Study on the scheme and risk of Shanghai Copper Futures Arbitrage Trading

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Abstract

Based on the analysis of the price difference of different varieties of Shanghai copper, this paper puts forward the intertemporal arbitrage trading scheme of Shanghai copper futures and carries on the risk analysis of the trading scheme. Based on the theory of carrying cost, the conditions of generating arbitrage opportunities and profit conditions are obtained. According to the different contract price trend, it gives the low position, low position after liquidation, high position, high position after liquidation and the end of the month. According to this scheme, we take one hand as an example to conduct empirical analysis and test. In the process of empirical trading, 68 times of arbitrage, 47 times of profit, profit rate of 69%, total profit of 66,922.74 yuan. Therefore, this scheme has a better profit and profit rate.

The feature of this paper is to use a variety of programming software to analyze the opportunities and solutions of intertemporal arbitrage. In addition, in the empirical study of the intertemporal arbitrage trading scheme proposed in this paper, it is found that the trading scheme has a good profit and profit rate, and the trading scheme is simple and reliable, with strong operability.

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1 Introduction

Theoretically, the price of futures should be the sum of the spot price and storage costs, and the price of recent varieties is lower than that of forward varieties. Due to the traders' different judgment of the future price, the futures price of the trade fluctuates up and down the theoretical price. When the delivery period of the futures contract is approaching, the spot price and the futures price tend to converge and approach each other, and they coincide during the delivery period. Such fluctuations often occur when the deviation between the trading prices of the near and forward varieties deviates greatly from the theoretical deviation value. To earn the difference (the difference) by buying the most recent variety and selling the forward variety, or selling the most recent variety and buying the forward variety, is called span arbitrage.

2 Symbol Description

Table 1 Symbols and descriptions

Symbol	Descriptions
C	Position costs, including interest on occupied funds, storage charges, transaction delivery charges, VAT, etc. The price of a recent contract at time t with a delivery period of u.
Ft(u)	The price of a recent contract at time t with a delivery period of u.
Ft(v)	The price of a forward contract with a delivery period of v at time t.
Fk(u)	The price of a recent contract at time k when the delivery period is u.

3. Establishment and solution of the model

This paper analyzes the interperiod arbitrage of different varieties of Shanghai copper and puts forward the effective interperiod arbitrage trading mode. For arbitrage trading, there are two ideas at present. The first idea is to give the range of price fluctuation according to historical statistical data, and then judge the position of the price spread in the current market and whether there is bias, and then give the arbitrage trading plan. The second way of thinking is to calculate the holding cost of two contract periods according to the carrying cost principle. If the price of the far month contract is greater than that of the near month contract, and the gap is larger than the holding cost of the period, there is an arbitrage opportunity. Then according to the historical data, judge the current market price difference is too large or too small, so as to give the market entry and exit time judgment method.

3.1 Preparing Models

3.1.1 Data selection

According to the futures trading rules, the exchange adjusts the proportion of the guarantee fund according to the different stages of the futures contract listing operation (near the delivery period). The margin charging standard of copper futures trading is as follows:

Table 2 Collection standard of trading margin

Trading period	Margin ratio of copper trading
From the date of listing the contract	5%(The current rate is 7%
From the tenth trading day of the second month before the month of delivery	7%
From the first trading day of the first month before the month of delivery	10%
From the tenth trading day of the first month before the month of delivery	15%
From the first trading day of the month of delivery	20%
Two trading days before the last trading day	30%

As can be seen from the above table, when the contract approaches the delivery month, the trading margin will increase significantly, and if the position continues to be held, the cost will increase significantly. Moreover, when the amount is insufficient to pay the margin, the position will be forced to close, which will bring unnecessary losses. Therefore, in the establishment of the arbitrage model, the contract one month before the delivery month is not considered. In addition, the trading volume of contracts far away from the delivery month is small, while in general, the arbitrage value can be found between contracts of different periods with large trading volume. That is to say, in general, only the arbitrage value can be found between 02, 03 and 04 of Shanghai copper connection.

3.1.2 Mechanism analysis

We select the data of Shanghai Copper Connection 02 and Shanghai Copper Connection 04. The value in the chart is the difference between the daily closing price of Shanghai copper connection 02 and the daily closing price of Shanghai copper connection 04. In terms of time selection, choose the time when both contracts exist. Because the December contract ends on December 15th each year (regardless of the details), we will not calculate the price difference during the period from December 15th without you to March 15th of the following year (namely, the end time of the contract). In addition, if there are seven types of data of the two contracts and the data of one contract does not exist on a certain day (that is, the data of the two contracts do not exist at the same time on a certain day), then we will not calculate on that day. In general, the data we choose is the price difference between the Shanghai copper Connection 02 contract and the Shanghai copper connection 04 contract, the closing price is calculated, the time when the two contracts exist at the same time and the date with data, the time span is

