Cross-section Analysis of Options Returns and Volatility in Chinese Market

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Abstract: Through comparisons of implied volatility and historical volatility of 50ETF options in Chinese option market, we find some options were mispriced when applying Black Scholes model. Therefore, we construct an options trading strategy that longing options with positive RI (historical volatility – implied volatility) and shorting options with negative RI. The empirical results indicate the cumulative return of strategy during sample period is almost 400 times higher than that of 50ETF fund and is robust to subsample tests.

1. Introduction

1.1 Source of strategy profits: mispricing options

Options are used to hedge the risk of underlying assets such as stocks, interest rates and commodities. In Black Scholes model (1972), the value of the option contract is discounted by the risk-free rate from the expected terminal cash flows under the assumption of risk-neutral pricing and other strict limitations [1]. Then the expected rate of return is naturally the risk-free rate which is a constant despite of the price and the expected terminal cash flows. Therefore, once the price of option is underestimated, the expected return of option will be larger than r_f while it is less than r_f when options are overestimated. We assume the expected return of underestimated option is $r_f + a$ while the overestimated one is $r_f - b$. Then if we long the underestimated one and short the overestimated one, the expected return of the strategy will be $a + b$ theoretically. Therefore, profits can be gained from the mispricing of options, which gives us an inspiration to construct an option trading strategy.

Amit G and Alessio S (2009) successfully constructed an option trading strategy with data from US market [2]. Their findings supported the feasibility of option strategy with respect to the mispricing. Consequently, according to the theory and prior literature in option mispricing, we tempt to construct an option strategy by capturing option mispricing in Chinese market and test the profitability of our strategy. Supportively, general investors usually hold wrong expectations about the future market leading to mispricing of options indicates option strategy from mispricing of options is not a disposable strategy [2].

1.2 Source of mispricing options: estimations of volatility

One of determinants of value of the option contract in B-S model is the volatility of underlying assets. Standard deviation of returns of the underlying asset used to quantify the volatility is often called the historical volatility (HV). In contrast, implied volatility (IV) derived by inverting the current option price into B-S model represents the estimations of general investors toward the underlying asset.

Options are tools for hedging risk while volatility of the underlying assets represents the risk, indicating the price should be positive with the extent of potential risk in an intuitive and theoretical way. Therefore, if the estimations of volatility (IV) from general investors is either higher or lower than the historical volatility, there would be deviations from the true value of option contracts and the profits space of the option trading strategy linked with mispricing appears.

In fact, Granger and Poon (2003) [3] and Anderson, Bollerslev, Christoffersen, and Diebold

(2006) found that estimations of investors (IV) are mean-reverting [4]. IV converges to HV in the long term but varies around HV in the short term, which also supports the existence of mispricing at least for short terms. Consequently, IV can be used as a signal to indicate if the option is mispriced and RI (historical volatility – implied volatility) predicts the direction of mispricing as option price is positively correlated with volatility.

2. Data

2.1 Options

Raw data come from the database of Choice and Tushare which includes all options contract information traded in Shang Stock Exchange. However, only 50ETF option has a relatively long trading history while the available information about others are too limited to give a convincing result. Therefore, our target option product will only be 50ETF options from March 2015 to April 2020. We then remove the options whose term to maturity is less than one month from our sample, since IV of these options might be lightly different from HV where deviations from actual value might be small. Therefore, we seek options with potential large profit space.

2.2 Risk-free rate

We choose the historical yield of one-year treasury bonds in China as our risk-free rate. Since short-term bond is more liquid and the returns are more likely to be realized, the value of options will be more accurate correspond to the maturity.

2.3 RI (Historical Volatility-Implied Volatility)

The monthly HV will be calculated as the standard deviation of rate of returns in prior 12 months and the IV will be calculated by inverting the B-S model. RI is the difference between historical volatility and implied volatility. When RI is positive suggesting investors underestimate the potential or future volatility, the price will be underestimated. When RI is negative suggesting investors overestimate the potential or future volatility, the price will be overestimated. We could then build a long-short portfolio depending on RI and empirically test its profitability.

