ELSEVIER

Pacific-Basin Finance Journal 3 (1995) 257–284

PACIFIC-BASIN FINANCE JOURNAL

The profitability of technical trading rules in the Asian stock markets ☆

Hendrik Bessembinder, Kalok Chan

Department of Finance, College of Business, Arizona State University, Tempe, AZ 85287-3906, USA

Abstract

We assess whether some simple forms of technical analysis can predict stock price movement in Asian markets. We find the rules to be quite successful in the emerging markets of Malaysia, Thailand and Taiwan. The rules have less explanatory power in more developed markets such as Hong Kong and Japan. On average for our sample, mean percentage changes in stock indices on days that the rules emit buy signals exceed means on days that the rules emit sell signals by 0.095% per day, or about 26.8% on an annualized basis. We estimate "break-even" round-trip transactions costs (which would just eliminate gains from technical trading) to be 1.57% on average. We also find that technical signals emitted by U.S. markets have substantial forecast power for Asian stock returns beyond that of own-market signals. This is consistent with the reasoning that the technical rules identify periods when global equilibrium expected returns deviate substantially from their unconditional mean.

Keywords: Technical analysis; Asian stock markets; Return forecastability; Transaction costs; Time-varying risk premia

JEL classification: G12, G14, G15

1. Introduction

Asian stock markets have been the subject of substantial recent interest on the part of academics and investors alike. This interest is attributable in part to

☆ The authors thank Warren Bailey, Grant McQueen, Joe Prendergast, Paul Seguin, John Wei, and seminar participants at the 1994 PACAP Finance Conference in Jakarta for insightful comments.

This paper won the Chicago Mercantile Exchange/PACAP Competitive Research Award.

SSDI 0927-538X(95)00002-X

observations of stellar returns and rapid growth in Asian market capitalization. For example, while in 1980 the Asia-Pacific region accounted for 23% of the total market capitalization of the Financial Times-Actuaries World Index, by the end of 1990 it accounted for 35%. From 1985 to 1990, the FT-Actuaries Pacific-Basin Index generated a total U.S. dollar return of 176%, while returns to the FT-Actuaries U.S. Index was 98% (Park and Schoenfeld, 1992, p. 8). This performance has led global investors to realize that ignoring the Asian markets can have substantial opportunity costs.

Despite the substantial recent growth of these markets, their institutional structure has led some to question whether they are as informationally efficient as their U.S. or European counterparts. Some Asian markets are dominated by a few large companies with ownership concentrated in the hands of a small number of investors, and the incidence of insider trading is relatively high. Also, requirements for financial disclosures are less stringent, leading to a scarcity of publicly available information. Furthermore, with the exception of Japan, the Asian equity markets are characterized by relatively low volume and thin trading. Some have pointed to the volatility of the Asian markets and to alleged occurrences of "speculative bubbles" (including Hong Kong in the early 1970's and Japan and Taiwan in the late 1980's) as evidence in support of the inefficiency of these markets. Despite these concerns, there is little empirical work that attempts to determine whether traders could exploit the alleged market inefficiencies in their trading strategies. Bailey et al. (1990) and Pan et al. (1991) present evidence that prices in several Asian stock markets exhibit substantial deviations from random-walk behavior. However, it has not been determined whether these deviations reflect profit opportunities.

In this paper, we assess whether changes in several Asian stock market indices can be predicted by some simple forms of technical analysis. While most early empirical evaluations of technical trading rules, including Fama and Blume (1966) and Jensen and Benington (1970), concluded that the rules are not useful, more recent studies of both American equity markets (Brock et al., 1992) and the currency markets (e.g. Sweeney, 1986) have documented that some technical trading rules possess non-trivial ability to forecast price changes. If the Asian stock markets are in fact relatively inefficient, technical analysis may be able to exploit the inefficiencies. We test whether the technical trading rules evaluated by Brock et al. (1992) also possess forecast power for price changes in Asian Stock markets.

We evaluate these technical trading rules using observations on stock price indices for Japan, Hong Kong, South Korea, Malaysia, Thailand, and Taiwan. Averaged across all six countries and across all evaluated trading rules, mean percentage changes in stock indices on days that the rules emit buy signals (henceforth "buy days") exceed means on days that the rules emit sell signals (henceforth "sell days") by an economically significant margin of 0.095% per day, or 26.8% on an annualized basis. [1] Overall, the rules are more successful in predicting stock price movements in the emerging markets of Malaysia, Thailand and Taiwan, where buy day returns exceed sell day returns by an average of 0.167% per day (51.9% per year), than in the more developed markets of Japan and Hong Kong, and Korea, where buy day returns are only 0.028% per day (5.9% per year) greater than sell day returns on average.

The observation that technical trading rules have predictive power for changes in some Asian stock market indices is consistent with the reasoning that these markets are, or were during the sample period, inefficient. However, we believe that such a conclusion is premature. While we cannot resolve the issue definitively, we note that there are at least three alternate explanations for the observation that technical trading rules predict index returns, and we conduct additional tests to shed light on each of these potential explanations.

A first consideration is that measurement errors due to nonsynchronous reporting of prices induce spurious positive autocorrelation in portfolio or index price changes (Scholes and Williams, 1977). The technical trading rules we evaluate exploit positive serial dependence. Typically, the technical rules initially emit a buy (sell) signal on a day characterized by an unusually large upward (downward) market movement. The partial adjustment of index values resulting from nonsynchronous trading of the component securities implies that the measured next day return will tend to be biased in the same direction as the prior day price change. This bias implies that profits from the technical rules will tend to be overstated. As a simple control for the effects of nonsynchronous trading, we compare buy and sell day returns while implementing a one-day lag between the initial emission of a signal and the resulting trade. Again averaged across all countries and rules, mean buy day returns then exceed mean sell day returns by 0.072% per day, or about 19.7% on an annualized basis.

A second consideration is that the technical trading strategies, which generate more transactions than a buy-and-hold approach, may not be profitable once transaction costs are considered. As Bailey et al. (1990) discuss, mispricings that are smaller than transactions costs need not be immediately eliminated even in an efficient market. To evaluate the effect of transactions costs on the profitability of trading rules, we simulate a "double-or-out" strategy, in which an investor borrows to double the stock investment upon buy signals, sells stocks to hold cash on sell signals, but holds a standard long stock position in the absence of a signal. We compare returns from these trading strategies to returns from a buy-and-hold strategy, and determine the magnitude of transactions costs that would eliminate

[1] We compute daily returns as changes in logarithms of stock prices. Throughout this article we compute approximate annualized returns on the basis of 250 trading days per year as $\exp(250R) - 1$, where R is the mean daily return. Some of the stock markets in our sample traded on Saturdays for at least a portion of the sample period. Therefore the actual number of trading days per year exceeds 250 on average, and our annualization can be considered conservative.

any gain to the trading strategies. We compute these break-even costs in two ways. In the first calculation we use the full sample, including returns pertaining to the first day after a signal. Such first-day returns are calculated from the closing index values that initially generate signals. In the second calculation we again impose the one-day trading lag, under the reasoning that traders require time to react to the signal and that the initial return may be biased due to nonsynchronous trading. When all returns are included, we find that mean (averaged across all rules and countries) round-trip transactions costs of 1.57% would just eliminate gains from trading on the technical signals. With the one-day lag imposed, break-even transactions costs are reduced to 1.34% per round-trip transaction. Break-even costs are not homogenous across markets, however. For the emerging markets of Malaysia, Thailand, and Taiwan break-even costs average 2.32% for all data, and 2.04% if the first return is omitted.

Finally, as Fama and French (1988) observe, market efficiency does not preclude a degree of forecastability, which could result from time-varying risk premia. The difference between returns on "buy" and "sell" days could simply reflect time-variation in equilibrium expected returns. Fama (1991) notes that return forecastability resulting from time variation in equilibrium expected returns should display commonality across markets. Bessembinder and Chan (1992) argue that, if return forecastability occurs in equilibrium, then those instrumental variables that contain forecast power for returns in one market should also contain forecast power for returns in other markets. We therefore test for commonality of forecastability by examining whether the buy and sell signals emitted by the technical rules are correlated across the Asian markets and with signals emitted for the U.S. market. We find that there is substantial cross-market correlation in the signals emitted by the technical rules. We also document that the buy and sell signals emitted by technical rules in the U.S. market contain incremental forecast power for returns in Asian markets. This type of commonality is consistent with the reasoning that the technical rules identify periods when international equilibrium expected returns deviate from unconditional means. However, even after allowing for forecastability driven by U.S. market signals, there remains some forecastability attributable to country-specific signals. This suggests some inefficiency or country-specific risk premia.

2. The technical rules

Brock et al. stress the substantial danger of detecting spurious patterns in security returns if trading strategies are both discovered and tested in the same database. To mitigate the danger of "data snooping" biases, we do not search for ex-post "successful" technical trading rules, but rather evaluate the same set of rules as Brock et al.. These simple rules have been known to practitioners for at least several decades. Also, like Brock et al., we report the results of all trading rules we evaluate.

