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Review Article

# The Impact of Stock Index Future Trading on Volatility of Underlying Market-Chinese Stock Market

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## Abstract

Stock price index futures have long been viewed by experts and scholars as a risk-hedging trading tool that can help investors' hedge risk and ensure the healthy and stable development of China's financial stock market. The asset underlying of stock price index futures is the stock price index. The CSI 300 stock index futures, a type of stock price index futures, were created on April 16, 2010, and its birth marked the official start of stock index futures trading in China. After the launch of CSI 300 stock index futures, the China Financial Futures Exchange launched (CFFEX) SSE 50 stock price index futures and CSI 500 stock price index futures one after another. The introduction of stock price index futures trading can bring about an impact on the volatility of the stock spot market to a certain extent and play a role in reducing volatility. The speed of transmission of stock index information to market participant decreases after the China Financial Futures Exchange restricts stock index futures trading. Based on the results that the coefficients of DF-DT, the cross term of the two dummy variables added to the GARCH model, have significant values and values less than zero, it can be analyzed that the restrictive measures taken by the China Financial Futures Exchange on stock index futures trading enhance the mitigating restrictive effect of the introduction of stock index futures trading in China on the volatility of the Chinese stock spot market.

**Keywords**: *Stock Index Futures, GARCH Model, Stock Market Volatility, Restrictions, Risk-Hedging, Financial Market.*



## 1. INTRODUCTION

The implementation of stock price index futures trading will have a very important impact on the Chinese stock spot market, mainly in terms of volatility, liquidity, volume and efficiency in the transmission of market information in the Chinese stock market. Among these influencing factors, the most studied and important issue is the study of market volatility. The volatility of the market is related to many factors, such as liquidity, information transmission efficiency, etc. It can directly reflect the volatility of the stock market returns over a period of time, so that volatility can be used to observe the possible risks of the stock market, so if the implementation of stock price index futures trading can be studied in depth to bring a certain degree of impact on the volatility of the Chinese stock spot market. The asymmetric effect of short news and the results of the research will be useful to provide some ideas and a little theoretical basis for future research on this issue. It can also provide a little help to the stability and health of stock price index futures market trading and play a role in ensuring their stability.

At the time of the stock market disaster, the financial exchanges also made a response by timely restricting the trading of stock price index futures, although the stock market storm has passed for many years, but so far this restriction has not played a corresponding role in the end, and how much influence has been played after the restriction of trading? We do not have a clear answer yet. Looking back at that time, this paper uses the 2015 stock market disaster as a backdrop to illustrate whether the restriction on trading of stock price index futures could have a certain degree of impact on stock market volatility and whether this impact is reduced. After the results of the empirical tests are obtained, the paper explains, based on the results of the study, whether it is still necessary to restrict trading in stock price index futures if a similar disaster occurs in the stock market again, and whether it is still necessary to continue to restrict trading in futures if the stock market is healthy and stable. And give some suggestions. At the same time, China is still working hard on new varieties of stock price index futures, and the country wants to introduce more types of futures trading, this study can also help the country to determine whether it can continue to introduce varieties of futures and introduce more types of futures trading. It has a strong practical significance.

