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A Review on High Frequency Intraday Trading in Hong Kong Stock Market

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ABSTRACT

This paper tests the effectiveness of trading range break (TRB) trading rules in the Hang Seng index futures market. Such trading rules are linked up with a test using market high-time and market low-time. It is discovered that the market inefficiency observed by Mok, Li and Lam (2000) has no longer persisted in HSIF market. This particular example is interesting because the market inefficiency does not come together with any trading rule.

KEYWORDS: trading range break; Hang Seng index futures; market inefficiency

1 INTRODUCTION

As the financial market is getting more sophisticated, intraday trading is becoming more and more popular. In the last two decades, there is a wider use of high frequency price series in the decision making process. This observation is supported by the fact that for many future contracts, trading volume increases much more substantially than the increase in open positions. In the literature, there is also much work on the test of these hypotheses under an intraday setting (French and Roll, 1986; Daigler, 1997; Choi and Lam, 1998; Mok, Lam & Li, 2000; Copland, Jones and Lam, 2001; Fung, Mok and Lam, 2000; Fung and Lam, 2003; Neely and Weller, 2003; Chan, Fung and Lam, 2008; Fung, Lam and Lam, 2009). This article will also look at whether these hypotheses are valid or not in the Hang Seng Index futures (HSIF) market.

In this study, we focus on observing the time of daily high /low rather than the actual value of the daily high/low of HSIF. After knowing pattern of the frequency distribution of daily high/low time for the HSIF market, merchandisers and traders can make more informed decision about when to purchase/sell an index futures contract, when to close a hedging position, when/how to turn a deviation from random walk hypothesis into a possible profit opportunity. Also, we choose to investigate whether there is any significant deviation from the random walk hypothesis in HSIF market due to the market inefficiency. Our basic approach is an extension of the procedure in Mok, Lam and Li (2000) to test for the intraday pattern in the frequency distribution of daily high/low times in HSIF market. We first compare the empirical distribution with the theoretical distribution of the daily high/low time. We then find out the time interval in which there is more price dependence. The above analysis will be done under an assumption of uniform trading speed and also under an assumption of time-varying trading speed. Instead of considering all 15-minute within a day, we break the trading day into the morning trading sessions and the afternoon trading sessions. 5-minute returns within one single session will be considered. By separating the study into morning efficiency and afternoon efficiency, we can have more accurate tests of the random walk hypothesis. We will also test random walk hypothesis by testing the effectiveness of certain intraday trading rules, the trading range breakout rule (TRB), which depends on the time into a trading day.

2 LITERATURE REVIEW

2.1 Testing efficient market hypothesis (EMH) with trading range breakout rules

Brock, Lakonishok, and LeBaron (1992) provide detailed description and historical perspective on Trading Range Break (TRB). In their study, Brock et al. (1992) evaluate TRB rules where the recent maximum or minimum are based on the past 50, 150, and 200 days. Each of these is evaluated with and without a one percent band, making for six TRB rules in total. TRB rules positions taken in response to buy and sell signals are held for a fixed ten-day horizon. Brock et al. (1992) found that the profits generated by buy signals are greater and less volatile than the profits generated from sell signals in the study. Therefore, traders potentially profit from use of these rules if prices continue to move in the same direction as the price change that initiated a signal. In their studies TRB rules are positive reinforcement or momentum strategies. Brock et al. (1992) conclude that the technical analysis helps to predict the changing of stock price and the predictable variation in equity returns may not economically and statistically insignificant.

Sharpe, Alexander, and Bailey (1995) state that the apparent success of these (technical) strategies offers a challenge to those who contend that the U.S. stock market is highly efficient. They note that the predictive power of technical analysis trading rules in the Asian stock markets is an interesting issue for the researchers since there are much empirical evidence which suggests that the Asian stock markets are relatively inefficient when comparing to US and European stock markets. Hence, the technical trading rules may exploit the inefficiency of Asian stock markets.

Gunasekaragea and Powerb (2001) analyze the performance of the trading rules using index data for four emerging South Asian capital markets the Bombay Stock Exchange, the Colombo Stock Exchange, the Dhaka Stock Exchange and the Karachi Stock Exchange and examine the implications of the results for the weak form of the efficient market hypothesis. The findings indicate that technical trading rules have predictive ability in these markets and reject the null hypothesis that the returns to be earned from studying moving average values are equal to those achieved from a naive buy and hold strategy; the employment of these techniques generates excess returns to investors in South Asian markets.

Lai and Lau (2006) examine the profitability of the applications of variable and fixed moving averages as well as trading range breakout on nine popular daily Asian market indices from 1 January 1988 to 31 December 2003. The test results provided strong support for variable moving averages and fixed moving averages in the China, Thailand, Taiwan, Malaysian, Singaporean, Hong Kong, Korean, and Indonesian stock markets. The technical attractiveness of trading rules offers many profit opportunities for market participants.

