Student Name:

Course: MATH4900 Topics in Financial Mathematics

Lecturer: Prof. Ma Ka Chun, Alfred

The Profitability of Technical Trading Strategy — Trading Range Break

Abstract

This paper explores the effectiveness of the trading range break strategy, a widely used technical rule, in predicting future price changes. The study utilizes the Standard and Poor's 500 (S&P 500) index from January 10, 2009, to September 20, 2019, encompassing 2,510 daily data points over ten fiscal years. The research aims to evaluate the predictive power of the trading range break strategy by analyzing the returns during buy and sell periods. The paper includes previous research on technical trading rules and outlines the methodology employed, including the data source, the technical trading rule used, and the hypothesis testing tested. The results of the empirical tests are presented, followed by the limitations of the research.

Introduction

Technical analysis is a field of study that examines historical market data, such as price and volume, to gain insights into future market behavior. By integrating market psychology, behavioral economics, and quantitative analysis, technical analysts aim to predict future market movements based on past performance (Chen, 2023). However, the efficacy of technical analysis in predicting equity returns based on past returns remains a subject of debate.

This paper focuses on evaluating the trading range break strategy, which is one of the simplest and most widely used technical rules. This strategy generates signals when stock prices reach new highs (resistance levels) or lows (support levels). The effectiveness of this rule will be assessed in terms of its ability to forecast future price changes.

Findings from my study reveal that the trading range break strategy does not offer significant predictive power for stock price changes. The results indicate that returns during buy periods are smaller than returns during sell periods, suggesting an average loss.

The remainder of this paper is structured as follows: Section I describes the methodology employed, encompassing the data utilized and the technical trading rule. Section II presents the empirical results of the tests conducted. In Section III, observed differences compared to previous studies and limitations of the research are discussed. Finally, Section IV concludes and summarizes the findings regarding the trading range break strategy.

I. Methodology

a. Data

The data series used in this paper is the Standard and Poor's 500 (S&P 500) from 1/10/2009 to 20/09/2019. This period of analysis was selected as it falls after the Great Recession (2007-2009) and before the onset of the COVID-19 pandemic in 2019. The dataset consists of 2,510 daily data points, spanning ten fiscal years.

The S&P 500 is a widely recognized stock market index that tracks the performance of the largest 500 companies listed on stock exchanges in the United States. These companies represent a broad market breadth, primarily consisting of large-cap companies. In recent years, the nine largest companies in the index accounted for approximately 31 percent of the United States' total market capitalization. While the index has experienced minimal changes in its constituent stocks over time, the impact of these changes is negligible. Additionally, all the stocks in the index are actively traded, mitigating concerns related to non-synchronous trading issues that may arise in other datasets.

The closing prices of the S&P 500 stocks were utilized in this paper. The closing price is widely regarded as the most accurate valuation of a stock or security until trading resumes on the subsequent trading day (Hayes, 2021). It serves as a benchmark price for traders and investors, facilitating performance comparisons with historical prices. Analyzing closing prices provides insights into stock behavior, enabling well-informed decision-making.

b. Technical Trading Rule – Trading Range Break

When a stock surpasses or falls below its trading range, it often indicates the presence of momentum, either positive or negative. A breakout occurs when the price of security surpasses an established trading range, while a breakdown happens when the price falls below the range. Breakouts and breakdowns are typically considered more reliable when accompanied by significant trading volume, suggesting broad participation from traders and investors (Hayes, 2022).

Support level refers to a price level at which demand is believed to be strong enough to prevent further price declines. According to market logic, as the price approaches the support level and becomes more affordable, buyers become more inclined to purchase, while sellers become less inclined to sell. Resistance, on the other hand, represents a price level at which selling is believed to be strong enough to prevent further price increases. The underlying logic suggests that as the price approaches the resistance level, sellers become more inclined to sell, while buyers become less inclined to buy.

It is important to note that there are numerous variations of support and resistance levels that are not examined in this study. For instance, other variants of resistance levels incorporate pivot points, oscillators, volume, and volatility indicators. While a multitude of

trading range break rules can be devised, and undoubtedly some of them may prove effective, for the sake of simplicity, this study focuses on the simplest version, defining the resistance level as the global maximum and the support level as the global minimum.

