

Study on the Impact of CSI 300 Stock Index Futures on Spot Market Volatility

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Abstract

Since the 1990s, with the continuous development of economic globalization, the status of finance in national economic development has been increasing, so the stock index futures had become one of the most important financial tools in the economic development of various countries, but the impact of stock index futures on the spot market has not yet been determined. Therefore, this paper aims to analyze the impact of the futures market on the spot market, and hopes to put forward effective suggestions for the development of China's securities market. In order to investigate the impact of CSI 300 stock index futures on the daily return rate of CSI 300 index, This paper first gives the basic overview of the stock index futures, and then analyzes the impact of the stock index futures on the spot market, and finally carries on the empirical analysis. In the empirical analysis, this paper uses EViews11 software to conduct ADF unit root test on the daily return rate of CSI 300 index and the daily return rate of CSI 300 stock index futures contract to prove their stationarities, and then uses the lagged two-order ARCH LM method to test whether the ARCH effect exists in the daily return rate of CSI 300 index. Thus, GARCH model is used to complete the empirical analysis. The findings are as follows: First, after the introduction of futures contracts, the volatility of the spot market has increased for a certain period of time, and its smoothness has not been reflected. Based on the analysis of the actual situation, it can be seen that due to the huge difference in market size, stock index futures cannot truly reflect their stabilizing effect, but instead lead to increased volatility. Second, after the stock index futures entered the market, the leverage effect was significantly weakened, and even no obvious effect appeared. Compared with the futures market, the overall transparency of the domestic stock market is very insufficient. Therefore, after the launch of stock index futures, it will play an important and positive role in promoting the transparency of the domestic stock market and enable stock prices to respond to market news more quickly.

Keywords

CSI 300 Stock Index; Futures Volatility; GARCH Model.

1. Introduction

With the rapid rise of China's national economy and the increasing maturity of the capital market, stock index futures have emerged accordingly. The global economic landscape has undergone profound changes after the collapse of the dollar and the Bretton Woods system, as well as the decoupling of gold from the gold standard. In the 1980s, emerging financial markets sparked severe turbulence. When the economic crisis drove the United States to adopt a high interest rate policy to curb inflation[1], the uncontrollability of exchange rates and interest rates brought an unprecedented crisis to the stock market. Therefore, financial institutions began to delve deeply into risk management, forming risk management techniques that adapt to various environments[2]. From 1972 to 1973, foreign exchange futures and interest rate

futures began to rise, and by 1982, stock index futures were first introduced. During this period, the Dow Jones Index also emerged, with its index soaring from over 1,000 points in 1981 to over 10,000 points in 1999[3].

Stock price index futures, as an innovative hedging tool, are a kind of futures contract based on the stock index, which has the characteristics of guarding against systemic risk. Stock index futures are financial derivatives that investors use to hedge spot market risks. China's first financial future is the CSI 300 stock index future, which covers many large and highly liquid stocks, accounting for 60% of the total market value of China's stock market, and it more accurately reflects the overall trend of China's stock market[4].

The emergence of stock index futures is the inevitable demand for market development, which is reflected in the following four aspects: hedging systemic risk in the stock market; improving the quality of institutional investors and promoting the development of the securities market; making stock price fluctuations more reasonable[5]; optimizing the capital market development system and enhancing its competitiveness. In a mature capital market, a good combination of spot and futures is necessary[6].

This study will select relevant data of the CSI 300 stock index futures, and combine it with the data of the spot market, to study the impact of stock index futures on the spot market. The research results provide suggestions for the policy formulation in relevant fields, further standardization of stock index futures trading, and the exercise of the functions of stock index futures. In addition, the research also provides references for the development and research of financial derivatives such as stock options, and is of great significance for further improving China's financial market.

