6. Discretion of Dynamic Position Adjustment in Hedging Strategy

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Abstract

This paper investigates the trade-off between avoiding portfolio risk and increasing transaction costs in dynamic hedging strategy. In dynamic hedging strategy, although adjusting positions frequently can reduce the risk of portfolio, it inevitably leads to outrageous trading cost. Applying the economic value function, this paper quantifies the value of avoided risk and compares it with the corresponding transaction costs. In this way, decisions can be made at each point, that is, investors can determine whether to dynamically adjust their positions or maintain original positions, thus optimizing the hedging strategy. Furthermore, the empirical results confirm that the strategy modified by economic value is more effective than traditional hedging strategy. By analyzing hedging strategies of different position adjustment cycle, it is proved that the efficiency of dynamic hedging strategy can be improved through economic value modified.

Keywords: hedging, economic value, transaction cost

JEL Classification: G32, G11, G17

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I. Introduction

The risk of price fluctuation of the futures and spot portfolio can be reduced through adjusting positions dynamically. But when considering the transaction costs, whether the dynamic strategy is superior to the static policy remains controversial. Many

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scholars studied the dynamic hedging strategy performance through the improvement and innovation of various models and estimation methods, and then compare it with the static strategy, reaching the conclusion on the relative merits of static and dynamic strategy. However, it could be arbitrary to completely accept one strategy just according to the performance, and neglect the reduced risk of dynamic strategy or high transaction costs caused by some of the position adjustment strategies. Such problems come from the narrow focus on the evaluation of the overall performance while ignoring the performance evaluation on each point. In other words, investors should make investment decisions at each point of dynamic position adjustment, instead of at the beginning of the holding period like static policy. Comparing the performance of different hedging strategies during the holding period is simply to add up the performance of each point and get the average performance, then evaluate the decision of the entire holding period according to it. But such decisions are obviously not optimal. The positive average performance only shows that the positive performance of correct decisions is greater than the negative performance of wrong decisions on the average, which is not efficient. Therefore, this article solves the game problem of dynamic portfolio reallocation at each point by applying economic value to the field of hedging, thus fixing the dynamic hedging strategy.

II. Literature Review

Ederington (1979) applied the hedging method proposed by Johnson (1960) to the financial futures market, using the OLS model to estimate the minimum variance hedging ratio. He also gave the index which measures the effective degree of the hedging measures in futures market, namely the variance reduction of hedged portfolio relative to unhedged portfolio. This is the earliest study on static hedging strategy in futures market. With the development of econometrics theory, the research based on static hedging strategy is unceasingly thorough. For instant, Asim Ghosh (1993) studied the hedging ratio in stock index futures market by error correction model (ECM), and achieved better hedging effect compared to OLS model.

Either the OLS or the ECM model can only estimates the average hedging ratio for a period of time, namely the static hedging strategy. However, the market is changing all the time, so is the relationship between futures and spot price. Therefore, fixed hedging ratio cannot effectively avoid the risk of price fluctuations, and researchers tried to use dynamic hedging strategies to better avoid the risk of asset price fluctuations.

The autoregressive conditional heteroscedasticity model (ARCH) model proposed by Engle (1982) made it possible to calculate conditional variances of time series at each point, which provides the theoretical basis for dynamic hedging strategy. Dynamic hedging ratio can be computed based on the dynamic volatility, so as to achieve dynamic allocation and time-varying risk control. Wilson H.S. Tong (1996) estimated the covariance matrix of spot and futures price series by VAR-GARCH model, and then calculated the dynamic hedging ratio, finding out that dynamic strategy is better than static strategy through the comparison of hedging performance. Kroner and Sultan (1993) also reached the same conclusion by combining the ECM model and GARCH model, giving consideration to cointegration relationship and conditional heteroscedasticity. In the subsequent studies, Tse and Tsui (2002) put forward the

DCC-GARCH model. This model estimated the dynamic hedging ratio, taking into account the dynamic correlation coefficient between the spot price and futures price, which also achieved good hedging performance.

Thereafter, more and more scholars put forward improvements for hedging strategy model. For example, Lee and Yoder (2007a, 2007b) combined MRS model with TVC-GARCH model, BEKK-GARCH model, respectively.

