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The Impact of Stock Index Futures on Spot Market: Data Analysis of CSI 300

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Abstract:

In the financial market, spot and futures are two important trading products with a relationship. This paper analyzes the impact of the CSI 300 stock index futures contract on the actual market based on the index data before and after the contract's launch. It selects the data from 2008 to 2024 as the sample and uses the method of combining GARCH and TGARCH models for empirical research. At the same time, this paper specifically selected the period of market recovery after the pandemic to conduct independent analysis, providing recommendations and directions for short-term sample studies in the long run. This research illustrates the CSI 300 futures contract has exacerbated the market volatility in the short run before and after its launch, but has a dampening effect on the volatility of the actual market at specific periods in the long term. The results also warn of the factors that should be taken into account when policy intervention is carried out.

Keywords: Stock index futures; GARCH; TGARCH; CSI300.

1. Introduction

As one of the highly traded financial derivatives with long-term market activity, futures contracts have been influenced by various types of global commodity trading as a result of the continuous opening and development of the global economy. With the formation of an increasingly globalized economic market, futures trading has attracted more attention from investors, playing a key part in contemporary financial markets. On April 16, 2010, the CSI 300 stock index futures contracts on the China Financial Futures Exchange magnified the diversity of the Chinese futures market, providing investors with more choices and offering different investment portfolio options and risk hedging avenues for major financial institutions. Additionally, fluctuations in spot values in the stock market directly impact the prices of stock index futures. As China's stock market is primarily limited to long positions, short-selling transactions in the future will inevitably affect the existing stock market to some degree. Due to these unique national circumstances that differ from Western countries, similar research on investment and financial market development cannot be fully applicable to China's financial markets. Furthermore, China's financial futures market system is still under construction and has a relatively short establishment period; therefore, related research has limitations in terms of sample time frame and scope. Hence, it is imperative to research Chinese stock index futures.

Previous studies have conducted various methodological research on other index futures, such as the SSE 50 Index. Besides, they have refined the research on different types of futures for industry common indices. As claimed by Ausloos et al, the TGARCH model deduces that the trading of these futures significantly reduced the fluctuation of the actual markets [1]. Similarly, Qian Shan employed this model along with Granger causality tests for empirical analysis, concluding that there is a positive correlation between the two markets and an effect of volatility spillover [2]. Specialized research on the CSI 300 Index futures, as contended by Wang et al, introduced a novel volatility model on the grounds of copula function data, which enhanced the methodologies and risk management abilities for volatility analysis [3]. In this study, the scholars compared the new research method with the previous model. Although it is impossible to validate the precision of this new method and previous results, it describes a new direction for the research that is more in line with the Chinese market [3]. During the quantitative examination of intraday data, Baolin Guo realized that stock index futures had triggered similar volatility and affected both markets through closing price data from mature and emerging markets [4]. Imtiaz Sifat, Azhar Mohamad, and Kevin Reinaldo Amin performed wavelet analysis on high-frequency data, suggesting statistical arbitrage op-

portunities in this context [5]. Concurrently, as discovered by Alemany et al., the arbitrage opportunities in the spot and stock index futures markets substantially altered the lead-lag dynamics [6]. In the overall market research on China`s stock index futures, scholars have also studied the market under different conditions. Yang (Greg) Hou and Steven Li examined the influence of trading measures on market fluctuation and spillover effects during market crashes, providing insights into the restoration of market efficiency [7]. The spot market can also be linked to ETFs. Byung Jin Yim and Xiang Yang researched the correlation between the CSI 300 Index futures and ETFs, reflecting the impact of variations in stock index futures according to the ETF index volatility. The impact of the futures on the actual market must affect the listed companies [8]. Through differentiated analysis, Wan Yinglin concludes stock index futures are a key player in reducing asymmetric information for quoted companies, and significantly impact the companies with larger market value turnover rates [9]. Although the aforementioned research appears to be quite comprehensive, there are still areas that need to be expanded in terms of the diversity of data analysis and research methods, as well as in the attribution of descriptions.