We evaluate three types of rules: Variable Length Moving Average (VMA) rules, Fixed Length Moving Average (FMA) rules, and Trading Range Break (TRB) rules. Brock et al. provide additional description and motivation for these trading rules, as well as some historical perspective on their usage. The moving average rules involve comparison of a short-term moving average of prices to a long-term moving average. Buy (sell) signals are emitted when the short-term average exceeds (is less than) the long-term average by at least a prespecified percentage band. The most popular moving average rule is 1–200, where the short average is one day and the long average is 200 days. Other variations that we (and Brock et al.) evaluate include 1–50, 1–150, 5–150, and 2–200. Each rule is evaluated with bands of 0 and 1%, making for ten moving average combinations in total. With a band of zero this method classifies all days into either buys or sells. Buy (sell) signals are emitted when the short moving average cuts the long moving average from below (above) and moves beyond it by the prespecified band. Once a signal is emitted, VMA rules call for the position to be maintained until the short and long moving averages cross again, while FMA rules hold the position for a fixed number of days. We evaluate FMA strategies with fixed holding periods of ten and thirty days.

Trading Range Break rules involve comparing the current price to the recent minimum and maximum. TRB rules emit buy signals when the current price exceeds the recent maximum by at least a prespecified band, and emit sell signals when the current price falls below the recent minimum by at least the prespecified band. Like Brock et al., we evaluate separate TRB rules where recent minimums and maximums are defined as the extreme observations recorded over the prior 50, 150, and 200 days, respectively. We use bands of 0 and 1%, making for a total of six TRB combinations, and then evaluate each TRB rule using fixed investment horizons of 10 and 30 days.

3. Empirical results

In Table 1 we report some descriptive statistics for the six markets that are the subject of our study. We obtain daily stock price index data for the interval January 1975 to December 1989 from the Pacific Basin Capital Market Research Center. [2] Returns are computed as daily changes in logarithms of price indices, and thus exclude dividend yields. Mean returns average 0.065% per day across the six markets. Consistent with results reported by Bailey et al. (1990), there is

[2] Data series for Korea and Malaysia begin January 1977, while those for Hong Kong and Malaysia are extended to December 1991.

Table 1
Mean daily returns (%) and correlations for six Asian stock market indices [a]

Country	Period	Mean returns (t-stat)	Return autocorrelation at lag:			Pearson correlation among returns						
			1	2	3	Japan	Korea	Malaysia	Thailand	Taiwan	Lagged U.S.	U.S.
Hong Kong	75/01–91/12	0.077 [b] (2.75)	0.069 [b]	−0.009	0.076 [b]	0.188 [b]	−0.012	0.355 [b]	0.100 [b]	0.051 [b]	0.206 [b]	0.165 [b]
Japan	75/01–89/12	0.056 [b] (5.16)	0.120 [b]	−0.032	0.025		0.030	0.236 [b]	0.085 [b]	0.062 [b]	0.366 [b]	0.091 [b]
Korea	77/01–89/12	0.059 [b] (3.51)	0.153 [b]	−0.016	−0.006			0.034	0.021	0.012	0.007	−0.046 [b]
Malaysia	77/01–91/12	0.048 (2.08)	0.131 [b]	0.042	0.053 [b]				0.162 [b]	0.061 [b]	0.332 [b]	0.117 [b]
Thailand	75/05–89/12	0.060 [b] (3.57)	0.289 [b]	0.084 [b]	0.065 [b]					0.076 [b]	0.162 [b]	−0.003
Taiwan	75/01–89/12	0.090 [b] (4.18)	0.142 [b]	0.023	0.132 [b]						0.082 [b]	0.011

[a] The stock market indices used are Hang Seng Index (HSI) for Hong Kong, Tokyo Stock Exchange Price Index (TOPIX) for Japan, Korea Composite Stock Price Index (KOSPI) for Korea, Kuala Lumper Stock Exchange (KLSE) Composite Index for Malaysia, Stock Exchange Thailand (SET) Index for Thailand, Taiwan Stock Exchange Capitalization Weighted Stock Index (TSE Index) for Taiwan and Dow Jones Index for U.S.
[b] Coefficient significantly different from zero (p-value < 0.01).

non-trivial autocorrelation in Asian stock index returns. First order return autocorrelations vary from 0.069 for the Hang Seng Index (HSI) to 0.289 for the Stock Exchange Thailand (SET) Index, with the mean AR1 coefficient equal to 0.151. Autocorrelations at two and three lags are considerably closer to zero.

3.1. *Returns on "buy" and "sell" days*

If technical analysis does not have any power to forecast price movements, then we should observe that returns on days when the rules emit buy signals do not differ appreciably from returns on days when the rules emit sell signals. To evaluate the forecast power of technical rules, we compare return means and variances on buy versus sell days for each rule described.

Table 2 reports results for ten VMA rules. The rules are described as (short, long, band) where short is the length of the short moving average and long is the length of the long moving average. For each rule in each market we report mean returns on buy days and sell days, standard deviations of returns on buy and sell days, and a bootstrap p-value for the difference between buy and sell day returns. We also report averages of return means and standard deviations computed across the ten rules, and a bootstrap p-value for difference in means across rules.

The bootstrap procedure we use is similar to that employed by Brock et al., and accommodates the dependencies across rules. We scramble the actual return data by randomly drawing from the original series with replacement, and construct simulated indices. We apply the trading rules to the simulated indices, and compute returns for each trading rule and the mean return across trading rules. This process is repeated 500 times to generate an empirical distributions of returns. We record the fraction of the simulations that generate a return larger than that observed in the actual series. This fraction is interpreted as a simulated p-value.

For fifty-three of the sixty observations (ten VMA rules times six markets) the mean return conditional on buy signals exceeds the mean return conditional on sell signals. (All seven exceptions pertain to the Tokyo market.) These differences in means are large enough to be economically relevant. Averaged across the 10 rules and six markets the difference in means is 0.103% per day, or about 29.2% on an annualized basis. The rules have greater forecast power for stock markets in Malaysia, Thailand, and Taiwan, where the difference in means across all 10 rules averages 0.168% per day, than in Hong Kong, Japan, and Korea, where the difference in means averages 0.037% per day. The conclusion that the rules forecast power differs across markets is confirmed by the bootstrap simulations: for Malaysia, Thailand, and Taiwan the hypothesis that mean (across rules) buy day returns equal mean sell day returns can be rejected with a p-value less than 0.001. In contrast, p-values for the same hypothesis are 0.160, 0.334, and 0.038 for Hong Kong, Japan, and Korea, respectively.

Brock et al. report that, for the Dow Jones Industrial Average, risk is higher on sell days than on buy days. Here, we observe that return variances on sell days

Table 2
Mean daily returns (in %) conditional on buy and sell signals generated by ten variable-length moving (VMA) rules. Rules are identified as (short, long, band) where short and long are the lengths of short and long moving averages, respectively, and band is the percentage difference required to generate a signal. Returns are for trades executed with 0-day or 1-day lag. Figures in parentheses are standard deviations. Bootstrap p-values test for the difference between buy and sell returns

Rule		Hong Kong	Japan	Korea	Malaysia	Thailand	Taiwan
Returns with 0-day lag							
(1,50,0)	Buy	0.122 (1.39)	0.078 (0.57)	0.072 (1.00)	0.142 (1.10)	0.165 (1.04)	0.186 (1.41)
	Sell	−0.047 (2.36)	−0.003 (0.93)	0.036 (1.10)	−0.106 (1.78)	−0.081 (0.94)	−0.046 (1.40)
	p-value	0.000	0.000	0.146	0.000	0.000	0.000
(1,50,0.01)	Buy	0.130 (1.40)	0.085 (0.58)	0.087 (1.06)	0.148 (1.12)	0.204 (1.12)	0.209 (1.43)
	Sell	−0.073 (2.52)	0.008 (0.95)	0.038 (1.22)	−0.137 (1.87)	−0.095 (1.01)	−0.050 (1.45)
	p-value	0.000	0.006	0.098	0.000	0.000	0.000
(1,150,0)	Buy	0.078 (1.64)	0.054 (0.65)	0.077 (1.00)	0.115 (1.13)	0.146 (1.08)	0.112 (1.45)
	Sell	0.042 (2.02)	0.053 (0.87)	0.022 (1.15)	−0.073 (1.79)	−0.043 (0.91)	0.023 (1.28)
	p-value	0.276	0.000	0.052	0.000	0.000	0.024
(1,150,0.01)	Buy	0.077 (1.67)	0.060 (0.60)	0.083 (1.01)	0.120 (1.13)	0.163 (1.11)	0.124 (1.48)
	Sell	0.047 (2.09)	0.067 (0.99)	0.035 (1.23)	−0.086 (1.83)	−0.055 (0.95)	0.019 (1.32)
	p-value	0.320	0.566	0.090	0.000	0.000	0.014
(5,150,0)	Buy	0.077 (1.65)	0.048 (0.65)	0.076 (1.00)	0.104 (1.20)	0.140 (1.08)	0.104 (1.46)
	Sell	0.044 (1.99)	0.072 (0.86)	0.025 (1.14)	−0.054 (1.72)	−0.035 (0.92)	0.035 (1.28)
	p-value	0.306	0.774	0.078	0.000	0.000	0.068
(5,150,0.01)	Buy	0.068 (1.68)	0.049 (0.68)	0.075 (1.01)	0.103 (1.20)	0.156 (1.10)	0.108 (1.49)
	Sell	0.061 (2.07)	0.070 (0.91)	0.037 (1.21)	−0.055 (1.76)	−0.036 (0.96)	0.031 (1.28)