2. Theoretical Analysis

2.1. Impact of the Introduction of Stock Index Futures in Foreign Markets on the Spot Market

The inception and evolution of stock index futures contracts in mature financial markets such as the United States and Europe serve as an interesting contrast. In 1982, pre-stock index futures, the US economy faced significant challenges as the Dow Jones Index plummeted[7]. Post the bear market, from April to June, the US stock market began to recover slowly, and by August, it entered the pre-bull market stage. The launch of the stock futures market ensued, leading to a continual increase over the next few years[8]. However, the long-term trend of the US stock market remained relatively independent of these developments, primarily driven by the corporate and economic climate. In 1988, before implementing stock index futures, Japan's stock market saw a sharp rise, with the Nikkei 225 index skyrocketing by 6000 points to exceed 18,000. Following the implementation of stock index futures, the Nikkei index plummeted to 15,820 points within a month, representing a 15.4% decrease[9]. However, the long-term upward development trend of its stock market remained, tied to the interest rates, exchange rates, and overall economic strength of its listed companies. In 1996, prior to the introduction of stock index futures, the KOSPI 200 index in Korea increased from 97 to 110 points in the short term[10]. The entry of stock index futures led to a swift decline back to 90 points, stabilizing thereafter, with the stock market persistently sliding, signaling the start of a bear market. The introduction of stock index futures to India's financial market in 2000 saw limited participation, leading to low trading activity and significant price fluctuations in the early stage. As more participants entered the market, price volatility became steadier[11]. Despite these developments, the launch of India's stock index futures had no discernible impact on the spot market.

2.2. The Impact of the Introduction of Stock Index Futures in China on Stock Market Movements

On April 16, 2010, China's CSI 300 stock index futures officially went public. Prior to this, the total turnover of the Shanghai and Shenzhen stock markets reached 190.3 billion. After that, the turnover of the two markets continued to decline. By July 2, the turnover had fallen to 119.5 billion, reaching its lowest level. After that, the index began to rise continuously, and the overall trading volume also began to increase. On October 18, the turnover achieved an increase of 48.86 billion [11]. After the launch of the CSI 300 index futures, China's stock market began a major adjustment. On the one hand, the Greek debt crisis had an adverse impact on it. On the other hand, the short selling mechanism of margin financing and securities lending had an adverse impact on it, causing great changes after its launch and causing significant volatility in the entire spot market.

2.3. Impact of Stock Index Futures on Spot Market Liquidity

Stock index futures themselves can achieve two different effects. On the one hand, capital will flow in over a long period of time. On the other hand, capital outflows occur within a relatively short period of time. The overall trading cost of stock index futures is very low, and it has high leverage, which attracts a large number of speculators to participate, thereby allowing its funds to flow in, leading to adverse effects on the liquidity of the entire stock market in a short period of time. In terms of long-term development, after the emergence of stock index futures, it will attract more funds to enter the stock market, thereby achieving rational control and avoidance of risks, adopting effective risk management measures, attracting the attention of investors more effectively, ensuring that there is continuous capital entry in the market, ensuring the activity of the stock market, and increasing the total capital while ensuring the liquidity of the stock market.

3. Model Setup and Data Description

3.1. Research Idea

To examine the impact of stock index futures on the volatility of the stock spot market, two aspects need to be considered: On one hand, whether the emergence of stock index futures has affected the actual volatility changes in the stock market. If there is an impact, whether it makes the spot market unstable or more stable. On the other hand, whether the volatility relationship between the futures and spot markets changes in different periods. This paper uses Eviews11 software to conduct an ADF test on the daily returns of the CSI 300 Index and CSI 300 Stock Index Futures to confirm their stationarity, then uses the ARCH-LM to analyze the ARCH effect of the daily returns of the CSI 300 Index, and finally tests the impact on its volatility using the GARCH model.