The above studies all draw positive and negative feedback from data models and give suggestions and inspirations concerning the impact of the future on the actual market. However, the changes in the spot market may not be directly caused by stock index futures, but also have an impact on investor confidence caused by the changes in stock index futures, indirectly leading to investor funds flowing into or out of the market. In the general direction, the bullish or bearish risk hedging of institutions will also affect the judgment of hot money in the market to a certain extent. This will exert a secondary effect on the actual market index. In addition, the above studies have a certain degree of similarity in the use of models, mainly using the TGARCH model for analysis to reach similar conclusions, and the extensibility of methods and the discussibility of results are not significant.

2. Methods

2.1 Data Preparation

The closing price for everyday CSI 300 index between April 16, 2008, and April 15, 2024, and the closing price of CSI 300 stock index futures between April 16, 2023, and April 15, 2024, represent some significant events, including the end of the coronavirus pandemic, the halving of stamp duty charges and the issuance of an additional trillion yuan of government bonds. The above data also reflects the recovery process of the Chinese market after the epidemic was affected by the government's economic policies.

2.2 Model Construction

2.2.1 Model GARCH

The general variance equation of the ordinary GARCH (p, q) model is described below [10]:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \epsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \quad (1)$$

Dummy variable d is introduced to change the above equation, and the dividing point is defined as the listing time of the CSI 300 stock index futures [2]. d=0 means the period before the listing time, and d=1 means the time after they go public. Thus, the above equation is converted into:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \epsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \lambda d \quad (2)$$

σ represents the conditional variance at time point t. α_0 is a constant term which means the variance of the base condition. α is the response coefficient to the previous residual squared ϵ_{t-i}^2 and is called the GARCH parameter. β is the response coefficient to the previous conditional variance σ_{t-i}^2 called the ARCH parameter. λ means the coefficient of the variable d, measuring the effect of the variable on the conditional variance.

2.2.2 Model TGARCH(GJR-GARCH)

The TGARCH model is also used for volatility analysis since it manifests the leverage effect. At the same time, in reality, when the actual rate of return is lower than the mean value equation, the volatility tends to be larger. To measure the asymmetric volatility of the yield rate, the TCAGCH model is described below:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} (\alpha_i + \gamma_i d_{t-i}) \epsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \quad (3)$$

The core of the TGARCH model lies in its asymmetric response to the square of residuals, i.e. when the residuals are negative, their effect on volatility may be different than when the residuals are positive. The positive effect of ϵ_{t-i} on σ^2 is $\alpha_i \epsilon_{t-i}^2$, while the negative effect of ϵ_{t-i} on σ^2 is $(\alpha_i + \gamma_i)\epsilon_{t-i}^2$, which shows the negative ϵ_{t-i} has a greater impact.

3. Results

3.1 Descriptive Analysis of the CSI 300 Index

Differential data processing is carried out on the CSI 300 data cited above, and the calculated rate of return R is multiplied by 100, where P is the closing price and t is the time point. This paper adopts the sample data of 2 years before listing (short-term), 14 years before and after list-

ing (long-term), and the characteristic period after listing (short-term), and thus researches and deduces the influence of CSI 300 futures on the actual market.

Table 1. Descriptive analysis of everyday returns of the CSI 300 index

	2 years	14 years	2023-2024
mean	0.034930	0.011726	0.070507
maximum	8.823781	9.586284	2.761875
minimum	-8.543818	-8.543818	-3.990312
Standard deviation	2.415315	1.561998	0.963473
kurtosis	1.369894	4.832491	1.479601
skewness	0.253270	0.606819	-0.489975
Confidence coefficient	0.214829	0.049107	0.122514

Table 1 describes the analysis results of the data from the three time periods. Column 2 has a thick tail with a kurtosis greater than 3, while Columns 1 and 3 have a thin tail with a kurtosis less than 3. Columns 1 and 2 show right skewness when their skewness is greater than 0, and column 3 shows left skewness when their skewness is less than 0. The above results show the statistical characteristics of non-normal distribution.