	p-value	0.442	0.694	0.152	0.000	0.000	0.048
(1,200,0)	Buy	0.072 (1.66)	0.055 (0.66)	0.081 (1.02)	0.111 (1.15)	0.136 (1.10)	0.109 (1.46)
	Sell	0.050 (2.02)	0.060 (0.92)	0.014 (1.14)	−0.062 (1.79)	−0.030 (0.88)	0.024 (1.25)
	p-value	0.334	0.500	0.038	0.000	0.000	0.050
(1,200,0.01)	Buy	0.072 (1.66)	0.057 (0.67)	0.087 (1.04)	0.113 (1.16)	0.146 (1.14)	0.113 (1.48)
	Sell	0.060 (2.07)	0.092 (1.04)	0.038 (1.07)	−0.067 (1.81)	−0.041 (0.87)	0.028 (1.27)
	p-value	0.406	0.796	0.090	0.000	0.000	0.046
(2,200,0)	Buy	0.070 (1.66)	0.052 (0.66)	0.077 (1.02)	0.098 (1.21)	0.135 (1.10)	0.105 (1.46)
	Sell	0.056 (2.01)	0.075 (0.90)	0.020 (1.14)	−0.041 (1.72)	−0.029 (0.88)	0.032 (1.25)
	p-value	0.384	0.758	0.052	0.000	0.000	0.074
(2,200,0.01)	Buy	0.076 (1.67)	0.054 (0.67)	0.082 (1.04)	0.104 (1.21)	0.143 (1.14)	0.113 (1.49)
	Sell	0.066 (2.07)	0.090 (1.05)	0.028 (1.20)	−0.043 (1.73)	−0.032 (0.89)	0.037 (1.25)
	p-value	0.394	0.812	0.068	0.002	0.000	0.078
Average	Buy	0.084 (1.61)	0.058 (0.64)	0.079 (1.02)	0.116 (1.16)	0.152 (1.10)	0.127 (1.46)
	Sell	0.030 (2.13)	0.051 (0.93)	0.029 (1.16)	−0.072 (1.78)	−0.048 (0.92)	0.011 (1.31)
	p-value	0.160	0.334	0.038	0.000	0.000	0.000
Returns with 1-day lag							
Average	Buy	0.079 (1.66)	0.054 (0.68)	0.071 (1.02)	0.109 (1.20)	0.148 (1.10)	0.119 (1.47)
	Sell	0.041 (2.05)	0.059 (0.86)	0.043 (1.16)	−0.059 (1.73)	−0.039 (0.92)	0.025 (1.29)
	p-value	0.188	0.496	0.182	0.000	0.000	0.004

Table 3

Mean daily returns (in %) conditional on buy and sell signals generated by ten fixed-length moving (FMA) rules with 10 days holding period. Rules are identified as (short, long, band) where short and long are the lengths of short and long moving averages, respectively, and band is the percentage difference required to generate a signal. Returns are for trades executed with 0-day or 1-day lag. Figures in parentheses are standard deviations. Bootstrap p-values test for the difference between buy and sell returns

Rule		Hong Kong	Japan	Korea	Malaysia	Thailand	Taiwan
Returns with 0-day lag							
(1,50,0)	Buy	0.075 (1.29)	0.110 (0.55)	0.039 (0.96)	−0.049 (1.71)	0.018 (1.14)	0.045 (1.31)
	Sell	−0.127 (2.44)	0.052 (0.97)	0.095 (0.98)	−0.156 (1.81)	−0.023 (1.04)	−0.130 (1.50)
	p-value	0.000	0.008	0.962	0.020	0.156	0.000
(1,50,0.01)	Buy	0.050 (1.55)	0.275 (0.79)	0.073 (1.11)	0.028 (1.49)	0.082 (1.63)	−0.009 (1.75)
	Sell	−0.259 (3.50)	0.075 (0.96)	0.225 (1.41)	−0.152 (1.73)	−0.020 (1.66)	−0.307 (1.90)
	p-value	0.004	0.010	0.964	0.048	0.104	0.002
(1,150,0)	Buy	−0.073 (1.91)	0.057 (0.51)	0.047 (1.29)	−0.017 (1.43)	−0.050 (0.85)	0.081 (1.26)
	Sell	−0.137 (2.15)	0.053 (0.91)	0.059 (1.30)	−0.233 (2.69)	−0.030 (0.83)	0.013 (1.33)
	p-value	0.238	0.436	0.630	0.004	0.652	0.138
(1,150,0.01)	Buy	−0.263 (2.69)	0.013 (0.63)	0.028 (1.12)	−0.105 (1.84)	0.055 (1.12)	0.071 (1.25)
	Sell	−0.268 (2.80)	0.491 (3.13)	0.075 (2.16)	−0.365 (3.90)	−0.060 (1.48)	−0.095 (1.82)
	p-value	0.486	0.998	0.690	0.054	0.202	0.084
(5,150,0)	Buy	0.130 (1.34)	0.059 (0.45)	0.079 (0.89)	0.114 (1.02)	−0.072 (0.91)	0.150 (1.26)
	Sell	−0.116 (2.36)	0.106 (1.03)	0.013 (1.34)	−0.236 (2.80)	−0.012 (0.93)	−0.068 (1.41)
	p-value	0.032	0.864	0.192	0.000	0.824	0.020
(5,150,0.01)	Buy	−0.019 (1.11)	−0.320 (0.50)	0.335 (0.83)	−0.002 (0.79)	0.807 (1.01)	0.220 (1.80)
	Sell	−0.425 (3.05)	NA	0.157 (1.61)	−0.57 (5.25)	0.016 (2.73)	−0.989 (1.82)

	p-value	0.184		0.226	0.074	0.014	0.008
(1,200,0)	Buy	0.010 (2.03)	0.031 (0.57)	−0.005 (1.14)	0.069 (1.30)	−0.083 (1.20)	0.037 (1.41)
	Sell	−0.058 (2.27)	0.048 (1.00)	−0.010 (1.21)	−0.161 (2.60)	0.046 (1.22)	−0.072 (1.41)
	p-value	0.236	0.670	0.452	0.006	0.988	0.068
(1,200,0.01)	Buy	−0.044 (2.52)	0.271 (0.83)	0.134 (0.88)	0.052 (1.09)	0.008 (1.84)	−0.057 (1.48)
	Sell	−0.486 (3.22)	0.399 (2.86)	0.693 (1.18)	−0.288 (4.81)	−0.089 (2.31)	−0.317 (2.05)
	p-value	0.008	0.806	1.000	0.026	0.260	0.030
(2,200,0)	Buy	−0.035 (2.13)	0.019 (0.53)	0.053 (0.73)	0.012 (1.27)	−0.143 (1.21)	0.049 (1.32)
	Sell	−0.011 (2.47)	0.082 (0.98)	−0.010 (1.26)	−0.116 (2.56)	0.039 (1.23)	−0.052 (1.50)
	p-value	0.282	0.920	0.182	0.092	0.996	0.148
(2,200,0.01)	Buy	0.101 (1.20)	0.025 (0.48)	0.033 (0.90)	0.276 (0.92)	−0.140 (3.69)	−0.029 (2.07)
	Sell	−0.334 (3.91)	0.299 (2.95)	0.307 (1.43)	0.029 (3.75)	0.202 (2.10)	0.297 (2.03)
	p-value	0.050	0.928	0.892	0.180	0.930	0.948
Average	Buy	0.010 (1.80)	0.069 (0.55)	0.047 (1.02)	0.005 (1.48)	−0.030 (1.19)	0.055 (1.38)
	Sell	−0.167 (2.63)	0.073 (1.08)	0.062 (1.26)	−0.182 (2.64)	−0.006 (1.20)	−0.092 (1.54)
	p-value	0.016	0.556	0.658	0.000	0.742	0.000
Returns with 1-day lag							
Average	Buy	0.026 (1.78)	0.055 (0.53)	0.027 (1.00)	0.028 (1.47)	−0.055 (1.13)	0.036 (1.41)
	Sell	−0.169 (2.35)	0.064 (0.87)	0.077 (1.24)	−0.157 (2.44)	0.007 (1.15)	−0.082 (1.51)
	p-value	0.006	0.668	0.942	0.000	0.944	0.014

exceed variances on buy days for all ten VMA rules in Hong Kong, Japan, Korea, and Malaysia. However, the opposite result is observed for each rule in Thailand and Taiwan. Therefore, in the case of Thailand and Taiwan, the higher returns on buy days could be compensation for higher risk.

Moving average trading rules exploit positive serial dependence in stock price changes. They generate profits if, subsequent to the price movement that initially generates a signal, prices continue to move in the same direction. Typically, the technical rules initially emit a buy or sell signal on a day characterized by an unusually large price move. The partial adjustment of index values resulting from nonsynchronous trading implies that the next day change in the index value will tend to be a biased measure of true returns, with the bias in the same direction as the sign of the prior price change. As a simple control for the effects of nonsynchronous trading, we compare buy and sell day returns while implementing a one-day lag between the initial generation of a signal and the resulting trade. [3]

At the bottom of Table 2 we report the average (across the ten VMA rules) of returns on buy days and sell days with the initial return omitted. We again observe that means are higher on buy days than on sell days. The magnitudes of the difference in means is only slightly reduced; averaged across all six markets and all ten rules, mean returns on buy days exceed mean returns on sell days by 0.085% per day, or about 23.7% per year.

