Research on the correlation between CSI 300 stock index futures and spot

Yiqun Wang *

School of Economics and Management, Nanjing University of Science and Technology, Nanjing, China

* Corresponding Author Email: 2574607159@qq.com

Abstract. This paper mainly focuses on the correlation between China's stock index futures and spot markets, and the selected products are CSI 300 stock index futures and spot. This paper takes CSI 300 as the research object, and based on the daily data from 2010 to date, uses the E-G cointegration test method and the error correction model method to verify the existence of a long-term equilibrium relationship between the period and the spot market, as well as the repair mechanism when the short-term deviation from equilibrium occurs. The results show that there is a long-term equilibrium relationship between stock index futures and the spot market, and there is a repair mechanism when the short-term deviation from equilibrium occurs. As the policy range moves forward, the signal role of the futures market in pricing gradually increases, and more investors begin to refer to the futures market trend to make decisions in the spot market.

Keywords: Stock index futures, Cointegration test, Error correction model.

1. Introduction

In 2010, China launched its first stock index futures product, the CSI 300 stock index futures, marking the realization of the country's stock index futures construction from scratch. In 2015, the CSI 500 and SSE 50 stock index futures were launched one after another, and China's stock index futures construction made further progress. However, the rapid development of stock index futures in 2015 was too close to the stock market crash that followed, which aroused a lot of suspicion and association among outside observers. Some observers believe that stock index futures and spot have a close and long-term linkage, and the behavior of shorting stock index futures has, to some extent, caused a stock market crash in the spot market, thereby disrupting the healthy development of the capital market. In order to stabilize the spot market, during the 2015 stock market crash, the regulators imposed severe restrictions on the trading of stock index futures, which was not gradually lifted until 2017, and the last major lifting of restrictions was implemented in 2019.

The main research content of this paper is to verify whether there is a correlation between China's stock index futures and spot from 2010 to 2023. It can be divided into two dimensions: ① Verify whether there is a long-term and balanced relationship between the price series of China's stock index futures and spot; ② Explore the mechanism of mutual traction between stock index futures and stock index spot to achieve repair when the yield series of stock index futures and stock index spot deviate from equilibrium in the short term, and the status of both parties in the price guidance function under different restrictive policy periods. The stock index selected in this paper is the Shanghai and Shenzhen 300 Index. The first chapter of this paper is the introduction, the second chapter is the literature review, the third chapter is the empirical design, the fourth chapter is the empirical process, and the fifth chapter is the summary of the whole article.

2. Literature review

Generally speaking, cointegration tests such as the E-G two-step cointegration test are commonly used statistical methods to verify whether there is a long-term and equilibrium relationship between the yield series of stock index futures and spot prices. Jiang Shuailan and Liao Yijing (2019) used the E-G two-step method to conduct a cointegration test between gold futures and spot prices, and

successfully verified that there is a long-term equilibrium relationship between the two. They then used the error correction model to conclude that there is an error correction mechanism when the prices of the two deviates in the short term. [1]. Many scholars such as Yang Yuhong and Tang Yanwei (2013), Xiong Hu (2019), and Wang Hongtao and Li Lan (2019) applied the cointegration test method to the CSI 300 futures and spot, and successfully verified that there is a long-term and stable relationship between the CSI 300 stock index futures and spot [2] [3] [4]. Wang Bei (2019) used the Johansen cointegration test method and the Granger method to verify that there was a mutual guidance relationship between the CSI 500 futures and spot during the 2015 stock market crash [5]. Geng Ying (2017) used the cointegration test method and the Granger method to test the SSE 50 spot futures and concluded that there is a long-term and stable relationship between the two [6].

3. Empirical model and data

3.1. Model setting

The E-G (Engle-Granger) two-step cointegration test method is a method in econometrics used to test whether there is a cointegration relationship between time series variables. The E-G test is divided into two steps:

① Regression analysis. Select two or more non-stationary time series variables, and perform linear regression on one of the variables (dependent variable) and the other variables (independent variables) by the least squares method, and then save the residuals obtained from the regression.

② Unit root test. Perform a unit root test on the residuals obtained in the first step to test whether the residual sequence is stationary. If the residuals are stationary, it means that there is a cointegration relationship between the original variables. If the residuals are non-stationary, it means that there is no cointegration relationship between the original variables.

