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The Performance of Trading Strategies based on the Ratio of Option and Stock Volume

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Abstract

Based on Johnson and So [11], we construct a portfolio based on the ratio of trading volume of the stock option to its underlying stock (O/S). We compare the profitability of the OS strategy with those of 52-week highs, trading volume, and price momentum strategies to examine whether OS investment returns are more profitable. We find that the longer holding period is associated with the better the OS strategy to earn returns. Thus, the OS strategy is more suitable for long-term investment. The return of the OS strategy is higher than that of the trading volume strategy. The longer the holding period, the greater the gap is. In long-term investment, return of OS strategy is higher than that of the 52-week high and price momentum strategy. Given the investment period is more than one year, we find that the OS strategy can indeed help investors make profits, and its return is higher than other strategies.

JEL classification numbers: G11, G12
Keywords: OS strategy, 52-week highs strategy, trading volume strategy, and price momentum strategy, option volume

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1. Introduction

Since the relationship between financial goods is getting closer and the gap between investment strategies is becoming shallower and lighter, the choice of investment strategies plays a very important role for investors. More types of investment strategies appear in the market, and different strategies can be combined to form a two-dimensional investment strategy. Based on the performance to select the best profitability strategies, we can help investors to have more diversified strategies to select.

Many investors predict price movements based on the past share price performance, and this type of investment model is the most widely used in the stock market. For example, the “price momentum strategies” proposed by Jegadeesh and Titman [10] distinguish the winners and losers by the past returns of individual stocks, and find that the stocks with holding periods from 3 to 12 months are profitable. In the medium and long term (from 12 months to 3 years), the stock price shows the phenomenon of “the stronger always the winner, the weaker always the loser”, and investors use the way of buying winners and selling losers to invest stocks. Nevertheless, DeBondt and Thaler [3] point out that the market is irrational, and investors can use the contrary investment strategy to get excess returns.

To understand the stage that the stocks stay, and to more clearly determine which stocks are overreacting or underreacting, Lee and Swaminathan [12] put trading volume into price momentum strategy and check whether the trading volume and the rate of return affect each other. That is, they propose the “momentum life cycle” theory, which is a two-dimensional strategy of adding stock volume into price momentum. Glaser and Weber [7] use the German stock market data to study momentum life cycle and conclude that the higher turnover rate, the higher return of individual stocks.

In addition to the trading strategies based on stock returns and volume, some studies also use the past highest price as a reference indicator for investment. The "52-week high strategy" proposed by George and Hwang [6] takes the highest price of the past 52 weeks as the indicator, and determines the investment direction based on the difference between the current price and highest price, and they conclude that the 52-week high strategy is easier to get the information of market. Chan and Wu [2] apply the 52-week high strategy to the Taiwan stock market and divide the stocks into individual stocks and industry categories to compare them. They find that the 52-week high strategy was more profitable than momentum strategy.

Due to the rapid development of derivative financial products and the increasing relevance of various commodities, the price discovery function of derivative commodity let investors organize the information and investment strategies into a tool to increase profit. The high leverage and high reward characteristics of derivative goods also cause investors to generate more information than the underlying assets themselves when trading this type of goods. Especially for some investors, the option only needs to pay a small amount of premium in advance, and will earn a large amount of money. Johnson and So [11] use the ratio of options to stock trading volume (O/S), and find that in the case of information asymmetry, the transaction cost and short sale constraint of the stock market will lead to a negative relationship between the trading volume of the option market and the future stock price of the company. Moreover, the return from the lowest group of O/S is higher than the highest one. Cao et al. [1] use the information of corporate acquisitions to examine the efficiency of price discovery in the option market and the stock market. They infer that some informed transactions are driven by illegal information, and the information of the option market is faster than the stock market. Roll et al. [13] find that O/S increases due to the firm size and the potential volatility of price and decreases by the impact of option spread and institutional holdings. Ge et al. [5] employ the market information of options prior to the bankruptcy filing to explore the existence of informed traders and internal information. Further, they exploit the bankruptcy incident to simulate the O/S forecasting ability of the bankrupt enterprise before bankruptcy. They find that the number of insiders and informed traders in the option market is much higher than that in stock market and the content of the information in the option market is affected by its liquidity.

Johnson and So [11] use the EOS model proposed by Easley et al. [4] for forward and reverse trading, and find that the option market is more attractive to investors with negative news. Hsu [8] applies O/S to the index forecasting method to extend the O/S forecasting ability to individual stocks. Based on the "O/S" concept of Johnson and So [11], we construct a portfolio of ratios between the option market and the stock market and explore the difference in investment performance between the O/S strategy and the 52-week high, Momentum Life Cycle, price momentum strategies. Moreover, we combine O/S strategy with other strategies to construct two-dimensional strategies and compare the investment performance with other two-dimensional strategies in the current market. After exploring whether this strategy can earn excess returns more effectively, we can provide investors with more strategic options.

The remainder of this paper is organized as follows. In Section 2, we develop our hypotheses. Section 3 presents the sample. In Section 4, we discuss the results. In Section 5, we do the robustness check. Section 6 provides the conclusion.