To summarize, the evidence indicates that VMA rules have considerable power to predict changes in Asian stock market indices. While it is possible that some of this forecastability derives from errors in measuring true returns, it appears that it cannot all be.

In Tables 3 and 4 we report results for Fixed-Length Moving Average (FMA) rules with holding periods of ten and thirty days, respectively. [4] These results support the same conclusions as those obtained from the VMA rules, although the difference in mean returns is somewhat smaller. For the fixed ten-day holding period, mean returns on buy days exceed mean returns on sell days by 0.078% per

[3] This serves as a complete control for nonsynchronous trading bias only if all stocks in the index trade the next day. An alternative would be to exclude returns for two or more days subsequent to generation of a signal. However, Bailey et al. (1990) argue that the serial dependence observed in these markets is too large and variable to be attributed to nonsynchronous trading alone. When we omit returns we purge any true serial dependence as well as measurement errors. As a second control, we also extract return innovations (residuals) from a third-order autoregressive process. These residuals can be interpreted as returns that have been purged of linear serial dependence, including that introduced by non-synchronous trading, to three lags. We then compare these return innovations on 'buy' days to innovations on 'sell' days. Again averaged across all six countries and all rules examined, mean return innovations on buy days exceed that on sell days by 0.061%, or about 16.5% on an annualized basis. Thus, controlling for linear serial dependence reduces but does not eliminate the predictive power of the technical rules.

[4] The FMA rule (5,150,0.01) for Japan fails to generate any sell signals during the sample, so mean sell returns are not available.

day, again averaged across all six markets and all ten rules. For the fixed thirty-day holding period the difference in mean returns averages 0.055% per day.

In Tables 5 and 6 we report results for the TRB rules with fixed holding periods of ten and thirty days, respectively. These rules assess the profitability of strategies that emit signals when prices cross their recent minimums or maximums. These recent extremes are interpreted as ''resistance levels'' and ''support levels'', and the rules' success relies on positive serial dependence following price movements through such a barrier.

These results indicate that the TRB rules forecast subsequent index price changes to an even greater degree than the moving average based rules. Averaged across the six markets and six rules, mean returns conditioned on TRB buy signals exceed mean returns conditioned on TRB sell signals by 0.145% per day over fixed ten-day holding periods and 0.095% per day over fixed thirty-day holding periods.

We again assess the effect of imposing a one-day lag subsequent to the initial emission of a signal. For ten-day holding periods, mean returns on buy days then exceed mean returns on sell days by 0.091% per day on average. For thirty-day holding periods, buy day residuals then exceed sell day residuals by 0.065% per day on average. Thus we conclude that the ability of TRB rules to forecast Asian index returns is partially, but not exclusively, attributable to the potentially biased returns measured the first day after a signal is emitted.

3.2. *Trading profits and transactions costs*

We next provide some information on the degree to which traders using these technical trading rules could have earned trading profits in excess of transaction costs during our sample period. The ex-post profitability of a technical trading rule depends on (i) the trading strategy itself; the positions taken on days with buy signals compared to positions taken on days with sell signals, (ii) mean returns on buy days versus mean returns on sell days, (iii) the number of days that each trading position is held, and (iv) the magnitude of transactions costs incurred when positions are changed.

In Table 7 we provide summary information on the total number of buy and sell signals generated by the technical rules in each market, and on the proportion of days for which a position would be held under each rule. A trader relying on VMA rules would take a position most days; the only days a position is not taken are those where the short moving average differs from the long moving average by less than the prespecified band. For rules with a band of zero a trading position is held all days. Averaged across the ten VMA rules and across the six markets, 52 buy signals and 48 sell signals are issued during our eighteen-year sample. Positions taken on the basis of buy signals are held on 62% of days, positions taken based on sell signals are held on 32% of days, while there is no signal on 6% of days.

Table 4
Mean daily returns (in %) conditional on buy and sell signals generated by ten fixed-length moving (FMA) rules with 30 days holding period. Rules are identified as (short, long, band) where short and long are the length of short and long moving averages, respectively, and band is the percentage difference required to generate a signal. Returns are for trades executed with 0-day or 1-day lag. Figures in parentheses are standard deviations. Bootstrap *p*-values test for the difference between buy and sell returns

Rule		Hong Kong	Japan	Korea	Malaysia	Thailand	Taiwan
Returns with 0-day lag							
(1,50,0)	Buy	0.072 (1.35)	0.061 (0.74)	0.037 (1.08)	0.015 (1.61)	0.010 (0.96)	0.036 (1.24)
	Sell	−0.043 (1.99)	0.035 (0.77)	0.072 (1.05)	−0.031 (1.66)	−0.029 (0.93)	0.002 (1.42)
	p-value	0.006	0.024	0.976	0.056	0.036	0.082
(1,50,0.01)	Buy	0.068 (1.37)	0.025 (2.73)	0.089 (1.15)	0.133 (1.30)	0.009 (1.24)	0.105 (1.57)
	Sell	−0.125 (2.54)	−0.055 (1.01)	0.133 (1.16)	−0.002 (1.74)	−0.081 (1.36)	−0.029 (1.79)
	p-value	0.002	0.072	0.794	0.010	0.038	0.000
(1,150,0)	Buy	0.083 (1.62)	0.048 (0.83)	0.005 (1.08)	−0.108 (1.55)	−0.007 (0.98)	0.081 (1.37)
	Sell	−0.019 (1.92)	0.037 (0.90)	0.028 (1.10)	−0.192 (2.17)	−0.062 (0.92)	0.075 (1.43)
	p-value	0.020	0.280	0.812	0.022	0.058	0.456
(1,150,0.01)	Buy	0.061 (1.98)	0.016 (1.64)	0.028 (1.12)	−0.054 (1.70)	−0.003 (0.94)	0.071 (1.28)
	Sell	0.025 (2.03)	0.252 (2.07)	0.102 (1.57)	−0.303 (2.79)	−0.265 (1.39)	0.113 (1.86)
	p-value	0.366	0.990	0.870	0.002	0.004	0.734
(5,150,0)	Buy	0.154 (1.26)	0.024 (0.92)	0.061 (0.92)	−0.007 (0.97)	−0.018 (1.13)	0.059 (1.29)
	Sell	−0.014 (1.99)	0.040 (0.96)	0.060 (1.10)	−0.197 (2.16)	−0.087 (1.02)	0.045 (1.39)
	p-value	0.014	0.700	0.462	0.004	0.069	0.414
(5,150,0.01)	Buy	0.162 (1.06)	−0.151 (0.48)	−0.086 (0.83)	−0.070 (1.03)	0.310 (1.49)	−0.183 (1.60)
	Sell	−0.211 (2.78)	NA	0.232 (1.26)	−0.445 (3.60)	−0.323 (2.87)	0.372 (2.04)

	p-value	0.064		0.966	0.052	0.002	0.982
(1,200,0)	Buy	0.032 (1.71)	0.068 (0.53)	0.004 (1.03)	0.045 (1.20)	0.030 (1.03)	0.083 (1.38)
	Sell	−0.002 (1.94)	0.068 (0.86)	0.020 (1.06)	−0.121 (2.22)	−0.015 (1.12)	0.024 (1.41)
	p-value	0.272	0.488	0.718	0.000	0.126	0.096
(1,200,0.01)	Buy	−0.010 (2.01)	0.202 (0.68)	0.060 (0.88)	0.083 (1.14)	0.080 (1.16)	0.076 (1.43)
	Sell	−0.152 (2.62)	0.123 (1.92)	0.030 (1.03)	−0.411 (3.59)	−0.099 (2.05)	−0.016 (1.73)
	p-value	0.080	0.174	0.998	0.000	0.018	0.140
(2,200,0)	Buy	0.009 (1.77)	0.049 (0.49)	0.019 (0.84)	−0.011 (1.20)	0.027 (1.04)	0.098 (1.28)
	Sell	−0.007 (2.02)	0.055 (0.85)	0.031 (1.06)	−0.120 (2.11)	−0.018 (1.16)	0.050 (1.44)
	p-value	0.444	0.558	0.662	0.024	0.146	0.192
(2,200,0.01)	Buy	0.039 (1.47)	0.065 (0.47)	−0.050 (1.05)	0.170 (0.94)	0.274 (2.16)	0.040 (1.59)
	Sell	−0.122 (3.03)	0.125 (1.96)	0.208 (1.28)	−0.141 (2.61)	0.135 (1.45)	0.109 (1.67)
	p-value	0.164	0.656	0.970	0.012	0.132	0.724
Average	Buy	0.064 (1.56)	0.052 (0.83)	0.031 (1.02)	0.020 (1.40)	0.017 (1.05)	0.066 (1.35)
	Sell	−0.043 (2.15)	0.045 (0.93)	0.063 (1.11)	−0.124 (2.15)	−0.053 (1.14)	0.034 (1.51)
	p-value	0.008	0.304	0.938	0.000	0.004	0.140
Returns with 1-day lag							
Average	Buy	0.072 (1.55)	0.046 (0.83)	0.018 (1.02)	0.026 (1.39)	0.004 (1.02)	0.055 (1.35)
	Sell	−0.032 (2.00)	0.034 (0.88)	0.070 (1.10)	−0.119 (2.03)	−0.043 (1.14)	0.032 (1.49)
	p-value	0.000	0.242	0.992	0.000	0.022	0.196