The Error Correction Model is a model used to analyze time series data, especially when there is a cointegration relationship. It combines short-term dynamic changes with long-term equilibrium relationships and is an effective econometric analysis tool. Assuming there are two time series variables X_t and Y_t, there is a long-term cointegration relationship between them, which can be expressed as:

$$Y_t = \beta_0 + \beta_1 X_t + u_t \tag{1}$$

Where u_t is the cointegration residual (long-term equilibrium error). The first-order error correction model can be expressed as:

$$\Delta Y_t = \alpha + \varphi u_{t-1} + \theta \Delta X_t + \epsilon_t \tag{2}$$

The error correction model combines the long-term equilibrium relationship with short-term changes, reflecting how variables fluctuate in the short term and eventually adjust back to the long-term equilibrium state. Among them, α is a constant term; ΔY_t is the first-order difference of Y_t; u_{t-1} is the error correction term lagged by one period (i.e., the cointegration residual), reflecting the degree of deviation from the long-term equilibrium; φ is the coefficient of the error correction term, indicating the adjustment speed of the system to deviations from the long-term equilibrium; ΔX_t is the first-order difference of X_t, and θ is its coefficient, representing the impact of short-term fluctuations in X_t.

3.2. Variable measurement and data source

This paper selects the daily closing prices of the CSI 300 Index and its futures as spot sample data. In this paper, the codes of the CSI 300 Index and its corresponding futures are HS and IF, respectively, and the sample daily interval is from April 19, 2010 to July 7, 2023, with a total of 3213 sets of data. This paper takes the logarithm of the daily closing price data to obtain the price series LN(IF) and LN(HS). Then the first-order difference of the logarithmic price series is performed to obtain the yield series RIF and RHS. In order to reflect the changes in restrictive policies in different periods, this

article divides the entire research period into four sections according to the three-time nodes of policy tightening (2015.9.02), gradual release (2017.02.16), and complete relaxation (2019.4.22), namely the pre-restriction period, the policy restriction period, the restriction relaxation period and the post-restriction period.

4. Empirical findings

(1) Stationarity test

The ADF test method is used to test the logarithmic price series and yield series of the CSI 300 stock index futures and spot contracts. The results are shown in Table 1.

Table 1. Stationarity test results of price series and return series

Sequence	t-Statistic	1%	5%	10%	Prob.	Stability
LN(HS)	-1.721028	-3.432166	-2.862228	-2.567180	0.4205	No
LN(IF)	-1.851431	-3.432175	-2.862232	-2.567182	0.3558	No
RHS	-56.01187	-3.432158	-2.862224	-2.567178	0.0001	Yes
RIF	-57.03524	-3.432158	-2.862224	-2.567178	0.0001	Yes

The results show that, with a significance level of 5%, the logarithmic price series of the CSI 300 stock index futures and spot prices show significant non-stationarity, while the yield series shows significant stationarity.

(2) E-G two-step cointegration test

Since the price series is non-stationary and the yield series after the first-order difference is stationary, it can be deduced that both LN(HS) and LN(IF) have a unit root and are first-order single integral series. Therefore, the E-G two-step cointegration test method can be used to analyze whether there is a long-term and balanced relationship between stock index futures and spot.

The first step is to perform the least squares (OLS) regression on the logarithmic price series LN(IF) and LN(HS) of the CSI 300 stock index futures and spot, and construct two sets of equilibrium equations:

$$\begin{cases} LN(HS) = c_1 + \beta_1 \times LN(IF) + \varepsilon_1 \\ LN(IF) = c_2 + \beta_2 \times LN(HS) + \varepsilon_2 \end{cases} \tag{3}$$

The second step is to perform an ADF stationarity test on the residual term ε in the equilibrium equation to test the stationarity of the residual term. The test results are shown in Table 2.

Table 2. ADF test results of residual terms in equilibrium equation

Residual	t-Statistic	1%	5%	10%	Prob.
ε_1	-4.698096	-3.432172	-2.862231	-2.567182	0.0001
ε_2	-4.731373	-3.432172	-2.862231	-2.567182	0.0001

In Table 2, the ADF test results are significant and the null hypothesis can be rejected, that is, the residual term does not have a unit root, indicating that both groups of residual terms are stable, both groups of time series are cointegrated, and the long-term equilibrium relationship is established. Therefore, there is a long-term and two-way equilibrium relationship between the CSI 300 futures and the spot price series.