The context of Reyes and Mario (1996) study is the European stock market and their approach is to construct an asymmetric EGARCH model for two countries, Denmark and France, respectively, and the issues studied are consistent with this paper. The latest findings of their research analysis are that the introduction of stock index futures trading has led to significant changes in the stock markets of both Denmark and France. Specifically, the introduction of stock price index futures trading in France significantly reduced the volatility of French stock prices. In contrast, Drimbetas, Sariannidis and Porfiris (2007), who apply the same methodology as they do, use statistics that are more distant for the present time, selected from August 1997 to April 2005, but despite their remoteness, their findings are still informative, and they construct an asymmetric EGARCH model, by which they The study found that after the introduction of stock price index futures trading, the efficiency of the market were increased and the volatility of the market conditions were greatly reduced. In contrast to the former study of one problem, Bologna and Cavallo (2002) explored two questions, one question is when the stock market becomes less volatile, is it because of the introduction of stock price index futures trading? The other question is, if the answer to the former question is yes, is the effect of futures trading related to other contingent factors? Their results are that the introduction of stock index futures trading did reduce the volatility of the stock market to some extent, but there seems to be no other chance factor that influenced the stock index futures trading to play its role in reducing the volatility of the stock market. Also using an asymmetric model is Kasman (2008), who constructs an asymmetric GARCH model, or EGARCH model, and the context of his study is the situation of the stock exchange market in Istanbul. The data he chose is more than a decade away from us, from July 2002 to October 2007. When stock price index futures trading was introduced in this country, the effect was to reduce the price volatility of the stock market in terms of the statistical results of the asymmetric GARCH model. Unlike the previous paper, Chen, Han and Li (2013) do not construct a garch model, but instead use a policy assessment approach to avoid errors due to the omission of variables due to too many factors, and their findings corroborate the results of this paper's empirical test that stock index futures trading reduces stock market volatility. Tian and Zheng (2013) use Using daily stock market return data, six years of data from 2007 to 2013 were selected to deform the GARCH model, using the method of introducing dummy variables in the model, and their empirical test results show that stock market volatility decreases with the implementation of stock price index futures trading, while giving a good signal to the stock market.

The data selected by Guanqi Li and Xiaojing Chen (2011) are more than ten years away from us, being the daily trading data of the CSI 300 index for the four years from 2006 to 2010, but their findings are still worthy of our reference, and they mainly build GARCH models and asymmetric EGARCH models on the data, and the conclusions of the empirical tests are consistent with the conclusions obtained in this paper. Stock price index futures trading can indeed significantly reduce the volatility of the spot market to some extent. Besides, the data years selected by Renchong Liu and Xue Guo (2016) are a bit closer to us, being the seven years from 2007 to 2014, and the data selected are the same as those selected in this paper, which are daily closing price series data of the CSI 300 index. They construct not only a GARCH model but also an asymmetric TARCH model. They not only empirically test the conclusion that the implementation of stock price index trading makes the volatility of the stock spot market significantly lower, but also study the asymmetric effect of the stock market and conclude that stock index futures trading makes the asymmetric effect of the stock spot market significantly lower as well. Li, De-Feng, Zhang, Li-Qing, and Huang, Xing-Xi (2012) used data from 2009 to 2011, and also used the daily closing prices of the CSI 300 index, and their empirical results concluded that the introduction of stock price index futures trading can indeed bring about a certain degree of impact on the volatility of the Chinese spot market, and the introduction of stock price index futures will also The introduction of stock price index futures will be effective in significantly reducing the probability of large daily fluctuations of listed stocks. The data used by Jianglin Lu and Jiaqiu Yin (2016) are also the most recent data from our current year, so their research results are more informative. They also constructed two models, GARCH and TARCH, respectively, and studied the CSI 300 stock price index futures, and from the analysis of the results after empirical data testing, it can be concluded that the introduction of stock price index futures trading can effectively make a change in the volatility of the stock spot market, significantly reducing it. Similarly, Renhai Hua and Peng Zhang (2012) conducted a study on the impact of futures trading, using CSI 300 stock price index futures, and thus the results lead to the same conclusion: CSI 300 stock price index futures trading can effectively mitigate the volatility of the market to some extent. Again, as in the case of the domestic stock market, they focus on the impact of stock index futures trading on the volatility of the Indian stock spot market. From the results of this empirical test, it can be concluded that, as in the case of the Chinese stock market, the introduction of stock price index futures trading in India significantly reduces the volatility of the Indian stock market, but there is no pattern to this effect at the moment.