2.1.1 Evidence in Hang Seng index futures market

Bessembinder and Chan (1995) report that the same rules are useful for forecasting index returns for a group of Asian stock markets. They examined forecasting ability of the technical trading rules, simple moving average (SMA) and trading range break (TRB) trading rules and found that those simple technical trading rules work better in the emerging market such as Malaysia, Thailand and Taiwan than the more developed stock markets including Japan, Hong Kong and Korea. However, they emphasized that the nonsynchronous trading and transaction costs reduce the predictive power of the technical rules in Asian markets.

Coutts and Cheung (2000) apply the technical trading rule set of Brock et al. (1992) to investigate the applicability and validity of trading rules in the Hang Seng Index (HSI) on the Hong Kong Stock Exchange (HKSE) for the period January 1985 through June 1997, and for two subsamples of equal length, partitioned from the whole sample. They concluded that the moving average oscillator and the trading range break-out rules appeared to be present, to varying extents, for all three data samples, although the Trading Range Break-out rule was by far the strongest. However, their striking conclusion was that these rules were statistically significant over much shorter data periods than used in previous studies. They also suggested that because there is a tendency for potentially 'profitable' trading rules, once documented to cease existing, and consequently further research concerning the HSI was required in years hence.

Cai, Cai and Keasey (2005) examine whether the predictability and profitability of technical trading rules changed across the 1990’s by analyzing the stock markets in U.K., Hong Kong and Japan and China. On the basis of daily data, the results suggest that technical trading rules had short term predictive ability and profitability in the Chinese stock markets and the predictive ability of the technical trading rules are supported by the results for a number of the main developed markets studied.

Lai and Lau (2006) examine the profitability of the applications of variable and fixed moving averages as well as trading range breakout (TRB) on nine popular daily Asian market indices from 1st January 1988 to 31st December 2003. The test results provided strong support for variable moving averages (VMAs), in particular, and fixed moving averages (FMAs) in the China, Thailand, Taiwan, Malaysian, Singaporean, Hong Kong, Korean, and Indonesian stock markets. The length of 20 days and 60 days appeared to be the most profitable for variable and fixed moving averages, respectively. The technical attractiveness of trading rules offers many profit opportunities for market participants.

Lam, Yeung and Cheung (2009) assessed the profitability of simple technical trading rules, simple moving average (SMA) and trading range break-out (TRB) in Hong Kong stock market (Hang Seng Index) from 1972 to 2006. Their empirical results suggest that the SMA (1, 50) consistently outperforms the market before the integration of stock exchanges in 1986. The results are robust to the out of sample tests for the validity of the profitability of the trading rules. The returns of the trading range break rules are insignificant over the 35-year span. The findings of significant pre-1986 profits and insignificant post-1986 profits, contradict previous findings that returns are predictable in Hong Kong, suggesting that the Hong Kong stock market may be weak-form efficient after 1986.

Coutts (2010) re-examined the work of Coutts and Cheung (2000) for the Hang Seng index from 1997-2008 and find that those once potentially short-term 'profitable' trading rules are then defunct. Coutts (2010) suggested that the validity of 'profitable' trading rules, released to the 'public information set' via academic journals, would cease to exist.

2.2 Testing efficient market hypothesis (EMH) with Intraday data

Barclay, Litzenberger and Warner (1990) reported the phenomenon of Saturday trading and the international listing on the Tokyo Stock exchange. They found that the variance of market open on Saturday is 112 percent higher than the market close. Besides, the weekly variance is unaffected even though the weekly volume is increases. On the other hand, they found that the U.S stocks, which listed on the Tokyo exchange, do not increase the variance or overnight pattern even though there is a substantial increase in trading hours. The results of the study support the private-information-base rational trading models but inconsistent with the public-information hypotheses and irrational trading noise.

Shalen (1993) suggested that the peak volatility and volume occurring at the open may due to the greater dispersion. The mutual fund managers trade at the market close in order to make trades at the closing for fund purchases and redemptions. Besides, the short sellers always close out the position at the day end. Finally, investors frequently hedge the position at day end.