3. Methodology

3.1 Construction of strategy

We open our position in each month's last trade date via longing the options with positive RI and shorting the options with negative RI. We close our position at maturity date in the next month, delivering all contracts and fulfilling all obligations.

3.2 Empirical results

Figure 1 shows the result of returns of our option strategy compared to 50ETF index fund. Figure B shows Cumulative realized returns of option strategy during the sample period. If we hold this strategy until April 2020, we can achieve a rate of returns which is almost 400 times high than that of 50ETF fund which indicates that our strategy is profitable enough. We could also find from the graphs that option trading strategy is much more volatile comparing with fund investing.
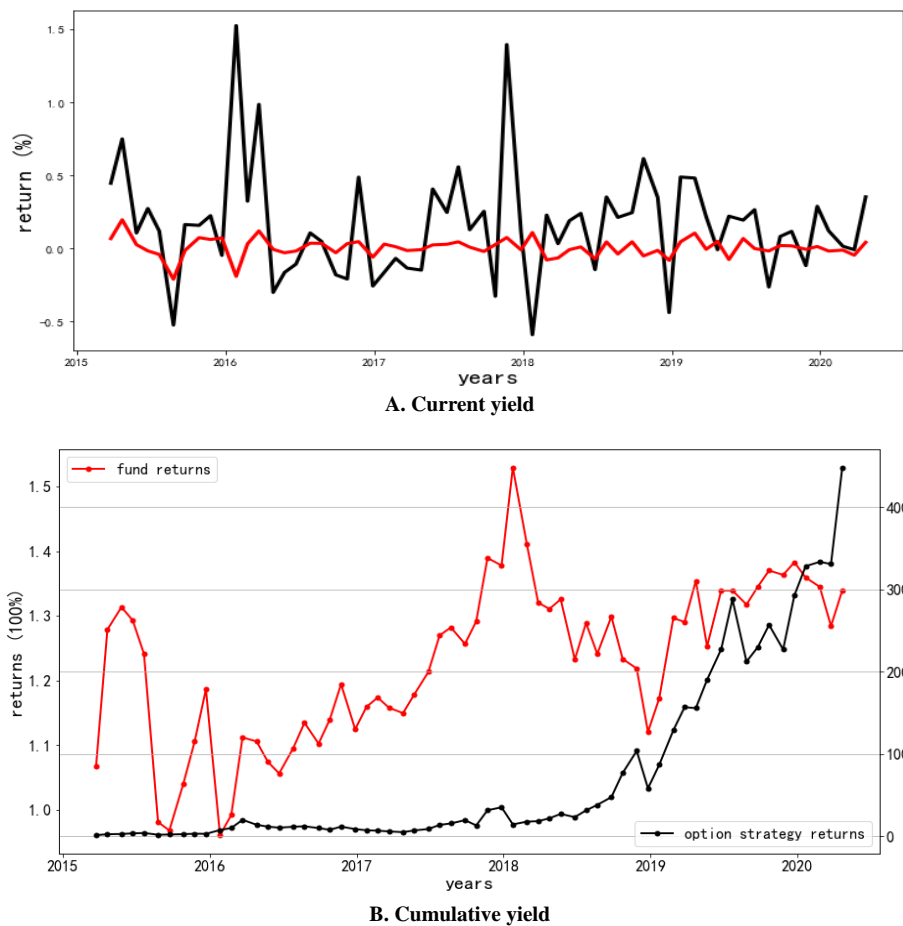
A. Current yield

B. Cumulative yield

Figure 1 Comparison of Returns between Strategy and Fund

Comparisons of rate of returns between fund and strategy established. In plot B, the right vertical axis measures the rate of returns of option strategy.