Table 5

Mean daily returns (in %) conditional on buy and sell signals generated by six trading range break (TRB) rules with 10 days holding period. Rules are identified as (window, band) where window is the length of prior period in recording recent minimum and maximum price, and band is the percentage difference required to generate a signal. Returns are for trades executed with 0-day or 1-day lag. Figures in parentheses are standard deviations. Bootstrap *p*-values test for the difference between buy and sell returns

Rule		Hong Kong	Japan	Korea	Malaysia	Thailand	Taiwan
Returns with 0-day lag							
(50,0)	Buy	0.145 (1.35)	0.059 (0.75)	0.139 (1.04)	0.141 (1.17)	0.238 (1.19)	0.234 (1.48)
	Sell	−0.143 (3.26)	0.046 (1.10)	0.098 (1.25)	−0.150 (2.25)	−0.116 (1.07)	0.027 (1.45)
	p-value	0.000	0.382	0.230	0.000	0.000	0.000
(50,0.01)	Buy	0.172 (1.42)	0.163 (0.77)	0.175 (1.20)	0.189 (1.27)	0.343 (1.32)	0.300 (1.63)
	Sell	0.093 (3.04)	0.237 (1.41)	0.160 (1.54)	−0.125 (2.55)	−0.069 (1.50)	0.086 (1.60)
	p-value	0.002	0.858	0.404	0.002	0.000	0.004
(150,0)	Buy	0.162 (1.37)	0.074 (0.62)	0.175 (1.08)	0.124 (1.15)	0.293 (1.31)	0.198 (1.53)
	Sell	0.230 (3.20)	0.298 (1.56)	0.192 (1.37)	−0.137 (2.38)	−0.066 (1.13)	0.026 (1.19)
	p-value	0.614	0.992	0.558	0.010	0.002	0.058
(150,0.01)	Buy	0.139 (1.47)	0.166 (0.82)	0.237 (1.22)	0.217 (1.29)	0.385 (1.37)	0.306 (1.67)
	Sell	0.241 (3.53)	0.536 (2.03)	0.212 (1.63)	−0.074 (2.63)	0.023 (1.68)	0.138 (1.36)
	p-value	0.692	0.994	0.402	0.010	0.010	0.110
(200,0)	Buy	0.176 (1.37)	0.072 (0.62)	0.168 (1.11)	0.117 (1.17)	0.323 (1.37)	0.207 (1.54)
	Sell	0.403 (3.48)	0.304 (1.22)	0.222 (1.49)	−0.124 (2.04)	−0.049 (1.06)	0.015 (1.02)
	p-value	0.892	0.980	0.662	0.016	0.002	0.076
(200,0.01)	Buy	0.145 (1.49)	0.166 (0.82)	0.246 (1.21)	0.216 (1.29)	0.396 (1.41)	0.308 (1.70)
	Sell	0.529 (3.45)	0.637 (1.65)	0.260 (1.70)	−0.031 (2.24)	0.032 (1.74)	0.144 (1.19)
	p-value	0.968	0.996	0.516	0.034	0.016	0.128
Average	Buy	0.157 (1.40)	0.083 (0.70)	0.178 (1.12)	0.155 (1.21)	0.312 (1.31)	0.250 (1.57)
	Sell	0.040 (3.25)	0.198 (1.36)	0.158 (1.41)	−0.118 (2.35)	−0.071 (1.25)	0.057 (1.38)
	p-value	0.104	0.996	0.328	0.000	0.000	0.008
Returns with 1-day lag							
Average	Buy	0.097 (1.45)	0.069 (0.70)	0.153 (1.15)	0.137 (1.21)	0.271 (1.33)	0.224 (1.60)
	Sell	0.043 (2.95)	0.182 (1.21)	0.229 (1.33)	−0.090 (2.23)	−0.025 (1.23)	0.067 (1.37)
	p-value	0.240	0.994	0.874	0.000	0.000	0.018

Table 6
Mean daily returns (in %) conditional on buy and sell signals generated by six trading range break (TRB) rules with 30 days holding period. Rules are identified as (window, band) where window is the length of prior period in recording recent minimum and maximum price, and band is the percentage difference required to generate a signal. Returns are for trades executed with 0-day or 1-day lag. Figures in parentheses are standard deviations. Bootstrap *p*-values test for the difference between buy and sell returns

Rule		Hong Kong	Japan	Korea	Malaysia	Thailand	Taiwan
Returns with 0-day lag							
(50,0)	Buy	0.077 (1.55)	0.051 (0.72)	0.083 (0.99)	0.116 (1.20)	0.181 (1.16)	0.142 (1.45)
	Sell	−0.006 (2.54)	0.064 (0.88)	0.038 (1.09)	−0.094 (2.00)	−0.066 (0.91)	0.073 (1.38)
	p-value	0.086	0.664	0.112	0.000	0.000	0.090
(50,0.01)	Buy	0.034 (1.93)	0.096 (0.74)	0.111 (1.11)	0.094 (1.35)	0.280 (1.15)	0.235 (1.54)
	Sell	0.032 (2.38)	0.101 (1.07)	0.068 (1.25)	−0.110 (2.14)	−0.110 (1.16)	0.090 (1.44)
	p-value	0.494	0.530	0.196	0.000	0.000	0.008
(150,0)	Buy	0.068 (1.65)	0.066 (0.60)	0.127 (1.04)	0.126 (1.26)	0.242 (1.29)	0.166 (1.55)
	Sell	0.196 (2.56)	0.135 (1.10)	0.085 (1.08)	−0.065 (2.22)	−0.021 (1.10)	0.022 (1.13)
	p-value	0.884	0.930	0.234	0.004	0.000	0.036
(150,0.01)	Buy	0.025 (2.15)	0.087 (0.78)	0.167 (1.16)	0.096 (1.43)	0.305 (1.21)	0.235 (1.59)
	Sell	0.242 (2.73)	0.218 (1.46)	0.099 (1.24)	−0.028 (2.25)	0.041 (1.41)	0.052 (1.24)
	p-value	0.968	0.946	0.192	0.074	0.006	0.036
(200,0)	Buy	0.067 (1.69)	0.065 (0.61)	0.137 (1.05)	0.121 (1.27)	0.248 (1.37)	0.154 (1.56)
	Sell	0.257 (2.78)	0.124 (0.85)	0.093 (1.30)	−0.087 (1.85)	0.016 (0.93)	0.025 (0.99)
	p-value	0.932	0.828	0.238	0.006	0.006	0.078
(200,0.01)	Buy	0.036 (2.23)	0.087 (0.78)	0.171 (1.16)	0.093 (1.45)	0.297 (1.26)	0.244 (1.62)
	Sell	0.312 (2.69)	0.237 (1.14)	0.081 (1.44)	−0.065 (1.84)	0.046 (1.21)	0.055 (1.09)
	p-value	0.978	0.934	0.148	0.038	0.014	0.034
Average	Buy	0.054 (1.84)	0.067 (0.68)	0.124 (1.07)	0.109 (1.31)	0.249 (1.23)	0.188 (1.53)
	Sell	0.103 (2.56)	0.107 (1.02)	0.066 (1.19)	−0.081 (2.06)	−0.035 (1.08)	0.061 (1.29)
	p-value	0.738	0.884	0.100	0.000	0.000	0.012
Returns with 1-day lag							
Average	Buy	0.043 (1.86)	0.061 (0.68)	0.116 (1.08)	0.095 (1.31)	0.237 (1.24)	0.169 (1.54)
	Sell	0.109 (2.39)	0.090 (0.93)	0.076 (1.15)	−0.066 (1.97)	−0.015 (1.07)	0.076 (1.28)
	p-value	0.798	0.792	0.154	0.000	0.000	0.034

Table 7
Frequency of trading and position-taking for variable-length moving rule (VMA), fixed-length moving rule (FMA) with 10 or 30 days holding period, and trading range break rule (TRB) with 10 or 30 days holding period. Proportion denotes the mean fraction of days that a position would be held by traders under the rules. Number denotes the average number of trades that would be generated