To implement the trading range breakout strategy, global maximum (or global minimum) prices were determined based on the past 50, 150, and 200 days. Additionally, the rule was implemented with or without a one percent band, which reduced the number of buy (sell) signals by eliminating "whiplash" signals.

c. Specifications

In this study, the closing price (P_c) is used as the primary price indicator. The band (β) is set to be either 0 or 0.01. Also, different days for the number of preceding days (*d*) at day *t* are considered, specifically 50, 150, or 200.

Mathematically, the resistance level during the day *t* is defined as

$$L_r \stackrel{\text{def}}{=} \max_{c\in[t-d,t-1]} p_c \tag{A1}$$

On the other hand, the support level during day t is defined as

$$L_s \stackrel{\text{def}}{=} \min_{c\in[t-d,t-1]} p_c \tag{A2}$$

The signal generated at day *t* is as follows.

$$A(t) = \begin{cases} 1, & p_c > (1+\beta)L_r \\ -1, & p_c < (1-\beta)L_s \\ 0, & otherwise \end{cases} \tag{A3}$$

, where *A(t) = 1* is the buy signal, *A(t) = -1* is the sell signal.

For each buy signal purchase one dollar's worth of stock, hold it for *h* periods, then sell it to obtain the return

$$R_t^h = \log(p_{t+h}) - \log(p_t) = \log\left(\frac{p_{t+h}}{p_t}\right) \tag{A4}$$

Here, *h=10* and we calculate the cumulative returns using ln return for simplicity.

Let

$$\mu_b = \frac{1}{N_b}\sum_{t\in b} R_t^h \tag{A5}$$

be the mean *h*-day holding buy return, where *b* is the set of all buy signals, and N_b is the total number of elements in set *b*.

The h-day holding sell return and mean h-day holding sell return can be defined similarly.

In this paper, the sample data is divided into 251 non-overlapping 10-day periods and the unconditional mean and variance of 10-day returns are

$$\mu = \frac{1}{251}\left(\sum_{t=0}^{t=251} \ln(p_{t+10}) - \ln(p_t)\right) \quad \text{(A6)}$$

$$\sigma^2 = \frac{1}{251}\sum_{t=0}^{251}(\ln(p_{t+10}) - \ln(p_t) - \mu)^2 \quad \text{(A7)}$$

respectively.

d. Hypothesis Testing

To find out the possible impacts in using trading range break, three hypothesis testing using t-statistics approach are performed at 5% significance level.

1. $H_0 : \mu_b - \mu = 0$
   $H_1 : \mu_b - \mu \neq 0$
2. $H_0 : \mu_s - \mu = 0$
   $H_1 : \mu_s - \mu \neq 0$
3. $H_0 : \mu_b - \mu_s = 0$
   $H_1 : \mu_b - \mu_s \neq 0$

Where μ_b is the 10-day buy returns, μ is the unconditional 10-day mean return, and μ_s is the 10-day sell returns.

The t-statistics used in the above three hypothesis testing are t_1, t_2, t_3 respectively. They are calculated as follows.

$$t_1 = \frac{\mu_b - \mu}{\sqrt{\frac{\sigma^2}{N} + \frac{\sigma^2}{N_b}}}$$

$$t_2 = \frac{\mu_s - \mu^{10}}{\sqrt{\frac{\sigma^2}{N} + \frac{\sigma^2}{N_s}}}$$

$$t_3 = \frac{\mu_b - \mu_s}{\sqrt{\frac{\sigma^2}{N_b} + \frac{\sigma^2}{N_s}}}$$

Where σ^2 is the unconditional variance for the entire sample, N is the number of observations, N_b and N_s are the number of signals for the buy and sell respectively.

In this paper, if the absolute value of the t-statistics is larger than 1.96, then the null hypothesis is rejected at 5% significance level.

