)	14.45	10.63	4.88	4.18
DMA(5,20)	2.48	2.02	1.99	1.8
DMA(5,30)	4.94	4.29	2.82	2.63
EMA(5)	43.17	21.07	8.66	6.05
EMA(10)	29.06	17.25	7.09	5.47
EMA(20)	16.37	11.71	5.34	4.52
DEMA(5,20)	9.3	7.85	3.88	3.57
DEMA(5,30)	15.48	13.82	5.28	4.99
MACD	6.13	4.85	3.17	2.82
TRIX	1.3	1.26	1.45	1.42

Figure 2
Comparison between Wealth from Different Rules (SSE)

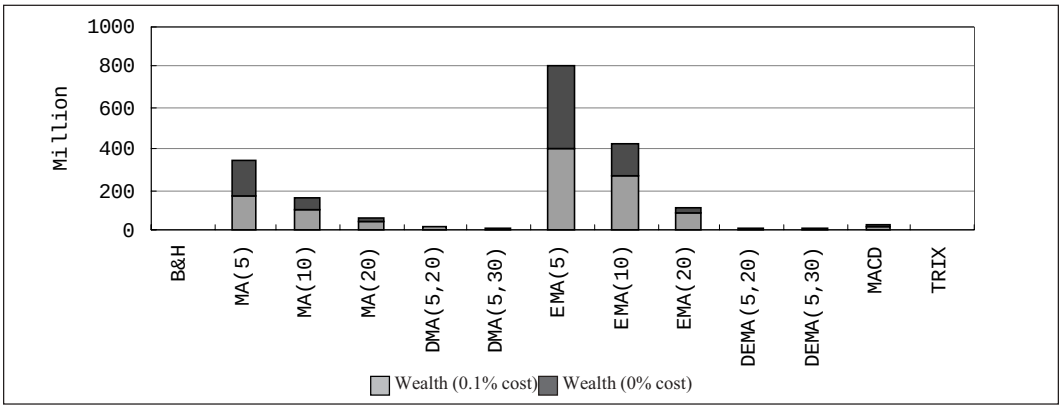


Figure 3
Comparison between Wealth from Different Rules (SEHK)

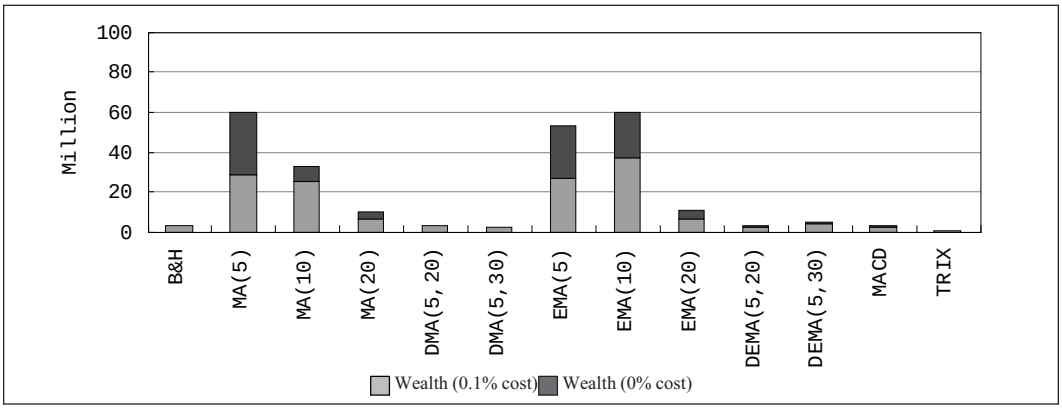


Figure 4
Comparison between Wealth from Different Rules (TSE) (With short)