Next, the error correction model is used to further study whether there is a repair mechanism between futures and spot to restore equilibrium under short-term fluctuations. Here, the residual term ε in the equilibrium equation (3) is extracted, and the error correction term ECM_{t-1} is formed by lagged one order, and then the futures and spot yield series RIF and RHS are introduced to establish the error correction model. The equation is

$$\begin{cases} RHS_t = c_1 + \alpha_1 RIF_t + \beta_1 ECM_{t-1} + \varepsilon_1 \\ RIF_t = c_2 + \alpha_2 RHS_t + \beta_2 ECM'_{t-1} + \varepsilon_2 \end{cases} \quad (4)$$

The analysis results of the error correction model are shown in Table 3.

Table 3. Analysis of the Error Correction Model of the CSI 300 Index and its Futures

Sample	α_1	Prob.	β_1	Prob.	α_2	Prob.	β_2	Prob.
Pre-restriction period	0.8316	0.0000	-0.1606	0.0000	1.0336	0.0000	-0.1833	0.0000
Policy restriction period	0.8113	0.0000	-0.3241	0.0000	1.0255	0.0000	-0.3555	0.0000
Restriction relaxation period	0.8828	0.0000	-0.3302	0.0000	1.0771	0.0000	-0.3660	0.0000
Post-Limitation Period	0.9430	0.0000	-0.3097	0.0000	1.0151	0.0000	-0.3278	0.0000

From the results in Table 3, we can find that for stock index futures and spot, there is a repair mechanism to restore equilibrium during short-term fluctuations. Under different policy periods, the spot yield series of the CSI 300 Index is jointly affected by the futures yield series and the error correction term of the previous period, and the results are significant; the futures yield series of the index also has the same performance. In addition, in all periods, the adjustment coefficient of the error correction term on futures prices is large ($\beta_2 > \beta_1$), which means that after short-term fluctuations cause deviations from long-term equilibrium, the futures yield is more affected by the correction of the spot yield than the spot yield; similarly, in all periods, α_1 as the futures yield coefficient is smaller than α_2 as the spot yield coefficient. The above situation shows that the stock index spot has a greater impact on the stock index futures, and the spot has more dominance in market pricing. However, after the loosening policy began, the α_1 coefficient of futures yields continued to increase, and the coefficient α_2 of spot yields also decreased in the post-untying period. This preliminarily indicates that after the policy loosening, the role of price signals in the futures market in market pricing may become increasingly important, while the role of the spot market will be relatively weakened.

5. Summary

In summary, it can be proved that there is a long-term and balanced relationship between China's stock index futures and spot markets. When the market deviates from the equilibrium state in the short term, the futures and spot yield series will pull each other to repair each other. In this process, the guiding role of the spot market on futures is more significant. However, as the policy range moves forward, the signal role of the futures market in pricing gradually increases, and the influence of the spot market is relatively weakened. More investors begin to refer to the futures market trend to make decisions in the spot market. This also shows to some extent that China's series of unblocking policies for the futures market may be effective, and the price guidance function of the futures market is gradually strengthened. This is also conducive to the Chinese regulatory authorities to indirectly affect the spot market through the futures market regulation policy in the future, and to ensure the smooth and healthy operation of the stock market.

References

[1] Jiang Shuailan, Liao Yijing. An empirical study on the relationship between gold futures prices and spot prices [J]. Journal of Chengdu Institute of Technology, 2019, 22 (3): 61 - 65.

[2] Yang Yuhong, Tang Yanwei. Research on the price relationship between CSI 300 stock index futures and spot market [J]. Journal of Qingdao University (Natural Science Edition), 2013, 26 (4): 83 - 88.

[3] Xiong Hu. Research on the relationship between the price of CSI 300 stock index futures and its spot price fluctuations [J]. Rural Economy and Science and Technology, 2019, 30 (24): 64 - 65.

[4] Wang Hongtao, Li Lan. Price fluctuation relationship and trend forecast between CSI 300 stock index futures and spot prices [J]. Journal of Xi'an University of Posts and Telecommunications, 2019, 24 (4): 93 - 103.

[5] Wang Bei. The impact of stock index futures on the stock market during the stock market crash [J]. Cooperative Economy and Technology, 2019 (5): 70 - 71.

[6] Geng Ying. Research on the price discovery function of stock index futures: Based on the Shanghai Stock Exchange 50 Index Futures [J]. Modern Business, 2017 (11): 98 - 100.