2. Hypothesis

According to Johnson and So [11], it is known that the option market is highly attractive to investors who hold significant news. Cao et al. [1] find that the business acquisition information is easier to expose in the option market. Ge et al. [5] use O/S to forecast the ability of corporate bankruptcy events. Thus, we infer that the option market is mainly influenced by informers and contains information on options and stocks. Using the conclusion that its information content is much higher than the stock market, it is concluded that the O/S strategy can help investors to make more profit. Moreover, we use the concept of momentum life cycle by Lee and Swaminathan [12] and the investment strategy method formed by individual stock trading volume [9] to form a trading volume momentum strategy. Based on this, the following hypotheses are proposed:

Hypothesis 1
The investment performance based on the ratio of option to stock trading volume (O/S) is better than that based on the 52-week high strategy.

Hypothesis 2
The investment performance based on the ratio of option to stock trading volume (O/S) is better than that based on the trading volume momentum strategy.

Hypothesis 3
The investment performance based on the ratio of option to stock trading volume (O/S) is better than that based on the price momentum strategy.

3. Data and methodology

3.1 Data

This study selects the composite stocks of NASDAQ 100 in 2015 as the sample. The Nasdaq Stock Exchange is a high-liquidity market and includes the industries of computer software, hardware and telecommunications and biotechnology. It is the largest electronic stock market in the United States. The volatility of stock price in electronic industry is greater than that in traditional industries, which means that the abnormal return is higher. It helps us to detect the informed transactions. We use the data of the OptionMetrics, CRSP, Compustat Industrial Quarterly and other databases to wxamine the relationship between investor behavior and strategic performance in the US stock and option markets. The database contains the final aggregated statistics of the listing options of all exchanges in the US stock market. To avoid the impact of financial crisis anomaly data, we select the period from January 2010 to December 2015 as the sample period. Based on Johnson and So [11], we require all data to meet the following screening conditions: First, listed company contains individual stock options. Second, the company's option and stock trading period covers 2010/01/01 to 2015/12/31. Third, if there is incomplete information during the sample period, the stock would not be included in the sample. Fourth, the stock price is higher than $1. Fifth, weekly Call and Put trading volume must be higher than 50.
According to the stock market value at the end of October each year, NASDAQ makes a regular adjustment every December. Therefore, some of the data cannot meet the screening conditions of this paper. For example, Facebook, Inc. and PayPal Holdings, Inc. and other six stocks were listed lately, and the data could not cover the sample period, and 10 stocks such as Fossil, Inc. have incomplete data. After screening, the original 100 samples are adjusted to 84.

3.2 Investment strategies and variable calculation

3.2.1 Forming and holding period

According to Jegadeesh and Titman [10], we format the forming period in 1, 3, and 6 months (J=1, 3, 6), and the holding period in 1, 3, 6, 12, and 24 months (K=1, 3, 6, 12, 24) to construct a portfolio. We use the following variables (O/S, 52-week high, trading volume momentum, and price momentum) to format the forming period, and then divide the sample into three groups. That is, there are three groups in our portfolio and we focus on the top 33% and the last 33%. The holding period is calculated by the method of buying and holding, and the product of the t-th period is calculated by the product method after being bought and held for K months:

$$\mathrm{KCR}_{i,t}^{J,K} = \prod_{j=t+1}^{t+K}(1 + R_{i,j}) - 1 \text{ ,} K = 1 \text{ , } 3 \text{ , } 6 \text{ , } 12 \text{ , } 24 \tag{1}$$

where K is the number of months held, $\mathrm{KCR}_{\mathrm{i,t}}^{\mathrm{J,K}}$ is the cumulative return of the stock i in the holding period of K month and the forming period of J month (J, K) in the period t, and $R_{i,j}$ is the monthly remuneration for the stock i in the period j.

In order to minimize the sample bias and enhance the power of interpretation, we use the overlapping period way to construct the portfolio, which only move one month and holding period. Figure 1 shows that the forming period and holding period are both 6 months, and the first group portfolio trading period is from January 2010 to January 2011. The second group of portfolio trading period is from February 2011 to February 2012, and so on:

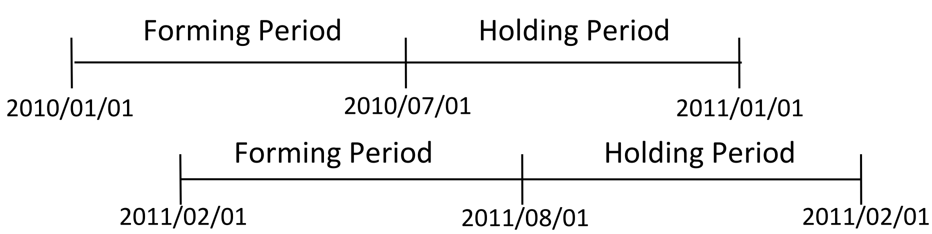

Figure 1: Architecture diagram during the overlap period

3.2.2 OS strategies

First, we calculate the ratio of the options and stock trading volume ($\mathrm{OS}_{i,t}$) of company i in month t. Based on Johnson and So [11], we know that the portfolio with stocks of the lowest O/S companies (OS_L) outperform that of the highest O/S companies (OS_H), implying that some informed traders with negative information prefer to trade in the option market. Therefore, this paper establishes a long position in the lowest 33% of O/S companies (OS_L) and a short positions in the highest 33%