4   Robustness tests

4.1 Transaction cost

In B-S model, transaction cost does not exist. However, to better show the extent of profitability of our strategy and make the strategy more realistic, we assume a cost of 3 percent of price of options as the transaction cost. Firstly, we assume that the current price of options listed in Chinese market is the average of values of bid and ask. Then we assume the bid-ask spread to be 3% as the transaction cost. Finally, we conduct our strategy again to analyze if the returns are significantly decreasing on the condition of transaction cost.

As Figure 2 illustrates, under the assumption of a transaction cost of 3 percent of price of options, the profit earned by strategy decreases and becomes nearly half of profits without transaction cost. However, though it is reduced, nearly 175 times of initial cash input is still large enough. 3% bid-ask spread is unbearably high. The reason for this setting is to quantify other kinds of cost from imperfect markets like commissions of brokers as we try to make more 'trouble' for our strategy to test the its profitability. In fact, we conducted more transaction cost test with more reasonable spread from 0.5% to 2%. The results suggested, the transaction cost nearly had no influence on the final cumulative return of our strategy.
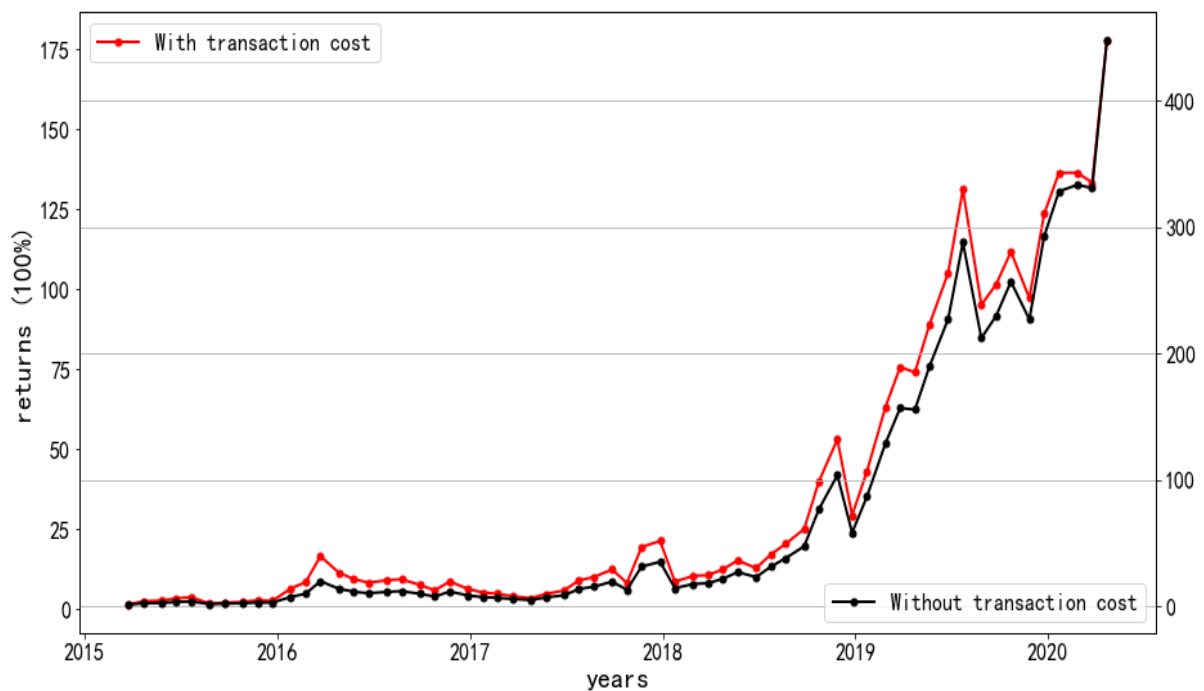
Figure 2 Tests for Transaction Cost

It shows the robustness test for strategy with transaction cost and comparison of rate of returns between strategy with and without transaction cost. The right vertical axis measures the rate of returns of strategy without transaction cost.