Rule	Signal		Hong Kong	Japan	Korea	Malaysia	Thailand	Taiwan	Grand average
VMA	Buy	Proportion	0.65	0.74	0.60	0.62	0.55	0.59	0.62
		Number	61.6	54.3	65.0	34.3	32.8	61.5	51.6
	Sell	Proportion	0.31	0.18	0.33	0.35	0.39	0.37	0.32
		Number	56.6	48.9	62.6	32.0	29.1	61.7	48.5
FMA	Buy	Proportion	0.07	0.05	0.08	0.05	0.04	0.07	0.05
(10 days)		Number	30.2	21.4	29.7	17.7	13.8	28.1	23.5
	Sell	Proportion	0.07	0.05	0.07	0.05	0.04	0.07	0.06
		Number	27.8	21.0	27.3	16.5	12.8	28.8	22.4
FMA	Buy	Proportion	0.16	0.11	0.16	0.11	0.09	0.15	0.13
(30 days)		Number	24.3	16.2	21.9	14.2	10.9	22.6	18.3
	Sell	Proportion	0.15	0.11	0.14	0.11	0.09	0.14	0.12
		Number	22.4	15.3	19.3	13.5	10.4	21.0	17.0
TRB	Buy	Proportion	0.22	0.20	0.18	0.22	0.18	0.19	0.20
(10 days)		Number	90.2	83.3	66.5	78.5	65.0	81.5	77.5
	Sell	Proportion	0.06	0.04	0.06	0.09	0.09	0.09	0.07
		Number	23.3	14.7	20.8	31.2	30.8	38.3	26.5
TRB	Buy	Proportion	0.37	0.32	0.30	0.33	0.26	0.29	0.31
(30 days)		Number	50.7	43.5	37.7	39.3	31.8	41.5	40.7
	Sell	Proportion	0.13	0.08	0.12	0.16	0.16	0.18	0.14
		Number	17.8	11.5	15.5	18.5	18.3	25.3	17.8

A trader relying on FMA rules with a 10-day holding period would have entered positions based on buy signals 23 times per market, and would have entered positions based on sell signals 22 times per market. Traders using 30-day FMA rules would have transacted based on buy signals 18 times per market and transacted based on sell signals 17 times per market. Since the FMA rules involve less trades, they generate smaller trading costs than the VMA rules. [5] However, positions are held for fewer days: under the 10-day FMA rule a trading position is held on only 11% of days, while under the 30-day FMA rule a position is held on 25% of days in the sample.

Fixed-Length TRB rules lead to more trades than fixed length moving average (FMA) rules. TRB rules with 10-day holding periods generate 78 buy trades and

[5] FMA rules involve less trades than VMA rules due to the requirement that the position be held for a fixed number of days. For example, consider a buy signal received five days after a sell signal. Under a VMA rule the trader would respond to the second signal; under an FMA rule with a holding period longer than five days the trader would not react.

27 sell trades per market over the eighteen years, while TRB rules with 30-day holding periods generate 41 buy trades and 18 sell trades per market. A trader using 10-day TRB rules holds a position on 27% of days, while a trader using 30-day TRB rules holds a trading position on 45% of days.

The data on mean returns reported in Tables 2 through 6 can be combined with the data on numbers of trades and proportions of days that positions are held in Table 7 to evaluate the ex-post profitability of implementing technical trading rules in the Asian markets. We evaluate a "double or out" trading strategy in which a trader reacts to buy signals by borrowing money to double their equity investment. This gives a pre-transactions cost trading return on buy days of $TR_t = 2 * R_t - r_t$, where R_t is the index return on day t and r_t is the daily interest rate. The trader reacts to sell signals by liquidating any equity holdings and purchasing interest bearing instruments, leading to sell day trading returns of $TR_t = r_t$. On days where no signal is emitted the trader simply holds a long equity position, giving a trading return of $TR_t = R_t$. In the absence of transactions costs, the additional return (π) earned by technical trading relative to a buy-and-hold strategy is given as:

$$\pi = \Sigma TR_t - \Sigma R_t = N_B R'_B - N_S R'_S,$$

where N_B is the number of days the doubled (buy) position is held, N_S is the number of days the out (sell) position is held, R'_B is the mean excess (over r_t) return on buy days, and R'_S is the mean excess (over r_t) return on sell days. This quantity is interpreted as the additional terminal wealth, per currency unit initially invested, of using the double or out strategy instead of buy and hold.

Daily interest rate data for these markets are not available to us. We approximate π as $N_B R_B - N_S R_S$, where R_B and R_S are mean raw (rather than excess over the interest rate) returns on buy and sell days, respectively. If the average interest rate is the same on buy and sell days and N_B is equal to N_S, then failure to deduct interest rates introduces no bias to our profit measure. If, however N_B differs from N_S, our excess profit measure will typically be biased. On an annualized basis, the bias is approximately $(w_B - w_S) * r$, where w_B is the proportion of buy days, w_S is the proportion of sell days, and r is the average annual interest rate. We note that for typical interest rates this bias is small relative to the magnitude of buy versus sell day returns.

Of course, a trader would incur transactions costs. Let C denote the percentage round-trip cost of buying and selling the equity index. On days that a buy or sell signal is initially emitted the trading return is reduced by $C/2\%$. When that position is subsequently closed out the trading return is reduced by another $C/2\%$. Therefore, each buy or sell signal reduces total return by $C\%$, and aggregate transactions costs exactly consume the excess return from trading if $\pi = C * (n_B + n_S)$, or:

$$C = \pi/(n_B + n_S),$$

where n_B and n_S are the number of days on which buy and sell signals are

Table 8
Mean breakeven cost (in %) for the double and out strategy (borrow to double long positions in the stocks on buy signals and invest in risk-free assets on sell signals) relative to the buy and hold strategy. Buy and sell signals are generated from variable-length moving rules (VMA), fixed-length moving rules (FMA) with 10 or 30 days holding period, and trading range break rules (TRB) with 10 or 30 days holding period. Returns are for trades executed with 0-day or 1-day lag

Rule	Hong Kong		Japan		Korea		Malaysia		Thailand		Taiwan		Grand average	
	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades
VMA	1.54	1.32	1.37	1.19	1.10	0.82	5.19	4.73	5.79	5.48	2.39	2.06	2.90	2.60
FMA (10 days)	0.85	0.95	−0.02	−0.04	−0.06	−0.23	0.91	0.90	−0.13	−0.32	0.74	0.59	0.38	0.31
FMA (30 days)	1.63	1.59	0.15	0.22	−0.40	−0.69	2.11	2.14	1.04	0.69	0.56	0.39	0.85	0.72
TRB (10 days)	1.17	0.68	0.41	0.32	0.98	0.62	1.45	1.24	2.35	1.92	1.51	1.30	1.31	1.01
TRB (30 days)	0.40	0.11	0.92	0.88	2.07	1.80	3.01	2.57	5.12	4.67	2.81	2.29	2.39	2.05
Estimated cost [a]	1.22–2.72		1.64		1.22		2.80		1.00		0.30			

[a] The estimates are based on Rhee, Chang and Ageloff (1990) who estimate one-way transactions costs, including brokerage fees and transaction taxes, for investments of $100,000 in various markets. The figures reported are round-trip costs obtained by multiplying their estimates by two.

initially emitted, and their sum is the total number of round-trip transactions that result from implementing the trading rule.

In Table 8 we report "break-even" transactions costs, which are the percentage round-trip costs that eliminate the additional return from technical trading. These are computed separately for each rule we evaluate. To save space, however, we report mean break-even costs averaged across each group of ten moving average rules and each group of six trading range breakout rules, for each market. Break-even costs are computed both from the full sample and from a restricted sample where we again impose the one-day lag subsequent to the initial emission of a signal. This lag can be motivated by delays in reacting to signals, or on the basis of nonsynchronous trading bias, as discussed above.

Averaged across all rules and all markets, break-even transactions costs are 1.57% for the full sample and 1.34% when first-day returns are excluded. We observe the highest break-even costs for the VMA trading rules; 2.90% for the full sample and 2.60% with the one-day lag, averaged across the six markets. Break-even costs for the 30-day holding period TRB rules are nearly as high; 2.39% for the full sample and 1.34% for the restricted sample. Consistent with our earlier observations regarding mean returns, we observe that break-even costs are higher for Malaysia, Thailand, and Taiwan. Averaged across all rules, break-even costs for these three countries are 2.32% for the full sample and 2.04% in the restricted sample. Some sets of rules in individual countries allow higher break-even costs. For example, in Thailand break-even costs for the VMA rules averaged 5.79% for the full sample and 5.48% with the one-day lag imposed. On the other hand, break-even costs for some rules in some markets (e.g. FMA rules in Korea) are negative, indicating that even those who can trade at zero cost would have earned less by trading on the rules than from a buy and hold strategy. It should be kept in mind however that these are ex-post observations, and that actual profits for each rule differ from expected profits due to random outcomes. In the absence of ex-ante reasons to prefer one strategy or market over the others, break-even costs averaged across rules and markets provide the appropriate benchmarks.

Our computed break-even costs can be compared to estimates of actual transactions costs for Asian markets provided by Rhee et al. (1990). They estimate one-way transactions costs, including brokerage fees and transactions taxes, for investments of $100,000. Their estimates, multiplied by two, comprise estimated round-trip transaction costs, and are reported also in Table 8. Based on this comparison it appears that profits from technical trading were unlikely in Hong Kong, Japan, and Korea. For each of these markets, the mean break-even round-trip costs (computed across all rules) is less than the Rhee et al. estimate of round-trip costs. For Malaysia, Thailand, and Taiwan the possibility of trading profits cannot be dismissed, as the mean (across rules) of the break-even costs we calculate are greater than the Rhee et al. estimates. However, their estimates may understate the costs of transacting since they do not include any costs due to bid–ask spreads or price pressure.