of O/S companies to exploit the O/S strategy profitability. The option transaction includes the call and put. In order to know whether the transaction signal is from the purchase or sale volume, we divide the ratio of the option and the stock transaction volume ($\mathrm{OS}_{i,t}$) to the ratio of the call to the stock trade volume ($CS_{i,t}$); and the ratio of put to the stock trade volume ($PS_{i,t}$). Moreover, we also consider the change of option volume (Delta $\mathrm{OS}_{i,t}$). According to Johnson and So[15], we calculate the ratio of the choice of the enterprise i to the stock transaction volume in month t:

$$\mathrm{OS}_{i,t} = \frac{OPVOL_{i,t}}{STVOL_{i,t}} \tag{2}$$

where $OPVOL_{i,t}$ is the total transaction volume of all contracts in the option market of company i in month t, and $STVOL_{i,t}$ is the total trading volume of the stock for the company in month t.
We calculate Delta $\mathrm{OS}_{i,t}$ as follows:

$$\text{Delta } \mathrm{OS}_{i,t} = OS_{i,t} - \frac{1}{12}\left(OS_{i,t-1} + OS_{i,t-2} + \cdots + OS_{i,t-12}\right) \text{, } t > 12 \tag{3}$$

The ratio of call and trading volume (CS) and Delta CS of the company i in the t month are calculated as follows:

$$CS_{i,t} = \frac{CSVOL_{i,t}}{STVOL_{i,t}} \tag{4}$$

$$\text{Delta } \mathrm{CS}_{i,t} = CS_{i,t} - \frac{1}{12}\left(CS_{i,t-1} + CS_{i,t-2} + \cdots + CS_{i,t-12}\right) \text{, } t > 12 \tag{5}$$

We calculate the ratio of put and trading volume (PS) and Delta PS of the company i in the t month as follows.

$$PS_{i,t} = \frac{PSVOL_{i,t}}{STVOL_{i,t}} \tag{6}$$

$$\text{Delta } \mathrm{PS}_{i,t} = PS_{i,t} - \frac{1}{12}\left(PS_{i,t-1} + PS_{i,t-2} + \cdots + PS_{i,t-12}\right) \text{, } t > 12 \tag{7}$$

3.2.3 52-week high strategy

We measure the past returns and historical prices of individual stocks, and divide the stocks into three groups according to the closeness between the current price and past 52-week high. Top 33% of the stocks closest to the past highs (H_h) are established in long positions and 33% of the stocks that are farther away from the past highs (H_L) are established in short positions. Then, we examine the profitability of this strategy. Following George and Hwang[10], we arrange the stocks according to the ratio of closing price of individual stocks in period t-1 and the price highs of individual stocks in the past 52 weeks:

$$\frac{P_{i,t-1}}{high_{i,t-1}} \tag{8}$$

where $P_{i,t-1}$ is the closing price of stock i at period t-1, and $high_{i,t-1}$ is the highest price for stock i during past 52 weeks in period t-1.

3.2.4 Trading volume momentum strategy.

The stocks are divided into three groups according to the accumulated volume of individual stocks. Top 33% of the stocks and bottom 33% of the stocks are defined as high volume positions (S_h) and low volume positions (S_L). That is, we calculate the ratio of monthly volume of individual stocks to the total volume of the past year:

$$TOR_{i,t}^{stock} = \frac{V_{i,t}^{stock}}{O_{i,t}^{stock}} \tag{10}$$

where $V_{i,t}^{stock}$ is the volume of stock i in month t, $O_{i,t}^{stock}$ is the total volume of the past year, and $TOR_{i,t}^{stock}$ is the momentum for stock i in month t.

3.2.5 Price momentum strategy

According to Jegadeesh and Titman [10], the sample with the highest cumulative returns (the top 33% of the return) and that with the lowest cumulative return (the low 33% of the return) are constructed to form the winners and losers portfolios. The return is calculated as follows.

$$R_{i,t} = \ln\left(P_{i,t}/P_{i,t-1}\right) \tag{11}$$

where $P_{i,t}$ is the closing price of stock i in period t, $P_{i,t-1}$ is the closing price of the stock i in period t-1, and $R_{i,t}$ is the return for stock i at period t.

According to the cumulative return in the formation period, the stocks are divided into winner positions (R_w), intermediate positions (R_m), and loser positions (R_L). Price momentum strategy is to buy the winner (R_w) and sell the loser (R_L) and contrarian strategy is to buy the loser (R_L) and sell the winner positions (R_w).

3.3 Research procedures and testing methods

3.3.1 O/S strategy effect

According to O/S, the stocks are divided into 3 portfolios from low to high (OS_L, OS_M, OS_H), which OS_L is the lowest 33% O/S portfolio and OS_H is the highest 33% O/S portfolio. We buy low O/S and sell high O/S portfolios to form the strategy.

$\begin{cases} H_0: OS_L - OS_H \leq 0 \\ H_1: OS_L - OS_H > 0 \end{cases}$, If H_0 is rejected, there is an O/S effect.