4.2 Subsample test

The results above indicate that investors will get a 400-time high of return of 50ETF fund if they hold this strategy for the sample periods. However, this assumption may be a little strict since many reasons such as urgent repayment of loan and liquidity preferences force investors not to hold this strategy for that long time. Therefore, we would like to test the profitability of the strategy if the holding periods are shorter or more subjective. We separate the whole period into 3 subparts and test the cumulative returns of each sub-period.

Figure 3 demonstrates the results from different periods. The cumulative returns are all reduced. Holding for period 1 of 12 months gives back a 10-time initial cash input of payoff which supports that our strategy is robust to the term of holding period. However, in the next 12 months of period 2, the cumulative return is nearly zero which seems to go against our strategy. In fact, when looking back to the period 2 we found that returns of 50ETF in this period kept stable, meaning RI would have comparatively small deviations from zero and profit space would be limited. However, though the return is slight, it is not negative. The only cost undertaken by the investors during this period might be risk-free rate as the opportunity cost and the cumulative return of bond is small. Therefore, period 2 illustrated that the profitability of our strategy depends on the significant variations of underlying asset. Period 3 consists of longer terms and our strategy performs well as presented above, obtaining a cumulative return of 70-time high of initial investment.

In conclusion, our strategy is robust to the term of holding since 50ETF fund in most time of our sample is quiet variable which provides enough profit space for our strategy.
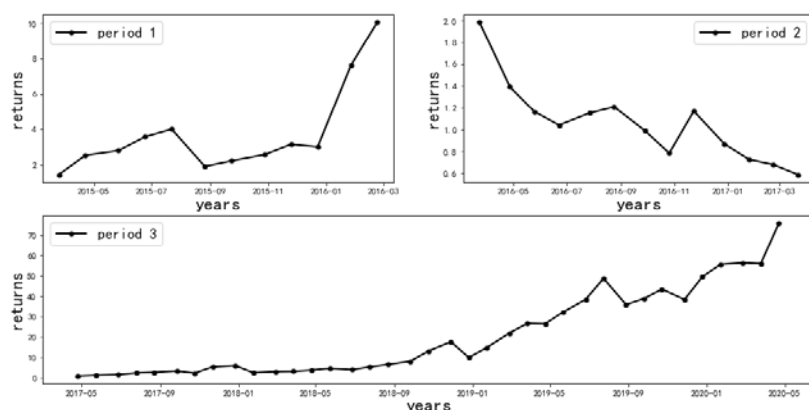
Figure 3 Subsample Tests for Strategy

5. Implications

The source of the profits from our strategy is the mispricing of options. Misestimation of volatilities of underlying stock in the future is the source of mispricing. According to Barberis and Huang model (2001), investors are loss averse while doing their mental accounting [5]. They assumed that investors' utilities are satisfied by the gain of wealth instead of the extent or magnitude of total wealth and investors are more focused on losses than gains. For example, the decrease of utility from the loss of a certain amount is more than the increase of utility from the gain of the same amount. They also assumed that the gain or loss are respective to each kind of individual assets which means 10-dollar loss from bonds and 20-dollar gains of stock will be calculated mentally separately. Therefore, the pattern of the BH model can explain the deviations of implied volatility from the historical volatility. When facing a bad performance of 50ETF index fund, investors got focused on the loss and such sensitivity will promote them to amplify the event and overestimate the risk (volatility) of 50ETF. In contrast, good performance of 50ETF indexed fund would not be 'attractive' enough to investors and they will remain positive towards the fund and underestimate the risk (volatility) of it. The whole series of reactions of investors facing different situations is summarized as overreaction of investors [2]. To test the overreaction theory, we use the proportion of number of long position options (RI > 0) over total options in each month as an indicator of emotion or expectation of investors. When this ratio is closer to 1, it means most of predictions are RI > 0 representing the positive emotions of investors. At the same time, we use the current yield of 50ETF as the performance of underlying stock.