Daigler (1997) employs 15-minute and 5-minute time intervals to examine the behaviour of the S&P500, MMI and T-bond futures contracts. The study showed that the most volatile time interval is approximately 30 minutes before the NTSE close. Also, there is no upward spike at the cash market close for stock index futures. Most importantly, the last anomaly is that the volatility measure for the 5-minute intervals is greater when the S&P500 futures close rather than when the cash market closes. This means the activity of scalpers at the futures close creates this pattern and that the S&P 500 futures market may dominate the cash market at the day end. Daigler (1997) report that various reasons for large trading activities at the market open and marker close. The portfolio based traders are active at the open and close to avoid the high volume, volatility and larger spread that mainly due to the change from a closed market to continuous trading. Also, the traders can have greater divergence of opinion at the beginning of the day, which create the greater volatility and potential larger trading volume.

Copland, Jones and Lam (2001) investigate whether the market efficiency associated with the changing from pit trading to screen trading in the British, French, Germany, and Korean futures markets by comparing the empirical frequency distribution of daily time low time with the theoretical distribution which represents the intraday random walk. They found that there are no improvements of market efficiency for these futures markets due to the screen trading.

Neely and Weller (2003) assess the out-sampled performance of the intraday technical trading rules, which are the optical trading approaches with the highest in-sample excess return generated from genetic program and optimized linear forecasting model, in the foreign exchange markets. They reported that all of the selected trading rules product no excess out-sample return if considering the realistic transaction costs and trading hours.

Yu and Huang (2005) analyze high frequency (per 5 min) data of Shanghai Stock Exchange Composite index (SSEC) from January 1999 to July 2001 is analyzed by multi-fractal spectrum and find that the correlation of the parameters of the multi-fractal spectra with the variation of daily return Z in SSEC is noticeably different from that in previous studies of Hang Seng index in Hong Kong stock market. Yu and Huang (2005) conclude that there may not be a universal rule for the dependence of the parameters of the multi-fractal spectra with daily return of a stock index.

Breymann, Kelly, and Platen (2006) propose an approach to the intraday analysis of diversified world stock accumulation indices. The growth optimal portfolio (GOP) is used as reference unit or benchmark in a continuous financial market model. Diversified portfolios, covering the world stock market, are constructed and shown to approximate the GOP, providing the basis for a range of financial applications. The normalized GOP is modelled as a time transformed square root process of dimension four. Its dynamics are empirically verified for several world stock indices. Furthermore, the evolution of the transformed time is modelled as the integral over a rapidly evolving mean-reverting market activity process with deterministic volatility. Breymann et al. (2006) empirically verify a rather simple and robust model for a world stock index that reflects the historical evolution, by using only a few readily observable parameters.

The first article to consider the profitability of intraday equity market technical analysis is carried out by Marshall, Rochester, Cahan and Cahan (2008). They survey the market participants and find out that more technical analysis than fundamental analysis is used by market practitioners. Another interesting finding from the survey is that market practitioners focus on a much shorter time horizon rather than those long-term technical trading rules as found in the technical analysis literature. Based on the survey, Marshall et al. (2008) validate the findings of their survey by considering the value of equity market technical analysis on an intraday basis using 5-minute Standard and Poor's Depository Receipts (SPDR) data. Their empirical results show that given the price pressure from order clustering is a short-term phenomenon, which lend support to intraday technical analysis rather than daily or monthly technical analysis.

2.2.1 Evidence in Hang Seng index data

Other than studying the interday return volatility pattern of HSIF, Choi and Lam (1998) also studied the 15-minute intraday return in the HSIF market from March 18, 1993 to May 31, 1995 in their article. They discovered that the 15-minute intraday return volatility follows the U-shaped pattern found in other financial markets except the afternoon opening volatility is found to be elevated from the regular U-shaped pattern. They argued that trading noise could be an important source for intraday volatility pattern in HSIF market.

Sun, Chen, Wu, and Yuan (2001) analyze the Hang Seng index by the multi-fractal spectrum. The Multi-fractal spectrum of the Hang Seng indexes is calculated by a box-counting method. The index variations with time are divided into many normalized boxes (time intervals) of different sizes. Their result shows that the correlation between the multi-fractal parameters and the variation of return in the same day were found.

Chen, Sun, Wu and Wang (2004) analyze the Hang Seng Index data recorded per minute in Hong Kong stock market from January 3, 1994 to May 28, 1997 by using various conditional probabilities to predict the index variation. (totally 838 trading days). They find that per minute Hang Seng Index data does not follow a random walk pattern because that the change of the close indexes is statistically correlated to the simple sign sequences of the close index variations in previous several days and to the sign sequences of the daily multi-fractal spectrum parameter in previous several days. Furthermore, two kinds of sign sequences as given conditions have been used to predict the future price movements. One is the parameter of multi-fractal spectrum based on the indexes recorded in every minute, and the other is the variation of the close index. Results show that correlation between large fluctuations of the close price and the condition in these two methods is strong and some sign sequences of the parameter can be used to predict the probability of the near future price movements.

