Research on the Performance of Hedging Strategy of Stock Index Futures

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Abstract. For investors, what are the different effects of different hedging strategies on the final performance? How big is the impact? On the basis of summarizing relevant hedging theories, this study empirically studies three hedging strategies based on programmed trading platform.The measurement of risk change before and after hedging is measured by Ederington measurement method, and the measurement of utility change before and after hedging is measured by utility increment method, so as to provide reference for investors in hedging transactions. The results show that investors can choose the positive hedging strategy of futures, carry out hedging when the market trend is fluctuating or falling, and give up hedging when the market trend is obviously rising, which not only saves the capital cost needed for hedging, but also improves the profit and efficiency of hedging.

1. Introduction

With the acceleration of globalization and the development of financial markets, the financial markets of various countries have been developing steadily.However, due to the unpredictability of financial market and the great variation of stock price volatility, most investors are faced with certain risks, especially comprehensive systemic risks.So investors need to hedge their holdings against future volatility.

The so-called hedging means that investors use financial derivatives, such as stock index futures contracts, to establish a "profit and loss complementation" mechanism to offset the potential price risk caused by the holding of spot assets, and actually replace the original price risk of spot with the basis risk between futures and spot. Basis is a decisive factor affecting the hedging effect, and basis is also predictable, so basis risk management is particularly important. Investors need to actively choose favorable hedging opportunities according to the expected change of the basis, and determine the appropriate hedging proportion, so as to better avoid systemic risks.

The theoretical and empirical studies on hedging ratio have developed to a more comprehensive stage[1,2,3,4]. However, the hedging strategy is mainly concerned with theoretical research, and the empirical part is less empirical due to insufficient data samples and the lack of evaluation of strategy performance[5].

Therefore, under the guidance of relevant hedging theories, this paper intends to empirically study positive and negative hedging strategies on the platform of programmed trading, and evaluate the performance results under different strategies, so as to provide references for investors' actual operations.

2. Empirical Process

2.1. Data Collection and Analysis

This paper takes csi 300 stock index futures as an example to study hedging strategies.The data are 2,260 sets of daily closing prices of the csi 300 stock index (000300) and csi 300 stock index futures (IF00C1) [1]from April 16, 2010 to July 31, 2019.The data comes from wind database.

[1] Since the stock index futures contract will end in the month after the delivery date, IF00C1 is selected here to overcome the discontinuity of the futures price.

Table.1. Descriptive statistics and correlation test of 000300 and IF00C1

Type	Mean	Median	Std.dev	Min	Max	Pearson
000300	3106.99	3159.21	637.36	2086.97	5353.75	0.99***
IF00C1	3099.77	3139.30	632.87	2062.80	5361.60	

Note: * indicates significant at 10%, * * indicates significant at 5%, and * * indicates significant at 1%.

As can be seen from the standard deviation in table 1, the price changes of 000300 and IF00C1 are not completely synchronized, and there are basis risks between them. Therefore, investors should actively choose favorable hedging opportunities to manage basis risks.The correlation coefficient of 000300 and IF00C1 was 0.99 and significant at the 1% confidence level, so they were highly correlated.

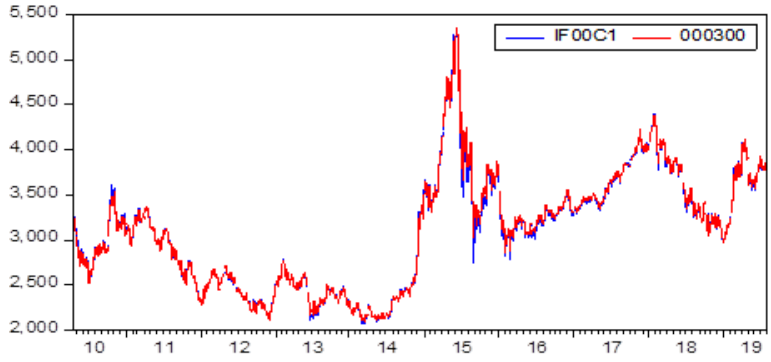

Figure 1. Daily closing price chart of 000300 and IF00C1

As can be seen from figure 1, the fluctuation and trend of 000300 and IF00C1 trend charts are almost the same, thus providing an ideal condition for hedging operation, which can be carried out.

2.2. Calculation of Hedging Ratio

Since csi 300 stock index futures and spot prices are highly correlated, the least square method (OLS) model will be used to construct the linear relationship between them to achieve the least square fitting.However, this method is based on the assumption that the error obeys the normal distribution of independent and homogeneous distribution and the time series is stable, and the price of futures and spot does not always change in the same direction and amplitude.When the stock market fluctuates violently, there may be a large deviation, and the time series of the two are not stable. Therefore, it is necessary to conduct first-order difference processing on the closing prices of spot and futures, and then convert them into relatively stable time series.In order to eliminate the possible heteroscedasticity, logarithmic rate of return is used to replace the first-order difference sequence in the formula, which can reduce the information loss caused by difference calculation.The regression equation is as follows:

$$\Delta \ln S_t = \alpha + \beta \Delta \ln F_t + \varepsilon_t \quad (1)$$

Where, $\Delta \ln S_t$ is the time series of spot yield taking logarithm at time t; $\Delta \ln F_t$ is the time series of logarithmic futures yield at time t; α is the intercept term of the regression equation;β is the slope, which is the optimal hedging ratio; ε_t is the random error.Next, STATA14.0 is used to calculate the optimal hedging ratio.