**Empirical Analysis**

For financial time series with volatility aggregation, GARCH model can well solve the volatility aggregation problem and better describe the characteristics of time series data. After combing through the literature, it is found that the GARCH modeling effect is relatively better in the studies about exploring the impact of stock index futures on the volatility generated in the stock spot market. The idea of empirical analysis in this paper is as follows: the daily return series of CSI 300 index is tested for smoothness, then the mean equation of the series is determined, and then the ARCH effect test is conducted on the residuals of the previously determined mean equation with the ARCH effect test. GARCH model, and vice versa, the GAHCH model cannot be established. The innovation of this paper is to include two dummy variables in the GARCH model with conditional variance, which represent two events, namely, the implementation of stock index futures trading and the introduction of restrictive measures, to empirically investigate how the stock market volatility will be affected when the dummy variables of stock index futures and restrictive measures are added. The empirical parts are estimated using Eviews 9.0 statistical software for regression and fitting.

**GARCH Model**

In order to make the GARCH model a better explanation of the problem studied in this paper, it is first necessary to determine the form of the mean equation, of which the ARMA model is a more widely used method to establish the mean equation. Thus, this paper analyzes the impact of the introduction of stock index futures and stock index futures restrictions on stock market volatility based on the ARMA model and the GARCH model in econometrics. The model used in this paper is.

Mean value equation: $R_t = \alpha_0 + \alpha_1 \text{AR(a)} + \alpha_2 \text{MA(b)} + \varepsilon_t$
Conditional variance equation: $\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-1}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t=j}^2$

R in the mean equation represents the return, “a” represents the lagged order of the ARCH term AR, “b” represents the lagged order of the GARCH term MA, and $\varepsilon_t$ represents the stochastic disturbance term; the conditional variance equation in the GARCH model $\alpha_i$ is the coefficient of the squared residual term in the lagged period, representing the effect of new information in the recent market on market volatility. $\alpha_i$ A smaller value indicates that the speed of information transmission to the spot market has decreased. $\beta_j$ Is the coefficient of the lagged conditional variance term, which represents the effect of old information on market volatility in the past. $\beta_j$ The more persistent the impact of old information on market volatility.

**Adding Dummy Variables to the GARCH Model**

In order to examine whether the implementation of CSI 300 stock price index futures trading can bring a certain degree of impact on Chinese stock market volatility before and after the implementation of CSI 300 stock price index futures trading, whether the volatility of Chinese stock market after the implementation of CSI 300 stock price index futures trading is related to the stock index futures restrictions to some extent, and how the above changes can be brought about after the China Financial Futures Exchange has restricted stock index futures trading. In this paper, a new GARCH model is constructed, which is based on the GARCH model, adjusting the conditional variance equation and adding two dummy variables DF and DT and their cross terms DF "DT to measure the magnitude of stock market volatility. The conditional variance equation of the modified GARCH model is.

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-1}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t=j}^2 + \lambda_1 \text{DF} + \lambda_2 \text{DT} + \lambda_3 \text{DF} \times \text{DT}$$

The dummy variable DF is assigned to 0 and 1, where DF is 0 before the launch of stock index futures and 1 after the launch of stock index futures, and the dummy variable DT is assigned to 0 and 1, where DT=0 indicates before the launch of stock index futures restrictions and DT=1 indicates after the launch of stock index futures restrictions. Where D T = 0 indicates before the introduction of index futures restrictions and DT = 1 indicates after the introduction of index futures restrictions.

Coefficient of DF$\lambda_1$ The coefficient of DT is an indication of whether the introduction of stock price index futures trading can have some impact on the volatility of the stock spot market, and how this impact is enhanced or diminished. $\lambda_2$ indicates whether the volatility of the stock spot market can be changed after the restriction of stock price index futures trading. If $\lambda_1$ passes the significance test, then it can be said that the implementation of CSI 300 stock price index futures trading can indeed bring about a certain degree of impact on the volatility of the Chinese stock spot market; if $\lambda_1$ not significant, it means that the implementation of CSI 300 stock price index futures trading does not change the volatility of the Chinese stock market. Looking at the impact specifically: if $\lambda_1$ >0, then it can be said that the impact of the implementation of stock price index futures trading on the volatility of the spot market is playing a negative role in increasing volatility; if $\lambda_1$<0, then it is said that the impact of stock price index futures trading on spot market volatility has a positive impact on reducing volatility; it is worth noting that if $\lambda_1$= 0, it indicates that when stock price index futures trading was implemented, it did not affect the volatility of the Chinese stock market, i.e., not only did it not contribute to an increase in the volatility of the stock spot market, but also did not contribute to a decrease in the volatility of the stock spot market.