Cheung, Ho, Pope, and Draper, (1994) observed a double U-shaped pattern when the intraday market return volatility of the Hong Kong stock market is plotted against the time of the day. They also analyze individual Hong Kong stocks and find that for both stocks that are traded on the London Stock Exchange and those that are not traded, open-to-open return autocorrelation exist.

Exploring the intraday price reversals occur in the index futures markets of S&P500 and Hang Seng Index, Fung, Mok and Lam (2000) compared the opening return, which is the difference of the market open and previous close, with a range of filter sizes in both markets in order to identify the market overreaction from 1 Sep, 1993 to 25 Jun, 1996 of S&P 500 Futures and those of HSIF from 19 Mar, 1993 to 30 Dec, 1996. After using the rigorous statistical tests, they showed that the intraday price reversal, which is related to initial price change, occurred at both S&P500 futures and Hang Seng Index futures markets. Furthermore, the study derived the profitable trading strategies in HSIF market, which has prominent price reversal than S&P500 futures' in terms of statistical significance, with a maximum 26% annual return in HSIF market, after taking transaction costs into account.

Tang and Lui (2002) examined the wait-to-trade hypothesis, which refer to stock index futures should be more volatile than the cash index as information is reflected faster in the futures market, by using the 15-minute intraday return of HSI and HSIF from 1994 to 1996. They reported that the 15-minute intraday return of HSI is significantly more volatile than HSIF at the first 15-minute time interval. However, the test statistic showed that the intraday return of HSIF of the remaining time intervals are significantly more volatile than HSI that support the wait-to-trade hypothesis. They showed that the close-to-close intervals on all weekdays except Wednesday has the lowest intraday correlation due to the fact that the cash market closes earlier than the futures market and the time period are not synchronized. They also argued that large open volatility is mainly due to the noise unrelated to information. The authors concluded the time intervals, which near the market opening and market closing, have the greater relative frequency mainly due to the overreaction to news.

Fung and Lam (2003) further investigated the price reversals for both the intraday trading and the following trading day of Hang Seng Index futures (HSIF) market during the period March 18, 1993 through December 29, 2000. The relative pricing error, which is the difference between the futures price and its fair value, in HSIF market has been used as the proxy of investor sentiment in the study. Furthermore, they found that the relative pricing error was negatively related to the return of HSIF. On the practical side, it is found that the market overreaction existed during the intraday trading and market closing in HSIF market. The profitability opportunities still exist after incurring the transaction cost, execution time lag and risk adjustment. Hence, the empirical results showed that the investors' overreaction in HSIF market was both statistical and economically significant, which may challenge the fundamental assumption of investment rationality in the field of finance.

Choi and Lam (1998) reported that the 24-hour interday return volatility in the HSIF market is U-shaped after using the transaction data for the period from March 18, 1993 to May 31, 1995. They argued that the private information can not be used to explain the volatility differences over interday 24-hour periods since the 24-hour returns will pick up the same amount of private information in the long run even though starting at different point of time.

Huang (2000) analyze probability distribution and autocorrelations of the minute-by-minute data of the Hang Seng Index in Hong Kong and finds that the index fluctuations for the first few minutes of daily opening show behaviors very different from those of the other times. In particular, the properties of tail distribution, which show the power-law scaling with exponent about four or an exponential-type decay, indicates the volatility of the Hang Seng Index an its correlations depend on the opening effect of each trading day.

Tang and Huang (2000) study the minute-by-minute move of the Hang Seng index (HSI) data over a 4-yr period and derive an analytic form for the probability distribution function (PDF) of index moves from functional forms of certain conditional averages of the time series. Furthermore, they find that the observed PDF can be reproduced by a Langevin process with a move-dependent noise amplitude.

Tang (2003) how that a Langevin equation with a variable noise amplitude correctly reproduces the ubiquitous fat tails in the probability distribution of intra-day price moves the Hang Seng index. Based on statistical models that pay attention to the underlying economic forces and the collective behavior of investors, this Langevin equation reveals the existence of simple universal rules governing the high-frequency price move in a stock market despite of the extremely complex nature of financial concerns and investment strategies found in the market.

Fong and Frino (2000) examine the impact of the extension of trading hours in Hang Seng Index futures traded on the Hong Kong Futures Exchange on the 20 November, 1998 to 15 minutes after the close of the underlying market the Stock Exchange of Hong Kong. Using the unique natural experiment provided by this change, a pattern similar to US markets is documented for the Hang Seng Index Futures following the change in trading hours. The study of Fong and Frino (2000) provides strong evidence that the intraday pattern in volatility is caused by market closure. In addition, evidence that bid–ask bounce also explains part of the observed intraday behaviour in price volatility is provided.

