Quantitative Bio-Science 34(2), 67~71(2015)

A Trading Strategy Using Divergence on Multiple Timeframes

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(Received November 7, 2015; Revised November 16, 2015; Accepted November 17, 2015)

ABSTRACT

Studies have examined the development of technical analysis strategies due to increasing interest in trading system. Commonly, trading is carried out by many technical analysis rules. Moreover, most studies have used methods that modify indicators or optimize trading rules. Studies using the unit of the time data are rare because one would find it difficult to measure a sensitive time unit appropriately. The present study proposes a method of configuring a trading strategy by using multiple units at the same time. The method, based on the simple trading rules of moving average convergence divergence and Bollinger bands, is tested based on the KOSPI200 futures index.

Key words : Bollinger bands, MACD, Technical analysis, Timeframes

1. Introduction

According to the efficient market hypothesis, price is a random walk because a share price will move immediately to reflect a variety of pieces of information. Since it is impossible to predict tomorrow's stock prices based on past price data, efforts on finding a predictive model of technological analysis or shares under the efficient market hypothesis become meaningless.

Initial studies have argued that the market is efficient through the statistical analysis of historical price data. However, many researchers have argued that price movements are partly inefficient because transaction costs occur in actual stock markets under certain restrictions such as trading schemes. In particular, the investment behavior of market participants who are ruled by greed and fear makes noise in the share price movements resulting in adding more complexity to the price. This fact implies that the market may be partially inefficient if the price does not reflect information immediately and appropriately. Elton et al. [1] also stated that arguing efficiency with a specific method is meaningless because the combinations of past stock prices can be infinite. In fact, market participants have long used a variety of technical analysis to understand investment performance [2].

In general, choosing the investment method based on technical analysis relies on various technical indicators. Because such technical indicators reflect basic information, they serve as the standard measurement tool. Here, information is based on price, trading volume, or another technical indicator. All technical indicators have unique characteristics and different information from one other. They can represent overbought, oversold, or even trend patterns [3-5].

The basic indicator in this regard is moving average (MA). MA helps identify the flow of stock prices according to the simple MA of the index [6]. Although this indicator varies in types, many technical indicators are based on it. These technical indicators simplify the creation of trading rules with particular values and are easy to automate [7,8].

This study focuses on the timing when the transaction is made, rather than on the technical indicators discussed above. Although it deals with technical indicators and has been optimized, it is often conducted in a certain unit of time (daily, hourly, half-hourly), depending on the sensitivity of these dif-

† This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (NRF-2014R1A2A1A11052670).
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ferent units. If a test is carried out at 30 minutes, the technical indicators are calculated every 30 minutes, too, to check the simulation of the transaction signals. The best time unit, however, can never be known. If the duration is too short, the signal will be generated too frequently, whereas if the duration is too long, it is difficult to make a transaction that reflects the right price at the right time. This study thus evaluates the possibility of formulating a trading strategy with the right sensitivity by applying multiple time units on the KOSPI200 futures index.

2. Literature Review

2.1 MACD oscillator

MACD (moving average convergence divergence) indicators, developed in the 1970s by Gerald Appel, are simple but highly reliable. They are known to be particularly effective in large markets with high price fluctuations. This indicator is called an oscillator because it moves up and down relative to zero. There are no upper and lower limits of amplitude. To obtain this indicator, short-term (12-day exponential MA, or slow MA) and long-term MA (26-day exponential MA, or fast MA) must be calculated first. MACD is then calculated by subtracting slow MA from fast MA. The signal line, namely the MA of MACD, usually uses a 9-day MA of the MACD indicator. The signal line moves more slowly and softly than the MA of the MACD indicators [9]. It is also used to make the MACD histogram and to determine the transaction time.

2.2 Bollinger band

The Bollinger band is a method of technical analysis first proposed by John Bollinger in the 1980s. Price changes are made to show a flexible band using volatility. Typically, the Bollinger band then adds or subtracts twice the standard deviation of a 20-day MA. The system does not have a limit; however, the top and bottom of the Bollinger band is more suitable for institutional markets with limits. The present study used a settlement strategy for the Bollinger band.

3. Proposed Model

3.1 Divergence as trading signal

To use divergence as a trading signal, C_Diff and M_Diff must be defined first. C_Diff is the difference between the close price at t-1 and that at t. Similarly, M_Diff is the difference between the MACD oscillator at t-1 and that at t.

$$\text{C\_Diff} = \text{Close Price}_t - \text{Close Price}_{t-1}$$
$$\text{M\_Diff} = \text{MACD Oscillator}_t - \text{MACD Oscillator}_{t-1}$$

Here, the divergence parameter N, which is the period, is used for comparison purposes. The buy signal by divergence is caused by the rule that C_Diff <0 and M_Diff >0 from t to t-N-1. If this rule is satisfied, the buy signal is used at t. Conversely, the sell signal is defined as C_Diff >0 and M_Diff <0 from t to t-N-1. If satisfied, this signal is used as the sell signal at t. If C_Diff $=0$ or M_Diff $=0$, neither rule is satisfied.

3.2 Trading strategy

The entry signal has two types; long and short positions. If the buy signal by divergence occurs, the long position is taken; otherwise, the short position is taken. When the entry signal takes one and more long/short positions, and if buy/sell occurs again, one more position is taken until it reaches the limit.

The long position can be settled in three ways: (i) when the sell signal by divergence occurs; (ii) when it touches the upper band of the Bollinger band; and (iii) when the price at t is more than the close price at t. In all cases, the settlement signal is used. On the contrary, when the buy signal by divergence occurs, when it touches the lower band of the Bollinger band, and when the price at t is less than the close price at t, the short position is settled.