Similarly if $\lambda_2$ is significant, then it indicates a change in stock market volatility after restricting trading in stock price index futures, and vice versa, no change.$\lambda_2 > 0$, then it indicates that the volatility of the market increased after restricting trading; while $\lambda_2 < 0$, then the market volatility has become smaller; if $\lambda_2 = 0$ if the market volatility has not changed, then the market volatility has not changed.

If the estimated parameter $\lambda_3$ is significantly non-zero, then it can be said that restricting trading in stock price index futures will have a significant effect on stock market volatility; will this effect be positive or negative? This needs to be determined based on $\lambda_1$ and$\lambda_2$ the sign and value of the

**Sample Selection and Processing**

The stocks of CSI 300 index have the advantage of large size and good liquidity, so this index can represent the A-share market well. Therefore, the original data selected for this paper is the daily trading data of CSI 300 index, a total of 3830 daily closing price data, which are collected and collated from CSMAR database to study whether CSI 300 index is affected by CSI 300 stock index futures and it's The sample time period chosen is from January 4, 2005 to December 30, 2022. In order to better study and analyze the impact of stock index futures on the volatility of the spot stock market, this paper divides the daily closing price data of the CSI 300 index into two intervals in chronological order, and then analyzes the data by using dummy variables. The first interval is from January 4, 2005 to April 15, 2010, because the implementation of CSI 300 stock index futures trading was on April 15, 2010. In this interval, so that DF takes the value of. This means that stock index futures trading has not yet been implemented. The second interval is from April 16, 2010 to December 30, 2022, during which DF is assigned a value of 1, indicating that index futures trading has been implemented. The date of the restrictive measures on stock index futures by the China Financial Futures Exchange is September 2, 2015, so the DT is assigned a value of 0 from January 4, 2005 to September 2, 2015, i.e., before the restrictive measures, and a value of 1 based on the DT from September 3, 2015 to December 30, 2022, i.e., after the restrictions. The implementation of measures to restrict futures trading is made independent, based on which it is possible to better study and analyze whether the introduction of policies to restrict trading in stock index futures has brought about a certain degree of impact on the volatility of the spot market.

Before conducting the statistical analysis, considering the special characteristics of financial time series data, we should do the processing of the data in advance, first take the logarithm of the daily closing price series, and then calculate the difference of the logarithm, so as to get the daily return series of CSI 300 index. Here is the calculation formula. $A_t$ =(In $B_t$ × In$B_{t-1}$) ×100%

In this formula, $A_t$ denotes the daily return of CSI 300 index, $B_t$ is the daily closing price of CSI 300 index at time t, and $B_{t-1}$ is the daily closing price of CSI 300 index at time t-1. After this processing, the original daily return data used in the empirical analysis is 3829.

**Descriptive Statistics**

Prior to the empirical test analysis, descriptive statistics are required to provide a brief description of the daily log return data of the CSI 300 index. The data processing for the empirical analysis was performed using Eviews 9.0 software. Figure 1 shows the series volatility graph, which reflects the volatility of the daily log return series of the CSI 300 index.