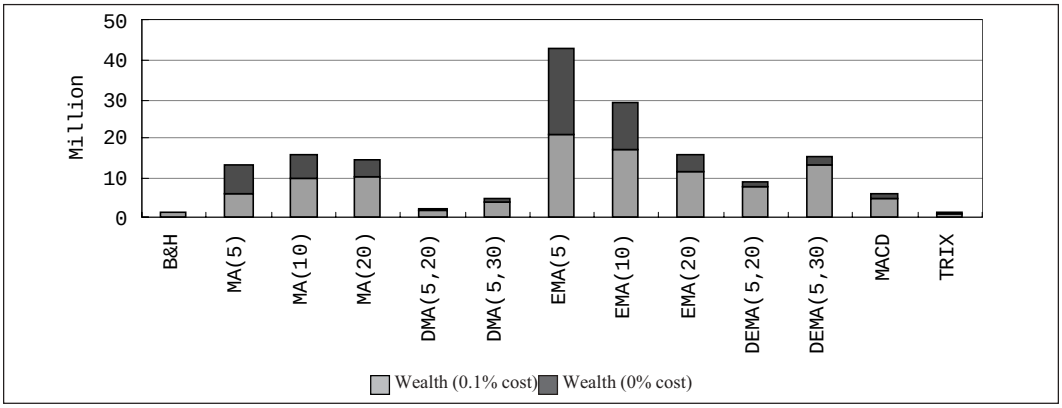


Table 6A shows the results in the Shanghai market. The most profitable rule is the 5-day *EMA.* Adopting this rule, even when short-selling is not allowed and a transaction cost of 0.1% per complete transaction is imposed, a 1-million dollars initial capital becomes more than 66.76 millions in 13 years. Adopting this trading rule with allowance for short selling, the endowment comes to $401 million and $801 million respectively, with and without transaction cost. For the Hong Kong market, as shown in Table 6b, the *MA(5)* and *EMA(5)* rules generate the highest profits. If short selling is allowed, a 1-million endowment becomes 60.45 millions for the *MA(5)* rules. With *EMA(5)* rule, the wealth stands at 116.46 millions even without short-selling and after a 0.1% transaction cost is deducted from the profits. When compared with the 3.3-million wealth profited from the *B&H* strategy, most of the trading rules reap higher profits in the Hong Kong market. For the Taiwan market, with short-selling, a 1-million endowment also generates up to 6.21 millions by the *MA(5)* rule under a transaction cost of 0.1%.

In all the three markets, adopting any of these *MA* trading rules is much more profitable than adopting the *B&H* strategy. Short selling in our analysis assumes the role of a yardstick, which is mainly for comparison purposes as short selling is usually very difficult (Ofek and Richardson, 2001), especially in the China stock market. However, Bessembinder and Chan (1995) have introduced a "double-or-out" investment strategy. One can easily modify his strategy to obtain a "synthetic" short strategy to make short strategy possible.

CONCLUSIONS

This paper investigates the predictability of the *MA* rules on the daily data of the stock markets of Shanghai, Hong Kong and Taiwan. In our empirical study, we find that the moving average approach can generate abnormal returns. Meanwhile, the profitability of these trading rules indicates that all the stock markets being studied in this paper are not weak-form efficient, which is consistent with Liu (2003).

We can conclude from the results that technical analysis can play a useful role in the timing of stock market entry and exit. By applying technical indicators, some individual traders and institutional investors may enjoy substantial profits, especially when trading costs are getting lower and short-sell prevails in the stock markets worldwide. It should be noted that our results are based on the sample from 1992 to 2004. The profitability opportunity or market inefficiency found in this study may vanish once China opens its market to international investors. We employ a bootstrap technique to handle the non-normality distribution problem in our paper. Besides the bootstrap approach, one may also use the Modified Maximum Likelihood Estimator approach to modify the test (Tiku, *et al.*, 2000; Wong and Bian 2005). Another alternative is to use the robust Bayesian sampling estimators (Matsumura *et al.* 1990) to improve the results. A third alternative is to use the 'distribution-free' approach to improve the test (see Wong and Miller, 1990). For more interesting findings, see the works of Wong and Li (1999), Fong, *et al.* (2005) and Broll, *et al.* (2005), which study the behavior of risk takers and risk averters in the stock market.