3.2. Research Methodology

In the process of studying the price volatility of financial products, the heteroscedasticity model is generally used. In the 1980s, Robert Engle developed the ARCH (Autoregressive Conditional Heteroskedasticity) model. Assuming r_t is the conditional mean of the return on financial assets, and ε_t is the error term, it follows a conditional normal distribution with a mean of 0 and a variance of δ^2 . δ^2 is not a constant data, its model will constantly change, and its expression is as follows:

$$r_t = u_t + \varepsilon_t. \quad (1)$$

$$\varepsilon_t = \delta_t e_t. \quad (2)$$

$$\delta_t^2 = a_0 + \sum_{i=1}^{i=q} a_i \varepsilon_{t-i}^2. \quad (3)$$

$$e_t \sim \text{iid } N(0,1). \quad (4)$$

In order to prevent the variance from becoming negative, it must satisfy $a_0 > 0, a_1 > 0, \dots, a_q > 0$. The moving average of the square of the error term of the return rate of financial assets can be depicted using the ARCH model. In 1986, Bollerslev expanded on Engle's original model by adding an autoregressive term, thus forming the general form of the ARCH model - the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model.

3.3. Data Processing

In this paper, we selected the daily return data of the CSI 300 Index from January 4, 2005, to April 19, 2021. After removing weekends and holidays, we finally obtained 3959 data points. In addition, we chose the relevant data of the CSI 300 Stock Index Futures from April 19, 2010, to July 22, 2020. After removing weekends and holidays, we finally obtained 2678 data points.

To ensure that the final research results are closer to the actual rate of return, this paper uses the log difference model for research. The calculation formula is as follows: $R_t = \ln P_t - \ln P_{t-1}$.

3.4. Statistical Analysis

We introduced Eviews11 to study the daily returns of the CSI 300 Index and the CSI 300 Stock Index Futures samples. The results are shown in fig.1 to fig.4.