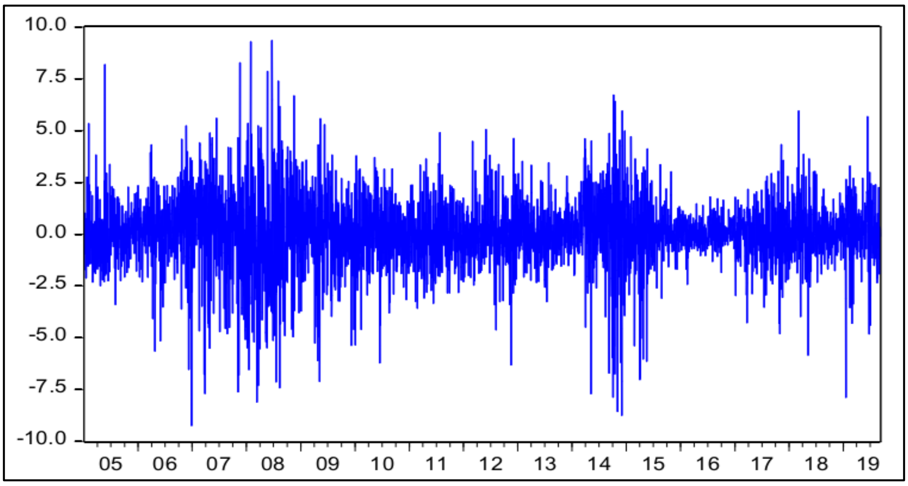


**Figure 1: Fluctuation of daily log returns of CSI 300 Index**
**Data source: Shanghai Stock Exchange website**

From the figure we can see that the CSI 300 daily log return volatility has obvious volatility aggregation characteristics: when the magnitude of the volatility is large, the volatility within this fixed interval are more concentrated, the latter volatility will not immediately become smaller, but equally larger; when the magnitude of the volatility is smaller, within the fixed time interval, the latter volatility will not immediately become larger, but equally smaller. It indicates that there is ARCH effect in the series.

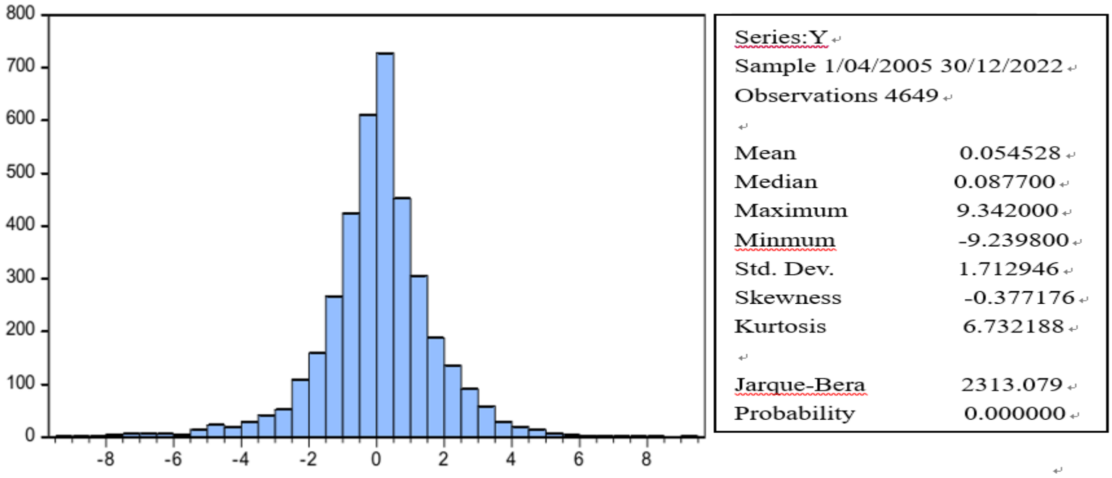


**Figure 2: CSI 300 Index bar Chart and Descriptive Statistics**
**Data source: Calculated based on data from the Shanghai Stock Exchange website**

Eviews 9.0 software can obtain the bar chart and descriptive statistics of the daily log return series of CSI 300 index, and the results show that the series has a very obvious spike and thick tail feature. From this, we can understand the basic statistical characteristics as follows: mean is 0.054528, median is 0.087700, maximum is 9.342000, minimum is -9.239800, standard deviation is 1.712946, skewness is -0.377176, kurtosis is 6.732188, J-B statistic is 2313.079, and p-value is. Because we know the skewness of the standard normal distribution is. The kurtosis value of the series is obviously greater than 3, and the spike characteristic of the series is very significant; the skewness is less than 0, and the time series shows the characteristic of left bias obviously. At the same time, the p-value of J-B test is 0 also indicates that the original hypothesis that the series satisfies the normal distribution should be rejected, and the results can be judged to be stronger, that is, the series can be identified as not obeying the normal distribution.