Table.2. The least square method (OLS) estimates the results

Variable	Coefficient	Std.dev	T-value	P-value
α	0.00	0.00	0.13	0.89
$\Delta \ln F_t$	0.83	0.01	112.16	0.00

The regression equation obtained by OLS is: $\Delta lnS_t = 0.83\, \Delta lnF_t + \varepsilon_t$, that is, the optimal hedging ratio of csi 300 stock index futures is 0.83, which means that the spot of csi 300 stock

index of 1 unit needs hedging of csi 300 stock index futures of 0.83 units to reach the optimal state.In the regression results, the T-value of regression coefficient of explanatory variable is 112.16 and P-value is 0.00, indicating that the coefficient is significantly not zero. Therefore, the optimal hedging ratio obtained by OLS model is effective.

2.3. Classification of Hedging Strategy

In the hedging strategy, the disadvantage of the full hedging strategy lies in the offset of all possible benefits. Therefore, in order to obtain higher returns while hedging, the optimal hedging ratio will be adopted to change the requirement of "equal amount" in the full hedging strategy, and the research focus will be placed on the comparison of strategies whether to carry out hedging at an appropriate time. In positive hedging strategy, the appropriate time is judged by the position of the moving average. Taking csi 300 stock index futures as an example, the hedging strategy can be divided into three strategies according to whether the futures and spot can be built or closed at an appropriate time, which are respectively:

1. Negative hedging strategy: hold stock index spot and stock index futures after construction;
2. Positive hedging strategy of futures: hold stock index spot after construction, and stock index futures choose to build or close positions at an appropriate time;
3. Positive hedging strategy of spot and futures: stock index spot and stock index futures all choose to build or close positions at an appropriate time.

2.4. Operation Result of Hedging Strategy

In order to facilitate analysis, the initial investment was set as RMB 100 million, the stock investment ratio was 80%, the futures margin ratio was 10%, the futures trading rate was 0.02%, and the stock trading rate was 0.05%. The average length of the short-term, medium-term and long-term averages were 5 days, 20 days and 60 days respectively.According to the formula of "optimal hedging ratio * (market value of spot asset/value of single futures contract)", the number of futures contracts required for hedging can be obtained.Next, three strategies are programmed on the TradeStation programmatic trading platform, mainly based on Xuebin Chen's programming language[6]. The strategy operation results are shown in table 3.

Table.3. Net asset value of the account under different strategies(million)

Type	Mean	Median	Std.dev	Min	Max
Strategy 1	98.85	98.91	2.16	94.91	107.89
Strategy 2	125.53	113.59	29.73	93.31	175.01
Strategy 3	123.99	111.57	27.15	91.91	174.44

As can be seen from table 3, under the strategy 1, the average asset value of the account is 98.85 million yuan, and part of the initial investment is lost, because of the initial transaction cost and the existence of the basis risk in the hedging transaction.Although hedging has maintained the basic stability of net asset value, it has lost part of initial investment without other investment gains. Strategy 2 and strategy 3 after the bull market at the end of 2014, the net asset value of the account increased significantly. In strategy 2, the futures selectively hedged the spot, but did not intervene in the spot. During the bull market in 2017, the profit from the spot was retained, so that the total net value of the account assets reached the highest value of 175.01 million yuan during this period, and the cumulative return rate of the account reached 75%.In strategy 3, investors all selectively hold spot and futures, which reached the highest value of 174.44 million yuan during the stock market crash in 2015. However, due to the lagging index, the account continued to trade, which greatly increased the cost brought by frequent trading, and the net value fluctuated greatly. The large standard deviation in strategy 2 and strategy 3 is caused by the absence of full hedging of spot, but it preserves the rising returns in the bull market period. So from the net asset value of the account, strategy 2 and strategy 3 performed better than strategy 1.

2.5. Performance Evaluation of Hedging Strategy

The performance measurement index of hedging strategy usually needs to consider the risk and utility and measure through quantitative analysis.Therefore, the performance of the three strategies will be measured from the perspective of risk and utility.