In terms of academic research, the calculation of dynamic hedging ratio are mainly concentrated in correction and improvement of the model itself, but this article aims to analyze the effectiveness during the hedging process.

The proponents of dynamic hedging strategy believe that the hedging ratio changes over time in the dynamic hedging strategy, thus it fits asset price volatility more accurately than the static strategy. As a result, dynamic hedging strategy performs better than the static hedging strategy under the criteria of minimum variance or minimum risk. Regardless of the transaction costs, the preceding conclusions are correct. However, the transaction cost is an important factor which has to be considered in the actual hedging operations. From this point of view, time-varying portfolio adjustment may be advantageous to control daily risk in dynamic hedging strategy, but the corresponding transaction costs can be avoided in the static strategy. The transaction costs of one single adjustment may not be high, but the entire transaction costs of dynamically adjusting portfolio every day during the holding period could be very large. So the tradeoff between the advantages of lower risk and the disadvantages of higher transaction costs is the key in the debate on the applicability of dynamic hedging strategy.

Thus, many scholars turn their attention to the hedging strategy which considers the transaction cost. Besides the minimum variance method, they also applied the utility function and the VAR model as the evaluation criteria to analyze whether the performance of the dynamic strategy is better than that of the static strategy. Nathan Liu,Yu-Sheng Lai (2012) applied the concept of economic value, proposed by Lence (1995) and Fleming *et al*. (2001), to the field of hedging to compare the dynamic and static hedging strategy. When economic value is greater than the transaction costs, dynamic hedging strategy is superior to static one; otherwise, the static hedging strategy is better. There are many other similar studies, but all of which compare the dynamic and static hedging strategy under the unreasonable assumption that hedgers have to balance the portfolio risk and trading costs during the entire holding period, standing in the beginning of the holding period. In fact, these methods are meaningless for hedgers, for they don’t recognize the real choice hedgers face and will generate a strange phenomenon: if the hedgers choose the dynamic hedging strategy according to the comparison of utility or economic value in the beginning of the period, they will dynamically adjust positions in each moment, even when the positive utility brought by the risk reduction cannot make up for the negative utility of higher transaction costs, which is clearly irrational. This is due to the fact that the traditional hedging research only analyzes the performance of the two hedging strategies according to the average profit and loss, neglecting the profit and loss of every single adjustable allocation.

Therefore, the real trade-off faced by hedgers is to dynamically adjust positions to avoid extra risk or maintain the same positions to avoid unnecessary transaction costs at every point required by the dynamic hedging ratio. Furthermore, what we have to quantitatively compare is the advantage of the reduced risks and disadvantage of higher transaction costs caused by dynamical adjustment at every time point. In this article, we also use the economic value. Moreover, we calculate it and compare it with the transaction costs at every moment, thus solve the trade-off faced by hedgers.

At present, domestic studies on hedging which consider transaction costs are not much and nearly no study focuses on the comparison of every phase in dynamic hedging strategy. Thus, the innovation of this article is the optimal dynamic hedging strategy based on economic value.

The third part of the article introduces the theoretical model, the fourth part shows the empirical results, and the fifth part is the conclusion.

III. Theoretical Model

The problem we need to solve in the formulation of hedging strategy is to compare the profits of reduced risk with the loss of higher transaction costs at each moment, which need to be quantified for comparison. The loss of higher transaction costs can be measured by transaction fees, thus the main difficulty is how to quantify the profits of reduced portfolio risk. The MV method measures the benefits of risk reduction by calculating the reduction of portfolio variance, which cannot be compared with transaction costs directly. Therefore we need to find another quantitative method.

The method that quantifying the profits of reduced portfolio risk through economic value proposed by Fleming *et al*. (2001) is used in this article. Furthermore, we improve it by calculating the opportunity cost of position adjustment at each point, namely, the economic value. And then compare it with the transaction cost, so as to decide whether to adjust positions or not at each point when the dynamic hedging ratio changes.

The concept of economic value proposed by Fleming *et al*. (2001) is used to compare dynamic and static portfolio at first. Different portfolios are evaluated through the comparison of their economic value.