3.3 Multiple timeframes

A trading strategy typically uses one type of timeframe (e.g., daily, hourly). If the strategy is based on 30 min data, the signal is checked and traded every 30 min. However, this paper uses multiple timeframes. When using too short a timeframe, the trading signal is too sensitive to trade. Here, the number of trades increases and transaction costs rise. By contrast, a long timeframe is too insensitive to follow a trend, which complicates capturing the timing of the buy or sell.

Therefore, 5 min, 10 min, and 30 min data are used concurrently. In other words, in every 30 min, three signals from 5 min, 10 min, and 30 min occur. In this case, the buy signal is regarded as $+1$, the sell signal as -1, and the hold as 0. The determined signal at t is the sum of the numbers from those signals. If the sum is more (less) than 0, it is treated as a buy (sell) signal.

4. Experimental Setup

The input data consisted of 3 min, 5 min, 10 min, 15 min, 20 min, 30 min, 40 min, 45 min, 60 min, 90 min, and 120 min data taken from the KOSPI200 futures index, from January 2, 2004 to December 31, 2014. Slippage was set as 1 tick, 0.05 pt. The parameters of the MACD oscillator were 12 for the short-term period, 26 for the long-term period, and 9 for the signal line. The divergence parameter N was set to 8. For the Bollinger band, the period was 20 and standard deviation was 2. In every trade by signal, one contract was traded and the maximum possible position that could be taken was 10. A stop-loss order that clarifies all positions was placed at a 2% loss.

Based on the 30 min data, we added one to the shorter and longer timeframe data. Hence, the dataset was composed of six sets. For all sets, the daily profits and Sharpe ratios are calculated (i.e., the value obtained by dividing the sum of the profits using the standard deviation).

Table 1. Trading result using multiple time frames from 2004 to 2014. Sharpe ratio is based on daily profit.

Time frame	Profit(pt)	Share ratio
30 min	73.54	13.93
20 min, 30 min, 40 min	500.42	42.85
15 min, 20 min, 30 min, 40 min, 45 min	645.61	44.87
10 min, 15 min, 20 min, 30 min, 40 min, 45 min, 60 min	816.51	51.16
5 min, 10 min, 15 min, 20 min, 30 min, 40 min, 45 min, 60 min, 90 min	847.54	44.78
3 min, 5 min, 10 min, 15 min, 20 min, 30 min, 40 min, 45 min, 60 min, 90 min, 120 min	−482.68	−32.66

5. Results

The experimental results for each dataset are summarized in Table 1. Figs. 1 to 6 illustrate the cumulative profit for each dataset graphically. The results for the 30 min data show a cumulative profit of 73.54 pt and a Sharpe ratio of 13.93. When we add the 20 min and 40 min data, profit rises to 500.42 pt and the Sharpe ratio to 42.85 (a threefold increase). As data are added, profit and the Sharpe ratio increase, but the rise declines in the last dataset. The profit of 5 min to 90 min shows

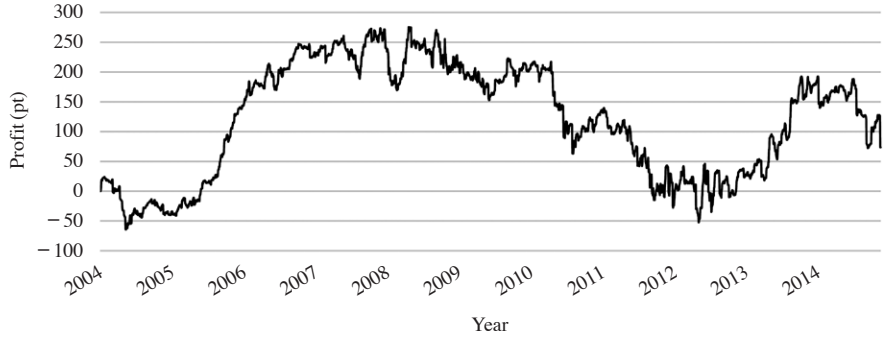

Fig. 1. The cumulative daily profit, 2004 to 2014 (only using 30 min).

Fig. 2. The cumulative daily profit, 2004 to 2014 (20 min, 30 min, 40 min).

Fig. 3. The cumulative daily profit, 2004 to 2014 (15 min, 20 min, 30 min, 40 min, 45 min).

Fig. 4. The cumulative daily profit, 2004 to 2014 (10 min, 15 min, 20 min, 30 min, 40 min, 45 min, 60 min).

Fig. 5. The cumulative daily profit, 2004 to 2014 (5 min, 10 min, 15 min, 20 min, 30 min, 40 min, 45 min, 60 min, 90 min).

Fig. 6. The cumulative daily profit, 2004 to 2014 (3 min, 5 min, 10 min, 15 min, 20 min, 30 min, 40 min, 45 min, 60 min, 90 min, 120 min).

the highest revenue. The Sharpe ratio is highest in 10 min to 60 min. In the case of the 3 min to 120 min data, profit and the Sharpe ratio are low.

6. Conclusion

This study proposed a method of configuring a trading strategy by using multiple units at the same time. The presented results show that the solution is not just to add datasets. Indeed, a number of optimal timeframes can be used. However, compared with the 30 min data, the remainder showed little decline from 2010 to 2013. This difference demonstrated the effect of the proposed model.

Too many timeframes were counterproductive, because of the sensitivity of the data, especially when the short datasets such as 3 min were used. High sensitivity increases the cost of generating the number of transactions, which may offset the benefits. However, additional experiments are needed to check the extent of the impact.

In this study, the parameters were determined empirically. However, future studies could improve these parameters, while another indicator or strategy could be selected to add variety. Using artificial intelligence and other optimization methods might also improve performance.

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