3.3.2 52-week high strategy effect

The 52-week high strategy (H_h-H_L) is to buy 33% of stocks that are closer to the past 52-week highs and to sell 33% of stocks that are farther away from the past 52-week highs. Then, we calculate the return by holding K months. Conversely, to buy 33% of stocks that are farther away from the past 52-week highs and to sell 33% of stocks closer to the past 52-week highs is a reverse strategy (H_L-H_h).

$\begin{cases} H_0: H_h - H_L \leq 0 \\ H_1: H_h - H_L > 0 \end{cases}$, If H_0 is rejected, there is a 52-week high strategic effect.

3.3.3 Trading volume momentum strategy.

Individual stocks are sorted according to trading volume, and the top 33% of the stocks are formed as the high volume portfolio (S_h), and the last 33% of stocks are formed as the low volume portfolio (S_L). The trading volume momentum strategy is to buy the high volume portfolio and sell the low volume portfolio ($S_h - S_L$). Then, we hold K months.

$\begin{cases} H_0: S_h - S_L \leq 0 \\ H_1: S_h - S_L > 0 \end{cases}$, If H_0 is rejected, there is a trading volume momentum effect.

3.3.4 Price momentum strategy

First, the stock portfolio with top 33% of return are formed as winners (R_w) and the portfolio with bottom 33% of returns are formed as losers (R_L). Then, we buy the winner portfolio and sell the loser portfolio as a trading strategy ($\mathrm{R}_w - \mathrm{R}_L$). We calculate the return after K months of holding, and check whether the return is significantly greater than zero.

$\begin{matrix} H_0: R_w - R_L \leq 0 \\ H_1: R_w - R_L > 0 \end{matrix}$, If H_0 is rejected, there is a price momentum effect.

Based on Johnson and So [11], Hsu [8], George and Hwang [6], Lee and Swaminathan [12], and Jegadeesh and Titman [10], we infer the O/S strategy, 52-week high, trading volume momentum and price momentum strategy can help investors to make profits. Therefore, the above hypotheses zero should be rejected.

3.3.5 Comparison of performance between strategies

We compare the performance of O/S strategy with that of 52-week high, trading volume and price momentum strategy:

The comparison of performance between O/S and 52-week high strategies is as follow:

$$\begin{cases} H_0: (OS_L - OS_H) - (H_h - H_L) \leq 0 \\ H_1: (OS_L - OS_H) - (H_h - H_L) > 0 \end{cases}$$

If H_0 is rejected, it means that the performance of O/S strategy is better than that of 52-week high strategy.

The comparison of performance between O/S and trading volume strategies is as follow:

$$\begin{cases} H_0: (OS_L - OS_H) - (S_h - S_L) \leq 0 \\ H_1: (OS_L - OS_H) - (S_h - S_L) > 0 \end{cases}$$

If H_0 is rejected, it means that the performance of O/S strategy is better than that of trading volume strategy.

The comparison of performance between O/S Strategy and price momentum strategy is as follow:

$$\begin{cases} H_0: (OS_L - OS_H) - (R_w - R_L) \leq 0 \\ H_1: (OS_L - OS_H) - (R_w - R_L) > 0 \end{cases}$$

If H_0 is rejected, it means that the performance of O/S strategy is better than that of price momentum strategy.

According to Johnson and So [11] and Easley et al. [4], O/S has strong predictive power for future stock return. Johnson and So [11] use short selling cost to obtain when short-term sales cost increase or option leverage is low, the information content provided by O/S would increase significantly, and the OS would be the indicator of the bad future performance of stocks. Based on Ge et al. [5], we know that the information content of the option market is higher than that of the stock market. Cao et al. [1] indicate that it is easier to obtain the information of the company acquisition the option market than that in the stock market. Based on the above conclusions, we infer that the O/S strategy outperforms the 52-week high, trading volume and price momentum strategy.

Table 1 shows the descriptive statistics of the OS and trading volume. Panel A presents the descriptive statistics of OS in years (expressed as a percentage). The average value of OS in 2013 is higher than that in other years, which means that the trading volume of options has grown substantially during that year. Therefore, we infer that the informed trades and the magnitude of information asymmetry in 2013 is relatively high. Panel B uses the OS level to classify the OS into three groups. VOLC is the trading volume of the call, VOLP is the trading volume of the put, OPVOL is the total trading volume of the option, and EQVOL is the total trading volume of the stock (in 100 shares). We find that the trading volume of the put (VOLP) is less than the volume of trading of the call (VOLC). From the standpoint of investors, it means that the current market conditions are good, and investors have sufficient confidence about future company's prospect. Moreover, the extent of increasing in the volume of options (including calls and puts) is different. That is, the volume in the middle of OS are twice as that in the bottom OS and the volume in the top OS is 10 times than that in the middle 33% OS. The extent of increasing in the volume of stock is different from the option. Although the volume of stock in the top OS is still the highest, the volume of stock in the middle OS is the smallest.

4. Empirical results

In this section, we explore the performance of investment strategy for the NASDAQ100 constituent stocks. First, the investment portfolio is established by the ratio of option to stock trading volume (OS), and the effect of strategy is examined according to the performance. Second, based on the price of the past 52 weeks of individual stocks, we use the closeness of the stock price to the highest price in the past to establish the portfolio. Third, we form an investment strategy based on the size of individual stock trading to examine the effect of the strategy. Fourth, we use the monthly return of individual stocks to divide stocks into winners and losers to construct the portfolio. Finally, we compare the investment performance of strategies.