Lia and Wang (2007) present a model of complex network generated from Hang Seng index (HSI) of Hong Kong stock market, which encodes stock market relevant both interconnections and interactions between fluctuation patterns of HSI in the network topologies. In the network, the nodes (edges) represent all kinds of patterns of HSI fluctuation (their interconnections). Based on network topological statistic, they obtain three uniform nodes of topological importance. From these topological important nodes, we can extract hidden significant fluctuation patterns of HSI. The results of Lia and Wang (2007) provide useful understanding on fluctuations regularity of stock market index. Lia and Wang (2007) conclude that Hong Kong stock market, rather than a random system, is statistically stable, by comparison to random networks.

Wong (2011) applies the class of Student t-mixture autoregressive (TMAR) models to the return series of the Hong Kong Hang Seng Index begins on January 2, 1996 and ends on December 30, 2005. A TMAR model consists of a mixture of g autoregressive components with Student t-error distributions. Several interesting properties make the TMAR process a promising candidate for financial time series modelling. These models are able to capture serial correlations, time-varying means and volatilities, and the shape of the conditional distributions can be time-varied from short to long-tailed or from uni-modal to multi-modal. The use of Student t-distributed errors in each component of the model allows for conditional leptokurtic distribution, which can account for the commonly observed unconditional kurtosis in financial data. It is well known that financial returns are usually not normally distributed, but rather exhibit excess kurtosis. This implies that there is greater probability mass at the tails of the marginal or conditional distribution.

3 DATA AND METHODOLOGY

To study the intraday return pattern in the morning and afternoon sessions of HSIF market, we collect the tick-by-tick data of HSIF for afternoon trading sessions from May 20, 2013 to July 22, 2016, which are obtained from Hong Kong Exchange and Clearing Ltd (HKEx). The trading months for HSIF contracts included the spot month, next calendar month and the next two calendar quarter months. Other than the expiration day, the spot month contract is usually the most liquid contracts in the market and the data for spot month contract will be studied in this study. On expiration day, the most liquid contract is the next month contract and the data of which will be studied in this study.

The daily high/low prices in the financial market have been attracting a lot of attention from academic researchers and market participants, since many technical analysts believe that it can be used as a basis for designing a profitable trading strategy (Kaufman 1987). Following Mok, Li and Lam, we bypass the actual level of daily high/low values for HSIF market and consider the high/low time instead; specifically, the time of afternoon-high and time for afternoon-low in each day in our study period. Note that in both sessions, T_H and T_L are well defined unless there are two time points with tied high prices or tied low prices. If tie occurs, we will break ties by random. Hence T_H and T_L are uniquely defined. Notice that in Mok Li and Lam, daily high/low time is considered instead. Because there are no breaks in each trading session, the theory which applies to the morning session should also apply to the afternoon session as well. In the study that follows, T_H and T_L are used to represent either the high/low time in the morning or in the afternoon session. Without loss of generality, we make reference to the morning session only for the discussion below, noting that the same argument works for the afternoon session. Denote the beginning time of the session by t=0 and denote the end of the trading session by t=1, the random variables T_H and T_L will take values in the interval (0,1), end values included.

We first assume that trading speed is uniform throughout the whole trading session. Let us assume that there are n trades within a trading session. Let T stands for either T_H or T_L . Under the assumption that the tick by tick return is independently and identically distributed, the corresponding cumulative distribution $F(t)$ of T as n tends to infinity can be derived as follows:

$$F(t) = \frac{2}{\pi}\sin^{-1}\sqrt{t} \qquad (1)$$

For a derivation of the above formula, we can refer to Feller (1965, p. 398). Once the cumulative distribution is known, it is easy to derive the limiting probability density function f(t) of the day high/low time T. f(t) is given by the formula below:

$$f(t) = \frac{1}{\pi\sqrt{t(1-t)}}, 0 < t < 1 \qquad (2)$$

The above theoretical probability density function $f(t)$ peaks at t=0 and t=1. This means that the daily high price or daily low price is more likely to appear at the time interval near session open or near the end of a trading session. It can be noted that T stands for either the session high time or the session low time meaning that under the random walk model, both T_H and T_L follow exactly the same distribution.