Table 9
Annualized excess returns (in %) for the double and out strategy (borrow to double long positions in the stocks on buy signals and invest in risk-free asset on sell signals) relative to the buy and hold strategy, at different levels of transaction costs (in %). Buy and sell signals are generated from variable-length moving rule (VMA), fixed-length moving rule (FMA) with 10 or 30 days holding period, and trading range break rule (TRB) with 10 or 30 days holding period. Returns are for trades executed with 0-day or 1-day lag

Rule	Transaction cost (%)	Hong Kong		Japan		Korea		Malaysia		Thailand		Taiwan		Grand Average	
		0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades	0-day lag trades	1-day lag trades
VMA	0.5	7.72	6.08	6.38	5.07	6.35	3.43	22.21	20.04	23.38	22.00	16.63	13.73	13.78	11.73
	1.0	4.02	2.39	2.70	1.38	1.04	−1.89	19.84	17.67	21.17	19.79	12.23	9.33	10.17	8.11
	1.5	0.33	−1.30	−0.99	−2.30	−4.28	−7.20	17.47	15.30	18.96	17.58	7.83	4.93	6.55	4.50
FMA	0.5	1.26	1.62	−1.56	−1.64	−2.64	−3.46	0.99	0.99	−1.20	−1.56	0.99	0.38	−0.36	−0.61
(10 days)	1.0	−0.55	−0.19	−3.07	−3.16	−5.02	−5.84	−0.23	−0.23	−2.15	−2.51	−1.04	−1.65	−2.01	−2.26
	1.5	−2.36	−2.01	−4.59	−4.67	−7.40	−8.21	−1.45	−1.45	−3.09	−3.46	−3.07	−3.69	−3.66	−3.91
FMA	0.5	3.29	3.17	−0.78	−0.64	−3.10	−4.10	3.19	3.25	0.82	0.29	0.18	−0.35	0.60	0.27
(30 days)	1.0	1.83	1.71	−1.90	−1.76	−4.81	−5.81	2.20	2.26	0.06	−0.47	−1.38	−1.91	−0.95	−0.99
	1.5	0.38	0.25	−3.03	−2.89	−6.53	−7.53	1.21	1.27	−0.70	−1.23	−2.94	−3.47	−1.93	−2.27
TRB	0.5	4.72	1.30	−0.60	−1.28	3.51	0.86	7.42	5.76	12.64	9.70	8.71	6.87	6.07	3.87
(10 days)	1.0	1.17	−2.24	−4.10	−4.78	−0.13	−2.78	3.51	1.84	9.22	6.27	4.41	2.57	2.35	1.47
	1.5	−2.37	−5.79	−7.60	−8.28	−3.77	−6.41	−0.41	−2.07	5.80	2.85	0.11	−1.72	−1.37	−3.57
TRB	0.5	−0.42	−1.69	1.65	1.49	6.94	5.78	10.38	8.55	16.54	14.95	11.03	8.57	7.69	6.27
(30 days)	1.0	−2.56	−3.83	−0.31	−0.47	4.73	3.57	8.31	6.48	14.75	13.15	8.65	6.18	5.60	4.18
	1.5	−4.70	−5.97	−2.27	−2.43	2.51	1.35	6.25	4.42	12.96	11.36	6.26	3.79	3.50	2.09

Table 10
Mean correlation among the trading signals (1 if buy, 0 if neutral, and −1 if sell) generated by ten variable−length moving (VMA) rules in the U.S. and six Asian−Pacific markets

	Hong Kong	Japan	Korea	Malaysia	Thailand	Taiwan	U.S.
Hong Kong		0.355	0.184	0.289	−0.055	0.104	0.365
Japan	0.355		0.118	0.286	0.121	0.195	0.362
Korea	0.118	0.184		0.055	0.044	0.261	0.011
Malaysia	0.289	0.286	0.055		0.159	0.329	0.303
Thailand	−0.055	0.121	0.044	0.159		0.118	0.056
Taiwan	0.104	0.195	0.260	0.329	0.118		0.157
U.S.	0.365	0.362	0.011	0.303	0.056	0.157	
Average	0.196	0.250	0.112	0.237	0.074	0.194	0.209

This comparison of break-even costs to the Rhee et al. transaction cost estimates is useful, but not definitive. Large scale traders (who invest more than $100,000) or market insiders may incur costs that are less than their estimates. Also, two rules that have the same break-even costs could, due to variation in the number of signals and proportion of buy and sell days, have different levels of profitability at alternate levels of transactions costs. In Table 9 we report annualized excess returns from the "double or out" trading strategy, relative to returns from a buy and hold strategy, for various pre-specified transactions costs. We compute excess returns for each group of trading rules and each market, for traders who incur fixed round-trip transactions costs of 0.5%, 1.0%, and 1.5%. The VMA trading rules seem to be the most profitable at all three levels of transactions costs, followed by the TRB rules. Averaged across markets, traders with round-trip costs of 0.5% would have earned substantial excess returns from VMA trading rules (13.78% per year for the full sample and 11.73% with the one-day lag imposed) and 30-day holding period TRB trading rules (7.69% and 6.27% in the full and restricted samples, respectively), but even this low level of costs would have eliminated profits from 10-day FMA rules. Transactions costs of 1.0% or 1.5% reduce but do not eliminate excess returns from VMA and TRB trading rules.

This analysis indicates that traders who incur round-trip transactions costs which are less than the break-even costs reported in Table 8 could have earned higher average returns by using technical trading rules than from a buy and hold strategy. However, we have not controlled for the relative riskiness of the technical trading strategies (which will typically differ from the riskiness of buy and hold). [6] Therefore, it cannot be concluded without further analysis that these higher trading returns represent excess profits after adjusting for risk.

[6] As a simple example illustrating that the risk of the double or out strategy differs from the risk of buy and hold, suppose that the variance of daily returns is a constant σ^2, and that there is no serial dependence in returns. Then the variance of T-day buy and hold returns is $T\sigma^2$. Compare this to a trading strategy where the position is doubled on $T/2$ days and the market is exited on $T/2$ days. On days that the position is doubled the variance is $4\sigma^2$, while on days the market is exited the variance is zero. The variance of the T-day trading return is $(T/2)(4\sigma^2)+T/2 * 0 = 2T\sigma^2$.

Table 11

Regression of daily returns (in %) in six Asian-Pacific markets on trading signals (1 if buy, 0 if neutral and −1 if sell) generated by ten variable-length moving (VMA) rules in the U.S., Japan and in its own market. Rules are identified as (short, long, band) where short and long are the lengths of short and long moving averages, respectively, and band is the percentage difference required to generate a signal. Figures in parentheses are T-values

Rule		Hong Kong	Japan	Korea	Malaysia	Thailand	Taiwan
(1,50,0)	own	0.065 (1.69)		−0.007 (−0.33)	0.069 (2.30)	0.143 (7.07)	0.099 (3.59)
	U.S.	0.088 (2.39)	0.051 (3.63)	0.030 (1.32)	0.144 (5.02)	0.039 (1.87)	0.042 (1.49)
	Japan	−0.039 (−0.99)	0.018 (1.20)	−0.032 (−1.30)	−0.029 (−0.94)	0.014 (0.63)	0.001 (0.03)
(1,50,0.01)	own	0.078 (1.93)		−0.007 (−0.27)	0.095 (3.00)	0.173 (7.64)	0.105 (3.54)
	U.S.	0.096 (2.30)	0.069 (4.33)	0.023 (0.89)	0.145 (4.45)	0.042 (1.79)	0.069 (2.19)
	Japan	−0.056 (−1.19)	0.012 (0.66)	−0.018 (−0.61)	−0.069 (−1.92)	0.009 (0.33)	0.000 (0.01)
(1,150,0)	own	−0.001 (−0.03)		0.010 (0.44)	0.060 (1.95)	0.087 (4.20)	0.030 (1.05)
	U.S.	0.080 (1.89)	0.081 (5.06)	0.054 (2.06)	0.099 (3.04)	0.073 (3.13)	0.029 (0.92)
	Japan	−0.014 (−0.27)	−0.040 (−2.16)	−0.046 (−1.51)	−0.023 (−0.59)	0.008 (0.29)	0.016 (0.43)
(1,150,0.01)	own	−0.002 (−0.05)		−0.000 (−0.01)	0.069 (2.15)	0.107 (4.87)	0.036 (1.19)
	U.S.	0.088 (1.93)	0.084 (4.92)	0.066 (2.38)	0.086 (2.49)	0.057 (2.30)	0.031 (0.92)
	Japan	−0.041 (−0.72)	−0.051 (−2.46)	−0.051 (−1.47)	−0.008 (−0.19)	0.021 (0.68)	0.035 (0.85)
(5,150,0)	own	−0.007 (−0.17)		0.003 (0.15)	0.067 (2.16)	0.077 (3.68)	0.032 (1.10)
	U.S.	0.031 (0.72)	0.054 (3.34)	0.079 (2.98)	0.045 (1.37)	0.049 (2.08)	0.016 (0.50)
	Japan	0.009 (0.18)	−0.039 (−2.06)	−0.063 (−2.02)	0.000 (0.00)	0.041 (1.49)	0.021 (0.57)