We assume that positive current yield represents the good performance of 50ETF. Figure 4 shows that in most of time when performance of 50ETF is good (current yield is large than zero), the ratio of long position options is almost 1 which means the strategy are full of longing options with RI >0 representing investors underestimate the risk of 50ETF. In the contrast, when performance is bad, the number of long position options is 0 which means strategy are full of options with RI < 0 representing investors overestimate the risk of 50ETF. Overall, overreaction can be accused of the mispricing of options due to the combinations of evidence from prior literature and our test. In addition, there are some other findings that can support the overreaction theory. Stein (1989) shows investors usually ignore the fact that volatility of underlying asset follows the mean-reversion [6] while Poteshman (2001) states that investors tend to overreact in option markets [7].
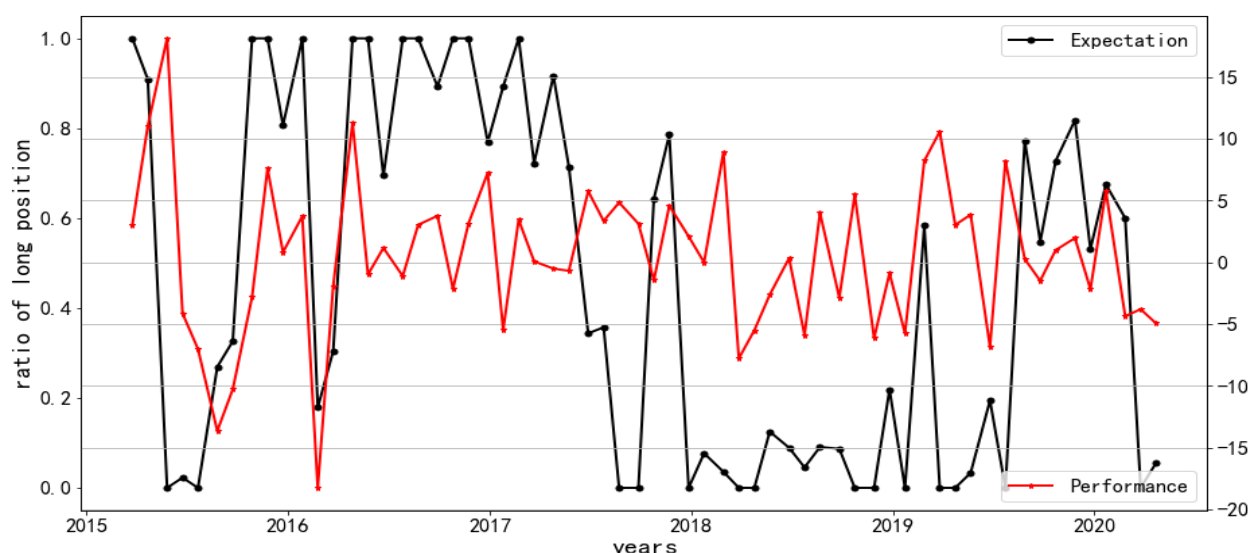
Figure 4 Test for Mental Accounting

Test if mental accounting phenomenon exists in Chinese investors of 50ETF option contracts. The right vertical axis shows the current rate of returns of underlying assets across the sample period.

6.　Conclusion

We get inspired from the logic behind Black and Scholes model (1973) that the price of options can be discounted by risk-free rate form the expected terminal cash flows [8]. We then argue that mispricing creates abnormal excess return and investors' misestimations of volatility leads to the usual existence of misprice of options. Meanwhile, Amit and Alessio's research on options in US market gives us an intuitive to conduct similar strategy in Chinese market.

We select 50ETF options as our data sample to construct an option trading strategy. The results of our strategy show a return of 400-time high of initial investment and the abnormal returns are robust to transaction cost and sub-sample tests.

Finally, the causes of misestimation are discussed. General investors' overreactions in option markets are accused of the profitability of our strategy, which corresponds to the conclusions of Barberis and Huang model (2001) [5].

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