Labuan Bulletin
OF INTERNATIONAL BUSINESS & FINANCE
Volume 10, 2012 ISSN 1675-7262

PROFITABILITY OF TRADING RULES BASED ON THREE MOVING AVERAGES

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Abstract

Conventional moving-average trading rules seldom use more than two moving averages. This article proposes new trading rules combining the use of short, medium and long-term moving averages. The trading strategies developed in this article are applied to 12 major stock market indices. For each trading rule, the profitability of the simple, weighted and exponential moving averages over a 15-year period are evaluated. Our moving-average trading rules perform remarkably well in the Greater China area, where some of the trading strategies generate an annualized return of 25%.

JEL Classification: G10, G14, G15
Keywords: *Technical Analysis, Moving Averages; Efficient Market Hypothesis*

I. Introduction

Technical analysis aims to forecast the movements of equity price using the information of historical prices and volumes. Under the Efficient Market Hypothesis (EMH), the use of technical trading rules cannot obtain excess returns (Fama, 1970). However, many previous studies have demonstrated profits generated by technical trading rules. For example, Neely, Weller and Dittmar (1997) find significant out-of-sample excess returns on six exchange rates using genetic programming

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techniques. Gencay (1998) demonstrates that nonparametric models based technical strategies earn abnormal profits relative to the buy-and-hold strategy. More recently, Chong and Ip (2009) have shown that the momentum strategy, which buys the winners and sells the losers in a portfolio, can earn considerable returns. Chong and Lam (2010) show that nonlinear trading rules are profitable in the U.S. stock market. The moving average is a common and widely studied technical trading tool (Brock *et al.*, 1992).. Most MA trading rules in the previous literature involve at most two moving average lines, which often produce more noise than signal if the market does not have a clear trend. In light of this, we develop a new trading method which integrates the information of short, medium, and long-term moving averages. The trading strategies developed in this article are applied to 12 major stock market indices. For each trading rule, the profitability of the simple, weighted and exponential moving averages over a 15-year period are compared. It is found that our strategies perform exceptionally well in the Greater China markets (Chong *et al.*, 2012).

2. Trading Rules and Data

A moving average is the average price of a security over a pre-specified window. In general, when stock prices are rising, the moving average will also rise. When the market is surging, the short-term moving average generally rises faster than the medium-term moving average, which in turn rises faster than the long-term moving average. The market is said to be strongest when all the short, medium, and long-term moving averages are rising and are in proper order, with the short-term MA in the highest position, followed by the medium term MA and long-term MA. To examine whether combining the short, medium, and long-term moving averages reveals profitable trading signals, we propose three trading strategies in this article:

Strategy 1: Increasing Moving Average Rule

Buy: The first time that $MA_{short}(t) > MA_{short}(t-1)$, $MA_{medium}(t) > MA_{medium}(t-1)$, and $MA_{long}(t) > MA_{long}(t-1)$ (1)

Sell: The first time that (1) does not hold

Strategy 2: High-Low Moving Average Rule

Buy: The first time that $MA_{short}(t) > MA_{medium}(t) > MA_{long}(t)$ (2)

Sell: The first time that (2) does not hold

Strategy 3: Combining Strategy 1+2

Buy: The first time that $MA_{short}(t) > MA_{short}(t-1)$, $MA_{medium}(t) > MA_{medium}(t-1)$, $MA_{long}(t) > MA_{long}(t-1)$, and $MA_{short}(t) > MA_{meduim}(t) > MA_{long}(t)$ (3)

Sell: The first time that (3) does not hold

For example, in strategy 1, we buy the index at time t if all the short-, medium- and long-term MA are rising from time t-1 to time t. The rules are applied to the simple moving average (SMA), weighted moving average (WMA), and exponential moving average (EMA).

The N-day simple moving average at time t is defined as:

$$SMA_N(t) = \frac{\sum_{i=1}^{N} P(t-i+1)}{N}.$$

The N-day weighted moving average at time t is defined as:

$$WMA_N(t) = \frac{\sum_{i=1}^{N} iP(t-N+i)}{\sum_{i=1}^{N} i}.$$

The N-day exponential moving average at time t is defined as:

$$EMA_N(t) = 2/N \times (P(t) - EMA_N(t-1)) + EMA_N(t-1).$$

The windows used for short, medium and long-term moving averages are 10-day, 20-day and 50-day respectively. Three assumptions are imposed: i) transaction cost is negligible; ii) short selling is prohibited; iii) consecutive buying or selling is not allowed. Since there are about 250 trading days in a year, the annualized rate of return is calculated by the following formula:

$$\text{Annual rate of return} = [(1 + r_1)(1 + r_2)(1 + r_3) \cdots (1 + r_m)]^{250/T} - 1,$$

where

$$1 + r_j = S(j)/B(j);$$

S(j) and B(j) are selling and buying prices respectively in the jth transaction; m is the number of transactions; T is the number of trading days in the sample.