There are many other indicators for stock market movement besides the *MA* family (Leung and Chong, 2003; Shik and Chong, 2005; Eckard, 2005). Each indicator has it own strengths and weaknesses. Similar testing procedures can be applied to other indicators or a combination

of indicators. To improve the performance of the technical trading rules, one can incorporate the fundamentals of the underlying asset in the analysis (Thompson and Wong, 1991; Wong and Chan, 2004; Wong *et al.* 2001).

NOTES

2. Hong Kong has been a member of WTO since 1995, two years before the handover in 1997, and China became a member of WTO in early 2001. The majority of the people in Hong Kong, China and Taiwan are ethnic Chinese, and the three places had been one country for thousands of years. Many Taiwanese nowadays still consider Taiwan as the Republic of China. In this connection, we call these three places the "Greater China".
3. See Section III for the explanation of the rules for the MA family. It could be sufficient to test MA and exponential MA. However, we follow Brock, *et al.* (1992) and others to study the performance of other MA rules apart from the simple and exponential MA as all these rules under studied are common and widely used by investors.
4. *EMAt,n* is usually defined as $EMA_{t,n} = \alpha C_t + (1-\alpha) EMA_{t-1,n}$ with $EMA_{1,n} = C_1$. In equation (2), $\alpha = \frac{2}{n+1}$. In addition, the first few $EMA_{t,n}$ values will be deleted so that the initial value for $EMA_{t,n}$ will not affect $EMA_{t,n}$.
5. Readers may refer to Brock, *et al.* (1992) for more details of this indicator.
6. A shares are listed and traded on the Mainland A-share markets (Shanghai and Shenzhen) and quoted in RMB. They cannot be traded by foreign investors on the stock exchange. B shares are listed and traded on the Mainland B-share markets (Shanghai and Shenzhen) and quoted in foreign currencies. They are not listed on the Stock Exchange. In the past, only foreigners or foreign institutions were allowed to trade B shares. Since February 2001, Mainlanders have also been permitted to trade B shares, but they must trade through legal foreign currency accounts. We study several other China indexes and obtain similar results. Thus, we only present the results for Shanghai A-share Index while the results for other indexes are available on request.
7. We choose 1988 for HSI and TWSEI to avoid the 1987 crash. The earliest date for the SAI available in Datastream is January 2, 1992.
8. buy (sell) at time t_i and sell (buy) at time $t_i + n_i$.
9. In estimating $\hat{\Sigma}_\Omega$, we will set the entries to be zero if they are not significant at the 5%. For example, in the Taiwan stock market data for the simple MA(5) long strategy, the only significant autocorrelations are at lag 1, 3 and 4 with their values to be -0.078, -0.090 and -0.073 respectively. Thus, in testing this rule in Taiwan data, we set all entries to be zero except autocorrelations at lag 1, 3 and 4.
10. The results for each sub-period are similar and thus we skip report these results which are available on request.
11. We note that we test the superiority of MA rules by studying the situations with and without trading costs. However, as the conclusion drawn from the results with trading costs are the same as the results without trading costs, we only report the results without trading costs in Tables 3 to 5. Nonetheless, we report the results with and without trading costs in Table 6.
12. except *TRIX* for Hang Seng Index but still it is not significantly positive.
13. except *TRIX* and DMA(5,30) at Hong Kong and for *TRIX* at Shanghai and Taiwan.

14. All positive return differences are not significant.
15. The pre-crisis period is 1992-1996 for the Shanghai A-share Index and 1988-1996 for both the Hang Seng Index and the Taiwan Stock Exchange Index while the post-crisis is 1997-2004 for all these three markets.
16. We only plot the results when short sell is allowed. The plots when short sell is not allowed are similar to the plots when short sell is allowed.

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