Table 1: Descriptive statistics of OS and trading volume

Panel A: Descriptive statistics of OS in years (expressed as a percentage)					
Year	Average	Q1	Q2	Q3	
2010	9.494	5.098	9.971	17.384	
2011	12.020	5.274	11.502	21.084	
2012	14.456	6.362	12.972	23.969	
2013	16.519	7.303	15.260	26.923	
2014	14.495	6.625	13.524	27.490	
2015	14.576	7.129	15.655	32.872	
Average	13.593	6.299	13.147	24.953	
Panel B: The stock trading volume by OS					
	O/S	VOLC	VOLP	OPVOL	EQVOL
Minimum 33%	6.289	38,483	17,215	55,698	100,405
Middle 33%	14.083	71,403	46,178	114,186	80,214
Max 33%	61.187	754,394	472,468	1,226,862	236,867
Max–Minimum	54.898	715,911	455,253	1,171,164	136,462

4.1 The investment performance of OS strategy

We calculate the ratio of options and stock trading volume (OS) for each company from 2010 to 2015, and constructs an investment strategy by buying the lowest OS portfolio and selling the highest OS portfolio. If the return of this strategy is significantly greater than zero, there is a profit-making effect on the OS strategy. Since the option is composed of the call and put, the strategy is also divided into the ratio of the call to stock (CS); and the ratio of put to stock (PS).

According to Table 2, the strategy effect in the longer holding period (K=12, K=24) is obviously better than that in the shorter holding period (K=1 and K=3). Moreover, the longer the formation period (J), the higher the significance of the effect. Table 4 shows when the formation period is 6 month (J=6) and the holding period is 12, 24 month (K=12, 24), the strategy effects are significantly positive, and are obviously better than those in the holding period is 1, 3 month (K=1, K=3). In the longest holding period (K=24) and the shortest holding period (K=1), we can get the highest profit (5.89%), and the average profit is 3.58%. Therefore, we can conclude that strategies based on OS are more suitable for longer formation period and longer holding period.

Johnson and So [11] indicate "informed traders frequently trade in the option market when they hold negative news." They infer that OS is a negative sign of future stock returns. We confirm their results and find that the profit of OS strategy will be gradually greater with the longer period of holding, which means that the OS strategy is more suitable for long-term investment in more than one year.

Table 2: Average monthly return with ratio of option to stock as a portfolio

	K=1	K=3	K=6	K=12	K=24
Panel A: OS					
J=1	-0.0209***	-0.0291***	-0.0292***	-0.0107	0.0255
	(0.0000)	(0.0000)	(0.0022)	(0.2421)	(0.1904)
J=3	-0.0162**	-0.0174**	-0.0074	0.0106	0.0388*
	(0.0030)	(0.0142)	(0.1866)	(0.2440)	(0.0729)
J=6	-0.0085	-0.0048	0.0034	0.0287**	0.0217*
	(0.1010)	(0.2799)	(0.3588)	(0.0119)	(0.0841)
Panel B: PS					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0130***	-0.0170***	-0.0093	0.0143	0.0361
	(0.0008)	(0.0087)	(0.1848)	(0.1944)	(0.1260)
J=3	-0.0089**	-0.0074	0.0089	0.0427***	0.0595**
	(0.0325)	(0.1484)	(0.1840)	(0.0054)	(0.0333)
J=6	-0.0059*	-0.0004	0.0228**	0.0463***	0.0397**
	(0.0686)	(0.4750)	(0.0165)	(0.0012)	(0.0814)
Panel C: CS					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0269***	-0.0386***	-0.0460***	-0.0396***	0.0046
	(0.0000)	(0.0000)	(0.0000)	(0.0052)	(0.4268)
J=3	-0.0177***	-0.0217***	-0.0223**	-0.0090	0.0555***
	(0.0005)	(0.0024)	(0.0118)	(0.2508)	(0.0046)
J=6	-0.0120**	-0.0147**	-0.0109	0.0217*	0.0710***
	(0.0276)	(0.0309)	(0.1303)	(0.0501)	(0.0012)

Note: μ is the average and p is p-value. ***, **, * denote significant at 1%, 5%, 10% level.

4.2 The investment performance of 52-week high strategy

George and Hwang [6] find that investors can get information from 52-week highs or lows stocks. In particular, companies whose prices are at a 52-week high or close to the highest price are the stocks that will have good news in the near future. In this section, we use the data of stock price during the past 52 weeks to check whether the investment portfolio formed by the closeness between the stock price and the past highest price has a profit effect, that is, the 52-week high strategy. We use the highest price in the past as a benchmark. This strategy is to buy the closest portfolio and to sell the farthest portfolio.

Table 3 presents that in the formation period is 1, 3 and 6 month (J=1, J=3, and J=6), all the strategies have significant profit-making effects. In the shorter holding period (K = 1, and 3), the effect is significantly higher than that in the longer period of holding (K = 12, and 24). Taking the formation period (J=1) as an example, the strategy can earn 6% of the return when the holding period is 1 and 3 months (K=1, and 3). Both effects are greater than zero at 1% significant level, and this effect is significantly greater than that in the 24-month holding period (K=24). Therefore, the 52-week high strategy can let investors earn excess returns.