Besides, we assume that the trading speed varies throughout a trading session. Let $S(t)$ represent the cumulative percentage of trades transacted from 0^{th} hour to the t^{th} hour, for any t in the unit time interval (0,1). It can be noted that $S(t)$ monotonically increases from 0 to 1 as t varies from 0 to 1. Let us now assume that the tick-by-tick return is independent and identically distributed. Note that even the tick-by-tick return follows an identical distribution, it does not follow that a 5-minute return follows identical distribution. Because of the time-varying speed of trades, the number of trades in one 5-minute interval can be different from that in another 5-minute time interval. Under the assumption of time varying speed, the limiting cumulative distribution $F(t)$ of T as t goes to infinity can be derived as follows:

$$F(t) = \frac{2}{\pi}\sin^{-1}\sqrt{S(t)}\ , \qquad (3)$$

Similar to Section 4.1, the limiting probability density function of T is given by:

$$f(t) = \frac{S^{'}(t)}{\pi\sqrt{S(t)(1-S(t))}}, 0 < t < 1, \qquad (4)$$

where $S'(t)$ stands for the derivative of the function S(t). An interpretation of S'(t) is that it represents the trading speed at time t. Note that since the trading speed in each time point can be estimated using the data collected, S'(t) can be considered as known and hence the probability density function can be computed.

Trading range breakout (TRB) is an extremely simple trading rule which is popular among traders. The fact that TRB is chosen is not a result of data snooping because this rule is a popular rule existing in the market for a long time. For each trading range break (TRB) trading rule, a trading session is broken into two time periods. The first period stretches from time 0 to time t. This period is called the observation period meaning that we are observing the market but will not trade during this period. At the end of the observation period, we record the period high/low prices (denoted by h_t and l_t respectively) and make use of these prices to guide our trading in the second period. In fact h_t will be regarded as a resistance level and l_t will be regarded as a support level. A buy signal is generated in the second period once a transected price penetrates the resistance level h_t and a sell signal will be generated once a transacted price penetrates the support level l_t. The interval (l_t, ,h_t) can be considered as a trading range of prices in the first period and once the trading range in broken in the second period, a trading signal is generated. That is why we call this rule a trading range breakout rule. Since we are interested in intraday trading strategies only, we will close out any position when the trading session comes to an end.

This study also combines TRB approach with the stop loss mechanism to produce an alternative trading rule. Under the stop loss mechanism, the threshold level of 100 index points is used for the purpose of limiting the loss to 100 points. After generating the buy (sell) signal, the long (short) position will be maintained until the price of HSIF move unfavorably from the buy/sell price by an amount of 100 points.

In a particular day in which the TRB rule is triggered, let f_t be the price of HSIF and let S_t be the trading signal of the trading rules. The percentage returns from the TRB trading approach can be calculated as follows:

$$r_t = \frac{S_t - S_{t-1}}{S_{t-1}} \tag{5}$$

In reality, transaction cost is one of the crucial considerations for evaluating the effectiveness of the trading rules, especially the intraday trading. In this study, the transaction cost, which is 0.02% for the 2-way transactions, will be deducted from the returns of all reported trading rules. To test whether the profit of TRB trading rules is significantly different from zero, we carry out a t-test for excess profit after deducting the transaction cost.

4 FINDINGS

4.1 Range Break Strategy Explanation

1. We used HSIF tick-by-tick data (dated from May 20, 2013 to July 22, 2016), and implemented the strategy in the afternoon session (13:00 - 16:14).
2. In the afternoon trading session, keep high and low of HSIF from session open to a specified time in the session. Let say we set a specific time of 15:00:00. The tick data between the beginning of the afternoon session and 15:00:00, will be used to keep the high and low value. In here, we have done a macro on the specified time. From 13:10 to 16:00, every 10 minutes.
3. If, at any time after the specified time, HSIF breaks the high value, take a long position immediately. Or if HSIF drops below the low value, take a short position immediately.
4. At the session close – 16:15, closes all the position at dayend price.

t	means the specified time of the strategy. 131000 means 13:10:00 (hh:mm:ss).
sig	1 means long position, -1 means short position
n	the number of trades
cost	we set a fixed trading cost of 5 index points per each trade, so cost will always be 5 index points.
mean	the profit mean
std	the profit standard deviation
sum	the profit sum

For example:

	t	sig	n	cost	Mean	std	sum
(1)	131000	-1	353	5	10.3570	125.1812	-3656
(2)	131000	1	340	5	9.7588	131.6825	-3318

For (1): specified time=13:10:00, the number of short selling trades are 353. Cost is 5 index points per trade. The short selling with a specified time of 13:10:00 has a mean profit of -10.36 index points, a standard deviation of 125.18 index points, and a sum of -3656 index points.

For (2): specified time is also=13:10:00, the number of long trades are 340. Cost is also 5 index points. The buy strategy with a specified time of 13:10:00 has a mean profit of -9.76 index points, a standard deviation of 131.68 index points, and a sum of -3318 index points.