Fleming assumes that investors' preference follows the quadratic utility function, namely, investors' utility function at time t+1 is

$$U\left(W_{t+1}\right)=W_t R_{p,t+1}-\frac{\alpha W_t^2}{2}R_{p,t+1}^2, \qquad (1)$$

where: W_{t+1} is investors' wealth at time t + 1, and α is the absolute risk aversion coefficient,

$$R_{p,t+1}=R_f+\omega_t' r_{t+1} \qquad (2)$$

is investors' portfolio return at time t+1, where R_f is the return rate of risk-free assets, r_{t+1} is the return rate of risk assets, and ω_t' is the weight of the investment in risk assets. Meanwhile, the degree of relative risk aversion of investors is assumed to be constant, namely,

$$\gamma_t = \frac{\alpha W_t}{1-\alpha W_t} \tag{3}$$

is constant, which is denoted as γ.

As the relative risk aversion coefficient is constant, the average utility can be calculated under a given initial wealth:

$$\bar{U}(\cdot) = W_0 \sum_{t=0}^{T-1} \left(R_{p,t+1} - \frac{\gamma}{2(1+\gamma)} R_{p,t+1}^2 \right), \tag{4}$$

where: W_0 is the initial wealth.

Therefore, different investment strategies can be compared through $\bar{U}(\cdot)$, but the comparison with the static policy is inappropriate simply by using utility value since dynamic investment strategy will induce extra transaction costs. Consequently, Fleming introduces the economic value, which is denoted by Δ, representing the highest cost investors are willing to pay from an strategy to another. It can be obtained by solving the equation below:

$$\begin{aligned} &\sum_{t=0}^{T-1} \left[\left(R_{d,t+1} - \Delta\right) - \frac{\gamma}{2(1+\gamma)} \left(R_{d,t+1} - \Delta\right)^2 \right], \\ &= \sum_{t=0}^{T-1} \left[R_{s,t+1} - \frac{\gamma}{2(1+\gamma)} R_{s,t+1}{}^2 \right] \end{aligned} \tag{5}$$

where: $R_{d,t+1}$ is the return rate of dynamic investment strategy at time t + 1, $R_{s,t+1}$ is the return rate of static investment strategy at time t + 1, and Δ is the economic value.

Besides, $\Delta > 0$ means investors are willing to pay positive costs for the conversion from static strategy to dynamic strategy, whereas investors are willing to pay negative costs for the same conversion, namely, requiring positive earnings. Then, the comparison of different portfolios is switched from the comparison of utility to that of economic value, and measuring unit is also switched from utility value to yield. Therefore, it is possible to compare the economic value with transaction costs of dynamic investment. When the economic value is greater than the transaction costs, the dynamic investment strategy is better than the static one; otherwise, the static strategy is better.

In this article, the economic value is introduced into the field of hedging, rather than comparing the performance of dynamic hedging strategy and static one, we focus on the economic value of each point, and compare it with transaction costs to determine whether to dynamically adjust positions or not, so as to solve the trade-off between risk reduction and transaction costs increase hedgers face.

Different from the comparison of average utility from time 0 to time T-1 proposed by Fleming, we only consider hedgers' behavior in the two phases of time t-1 and time t. The hedging strategy of these two phases is considered independently. What we have to do is to choose between dynamic strategy and static strategy. To be specific, the hedging ratio of time t-1 has been determined for the hedgers at time t, namely β_{t-1}, while the hedging ratio of time t needs to be decided at time t. If the positions are not adjusted, i.e., $\beta_t = \beta_{t-1}$, then the static strategy is performed, which is called relatively static strategy. If positions are adjusted, that is, using the estimated hedging ratio at time t from dynamic hedging model, then the dynamic strategy is performed during the two periods. Therefore, we can calculate the economic value of every point, and make a choice between the dynamic strategy and relative static strategy by comparing the economic value and the corresponding transaction costs so as to decide whether to adjust positions at each moment or not.

First, we still assume investors' utility function as below:

$$U\left(W_t\right) = W_{t-1} R_{p,t} - \frac{\alpha W_{t-1}^2}{2} R_{p,t}^2 . \tag{6}$$

Here, $R_{p,t}$ is defined as

$$R_{p,t} = R_{c,t} - \beta_t R_{f,t} , \tag{7}$$

where: $R_{c,t}$ is spot return at time t, $R_{f,t}$ is futures return at time t, and β_t is the estimated hedging ratio at time t from dynamic hedging model.