3.2 GARCH Model

After testing the ADF and ARCH effects of the above results, the consequences of Table 2 and Table 3 are obtained, which proves that the above results pass the test.

Table 2. Stability test of everyday returns of the index

	2 years	14 years	2023-2024
Prob	0.0000	0.00001	0.0000

Table 3. ARCH-LM examination

	2 years	14 years	2023-2024
Prob(F)	0.0000	0.0000	0.0000
Prob(Chi-Square)	0.0000	0.0000	0.0000

Virtual variable d was introduced to the conditional variance equation of the GARCH (1,1) model for fitting as exhibited in Table 4 below:

Table 4. The outcomes of GARCH(1,1) model

	2 years	14 years	2023-2024
α_0	0.000011	0.000005	0.000002
α_1	0.049990	0.100000	0.010172
β_1	0.929807	0.880000	0.969829
λ	0.001039	-0.000286	-0.000917

As shown in Table 2, the coefficient parameters are proven valid through the significance test, along with the coefficient of the variable d. According to its positive and negative properties and numerical inference, the coefficient λ of the CSI 300 futures is positive for two years around the listing time, indicating that the futures have positive feedback on the fluctuation of the actual market in the short term. The coefficient λ of 14 years is negative before and

after listing and at a specific time, indicating that the listing time of the futures exerts a long-term negative influence on the fluctuation of the spot market. Besides, in the case of special events, this coefficient has a certain degree of risk inhibition effect.

3.3 Descriptive Statistics of Association Analysis

Based on the analysis of everyday data between April 16, 2023, and April 15, 2024, a new series is obtained using logarithmic returns, as displayed in Table 5 below:

Table 5. Descriptive analysis of everyday returns

	CSI 300 Index	CSI 300 Index Futures
mean	-0.028278	-0.028599
maximum	1.484275	1.768494
minimum	-1.010782	-1.183202
Standard deviation	0.394160	0.419187
kurtosis	0.857935	1.572633
skewness	0.478588	0.536675
Confidence coefficient	0.050121	0.053303

Table 5 shows that the mean return rate of the CSI 300 index slightly exceeds that of the CSI 300 stock index futures. They both are less than 0, which indicates that the overall market is in a sagging tendency. Based on the comparison of standard deviation between the two, the strong price volatility reflects the returns of CSI 300 stock index futures fluctuate greatly. Meanwhile, skewness and kurtosis in Table 5 can prove that both of these two sequences are non-normal distributions.

3.4 GJR-GARCH Model

Table 6 illustrates the ARCH and GARCH coefficients of the two sequences are significant. The fitting results of the TGARCH model show that the α_1 index of CSI 300 stock index futures is larger. This demonstrates that it is more susceptible to external factors. In addition, β_1 values in both markets are much higher than a1 values, suggesting that market volatility depends more on its internal causes. At the same time, the value of $\alpha_1 + \beta_1$ in the two markets is less than but close to 1, which indicates that the market will stay fluctuating but its information will gradually weaken for future futures and spot fluctuations.

Table 6. The results of the TGARCH model

	CSI 300 Index	CSI 300 Index Futures
α_0	0.000008	0.000008
α_1	0.010000	0.020110
β_1	0.885000	0.965000
γ_1	0.010001	0.010030

By fitting the volatility of the CSI 300 index in the same period with the TGARCH model, the following Fig. 1 can be obtained:

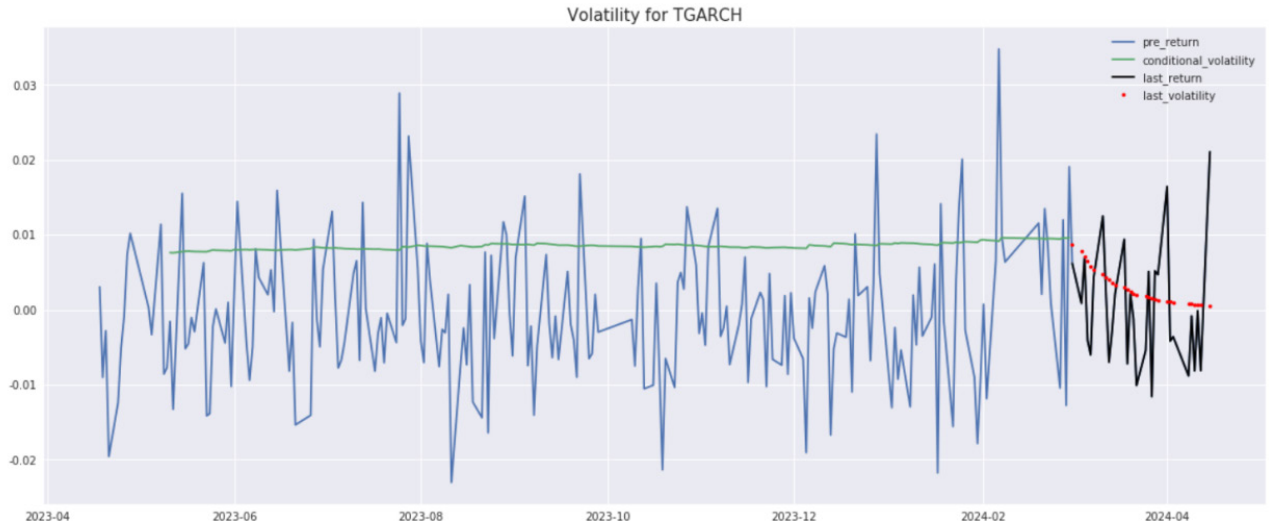

Fig. 1 Volatility for TGARCH

It can be seen from Fig. 1 that the volatility of CSI 300 is stable between -0.02 and 0.03 in the long run, and the overall market is in a state of gradual recovery in 2023 just after the end of the epidemic in China. As can be seen clearly in the chart, volatility increased after the implementation of the stamp duty halving policy in August 2023, as well as sharp volatility after the announcement of the issuance of 1 trillion Treasury bonds in early 2024, and gradually slowed down thereafter. In the case of several stimulus policies to intervene in the market, the fluctuation of the CSI 300 index did not exceed expectations, which proves that the CSI 300 stock index futures inhibit the spot market to some extent at any time after the listing.

4. Conclusion

This article empirically explores the impact of the virtual variables in the GJR-GARCH model on the actual market around the listing of CSI 300 stock index futures. In light of the practical historical market data, this study examines the short-term, long-term, and specific period effects on market volatility.

The experimental results reveal several findings: Firstly, the start of CSI 300 stock index futures exacerbates the volatility of the actual market in a short period; however, it exerts a remarkable dampening effect on market volatility in the long term and specific periods. Secondly, through studying specific periods using TGARCH model analysis, it can be inferred that under economic policies such as halving stamp duty or issuing government bonds, there is a temporary increase in market volatility due to policy stimulation; however, over time these policy effects gradually weaken due to internal market self-regulation and external factors such as options trading on index futures exerting inhibitory effects. Thirdly, from analyzing volatility charts fitted by TARGCH model estimation results, it is evident that markets respond more strongly to positive bullish news than negative bearish news. This may be attributed to China's large number of retail investors who tend to engage in leveraged operations during bullish times driven by speculative psychology.

Based on the above conclusions, the CSI 300 Index and CSI 300 Stock Index Futures exhibit significant asymmetric volatility due to various market factors such as institutional quantitative trading frequency and retail speculative psychology. As stock index futures reflect investors' expectations of the market, this conclusion largely depends on the accuracy of information dissemination in the futures market and the degree of cognitive bias and reaction lag caused by investors' information deviation. Therefore, the implementation of market incentives or restraints should consider more the integration efficiency of information transmission in the market and investors' ability to collect and process information to better mitigate asymmetric volatility in the market, through which stock index futures play a more important part in alleviating severe volatility of the actual market.

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