Table 3: Average monthly return with 52-week high as a portfolio

	K=1	K=3	K=6	K=12	K=24
J=1	0.0626***	0.0609***	0.0433***	0.0095	-0.1329***
	(0.0000)	(0.0000)	(0.0001)	(0.2775)	(0.0005)
J=3	0.0125***	0.0098**	0.0113**	0.0188*	0.0151
	(0.0000)	(0.0233)	(0.0444)	(0.0630)	(0.2328)
J=6	0.0078***	0.0056*	0.0077*	0.0170**	0.0097
	(0.0004)	(0.0938)	(0.0846)	(0.0424)	(0.3180)
Note: μ is the average and p is p-value. ***, **, * denote significant at 1%, 5%, 10% level.					

4.3 The investment performance of trading volume strategy

Huang and Lin [9] test the raw material commodities in the form of forward and reverse strategies. When they use the trading volume to establish an investment strategy, they adopt a reverse strategy to obtain higher investment returns. Thus, it is recommended that the holding period should not be too long. Table 4 shows that regardless the formation period is one, three or six month (J=1, 3, or 6), the strategic effect is not good. When the formation period is one month (J=1) and the holding effect is one, or three month (K=1 or 3), the effect is about -1.3%, and both are less than zero at the 1% significant level. The effects in other situation are also significantly negative. According to our observations, the longer the holding period (K), the greater the negative effect. This result is consistent with Huang and Lin [9].

Table 4: Average monthly return with trading volume as a portfolio

	K=1	K=3	K=6	K=12	K=24
J=1	-0.0130***	-0.0142***	-0.0169**	-0.0224**	-0.0418*
	(0.0000)	(0.0022)	(0.0102)	(0.0207)	(0.0551)
J=3	-0.0116***	-0.0129**	-0.0196**	-0.0398***	-0.0510*
	(0.0074)	(0.0193)	(0.0140)	(0.0011)	(0.0812)
J=6	-0.0097**	-0.0104**	-0.0142**	-0.0255**	-0.0274
	(0.0176)	(0.0351)	(0.0441)	(0.0174)	(0.2186)
Note: μ is the average and p is p-value. ***, **, * denote significant at 1%, 5%, 10% level.					

4.4 Analysis of price momentum strategy investment performance

According to the monthly return of stocks, top 33% of the companies with the highest rate of return is formed as the winner portfolio and bottom 33% of the companies is formed as the loser portfolio. The investment strategy is established by buying a winner portfolio and selling a loser portfolio. If the return is positive and significant, the price momentum strategy has a profitable effect.

According to Table 5, regardless the formation period is 1, 3, or 6 month (J=1, 3, or 6), the strategy effect is generally positive and significant, and this effect is not affected by the length of the holding period. In particular, the average profit of the price momentum strategy is 16.4% when the formation period is one month (J=1), and is greater than zero at the 1% significant level. As the formation period is longer, the strategy effect has gradually declined. For example, the average payout in the 6-month formation period (J=6) is 5.8% lower than the 9.1% in the 3-month formation period (J=3). The profitability in the above two formation periods is less than that in the 1-month formation period (J=1).

Jegadeesh and Titman [10] find that the effect of price momentum strategy is profitable when the holding period is from three to twelve months. However, if the holding period is too long, the reaction will be insufficient. Thus, the price momentum strategy is suitable for medium-term investment. This result is similar to our empirical results.

Table 5: Average monthly return with price momentum as a portfolio

	K=1	K=3	K=6	K=12	K=24
J=1	0.1379***	0.1624***	0.1599***	0.1842***	0.1951***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
J=3	0.0910***	0.0948***	0.0854***	0.0962***	0.0491
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.1213)
J=6	0.0650***	0.0596***	0.0564***	0.0535***	0.0063
	(0.0000)	(0.0000)	(0.0001)	(0.0097)	(0.4464)
Note: μ is the average and p is p-value. ***, **, * denote significant at 1%, 5%, 10% level.					

4.5 Strategies performance comparison

In this section, we compare the effects of OS, PS, and CS strategies with those of 52-week highs, trading volume, and price momentum strategies. We examine whether the effect of OS strategy is better than other strategies.

Table 6 exhibits the OS strategy is less effective when the investment period is shorter. Nonetheless, the longer holding period is associated with the higher the return. Further, the performance of OS strategy is better than that of 52-week high strategy. Taking the 6-month formation period (J=6) in Panel A as an example, the OS strategy has lower return when the holding period is from 1 to 6 month (K=1 to 6), but the gap is gradually smaller.

In the 12-month holding period (K=12), the profit of OS strategy is significantly greater (1.7%) than that of 52-week high strategy at the 5% significant level, supporting hypothesis 1. In the 24-month holding period (K=24), the discrepancy increases to 2.3%. The OS strategy is more suitable for long-term investments, whereas the 52-week high strategy is more effective in the short-term.

Therefore, the OS strategy and the 52-week high strategy can be used in different periods and we can make up the shortcomings for their respective strategies.