The three trading strategies developed in this article are applied to 12 major stock market indices. The closing prices of each index from 12/11/1993 to 14/11/2008 are extracted from the Data Stream, the details are shown in Table 1:

Table 1
Indices under study and the sample period

Index	Location	From	To
Shanghai A	China	12/11/1993	14/11/2008
Shanghai B	China	12/11/1993	14/11/2008
Shenzhen A	China	12/11/1993	14/11/2008
Shenzhen B	China	12/11/1993	14/11/2008
Hang Seng	Hong Kong	12/11/1993	14/11/2008
Nikkei 225	Japan	12/11/1993	14/11/2008
TWSE	Taiwan	12/11/1993	14/11/2008
Dow Jones Industrials	USA	12/11/1993	14/11/2008
S&P 500	USA	12/11/1993	14/11/2008
FTSE 100	United Kingdom	12/11/1993	14/11/2008
DAX	Germany	12/11/1993	14/11/2008
AORD	Australia	12/11/1993	14/11/2008

3. Results and Conclusion

Tables 2 and 3 report the annual rates of return (in percentage) generated by three trading strategies for the three moving averages for Asian and developed markets respectively. We use the closing price of 12/11/1993 as the initial EMA. The buy-and-hold annual rates of return are reported. The figures in parentheses are the numbers of transactions. For each index, the bolded figure is the highest return. If two trading rules generate the same maximum return, then the return of the rule with the smaller number of transactions is highlighted.

In essence, our results demonstrate the efficiency of developed stock markets. The three trading strategies do not perform well in the stock markets of the United States, Europe, Japan and Australia. For the Dow Jones Industrial average, S&P500 and FTSE 100, no trading strategy generates a rate of return higher than the buy-and-hold return. For the Nikkei 225, these rules generate a relatively small or even negative rate of return, which can be attributed to Japan's sluggish economy since the mid-1990s. For DAX and AORD, only the High-Low moving average rule using the EMA has a slightly higher rate of return than the buy-and-hold strategy. For the greater China market, including Hong Kong, China and Taiwan, the three strategies perform exceptionally well and generate higher returns than the buy-and-hold strategy. The increasing moving average rule generates 25.2% and 30.9% annualized rates of returns for the Shenzhen A and Shenzhen B. Finally, the weighted moving average and exponential moving average generally perform better than the simple moving average since they generate the highest returns in five out of six indices of Greater China stock markets.

Table 2
Return Estimation for Asian indices

		Rule 1			Rule 2			Rule 3		
	BH	**SMA**	**WMA**	**EMA**	**SMA**	**WMA**	**EMA**	**SMA**	**WMA**	**EMA**
Shanghai	5.56%	13.68%	***15.82%***	15.69%	10.40%	11.01%	13.83%	9.01%	10.11%	13.77%
A		(144)	***(159)***	(204)	(63)	(70)	(55)	(108)	(130)	(158)
Shanghai	1.90%	30.44%	29.75%	30.44%	***33.94%***	21.55%	16.17%	20.85%	23.14%	20.85%
B		(167)	(143)	(167)	***(56)***	(73)	(56)	(135)	(105)	(135)
Shenzhen	4.75%	13.71%	20.30%	***25.20%***	12.89%	12.49%	16.63%	10.05%	13.54%	18.84%
A		(158)	(160)	***(182)***	(64)	(69)	(49)	(115)	(131)	(137)
Shenzhen	4.56%	27.91%	***30.90%***	30.52%	12.23%	16.15%	17.54%	18.09%	23.02%	23.16%
B		(138)	***(151)***	(191)	(67)	(72)	(54)	(103)	(112)	(149)
Hang	2.15%	5.79%	8.97%	***11.27%***	8.49%	3.29%	7.80%	3.39%	5.76%	9.01%
Seng		(182)	(199)	***(227)***	(73)	(91)	(68)	(130)	(156)	(173)
Nikkei	-	***1.47%***	-0.01%	-1.29%	1.04%	0.55%	1.42%	-0.84%	-0.38%	-0.16%
225	4.87%	***(155)***	(217)	(252)	(65)	(83)	(65)	(112)	(156)	(173)
TWSE	0.27%	6.56%	***13.88%***	13.71%	4.94%	5.97%	10.48%	3.61%	8.80%	10.89%
		(156)	***(168)***	(205)	(72)	(83)	(52)	(126)	(142)	(157)

Table 3
Return Estimation for US/European/Australia indices

		Rule 1			Rule 2			Rule 3		
	BH	**SMA**	**WMA**	**EMA**	**SMA**	**WMA**	**EMA**	**SMA**	**WMA**	**EMA**
Dow	***5.48%***	1.03%	1.04%	3.75%	2.98%	1.17%	3.35%	-0.03%	0.10%	3.20%
Jones		(211)	(258)	(281)	(79)	(95)	(74)	(161)	(188)	(222)
S&P	***4.10%***	0.02%	0.49%	1.59%	2.72%	2.47%	2.72%	0.05%	1.39%	1.37%
500		(219)	(258)	(290)	(79)	(92)	(72)	(152)	(191)	(220)
FTSE	***2.01%***	-0.31%	-1.65%	-0.79%	0.25%	-1.15%	0.21%	-1.12%	-3.23%	0.06%
100		(207)	(257)	(300)	(82)	(92)	(78)	(155)	(200)	(221)
DAX	5.57%	3.84%	3.37%	5.77%	5.96%	4.33%	***6.20%***	2.45%	0.80%	5.24%
		(191)	(230)	(271)	(85)	(93)	***(67)***	(148)	(193)	(217)
AORD	3.84%	2.23%	3.37%	3.98%	2.24%	3.03%	***4.27%***	0.99%	2.40%	3.52%
		(197)	(228)	(278)	(84)	(93)	***(66)***	(151)	(178)	(213)

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