Then, the average utility function is transformed into the form with two phases:

$$\bar{U}\left(\cdot\right) = W_0 \sum_{k=t-1}^{t} \left(R_{p,k} - \frac{\gamma}{2\left(1+\gamma\right)} R_{p,k}^2 \right). \tag{8}$$

The equation of calculating the economic value at time t is

$$\begin{aligned} &\sum_{k=t-1}^{t} \left[\left(R_{d,k} - \Delta_t\right) - \frac{\gamma}{2\left(1+\gamma\right)} \left(R_{d,k} - \Delta_t\right)^2 \right] \\ &= \sum_{k=t-1}^{t} \left[R_{s,k} - \frac{\gamma}{2\left(1+\gamma\right)} R_{s,k}{}^2 \right] \end{aligned}, \tag{9}$$

where: $R_{d,k}$ is the return rate of the portfolio with dynamic position adjustment at time k, $R_{s,k}$ is the return rate of the portfolio without dynamic position adjustment at time k, and Δ_t is the economic value of the dynamic strategy relative to the static strategy at time t.

Thus, we get the economic value at each time point from time 1 to time T. Then, we can determine whether to hedge or not at time t by comparing the economic value with the cost of position adjustment at each time point. The cost of position adjustment is defined as below:

$$C_t = \left|\beta_t - \beta_{t-1}\right| * C . \tag{10}$$

If $\Delta_t > C_t$, it means for hedgers the cost of transforming the static hedging into the dynamic hedging is greater than the corresponding increased transaction fees at time t, thus the hedgers will choose to adjust positions.

On the contrary, if $\Delta_t < C_t$, it means for hedgers the cost of transforming the static hedging into the dynamic hedging is smaller than the corresponding increased transaction fees at time t, thus the hedgers will not choose to adjust positions.

We have established a model that weighs the pros and cons of dynamic hedging strategy at every moment, but in order to construct the dynamic hedging portfolio, we need to calculate the dynamic hedging ratio. As the aim of this article is to test and improve the effectiveness of the dynamic hedging strategy, the hedging strategy itself has no effect on the results of this article. Therefore, we only need one dynamic hedging model to estimate the dynamic hedging ratio, DCC-GARCH model is used in this article.

DCC-GARCH model is improved by Tse and Tsui (2002) on the basis of CCC-GARCH model proposed by Bollerslev (1990) and then they apply it to the hedging ratio estimation through the variance of spot and futures portfolio at each moment fitted by GARCH model.

$R_{s,t}$ and $R_{f,t}$ represent the spot and futures return, respectively.

$$R_{s,t} = \mu_s + e_{s,t}, \tag{11}$$

$$R_{f,t} = \mu_f + e_{f,t}, \tag{12}$$

$$e_t \left| \psi_{t-1} = \begin{bmatrix} e_{s,t} \\ e_{f,t} \end{bmatrix} \right| \psi_{t-1} \sim BN(0, H_t)$$

where: μ_s and μ_f are the average return rate of spot and futures, respectively, $e_{s,t}$ and $e_{f,t}$ are residuals. ψ_{t-1} is the information set at t-1.

BN follows the bivariate normal distribution and H_t is a 2×2 positive definite time-varying conditional covariance matrix.

$$\begin{aligned} H_t &= \begin{bmatrix} h_{s,t}^2 & h_{sf,t} \\ h_{sf,t} & h_{f,t}^2 \end{bmatrix} \\ &= \begin{bmatrix} h_{s,t} & 0 \\ 0 & h_{f,t} \end{bmatrix} \begin{bmatrix} 1 & \rho_t \\ \rho_t & 1 \end{bmatrix} \begin{bmatrix} h_{s,t} & 0 \\ 0 & h_{f,t} \end{bmatrix} \end{aligned} \tag{13}$$

where: $h_{sf,t}$ is the covariance of the spot and futures return. $h_{s,t}^2$ and $h_{f,t}^2$ are the variance of the spot and futures return, respectively.