**Smoothness Test**

Time series financial data that are not characterized by smoothness prior to modeling and are directly modeled for statistical analysis will not yield convincing conclusions. Therefore the premise of the test is that both series to be tested need to meet the smoothness requirement. Firstly, the smoothness test of the return series data used in the empirical analysis can lay the foundation for the GARCH model construction. When the results of the smoothness test show that the yield series is non-smooth, it will lead to the problem of "pseudo-regression" and the empirical results are not interpretable. In this paper, the ADF unit root test is used to test the smoothness of the daily return series, and the series are divided into two intervals according to the time order, and the daily logarithmic return series of CSI 300 stock index for the first interval (January 4, 2005 to December 30, 2022) and the second interval (April 16, 2010 to December 30, 2022) are tested. The daily log return series of CSI 300 stock index futures for the period from April 16, 2010 to December 30, 2022 are tested for smoothness, in addition to the PP test, where the PP test serves to further verify the findings of the ADF test. The software used is EVIEW S software and the results obtained are shown in the table below.

**Table 1: Summary of ADF smoothness test and PP test for daily log return series of CSI 300 index**

| Stability check | Type | T-statistic | Probability |
|---|---|---|---|
| | ADF statistic test with intercept term only | -60.25730 | 0 .0001 |
| ADF Inspection | ADF statistic test with trend and intercept terms | -60.26526 | 0 .0000 |
| | Unconditional ADF statistic test | -60.20472 | 0.0001 |
| | | Adjusted t-statistic | Probability |
| | PP statistic test with intercept term only | -60.28199 | 0.0000 |
| PP Inspection | PP statistic test with trend and intercept terms | -60.28811 | 0.0000 |
| | Unconditional PP statistic test | -60.26526 | D.0000 |

The results of the stability test are shown in Table 1, in which, in the unit root test with only the intercept term, the value of the t-statistic is -60.25730, with a p-value of 0.0001, rejecting the original hypothesis that the data pass the unit root test with the intercept term; in the unit root test with the trend term and the intercept term, the value of the t-statistic is -60.26526, with a p-value of 0 In the statistical test of unit root test without intercept and trend term, the value of T-statistic is -60.20472, P-value is 0.0001, which rejects the original hypothesis, that is, the data pass the unit root test without intercept and trend term, so we believe that the daily log return of CSI 300 stock index series is a smooth series.

This paper also uses the PP test to verify the results of the ADF test to further ensure the reliability of the test results. the results of the PP test show that the CSI 300 index series is a smooth series, so the daily return series of CSI 300 index can be subjected to Granger causality test as well as GARCH modeling.

**Table 2: Summary of ADF smoothness test and PP test for daily log return series of CSI 300 stock index futures**

| Stability check | Type | T-statistic | Probability |
|---|---|---|---|
| | ADF statistic test with intercept term only | -50.24088 | 0 .0001 |
| ADF Inspection | ADF statistic test with trend and intercept terms | -50.24748 | 0 .0000 |
| | Unconditional ADF statistic test | -50.24808 | 0.0001 |
| | | Adjusted t-statistic | Probability |
| | PP statistic test with intercept term only | -50.24154 | 0.0001 |
| PP Inspection | PP statistic test with trend and intercept terms | -50.24867 | 0.0000 |
| | Unconditional PP statistic test | -50.24929 | D.0001 |