4.2 Summary of Trading Strategy

t	sig	n	cost	mean	std	sum
131000	-1	353	5	-10.35694	125.1812	-3656
131000	1	340	5	-9.758824	131.6825	-3318
132000	-1	370	5	-11.04865	120.8503	-4088
132000	1	319	5	-6.959248	130.2486	-2220
133000	-1	366	5	-12.62568	123.9182	-4621
133000	1	318	5	-5.006289	117.7476	-1592
134000	-1	358	5	-11.37709	114.0399	-4073
134000	1	314	5	-2.566879	122.5346	-806
135000	-1	351	5	-7.826211	113.5783	-2747
135000	1	308	5	-4.152597	119.429	-1279
140000	-1	355	5	-6.830986	102.9136	-2425
140000	1	286	5	-2.814685	116.111	-805
141000	-1	338	5	-9.201183	100.4646	-3110
141000	1	274	5	-1.025547	107.4131	-281
142000	-1	326	5	-7.122699	93.03682	-2322
142000	1	264	5	-3.534091	104.0774	-933
143000	-1	316	5	-9.047468	87.2454	-2859
143000	1	248	5	-0.766129	94.06046	-190
144000	-1	304	5	-8.207237	80.78758	-2495
144000	1	228	5	0.723684	86.85462	165
145000	-1	292	5	-9.880137	73.66798	-2885
145000	1	216	5	7.111111	77.70293	1536
150000	-1	281	5	-8.160142	70.06741	-2293
150000	1	203	5	8.133005	74.45689	1651
151000	-1	259	5	-4.150579	66.69278	-1075
151000	1	191	5	4.973822	65.68885	950
152000	-1	220	5	-2.65	69.98461	-583

152000	1	173	5	0.815029	63.99155	141
153000	-1	188	5	-6.728723	58.07588	-1265
153000	1	149	5	0.57047	56.23205	85
154000	-1	159	5	-9.396226	52.47965	-1494
154000	1	125	5	-0.824	45.42382	-103
155000	-1	136	5	-10.08824	45.24656	-1372
155000	1	108	5	-4.787037	39.10232	-517
160000	-1	117	5	-6.871795	32.42991	-804
160000	1	82	5	-3.073171	30.70118	-252

One thing needs to be observed is that the transaction cost in the index futures market is much lower than that in the cash market. Because of the low transaction cost, it may seem possible for an intraday trader to profit from intraday trading. However, there are many professional players in the market. As remarked by Fung, Mok and Lam (2000), "players in the futures markets are on average better trained and better informed than stock market players as they may include more professional and institutional investors." This statement is strongly supported by a Retail Investment Survey by HKEx that is carried out in Mar 2010. The survey showed that the retail participation in HKEx derivatives (including futures and options) market remained low. Only 1.3% (75,000 individuals) of the Hong Kong adult population were derivatives investors, compared to 35.1% (2,069,000 individuals) of adult population were retail investor in stocks on HKEx in 2009. Because of the heavy concentration of professional traders in the derivative markets, it may render the market more efficient. If the intraday market is efficient, the current intraday price is the best summary of market information and the price movement from that time point onward cannot be forecasted. In other words, there should not be any trading strategy based on previous intraday prices that can make a consistent profit. This is because market participants will jump on such profitability opportunities and the opportunity will be gone after their intervention.

5 CONCLUSION

Our finding shows that the TRB rule fails to exploit the persisted market inefficiency, observed by Mok, Lam and Li in 2000 and by us in 2011. As the result, further research for searching for a profitable trading strategy to exploit the inefficiencies of the session-high/low time in HSIF market is still needed. Besides, the trading hours for the Hong Kong stock and futures market have been extended by HKEx since March 7, 2011. For the HSIF market, the morning trading sessions are from 9:15 to 12:00 and the afternoon trading sessions are from 13:30 until 16:15. Beginning on March 7, 2012, the trading session of HSIF market will be from 9:15 am to 12:00 and then from 13:00 until 16:00. Due to the changing of the trading hours, the continuous research for investigating the market anomalies and profitability of the trading rules in the Hong Kong financial market is necessary.

REFERENCES

Barclay, M, Litzenberger, R. and Warner, J., (1990), "Private information, trading, volume and stock-return variances", *Review of Financial Studies*, Vol. 3 (2), pp. 223-253.

Bassembinder, H. and Chan, K.,(1995), "The profitability of technical trading rules in the Asian stock markets'', *Pacific-Basin Finance Journal*, Vol. .3, pp. 257-284.

Breymann, W., Kelly, L. and Platen, E., (2006), "Intraday Empirical Analysis and Modeling of Diversified World Stock Indices", *Asia-Pacific Financial Markets*, Vol. 12, pp. 1-28.

Brock, W., Lakonishok, J. and LeBaron, B., (1992), "Simple technical trading rules and the stochastic properties of stock returns", *The Journal of Finance*, Vol. 47 (5), pp.1731-1764.