ρ_t is the time-varying conditional correlation coefficient of range yields of spot and futures, which obeys the ARMA process:

$$\rho_t = (1-\theta_1-\theta_2)\rho + \theta_1\rho_{t-1} + \theta_2\phi_{t-1}. \tag{14}$$

where: θ_1 and θ_2 are both nonnegative and $\theta_1+\theta_2 \le 1$.

$$\phi_{t-1} = \frac{\sum_{j=1}^{2}\varepsilon_{s,t-j}\varepsilon_{f,t-j}}{\sqrt{(\sum_{j=1}^{2}\varepsilon_{s,t-j}^2)(\sum_{j=1}^{2}\varepsilon_{f,t-j}^2)}} \tag{15}$$

where: ε_s and ε_f are both standardized residuals:

$$\varepsilon_{s,t} = \frac{e_{s,t}}{h_{s,t}} \tag{16}$$

$$\varepsilon_{f,t} = \frac{e_{f,t}}{h_{f,t}} \tag{17}$$

where: $h_{s,t}^2$ and $h_{f,t}^2$ are assumed to obey the GARCH(1,1) process with single variable:

$$h_{s,t}^2 = \gamma_s + \alpha_s e_{s,t-1}^2 + \beta_s h_{s,t-1}^2 \tag{18}$$

$$h_{f,t}^2 = \gamma_f + \alpha_f e_{f,t-1}^2 + \beta_f h_{f,t-1}^2 \tag{19}$$

where: γ, α and β are all positive, and $\alpha_i+\beta_i \le 1, i=s,f$.

Therefore, all unknown parameters are

$$\theta = \{\mu_s, \mu_f, \gamma_s, \gamma_f, \alpha_s, \alpha_f, \beta_s, \beta_f, \theta_1, \theta_2, \rho\}.$$

Furthermore, the maximum likelihood function is obtained as below:

$$L(\theta) = -T\log(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\log|H_t(\theta)| - \frac{1}{2}\sum_{t=1}^{T} e_t(\theta)' H_t^{-1}(\theta) e_t(\theta), \tag{20}$$

where: $h_{s,t}^2$, $h_{f,t}^2$ and $h_{sf,t}$ can be solved from the equation (18), (19) and (13); therefore, the time-varying hedging ratio is:

$$\hat{\beta}_t^* = \hat{h}_{sf,t} / \hat{h}_{f,t}^2. \tag{21}$$

IV. Empirical Results

IV.1 Data description

The study object of this article is the copper futures contracts on the Shanghai Futures Exchange, which is the most mature futures variety in China's commodity futures market. The futures price series are obtained according to the generally accepted extension method, which means that the data of the month when the expiration month extends back three months is taken as the futures price of that period. For instance, when considering a futures contract expired in April, we take its January data as the January data of the futures price series, as for one expired in May, the February data of the futures price series is taken as its February data. The reason is that futures contracts are not active in early trading period but more active near the delivery month, and the risk of bid-ask spread can be reduced through the use of active trading contracts.

The yield data of futures and spot are from March 23, 2010, to March 22, 2013, reaching a total of 689 observations. The futures contract data in this paper come from CSMAR and the spot data are from Straight Flush.

Table 1

Descriptive statistics of the data

	Spot return	Futures return
Number of observations	689	689
Number of missing values	0	0
Minimum	-0.061639	-0.055095
Maximum	0.076199	0.097542
Mean	-9.85e-06	1.40e-05
Variance	1.35e-4	2.25e-4
Standard deviation	0.01164	0.01500
Skewness	-0.4858	0.1651
Kurtosis	7.3300	4.2790
Correlation coefficient	0.7690	

IV.2 Empirical results

In order to study the performance of dynamic hedging strategies and calculate the economic value, we estimate the conditional variances series of spot and futures yields through the DCC-GARCH model, and then calculate the dynamic hedging ratio according to the equation (21). The descriptive statistics of the dynamic hedging ratio is showed by Table 2 and Figure 1.