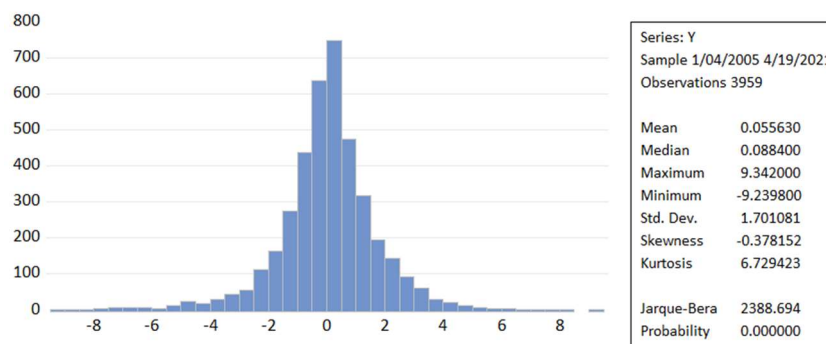


Fig.1 Statistical Characteristics of the Daily Returns of CSI 300 Index

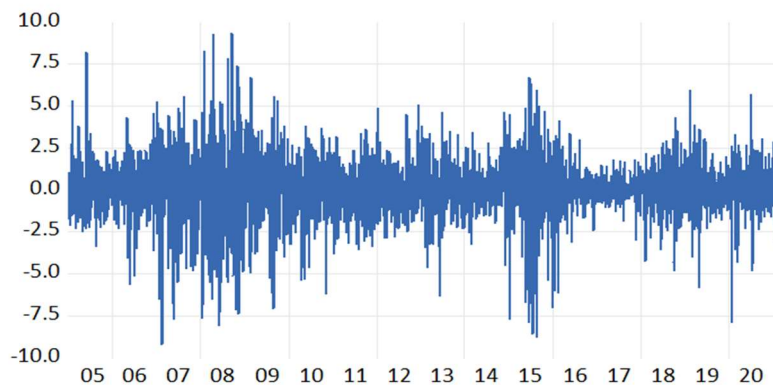


Fig. 2 CSI 300 Index Daily Return Trend

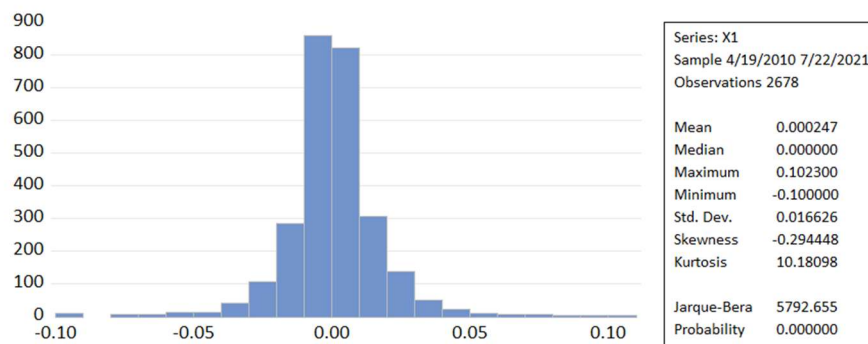


Fig. 3 Statistical Characteristics of Daily Returns of CSI 300 Stock Index Futures Contracts

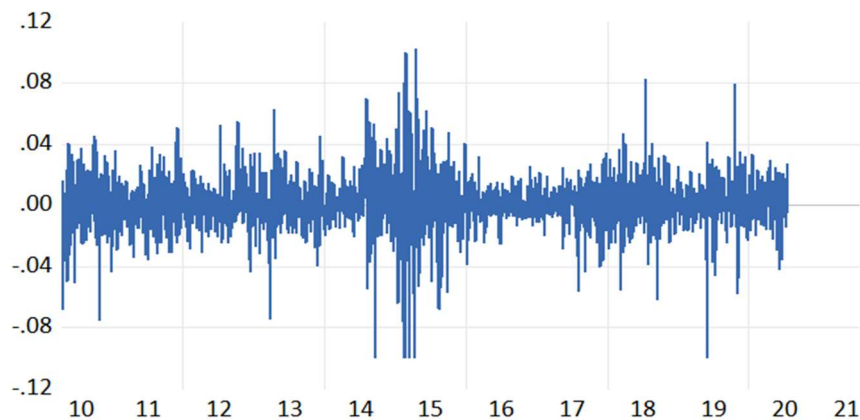


Fig. 4 CSI 300 Stock Index Futures Contract Daily Yield Trend

In the process of analyzing the specific distribution asymmetry of the sample data, the skewness indicator is used. If the absolute value of this indicator is large, it represents a high degree of asymmetry. If the data is positive, it indicates a long right tail, and if the data is negative, it indicates a long left tail. Based on the actual data in fig.1 and fig.3, the daily return rate of the CSI 300 Index has a left-skewed distribution asymmetry; the daily return rate of the CSI 300 Stock Index Futures contract also has a left-skewed distribution asymmetry. The two are approximately symmetrical.

When evaluating the thickness of the tail of the sample data, the indicator used is called kurtosis. When it is in a normal distribution state, the value of this indicator is 3. Generally, when measuring sample data, the thickness of its tail is compared with the normal distribution. When the kurtosis value is greater than 3, its distribution form belongs to a relatively leptokurtic and fat-tailed state; when the kurtosis value is less than 3, it belongs to a flat state. Based on the related data shown in fig.1 and fig.2, the data of both are greater than 3. Therefore, both distributions have leptokurtic and fat-tailed characteristics. In comparison, the overall degree of daily return rate of the CSI 300 Stock Index Futures contract is larger, so the probability of extreme situations is also greater.

In the process of analyzing the degree of variation in the distribution of sample data, the standard deviation indicator is used. Based on the related data shown in fig.1 and fig.3, the standard deviations of the two currently have certain differences, with the volatility of the daily return rate of the CSI 300 Index being greater. Based on the related data shown in fig.2 and fig.4,

the current volatility trends of the two are roughly the same, both fluctuating around the value of 0.