Chen, H., Sun, X. Wua, Z. and Wang, B., (2004), "Enlightenment from various conditional probabilities about Hang Seng index in Hong Kong stock market", *Physica A*, 335, p.183-196.

Cheung, Y. L., Ho, R. Y. K., Pope, P., and Draper, P., (1994), 'Intraday stock return volatility: The Hong Kong evidence', *Pacific-Basin Finance Journal*, Volume 2, Issues 2-3, Pages 261-276.

Choi and Lam, (1998), "Intraday and interday volatility patterns in HSIF contracts", *Advances in Pacific Basin Financial Markets*, vol. 4.

Copland, Jones and Lam, (2001), "The index futures market: Is screen trading more efficient?' *Journal of Futures Market*, vol. 24, 4, 337-357.

Coutts, A. J., (2010), "Trading rules and stock returns: some further short run evidence from the Hang Seng 1997-2008", *Applied Financial Economics*, vol. 20, issues. 21; p. 16-67.

Daigler, (1997), "Intraday futures volatility and theories of market behavior", *Journal of Futures Market*, vol. 17, 1, 47-74.

Daskalakis and Markellos, (2008), "Are the European carbon market efficient?" *Review of Futures markets*, vol17, 2, 103-128.

Fong, K. and Frino, A., (2001), "Stock market closure and intraday stock index futures market volatility: A contagion, bid–ask bias or both?", *Pacific-Basin Finance Journal*, vol 9, p. 219–232.

Fung, Mok and Lam, (2000) , "Intraday price reversals for index futures in the US and Hong Kong", *Journal of Banking and Finance*, 24, 1179-1201.

Fung and Lam, (2004), "Overreaction of index futures in Hong Kong", *Journal of Empirical Finance*, 11, 331-351.

Fung, Lam and Lam, (2009), "Overreaction of index futures in Asia to U.S. market performance -evidence of behavioral biases?" *Working paper series*.

Gunasekaragea, A., and Powerb, D. M., (2001), "The profitability of moving average trading rules in South Asian stock markets", *Emerging Markets Review*, 2, P17-33.

Huang, Z. F., (2000), “The first 20 min in the Hong Kong stock market”, *Physica A,* 287, 405- 411.

Lai, M. M., Lau, S. H., (2006) , “The profitability of the simple moving averages and trading range breakout in the Asian stock markets”, *Journal of Asian Economics,* 17, 144–170.

Lam, K., Chan, D. and Fung, J., (2008), “Will a winning trading strategy lose its effectiveness once it is publicly known?” *Working paper series*.

Marshall, B. R., Rochester, H., Cahan, R.H. and Cahan, J.M., (2008), “Does intraday technical analysis in the U.S. equity market have value?”, *Journal of Empirical Finance*,15, 199–210.

Mok, Lam and Li, (2000), “Using daily high/low time to test for intraday random walk in two index futures markets”, *Review of Quantitative Finance and Accounting,* 14, 381-397.

Neely and Weller, (2003), “Intraday technical trading in the foreign exchange market”, *Journal of Internal Money and Finance,* 22, 223-237.

Lam, Yeung and Cheung, (2009), “Intertemporal profitability and the stability of technical analysis: evidences from the Hong Kong stock exchange.” *Applied Economics,* 1466-4283.

Research and corporate development of Hong Kong Exchange and Clearing Limited, (2010), *Retail Investor Survey 2009,* 1-56.

Shalen, (1993), “Volume, volatility and the dispersion of beliefs”, *Review of Financial Studies,* vol.6, 2, 405-434.

Sun, X., Chen, H., Wu, Z., and Yuan, Y., (2001), “Predictability of multifractal analysis of Hang Seng stock index in Hong Kong”, *Physica A,* 301, p.473-482.

Tang, G. and Lui, D., (2002), “Intraday and intraweek volatility patterns of Hang Seng index and index futures, and a test of the wait-to-trade hypothesis”, *Pacific-Basin Finance Journal*, 10(4): 475-496.

Tang, L. H., Huang, Z. F., (2000), “Modelling high-frequency economic time series”, *Physica A,* 288, p. 444-450.

Tang, L. H., (2003), “Langevin modelling of high-frequency Hang Seng index data”, *Physica A,* 324, P.272-277.

Wong, C.S., (2011), “Modeling Hong Kong’s stock index with the Student t-mixture autoregressive model”, *Mathematics and Computers in Simulation,* 81,1334–1343.

Yu, W. and Huang, D., (2005), “Multifractal analysis of SSEC in Chinese stock market: A different empirical result from Heng Seng index”, *Physica A,* 355, p.497-508.