Figure 1

Estimated hedging ratio by the DCC-GARCH model

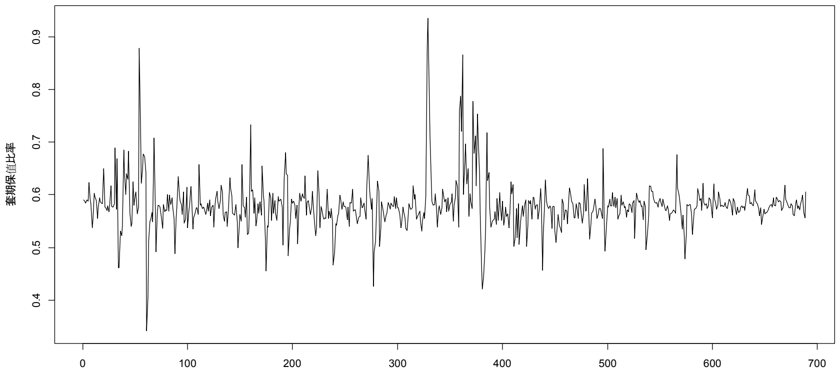


Figure 1 shows that the hedging ratio is changing at every point. Table 2 shows that in terms of the mean value the average hedging positions of dynamic hedging is relatively low - to be specific, only 0.579638 units of futures are needed to hedge for the average unit of spot asset. But it is obvious that the change of hedging ratio is fairly fierce, which is indicated by the variance of 0.002313 and the results of Figure 1 where the hedging ratio fluctuates between 0.341999 and 0.934775. Furthermore, that hedging ratio changes significantly at some moment meaning that the large fluctuations made by the market impel hedgers to adjust positions significantly so as to avoid risk. But it is also found that changes in the hedging ratio is very limited in most of the time, i.e., hedgers only need to fine-tune positions on the basis of the positions the day before, by which the risk arisen from market fluctuations can be avoid adequately.

Table 2

Descriptive statistics of the hedging ratio

Mean	0.5796	Median	0.5775
Minimum	0.3419	Maximum	0.9347
Standard deviation	0.04809	Variance	0.002313

By use of the dynamic hedging ratio obtained from equation (21), the biggest cost investors are willing to pay for positions adjustment at every moment, namely economic value, can be calculated through equation (9) (in case of $\gamma = 1$), and the descriptive statistics are showed in Table 3 and Figure 2.

Figure 2

Economic value

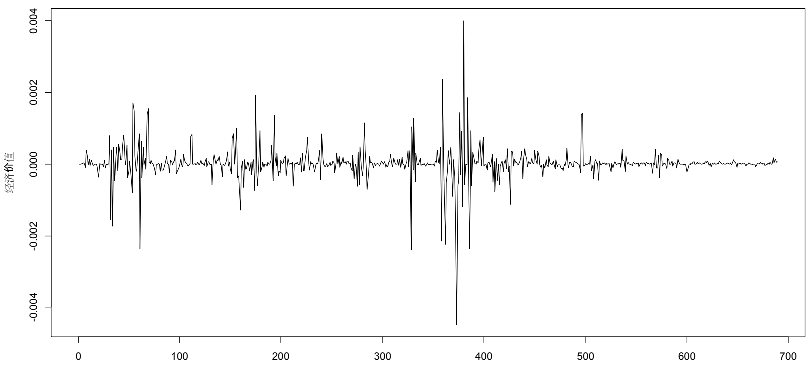


Table 3

Descriptive statistics of the economic value

Mean	1.1625e-05	Median	1.875e-06
Minimum	-0.004454	Maximum	0.003991
Variance	2.0894e-07	Standard deviation	0.0004571

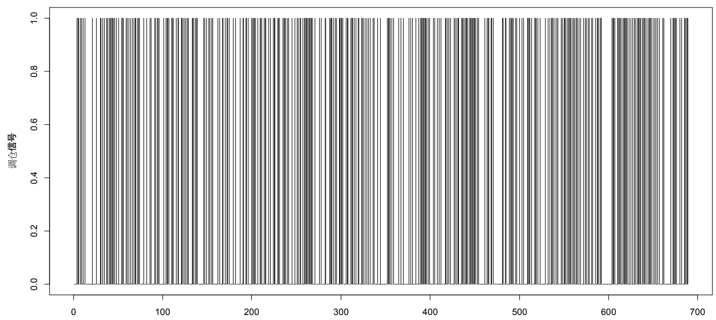
It is found that economic value is either positive or negative from the descriptive statistics, which means investors are willing to dynamically adjust positions in order to avoid risk and pay the corresponding positive cost when the economic value is positive. And when the economic value is less than zero, investors are not willing to dynamically adjust positions in order to avoid risk, which means that they are only willing to pay the negative cost, that is, there is no profit motivating them to dynamically hedge. In general, hedgers' attitude towards dynamic hedging strategy is different throughout the duration of hedging. When the economic value is negative, the hedger will not choose to dynamically adjust positions and decide to keep consistent with the previous futures position, namely the relatively static strategy. It is suggested that the traditional view that the pros and cons of dynamic and static strategy can be distinguished clearly is unreasonable. The mistake becomes more obvious when the transaction cost is taken into account further.