3.5. Empirical Results

3.5.1. Stability Check

Based on the related data shown in fig.2 and fig.4, the daily return rates of both have characteristics of stable growth. Therefore, we can preliminarily determine that both belong to a stationary series. In order to carry out a more accurate and strict test on its stationarity, this article uses Eviews11 to implement the ADF unit root test, and the final data results are as follows:

Table 1. ADF unit root test on daily returns of CSI 300 index and CSI 300 stock index futures contracts

	ADF test t-value	ADF test p-value
CSI 300 Index Daily Return	-61.21338	0.0001
CSI 300 Stock Index Futures Contract Daily Yield	-37.50635	0.0000

Based on the related data in Table 1, after testing, the t-values of the daily return rates of the two are -61.21338 and -37.50635, respectively, and the corresponding P-values are 0.0001 and 0.0000, respectively. This proves that both are in a stationary state.

3.5.2. Volatility Analysis

Using Eviews11 software, the test was performed with a lagged second-order ARCH-LM method, thus verifying the existence of the ARCH effect or not, and the results are shown in Table 2:

Table 2. ARCH test for CSI 300 Index

Obs*R-squared	Prob. Chi-Square(2)
176.1963	0.0000

From the results in Table 2, it can be seen that the size of the LM statistic is 176.1963, and the P-value is 0.0000. Based on the significant level of 1%, there is an ARCH effect, and a GARCH test can be conducted on it.

In the GARCH (1,1) model, the sample data of the CSI 300 index is input to establish the model: $GARCH = C(2) + C(3) * RESID(-1)^2 + C(4) * GARCH(-1)$. The specific modeling results are shown in Table 3:

Table 3. GARCH model of CSI 300 index

Variable	Coefficient	Std. Error	Statistic	Prob.
C(2)	0.000673	0.000176	3.826964	0.0001
C(3)	1.01E-06	3.82E-07	2.632503	0.0085
RESID(-1)^2	0.058894	0.006954	8.468763	0.0000
GARCH(-1)	0.940185	0.006503	144.5725	0.0000
GED PARAMETER	1.217336	0.034923	34.85738	0.0000

As can be seen from Table 3, the coefficient of $RESID(-1)^2$ is 0.058894, and the coefficient of $GARCH(-1)$ is 0.940185. Both are greater than 0 and their sum is close to 1. This indicates that

the benefits are persistent and have a certain degree of long-term nature, and they will not gradually converge.

The next static forecast of the stock price from April 19, 2020 to April 19, 2021 results in fig.5.