from October 7, 1994 to November 5, 2008. Below is the spread between the two contract prices:
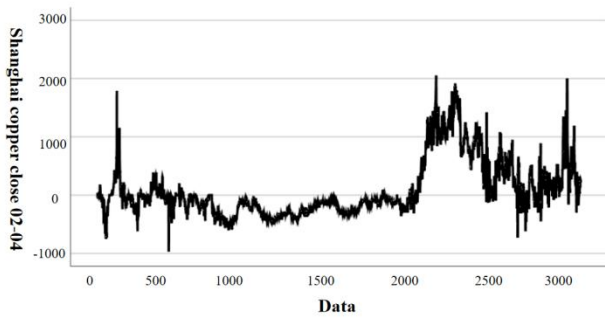

Figure 1 Variation of contract price spread

According to the figure of the closing price of the Shanghai copper connection (02-04), the price of the Shanghai copper Connection (02) has strengthened to a certain extent compared with that of the Shanghai copper Connection (04). This change cannot be sustained, it will no longer continue to strengthen, and the change will move in the opposite direction, that is, the price of the Shanghai copper Connection (02) will weaken compared with that of the Shanghai copper connection (04). As can be seen from the figure, when the 02-04 price spread of the Shanghai copper connection is far away from 0 upward or downward, there is always a tendency to return to 0. In other words, it can be believed that when the 02-04 price spread of the Shanghai copper connection reaches a certain value, we are confident that the price spread will approach 0 within a certain time. This will lead to arbitrage behavior. In this paper, the inter-period arbitrage scheme is implemented according to the strength of the 02 contract price compared with the 04 contract price of the Shanghai copper connection.

3.2 Model Establishment

3.2.1 Establishment of the model

As time goes by, the month is constantly changing, and the 02 of this month will become 01 of the next month. At this time, the required margin will start to rise sharply. In order to avoid unnecessary cost increase, people choose to close their positions at the end of each month and buy again in the next month.

According to the cost of carrying theory:

$$\text{Futures price} = \text{spot price} + \text{cost of position} \quad (1)$$

So in a theoretically normal market, the price of the front-month contract should equal the price of the front-month contract plus the cost of carrying the position. The conditions for generating arbitrage opportunities are: the price of the far month contract minus the price of the near month contract, that is, the price difference between the two contracts, should be greater than the holding cost C during the period.

Therefore, the conditions for generating arbitrage opportunities are :

$$Ft(v) - F(u) > C \quad (2)$$

When that happens, step in and arbitrage. The condition for profit is: the change between the prices of two futures contracts must be greater than this cost, that

is to say :

$$Ft(v) - fk(v) - (F(u) - Fe(u) > C \quad (3)$$

Only when this condition is met can the closing condition be satisfied.

3.2.2 Strategy formulation of inter-period arbitrage

1. Selection of position timing
This trend will reverse when the price of Shanghai copper Connect 02 contract decreases to a certain extent compared with that of Shanghai Copper Connect 04 contract. As can be seen from the figure 02-04 of the closing price of Shanghai Copper Connect, the price difference during this period mainly fluctuates between -1000 and 2000. We select 10% standard to determine the degree of unreasonableness. That is, we arrange the price difference of 02-04 from low to high, and select 10% quantile as the starting point of unreasonable degree, that is, we believe that the price difference will return to 0.

Table 3 Closing prices of Shanghai Copper Link 02-04

Number of valid cases	Range	Minimum	Maximum	10th percentile
3477	3020	-970	2050	-360.00

As can be seen from the statistical table, 10% quantile is -360. If the price of 02 contract minus 04 contract is less than -360, we will open a position for arbitrage trading, as shown in the figure below.
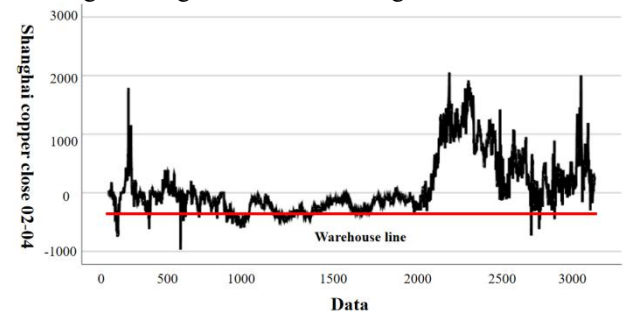

Figure 2 Position arbitrage

The red line in the figure represents the data point of -360. If the price of 02 contract of Shanghai copper connection weakens to a certain extent to reach the point of -360, it will choose to build a position, buy 02 contract of Shanghai copper connection and sell 04 contract of Shanghai copper connection.
2. The timing of closing positions
After the position is built at a low level, as time goes by, when the price of the 02 contract of the Shanghai copper connection is stronger than that of the 04 contract, we will arrange the price spread of the 02 to 04 contract from low to high, and select 40% quantile as the judgment point to close the position, that is, we believe that there is enough profit at this time, so we should choose to close the position for profit.