Tables 7 presents that the effect of OS strategy is obviously better than that of trading volume strategy. The longer the holding period, the larger the gap. Taking the 3-month formation period (J=3) and 6-month holding period (K=6) in Panel B as an example, the performance of PS strategy is significantly higher (2.8%) than that of trading volume strategy at 1% level, supporting hypothesis 2. Specifically, the difference is 11% in 24-month holding period (K=24). In other periods, the effect of OS strategy is always better than the trading volume strategy. Therefore, OS strategy is better than the trading volume strategy.

Table 6: The comparison between option-based and 52-week high strategies

Panel A: OS&52-week high strategy comparison					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0835***	-0.0900***	-0.0725***	-0.0183	0.1146***
	(0.0000)	(0.0000)	(0.0000)	(0.1878)	(0.0041)
J=3	-0.0288***	-0.0282***	-0.0208	-0.0082	0.0244**
	(0.0001)	(0.0054)	(0.2366)	(0.3416)	(0.0679)
J=6	-0.0164	-0.0105	-0.0039	0.0173**	0.0234*
	(0.1584)	(0.1527)	(0.3796)	(0.0164)	(0.0998)
Panel B: PS&52-week high strategy comparison					
	Average return on holding period of K months (%)				
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0756***	-0.0779***	-0.0527***	0.0044	0.1222***
	(0.0000)	(0.0000)	(0.0015)	(0.4244)	(0.0040)
J=3	-0.0215***	-0.0173**	-0.0023	0.0240**	0.0444**
	(0.0006)	(0.0428)	(0.1292)	(0.0236)	(0.0182)
J=6	-0.0137***	-0.0060	0.0152	0.0293**	0.0301*
	(0.0046)	(0.2578)	(0.1217)	(0.0317)	(0.0530)
Panel C: CS&52-week high strategy comparison					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0895***	-0.0995***	-0.0894***	-0.0445**	0.0995***
	(0.0000)	(0.0000)	(0.0000)	(0.0127)	(0.0044)
J=3	-0.0302***	-0.0316***	-0.0336***	-0.0277**	0.0404*
	(0.0000)	(0.0009)	(0.0038)	(0.0614)	(0.0714)
J=6	-0.0198***	-0.0203**	-0.0186*	0.0047	0.0613**
	(0.0030)	(0.0187)	(0.0556)	(0.3841)	(0.0136)
Note: μ is the average and p is p-value. ***, **, * denote significant at 1%, 5%, 10% level.					

Table 7: The comparison between option-based and trading volume strategies

Panel A: OS & trading volume strategy comparison					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0079**	-0.0148**	-0.0123	0.0106	0.0487**
	(0.0158)	(0.0232)	(0.1375)	(0.2778)	(0.0330)
J=3	-0.0046	-0.0054	0.0100	0.0503***	0.0905**
	(0.1258)	(0.2266)	(0.1651)	(0.0008)	(0.0256)
J=6	0.0011	0.0054	0.0179**	0.0598***	0.0605
	(0.4020)	(0.2521)	(0.0599)	(0.0002)	(0.1216)
Panel B: PS & trading volume strategy comparison					
	K=1	K=3	K=6	K=12	K=24
J=1	0.0000	-0.0028	0.0076	0.0333**	0.0563**
	(0.4975)	(0.3538)	(0.2568)	(0.0315)	(0.0252)
J=3	0.0027	0.0055	0.0286***	0.0825***	0.1105**
	(0.2241)	(0.2108)	(0.0034)	(0.0000)	(0.0180)
J=6	0.0038	0.0100	0.0370***	0.0719***	0.0671*
	(0.1490)	(0.1092)	(0.0018)	(0.0000)	(0.0971)
Panel C: CS & trading volume strategy comparison					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0139***	-0.0244***	-0.0291***	-0.0156	0.0336**
	(0.0003)	(0.0007)	(0.0034)	(0.1907)	(0.0880)
J=3	-0.0060**	-0.0088	-0.0027	0.0308**	0.1065***
	(0.0598)	(0.1093)	(0.3954)	(0.0238)	(0.0063)
J=6	-0.0024	-0.0043	0.0033	0.0472***	0.0984**
	(0.2925)	(0.2824)	(0.3835)	(0.0003)	(0.0134)
Note: μ is the average and p is p-value. ***, **, * denote significant at 1%, 5%, 10% level.					

Tables 8 shows the comparison between OS and price momentum strategies. We find that the price momentum strategy is generally better than OS strategy, whereas OS strategy only performs better in 24-mont holding period (K=24). Taking Panel A as an example, in the 6-month formation period (J=6) and the 1-month holding period (K=1), the profit of OS strategy is significantly lower (7.3%) than that of the price momentum strategy at 1% level. Nevertheless, in the 24-month holding period (K=24), the performance of OS strategy is significantly higher (2.6%) than that of the price momentum strategy at 5% level, supporting hypothesis 3.