By comparing the economic value with the transaction costs of position adjustment at each point, we find out that hedgers will adjust positions when the transaction cost is lower than the economic value, i.e., they use dynamic hedging strategy. On the contrary, when transaction cost is higher than the economic value, hedgers will not adjust positions, that is, they will remain the hedging ratio of the previous trading day, using the relatively static policy.

Figure 3 is the position adjustment signals diagram, obtained by transforming the daily comparison results into position adjustment signals.

Figure 3

Position adjustment signals

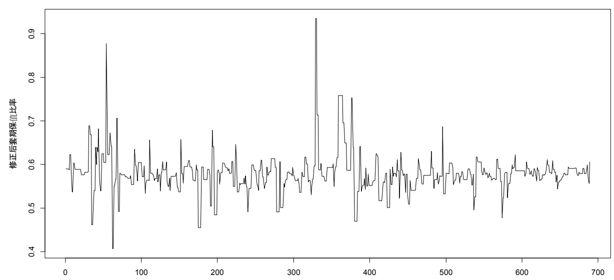


Each histogram refers to dynamically adjusting position adjustment and the blank means not in Figure 3. Statistically, there are 355 dynamic position adjustments in 689 trading days, i.e., dynamical position adjustments account for 51.52% throughout the hedging period, while the remaining 48.48% means keeping the positions unchanged. This shows that the optimal choice is not to adjust positions at every moment but to dynamically adjust positions in part of the time and just maintain the position of the previous moment during the rest of the time. It is concluded that the traditional time-varying position adjustment strategy is inappropriate and nearly half of the dynamic trading is not necessary, which will even cause losses.

When the economic value is greater than the transaction costs, dynamic hedging is chosen and hedging ratio remains the same as the previous one at any other time. Thus the modified dynamic hedging ratio is obtained and the ratio is used to make hedging strategy. The modified hedging ratio is shown in Figure 4.

Figure 4

Revised hedging ratio



It is found that the overall trend of the modified hedging ratio is similar in comparison of Figure 4 and Figure 1. To be specific, the modified hedging ratio levels off compared to the hedging ratio shown in Figure 1, but the relatively big change is almost the same. The difference lies mainly in the fact that hedging strategies modified by economic value tend not to dynamically hedge when the hedging ratio changes little between two adjacent trading days, thus reducing the corresponding transaction costs caused by small changes of hedging ratio.

Figure 5

Modified hedging ratio (ten days)

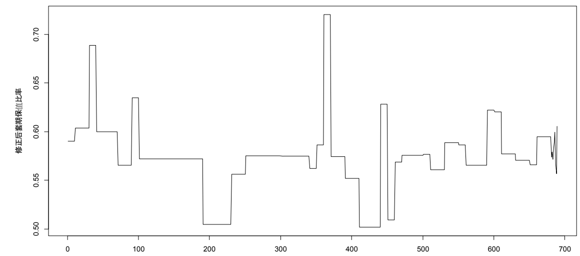


Figure 6

Modified hedging ratio (thirty days)

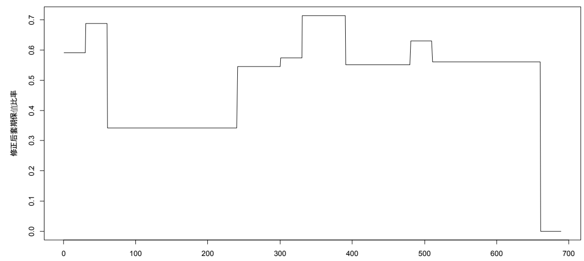


Table 4

The performance of hedging strategy

	Variance	Variance reduction	Cost of position adjustment （Each spot）
Not hedge	0.000135		
DCC	5.544e-05	59.08%	1242.714 Yuan
Modified	5.621e-05	58.52%	732.3785 Yuan