Ederington measurement method will be used to measure the risk change before and after hedging. The basic idea of ederington measurement method is to measure the reduction degree of yield variance after hedging compared with the unhedged yield variance, so as to measure the reduction degree of risk after hedging [7]. The yield variance of unhedged and after hedging can be expressed as:

$$Var(U_t) = Var(\Delta lnS_t) = Var(lnS_t - lnS_{t-1}) \tag{2}$$

$$Var(H_t) = Var(\Delta lnS_t) + h^2\, Var(\Delta lnF_t) - 2hCov\left(\Delta lnS_t,\ \Delta lnF_t\right) \tag{3}$$

Therefore, the hedging risk change measurement index is calculated as formula 4:

$$H_t = \frac{Var(U_t) - Var(H_t)}{Var(U_t)} \tag{4}$$

Where, $Var(U_t)$ is the unhedged yield variance,and $\mathrm{Var(H_t)}$ is the yield variance after hedging. Combined with the programmed trading procedure, the 60-day variance of net asset value is adopted to replace the yield variance to measure, and the measurement results are shown in table 4.

Table.4. Risk performance under different strategies

Type	Mean	Median	Std.dev	Min	Max
Strategy 1	0.66	0.75	0.23	0	0.86
Strategy 2	0.56	0.62	0.24	0	0.86
Strategy 3	-0.11	0.45	6.06	-247.9	0.83

As can be seen from table 4, the average value of risk indicators in strategy 1 is 0.66, indicating that the average risk reduction after hedging can reach 66% compared with the unhedged risk, which is better than 56% under strategy 2 and -11% under strategy 3.In strategy 3, the occurrence of negative value means that the risk after hedging is greater than that without hedging, and the risk is not written off, but magnified.This is because under strategy 3, stock index spot and stock index futures are held selectively, which is no longer a simple hedging strategy, but a hedging strategy combined with speculation, with great risks.At the same time, it can be seen from table 4 that the standard deviation of strategy 3 is much higher than that of strategy 1 and strategy 2,and the minimum value is also much lower than 0,which indicates that its volatility is very high. The reason is that strategy 3 relies on the correct judgment of indicators on the market trend, and the lag of indicators brings great risks to this strategy.Therefore, from the perspective of risk indicators, strategy 1 and strategy 2 are better than strategy 3.

Utility increment method will be used to measure the utility change before and after hedging.The basic idea of utility increment method is the utility increment gained by investors after hedging compared with the utility gained by investors without hedging[8].The measurement index of hedging utility change is calculated as formula 5:

$$UI = E(H_t) - E(U_t) \tag{5}$$

Where $\mathrm{E(H_t)}$ is the utility level obtained by the investor from the portfolio after hedging,and $\mathrm{E(U_t)}$ is the unhedged utility level obtained by the investor from the portfolio.Combined with the program trading program, the difference between portfolio net asset value and spot net asset value is used to measure the utility performance, and the measurement results are shown in table 5.

Table.5. Utility performance under different strategies(million)

Type	Mean	Median	Std.dev	Min	Max
Strategy 1	2.33	0	17.52	-58.58	30.97
Strategy 2	29.01	26.11	18.22	-2.06	64.81
Strategy 3	29.61	26.22	18.7	-2.01	62.38

As can be seen from table 5, the average value of utility increment under strategy 1 is 2.33 million yuan, indicating that compared with the utility without hedging, the average value of utility increment after hedging is only 2.33 million yuan, far lower than the value of 29.01 million yuan under strategy 2 and 29.61 million yuan under strategy 3.The conversion of bull and bear market in 2015 caused the standard deviation of three strategies to become larger, and the utility indexes of different strategies all fluctuated greatly.During this period, the utility value of strategy 2 and strategy 3 fell above and below the zero line and rebounded to a new high point, while the utility value of strategy 1 dropped to -58.58 million yuan, which was a big difference. During the bull market in the first half of 2015, spot gained a lot of returns, which were offset by losses of futures under strategy 1.However, with the continuous soaring of the index, the difference between the hedging and unhedged utility widened to -58.58 million yuan, reaching the historical low.In the second half of 2015, the stock market changed from a bull market to a bear market. Hedging played its role and avoided the sharp decline of spot market.Therefore, the utility values of the three strategies all rebounded substantially. Under strategy 1, the utility rebounded to near the zero line, while strategies 2 and 3 reached new highs, bringing greater returns to investors.Therefore, from the perspective of utility indicators, strategies 2 and 3 perform better than strategy 1.

The empirical results show that strategy 1 and strategy 2 are superior to strategy 3 from the risk perspective, and strategy 2 and strategy 3 are superior to strategy 1 from the utility perspective.

Therefore, combining the two perspectives, it can be found that strategy 2 performs better than the other two strategies.

3. Conclusion

Based on the empirical analysis of three hedging strategies on the platform of programmed trading, this paper finds that the performance of futures in selective hedging of spot is better than that of negative hedging and positive hedging strategy of spot and futures.The essence of futures selective hedging of spot is a phased strategy.When the stock trend has a relatively accurate judgment, selective hedging of spot will reduce the opportunity cost and greatly improve the performance of portfolio.Compared with the negative strategy, investors can choose the positive hedging strategy of futures.Hedging is carried out when the market trend is fluctuating or falling, and abandoned when the market trend is obviously rising.This not only saves the capital cost needed for hedging, but also improves the profit and efficiency of hedging.

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