II. Empirical Results

a. Sample Statistics

Table I contains summary statistics for the entire series. For simplicity, returns are calculated as natural log differences of the Standard and Poor's 500 level. And 10-days returns are based non-overlapping 10-days periods.

The mean daily return is slightly higher than the 10-days returns by 0.0000003. Moreover, volatility is larger for the daily return.

Table 1
Summary Statistics for Daily and 10-Day Returns

Results are presented for the full sample. Returns are measured as natural log differences of the level of the S&P500 Index. 10-day returns are based on non-overlapping 10-day periods.

	Full Sample	
	Daily Returns	10-Day Returns
N	2510	251
Mean	0.0004251	0.0042
Std.	0.0094099	0.0262600

b. Trading Range Break

Results for the trading range break rule are presented in Table 2. With this rule, buy and sell signals are generated when the price level moves above or below gobal maximums and minimums. gobal maximums and minimums are computed over the preceding 50, 150, and 200 days. We also use a band technique where the price level must exceed the local maximum by one percent or fall below the minimum by one percent. For the trading range break rule, we compute 10-day non-overlapping holding period returns following buy and sell signals.

The average buy-sell return is -2.42 percent, suggesting the traders or investors suffer from a loss. Of the six tests, half reject the null hypothesis of the buy-sell difference being equal to zero.

The buy return, on average, shows a positive value of 0.053 percent across rules without the band. On the contrary, the buy return shows a negative value of -0.717 percent across rules with band 0.01. The overall buy return has an average of -0.33 percent, suggesting whenever there is buy signal, the return will be decreased by 0.33 percent. For all 6 rules, since the absolute value of t-statistics is less than 1.96, we cannot reject the null hypothesis that the buy returns equal to the unconditional 10-day return at 5 percent significance level.

The sell returns are positive across all the rules with an average of 2.09 percent. For 3 out of 6 rules, the sell returns are significantly different from the unconditional 10-day return at the 5 percent level.

From the table, 3 out of 6 tests have a fraction of buy returns greater than zero, providing evidence that the trading range break strategy has half the potential to generate profitable trading opportunities. Yet, of all in 6 tests have the fraction of sell returns greater than zero. Since the overall returns is the difference between buy and sell, a higher fraction of sell returns greater than zero suggesting that potential profitability maybe undermined.

Table 2

Standard Test Results for the Trading Range Break (TRB) Rules

Results for daily data from 2009 to 2019. Cumulative returns are reported for fixed 10-day after signals. Rules are identified as (short, long, band) where short and long are the short and long moving averages respectively, and band is the percentage difference that is needed to generate a signal. "N(Buy)" and "N(Sell)" are the number of buy and sell signals reported during the sample. Numbers in parentheses are standard t-ratios testing the difference of the mean 10-day buy return and mean 10-day sell return from the unconditional 10-day mean and buy-sell from zero. "Buy > 0" and "Sell > 0" are the fraction of buy and sell returns greater than zero. The last row reports averages across all 6 rules.

Test	*N*(Buy)	*N*(Sell)	Buy	Sell	Buy > 0	Sell > 0	Buy – Sell
(1,50,0)	94	26	0.0006	0.0168	0.6064	0.6154	-0.0161
			(-0.0161)	(2.4196)			(-2.7703)
(1,50,0.01)	13	20	-0.0053	0.0232	0.4615	0.6000	-0.0286
			(-1.3088)	(3.2228)			(-3.0524)
(1,150,0)	71	7	0.0005	0.0130	0.5915	0.5714	-0.0125
			(-1.1951)	(0.8820)			(-1.2057)
(1,150,0.01)	7	6	-0.0081	0.0168	0.4286	0.5000	-0.0248
			(-1.2386)	(1.1668)			(-1.6999)
(1,200,0)	71	6	0.0005	0.0195	0.5915	0.6667	-0.0190
			(-1.1951)	(1.4185)			(-1.7020)
(1,200,0.01)	7	5	-0.0081	0.0361	0.4286	0.8000	-0.0442
			(-1.2386)	(2.7124)			(-2.8743)
Average			-0.0033	0.0209			-0.0242