As can be seen from the statistical table, 40% quantile is -120. If the price of 02 contract minus 04 contract is greater than -120, we will sell 02 and buy 04 to close out the position and complete the carry trade, as shown in the figure below.
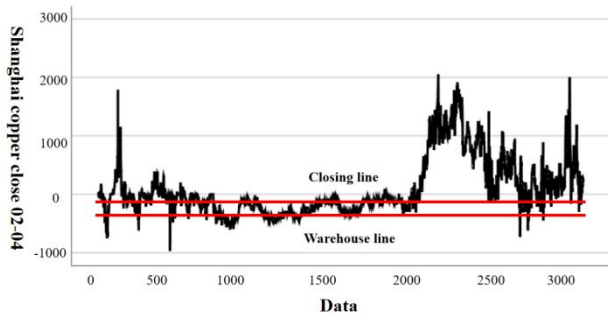
Figure 3 Unwinding arbitrage

In the arbitrage model, we choose to buy or sell Shanghai copper connection 02 and sell or buy Shanghai copper connection 04 for arbitrage at the same time. According to the margin collection standard in futures trading, when monthly changes occur after the opening of positions, Shanghai copper connection 02 and Shanghai copper connection 04 will correspondingly change into Shanghai copper connection 01 and Shanghai Copper connection 03. However, the margin required for Hutong Lian 01 will increase significantly as the delivery date gets closer and closer. Therefore, in order to avoid the cost and risk increase, we choose to close the position at the end of each month, and re-choose the appropriate time to open the position in the next month.

3.3 Simple trading mode scheme inspection

For ordinary investors, considering that the amount of capital owned is not particularly huge, the influence of the open position on the futures price is negligible. Therefore, taking 1 hand as an example, 5 hands and 10 hands are proportional. We selected 10% quantile as the position site for buying Hutong Lian 02 and selling Hutong Lian 04. Select 40% quantile as selling Shanghai copper link 02, at the same time buy Shanghai copper link 04 liquidation point; Select 90% quantile as the position site for buying Hutong Lian 04 and selling Hutong Lian 02. Select 60% quantile as selling Shanghai copper link 04, at the same time buy Shanghai copper link 02 liquidation point. The flow chart of the inter-period arbitrage trading algorithm is as follows:
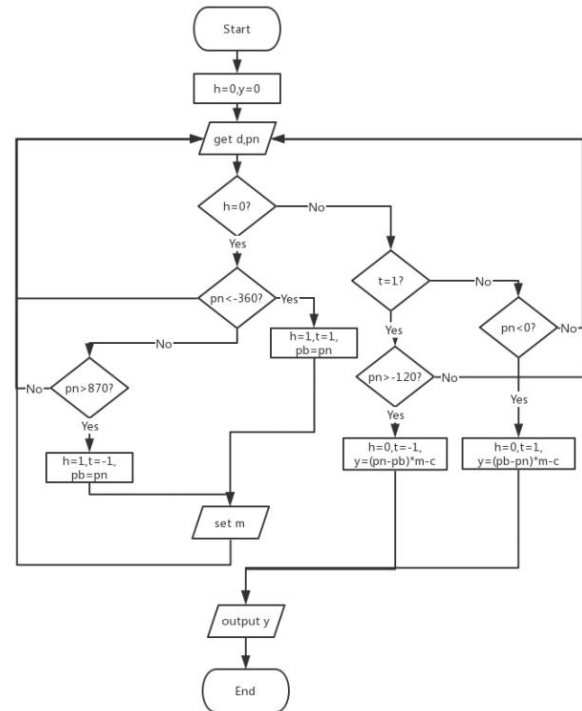

Figure 4 Flow chart of interperiod carry trading algorithm

We can calculate that, excluding the last arbitrage, transaction statistics are shown in the following table:

Table 4 Transaction statistics

Total arbitrage number	profit number	loss number	profit rate	total profit	average profit rate	average profit rate
68	47	21	69%	66922.74	984.16	4.35%

As can be seen from the chart, the profit rate of the intertemporal arbitrage scheme provided in this paper is 69%, which is a relatively good profit level under the low risk behavior of arbitrage.

4 Conclusion

By studying the price difference between different varieties of Shanghai copper futures, this paper proposes an intertemporal arbitrage trading model for Shanghai copper futures. This trading mode is mainly aimed at institutional and individual investors and does not involve physical delivery. It is simple and practical and has good operability. From the empirical study, this scheme has a good profit and profit rate. The trading model in this paper can be extended to other metal futures trading markets or other listed futures trading markets. At the same time, it can also provide reference for the government and futures exchanges to control traders' speculation and intertemporal arbitrage.

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