(5,150,0.01)	own	−0.020 (−0.46)		−0.003 (−0.13)	0.067 (2.07)	0.092 (4.16)	0.030 (0.99)
	U.S.	0.050 (1.08)	0.071 (4.13)	0.080 (2.84)	0.062 (1.76)	0.060 (2.40)	0.042 (1.23)
	Japan	−0.011 (−0.19)	−0.057 (−2.68)	−0.067 (−1.91)	−0.014 (−0.32)	0.019 (0.62)	0.006 (0.14)
(1,200,0)	own	−0.004 (−0.09)		0.015 (0.62)	0.063 (2.03)	0.057 (2.70)	0.026 (0.87)
	U.S.	0.085 (1.83)	0.055 (3.22)	0.089 (3.19)	0.084 (2.40)	0.073 (2.94)	0.013 (0.40)
	Japan	−0.097 (−1.68)	−0.031 (−1.42)	−0.085 (−2.42)	−0.030 (−0.69)	0.005 (0.16)	0.046 (1.05)
(1,200,0.01)	own	−0.020 (−0.44)		0.016 (0.62)	0.066 (2.08)	0.066 (2.96)	0.033 (1.05)
	U.S.	0.102 (2.10)	0.065 (3.64)	0.082 (2.80)	0.099 (2.69)	0.066 (2.53)	0.008 (0.23)
	Japan	−0.088 (−1.35)	−0.047 (−1.97)	−0.098 (−2.50)	−0.038 (−0.78)	0.024 (0.70)	0.052 (1.08)
(2,200,0)	own	−0.020 (−0.48)		0.011 (0.47)	0.056 (1.79)	0.057 (2.69)	0.028 (0.92)
	U.S.	0.083 (1.78)	0.055 (3.20)	0.080 (2.85)	0.077 (2.18)	0.065 (2.60)	0.005 (0.14)
	Japan	−0.079 (−1.37)	−0.039 (−1.81)	−0.084 (−2.38)	−0.029 (−0.65)	0.015 (0.49)	0.049 (1.14)
(2,200,0.01)	own	−0.018 (−0.40)		0.012 (0.48)	0.064 (2.00)	0.058 (2.61)	0.028 (0.89)
	U.S.	0.083 (1.70)	0.063 (3.49)	0.084 (2.86)	0.083 (2.26)	0.074 (2.86)	0.018 (0.51)
	Japan	−0.064 (−0.98)	−0.051 (−2.11)	−0.095 (−2.41)	−0.028 (−0.57)	0.018 (0.52)	0.040 (0.82)
Average	own	0.005 (0.15)		0.005 (0.24)	0.067 (2.15)	0.092 (4.26)	0.045 (1.52)
	U.S.	0.079 (1.77)	0.065 (3.90)	0.067 (2.42)	0.092 (2.77)	0.060 (2.42)	0.027 (0.85)
	Japan	−0.048 (−0.86)	−0.032 (−1.48)	−0.064 (−1.85)	−0.027 (−0.67)	0.017 (0.59)	0.027 (0.60)

3.3. Commonality in forecasts across markets

The mean returns reported in Tables 2 through 6 provide substantial evidence that technical trading rules predict changes in Asian stock price indices to an economically significant degree. Fama (1991) observes that forecastability of stock returns can derive from market inefficiencies or from time variation in equilibrium expected returns. He further observes that, if the variation arises from shifts in equilibrium then "the variation in expected returns should be common across different securities and markets" [7]. Bessembinder and Chan (1992) point out that, if return forecastability arises in equilibrium, then those variables that are successful in forecasting returns in one market should also be capable of forecasting returns in other markets.

We investigate the degree to which the forecast power of the technical trading rules is common across markets. For each market and each VMA rule, we construct an indicator variable that equals plus one when buy signals are emitted, minus one when sell signals are emitted, and zero on days when no signal is emitted. We then compute correlations across markets in these indicator variables for each rule. In Table 10 we report averages (across the 10 VMA rules) of these correlations.

The key observation is that these correlations tend to be positive. The average correlation between VMA signals emitted in the U.S. (Dow Jones) market with VMA signals emitted in the Asian markets is 0.209. Among the Asian markets the average correlation between VMA signals is 0.171. Of the 210 pairwise correlation (21 pairs times 10 rules), 163 (or 77.8%) are significant at 1% level of confidence. These positive correlations provide some support for commonness in signals across markets. However, positive correlations in signals might also reflect the ex post dependence of national equity returns on common global risk factors, which could cause several market indices to deviate in the same direction from their own moving averages.

As a second test for commonness in technical trading signals, we run regressions of index returns for each country on three variables. The regressors are the VMA trading rule indicator variables described above for signals emitted in the U.S. markets, signals emitted in the Japanese market, and signals emitted in the local market. In the absence of any commonality in forecastable returns across markets we should observe that returns are explained by own market signals, but not by U.S. or Japanese market signals. In contrast, positive coefficients on signals from non-local (U.S. and Japanese) markets are consistent with the technical

[7] If the forecastability is attributable to investor sentiment rather than fundamentals, and the sentiment is contagious, then price movements could also be common across markets. It is difficult, if not impossible, to distinguish between time variation in equilibrium expected returns and contagious investor sentiment.

trading signals identifying periods when global equilibrium expected returns are unusually high or low.

Results, reported in Table 11, support the notion that VMA trading rule signals contain substantial common information. For all six Asian markets, the average (across the ten VMA rules) coefficient on signals from the U.S. market is positive, and for all but two markets (Taiwan and Thailand) the average coefficient on the U.S. signal is larger than the average coefficient on the own country signal. In contrast, Japanese signals do not appear to have much forecast power for returns in other Asian markets. Local signals still contain substantial forecast power for returns in Malaysia, Thailand and Taiwan. This suggests either inefficiencies or country-specific risk premiums.

This analysis cannot resolve whether the ability of the technical trading rules to forecast Asian index returns reflects market inefficiencies or shifting equilibrium expected returns. It does support the existence of common information in technical forecasts across markets, which is to be expected if the forecastablity occurs in equilibrium.

4. Conclusions

We test whether the technical trading rules that Brock et al. demonstrate to possess forecast power for returns to the U.S. Dow Jones Index also contain predictive power for returns to Asian stock market indices. In general, we find that the rules are successful in predicting stock price movements in Japan, Hong Kong, South Korea, Malaysia, Thailand, and Taiwan, with the predictability strongest in the last three markets. Averaged across all six countries and across all trading rules we evaluate, mean percentage changes on buy days exceed means on sell days by an economically significant margin of 0.095% per day, or 26.8% on an annualized basis.

The observation that technical trading rules have predictive power for changes in some Asian stock market indices is consistent with the reasoning that these markets are, or were during the sample period, informationally inefficient. However, we observe that there are alternate explanations, and conduct additional tests to shed light on them. We find that implementing the strategies with a one-day lag, which can be motivated by delays in trading or by potential biases due to nonsynchronous trading, reduces but does not eliminate the predictive power of the technical rules. We determine the magnitude of transactions costs that would eliminate any gain to the trading strategies. On average for the full sample, round-trip transactions costs of 1.57% would eliminate all gains from trading. For returns that incorporate the one-day trading lag, break-even transactions costs are reduced to 1.34% per round-trip transaction. We also assess whether the buy and sell signals emitted by the technical rules are correlated across the Asian markets and with signals emitted for the U.S. market. We find that there is substantial cross-market correlation in the signals emitted by the technical rules, and document that the buy and sell signals emitted by technical rules in the U.S. market contain forecast power for returns in the Asian markets. This type of commonality is consistent with the reasoning that the technical rules identify periods when equilibrium expected returns deviate from unconditional means.

References

Bailey, W., R. Stulz and S. Yen, 1990, Properties of daily stock returns from the Pacific Basin stock markets: Evidence and implications, in: S. Rhee and R. Chang, eds., Pacific-Basin capital markets research (North-Holland, Amsterdam).

Bessembinder, H. and K. Chan, 1992, Time-varying risk premia and forecastable returns in futures markets, Journal of Financial Economics 32, 160–193.

Brock, W., J. Lakonishok, and B. LeBaron, 1992, Simple technical trading rules and the stochastic properties of stock returns, Journal of Finance 47, 1731–1764.

Fama, E., 1991, Efficient capital markets: II, Journal of Finance 46, 1575–1617.

Fama, E. and K. French, 1988, Permanent and temporary components of stock prices, Journal of Political Economy 96, 246–273.

Fama, E. and M. Blume, 1966, Filter rules and stock market trading, Journal of Business 39, 226–241.

Jensen, M. and G. Benington, 1970, Random walks and technical theories: Some additional evidence, Journal of Finance 25, 469–482.

Pan, M., J. Chiou, R. Hocking and H. Rim, 1991, An examination of mean-reverting behavior of stock prices in Pacific-Basin stock markets, in: S. Rhee and R. Chang, eds., Pacific-Basin capital markets research, Vol. II (North-Holland, Amsterdam).

Park, K. and S. Schoenfeld, 1992, The Pacific Rim futures and options markets (Probus Publishing Company, Chicago).

Rhee, S., R. Chang and R. Ageloff, 1990, An Overview of equity markets in Pacific-Basin countries, in: S. Rhee and R. Chang, eds., Pacific-Basin capital markets research (North-Holland, Amsterdam).

Scholes, M. and J. Williams, 1977, Estimating betas from nonsynchronous data, Journal of Financial Economics 5, 309–327.

Stoll, H. and R. Whaley, 1990, The dynamics of stock index and stock index futures returns, Journal of Financial and Quantitative Analysis 25, 441–468.

Sweeney, R., 1986, Beating the foreign exchange market, Journal of Finance 41, 163–182.