Table 8: The comparison between option-based and price momentum strategies

Panel A: OS & price momentum strategy comparison					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.1588***	-0.1915***	-0.1891***	-0.1770***	-0.1226***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0011)
J=3	-0.1072***	-0.1131***	-0.0949***	-0.0856***	-0.0096
	(0.0000)	(0.0000)	(0.0000)	(0.0034)	(0.4362)
J=6	-0.0736***	-0.0646***	-0.0527**	-0.0192	0.0268**
	(0.0000)	(0.0001)	(0.0124)	(0.1902)	(0.0260)
Panel B: PS & price momentum strategy comparison					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.1509***	-0.1795***	-0.1692***	-0.1542***	-0.1150***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0020)
J=3	-0.0999***	-0.1022***	-0.0764***	-0.0535**	0.0104**
	(0.0000)	(0.0000)	(0.0000)	(0.0455)	(0.0349)
J=6	-0.0736***	-0.0646***	-0.0527**	-0.0192	0.0268**
	(0.0000)	(0.0001)	(0.0124)	(0.1902)	(0.0260)
Panel C: CS & price momentum strategy comparison					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.1648***	-0.2011***	-0.2059***	-0.2032***	-0.1378***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0004)
J=3	-0.1086***	-0.1165***	-0.1077***	-0.1052***	0.0064
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.4534)
J=6	-0.0770***	-0.0743***	-0.0673***	-0.0318	0.0647
	(0.0000)	(0.0000)	(0.0019)	(0.1705)	(0.1436)
Note: μ is the average and p is p-value. ***, **, * denote significant at 1%, 5%, 10% level.					

5. Robustness Check

We use the amount of OS change (delta) to explore whether the results are robust. Table 9 presents that in the 6-month formation period (J=6) and 24-month holding period (K=24), the profit (4%) is significantly greater than zero at 10% level. Nevertheless, the effects are not good in other periods especially in 3-month formation period (J=3). Although there are profit-making effects in the strategies based on DeltaOS, DeltaPS, and DeltaCS, the effects are not as good as OS strategy. This result is not consistent with Hsu [8], which document that DeltaOS strategy is slightly better than OS strategy. Therefore, the strategy based on DeltaOS is not suitable for our sample.

Table 9: Average monthly return with delta variable as a portfolio

Panel A: DeltaOS					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0049*	-0.0040	-0.0044	-0.0171	-0.0463**
	(0.0975)	(0.2071)	(0.2694)	(0.1101)	(0.0479)
J=3	0.0016	0.0005	-0.0043	-0.0218*	-0.0359*
	(0.2478)	(0.4648)	(0.2893)	(0.0512)	(0.0923)
J=6	-0.0022	-0.0001	-0.0026	0.0046	0.0350**
	(0.2445)	(0.4920)	(0.3826)	(0.3620)	(0.0893)
Panel B: DeltaPS					
	K=1	K=3	K=6	K=12	K=24
J=1	0.0004	-0.0031	-0.0115	-0.0177	-0.0330*
	(0.4438)	(0.2922)	(0.0488)	(0.0344)	(0.0536)
J=3	-0.0066**	-0.0090*	-0.0078	-0.0293**	-0.0388*
	(0.0422)	(0.0722)	(0.1877)	(0.0322)	(0.0922)
J=6	0.0020	0.0061	0.0058	0.0189*	0.0405*
	(0.2803)	(0.1188)	(0.2016)	(0.0930)	(0.0551)
Panel C: DeltaCS					
	K=1	K=3	K=6	K=12	K=24
J=1	-0.0045*	-0.0022	-0.0053	-0.0193*	-0.0415*
	(0.0784)	(0.3216)	(0.2533)	(0.0822)	(0.0535)
J=3	-0.0012	0.0077	-0.0003	0.0053	0.0410
	(0.3357)	(0.0662)	(0.4842)	(0.3670)	(0.0526)
J=6	-0.0021	-0.0027	-0.0068	0.0011	0.0578**
	(0.2098)	(0.3110)	(0.1971)	(0.4680)	(0.0265)
Note: μ is the average and p is p-value. ***, **, * denote significant at 1%, 5%, 10% level.					

6. Conclusion

Based on the OS concept proposed by Johnson and So [11], we examine the performance of OS investment strategies in the US stock market and option market. Taking NASDAQ100 as the main research object, we compare the performance of OS strategy with 52-week high, trading volume and price momentum strategies. We find that the OS strategy with longer holding period is associated with better return, implying that the OS strategy is more suitable for medium and long-term investment over one year. The investment effect of OS strategy is better than that of the trading volume strategy, and the difference is larger as the holding period is longer. The OS strategy is less profitable than the 52-week high strategy and price momentum strategy in short-term holding periods. Nonetheless, it will gradually outperform the 52-week high strategy as the holding period becomes longer, suggesting that the 52-week high strategy is more concentrated in the short term. The OS strategy is more profitable than the price momentum strategy at K=24, which means that the OS strategy is more suitable for medium and long-term investment than other strategies. According to all the above test results, although the OS strategy is not effective in the short term. However, if the investment period is set more than one year, it can be found that the OS strategy can help investors to make profits.

Since we only use the single market data to detect the effectiveness of the strategy, future studies can examine the OS strategy through different types of investment markets or by extending the sample period. Future studies can divide the option into three parts (In the money, At the money, and Out the money) to understand whether trading performance is different under the options with different strike prices. In addition, we do not consider the transaction cost. Future research can include the transaction cost to examine whether the above results are still hold.

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