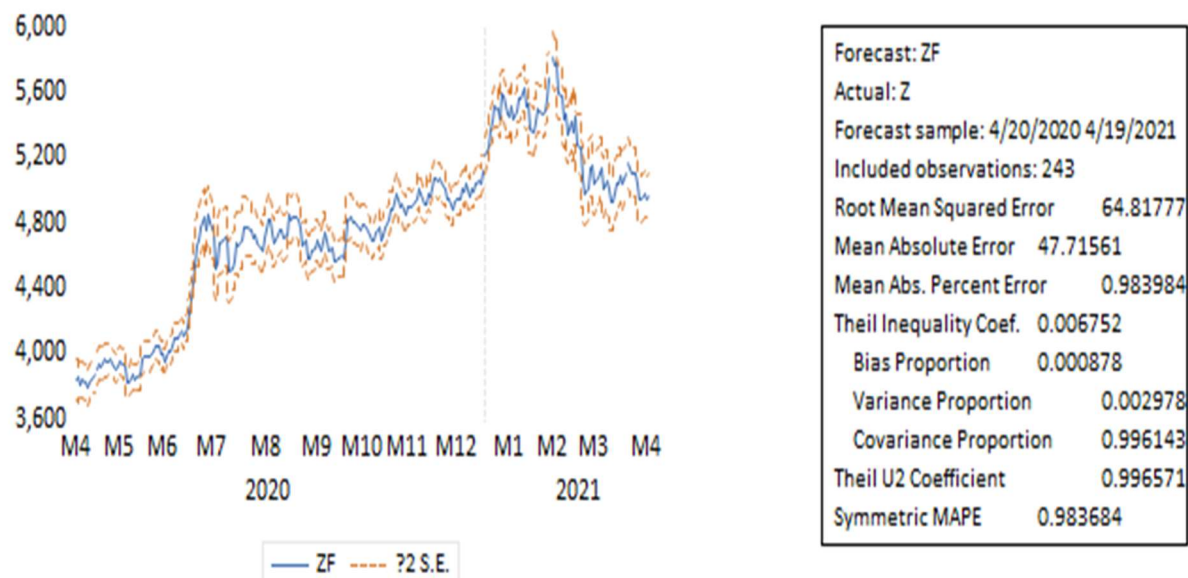


Fig. 5 Stock Price Forecast 2020-2021

As can be seen from fig.5, the bias ratio is 0.000878 and the variance ratio is 0.002978, both of which are relatively small, indicating that the degree of bias and deviation are both small. The covariance ratio is 0.996571, which is close to 1, indicating that the non-systematic error is small and the overall prediction result is good.

4. Summary

This study conducted a comprehensive empirical analysis based on the data of the CSI 300 Index from 2005 to 2021 and the CSI 300 Stock Index Futures from 2010 to 2020. After respectively collecting 3959 and 2678 working day samples, we made an exhaustive evaluation of the stock index futures, outlined the developmental trajectory of the CSI 300 Index, and employed the ARCH model to test the data to ascertain the applicability of the CARCH model. Subsequently, we utilized the GARCH (1,1) model to further investigate the specific impact of the CSI 300 stock index futures contracts on the CSI 300 Index. The empirical results demonstrate that the daily return series of both research subjects exhibit significant left-skewness distribution, especially the kurtosis of the stock index futures is more significant. The results of the ADF test reveal that the daily returns of the CSI 300 Index are stable, while the ARCH-LM test at the 1% significance level reveals significant volatility clustering characteristics in the daily return series of the stock index futures. The results from the GARCH (1,1) model further reveal that there was a significant negative leverage effect in the CSI 300 Index before the introduction of stock index futures, indicating an asymmetry in the impact of bull and bear news on its volatility, with bear news having a more pronounced effect. However, the introduction of stock index futures has significantly weakened this leverage effect, and in some cases, it even disappears, indicating that the introduction of futures contracts can effectively improve market efficiency. Despite this, the introduction of futures contracts initially exacerbated the volatility of the spot market, and the smoothing effect of futures was not reflected. The huge gap in market size resulted in the stock index futures failing to stabilize the

market effectively, but instead, they intensified market volatility. However, the introduction of stock index futures has improved the transparency of the stock market, enabling stock prices to respond more quickly to market news, which is beneficial to the healthy development of the market.

The empirical study on the CSI 300 stock index futures reveals the impact of futures on the volatility of the spot market and points out that there is still room for further optimization and improvement in the Chinese stock index futures market. In order to further strengthen the healthy development of the domestic stock index futures trading market, we propose the following suggestions:

- 1) Enhance regulatory efforts: Prevent market manipulation and excessive speculation by monitoring participant behaviors, conducting transaction reviews, and intervening in the market during extreme volatility to maintain market stability.
- 2) Increase market transparency: Make transaction data and market participant information publicly available, allowing investors to have a more comprehensive understanding of market dynamics.
- 3) Cultivate professional investors: Enhance investors' understanding and application skills of stock index futures through education and training, in order to increase market liquidity.
- 4) Improve risk management mechanisms: Update the margin system, establish a robust risk warning system, and enhance investors' risk management capabilities to reduce losses caused by market volatility.

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