Table 4 indicates that there is almost no difference between the performance of modified hedging strategies and the strategy obtained by the DCC-GARCH model, which means the price risk of the portfolio is still well controlled with the correction method of dynamic hedging strategy proposed in this paper. However, the transaction costs of modified hedging strategy are significantly lower than that of the DCC-GARCH model. It is concluded that a lot of unnecessary transaction costs are incurred in the traditional dynamic hedging strategy which aims at minimizing the variance of the portfolio, but such tiny adjustment of hedging ratio has little effect on reducing the portfolio risk.

Meanwhile, different risk aversion coefficients are adopted to analyze how the economic value changes under different degree of risk aversion and the influence on our correction strategy.

Table 5

Trading signal under different degree of risk aversion

	Number of Trading signals	Percent of trading signals
$\gamma = 0$	12	1.74%
$\gamma = 1$	355	51.52%
$\gamma = 100$	601	87.22%

One may see from Table 5 that with the higher degree of risk aversion, more position adjustments will occur, and the investors are more inclined to choose dynamic hedging strategy.

So far, it is assumed that hedgers make strategy choices on a daily basis; however, hedgers will not necessarily do that every day in practice. It is more likely that they adjust positions every one week, half a month, or even one month. Therefore, 10 and 30 days are taken as the adjustment cycle respectively, and then the first day of the 10 days (30 days) is chosen as the hedging ratio of that period. We calculate the economic value every 10 days (30 days) according to the daily method mentioned above. When the economic value is greater than the transaction costs, we will dynamically adjust positions, i.e., adjust the hedging ratio to the ratio calculated by the DCC-GARCH model, and then keep such positions for 10 days (30 days). Next, decide whether to adjust positions again by calculating the economic value after 10 days (30 days). Figure 5 and Figure 6 show the modified hedging ratio of 10 days' and 30 days' position adjustment, respectively. It is obvious that the hedging ratio fluctuation becomes smaller, which is due to the reduced number of position adjustment, to be specific, the total number of position adjustments during 10 days is only 31 and for 30 days, only 8. The comparison of hedging performance and transaction costs of 1 day, 10 days and 30 days strategy is shown in Table 6. It is suggested that as the time interval of position adjustment becomes longer, the risk of hedging portfolio gradually rises while there is a significant reduction in transaction costs accordingly. This further proves that the hedging strategy modified by economic value is effective.

Table 6

Performance of hedging strategies

	Variance	Variance reduction	Cost of position adjustment (Each spot)
Not hedge	0.000135		
1	5.621e-05	58.52%	732.3785 Yuan
10	5.560e-05	58.96%	81.4835 Yuan
30	5.645e-05	58.33%	66.83955 Yuan

V. Conclusion

Compared with the static hedging strategy, scholars generally believe that dynamic strategy performs better in reducing the portfolio price volatility and portfolio risk. However, dynamic hedging means adjusting positions in real time. As a result, the corresponding higher transaction costs have become the focus of the debate on the pros and cons of dynamic hedging strategy, and hedgers are often faced with the trade-off between risk reduction and cost increase in dynamic hedging strategy. This article provides a basis for hedgers' decision-making by comparing the economic value with the corresponding transaction costs at every moment. At the same time, in comparison of the modified dynamic hedging strategy and the strategy obtained by the DCC-GARCH model, it is found that only about half of the operation is effective in traditional dynamic hedging strategy and the other half has been proved to bring relatively high transaction costs instead of significantly improving the hedging performance.

The fact that some of the hedgers may not adjust positions on a daily basis is also considered in the empirical analysis. We calculate the modified hedging ratio of ten-day and thirty-day position adjustment and find that such position adjustments greatly reduce the transaction costs without bringing much risk exposure. In this way, we proved that the efficiency of dynamic hedging strategy modified by economic value can be improved.

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