In the same way as above, the smoothness of the daily return series of CSI 300 stock index futures is tested. In the unit root test with only the intercept term, the t-statistic is -50.24088, with a p-value of 0.0001, rejecting the original hypothesis that the data pass the unit root test with the intercept term; in the unit root test with the trend term and the intercept term, the t-statistic is -50.24748 ,with a p-value of 0, rejecting the original hypothesis that the data pass the unit root test with the trend term and the intercept term; in the unit root test without In the unconditional unit root test, the T-statistic is -50.24808, and the P-value is 0.0001, which rejects the original hypothesis, i.e., the data does not pass the unconditional unit root test; in summary, it shows that there is no unit root in the daily log return series of CSI 300 stock index futures, i.e., the daily log return series of CSI 300 stock index is consistent with the characteristics of a smooth series. To ensure the robustness of the experimental results, the PP test is used in this paper to further verify that the CSI 300 stock index futures series conforms to the characteristics of a smooth series. Therefore, Granger causality test as well as GARCH modeling can be performed.

**Grange: Causality Test**

The test method used in this paper is the Granger causality test, and the object of the causality test is two return series, that is, to test whether there is a causal relationship between the CSI 300 index return series and the CSI 300 stock index futures return series, X appearing in the table represents the CSI 300 index return series, and Y appearing in the table represents the CSI 300 stock index futures return series, and the results shown in Table 3. Table 3 shows the results of the lagged 5 period test.

**Table 3: Granger causality test results**

| Original hypothesis | Lag Period | F-statistic | P-value |
|---|---|---|---|
| Y does not Granger Cause X | 1 | 0.76039 | 0.3833 |
| X does not Granger Cause Y | | 29.4027 | 6.E-08 |
| Y does not Granger Cause X | 2 | 1.99487 | 0.1362 |
| X does not Granger Cause Y | | 14.0446 | 9.E-07 |
| Y does not Granger Cause X | 3 | 12.5606 | 4.E-08 |
| X does not Granger Cause Y | | 9.43102 | 3.E-06 |
| Y does not Granger Cause X | 4 | 10.2950 | 3.E-08 |
| X does not Granger Cause Y | | 6.97670 | 1.E-05 |
| Y does not Granger Cause X | 5 | 7.98183 | 2.E-07 |
| X does not Granger Cause Y | | 5.54573 | 4.E-05 |

The test results in Table 3 show that at a lag of 3 periods, when it is assumed that Y is not causal to X, the P-value is $4 \times 10^{-8}$, which is less than 0.01, that is, the original hypothesis is rejected at the 1% level of significance, indicating that there is a significant Granger causality of Y to X.

When it is assumed that X is not causal to Y, its P-value is $3 \times 10^{-6}$, which is less than 0.01, so the original hypothesis is rejected at the 1% level of significance, indicating that there is also a significant Granger causality of X to Y; then when lagged 3 periods, there is a relationship between the two that are Granger causal to each other. At lag 4, when it is assumed that Y is not causal to X, the p-value is $3\times10^{-8}$, which is less than 0.01, that is, the original hypothesis is rejected at 1% level of significance, and there is a significant Granger causality of Y to X. When it is assumed that X is not causal to Y, the p-value is $1\times10^{-8}$, which is less than 0.01, that is, the original hypothesis is rejected at 1% level of significance, and there is a significant Granger causality of X to Y. causality, indicating that there is a reciprocal Granger causality between the two. At lag 5, the two are also Granger causal to each other. When the lags are 1 and 2, there is unidirectional causality between X and Y, but not bidirectional Granger causality. Thus, after testing we found that the volatility of stock index futures caused the volatility of CSI 300 index in the short term. Therefore, the GARCH model was adjusted, and the dummy variable representing the implementation of stock index futures trading was added to the original basic GARCH model, and the data were statistically and analyzed with the new GARCH model.

**Determining the GARCH Model Mean Equation**

In order to ensure that the GARCH model can illustrate the problem better, before choosing the lag order of the model, it is necessary to establish an ARMA model for the daily log return series of the CSI 300 index, establish the mean equation using the ARMA model, and conduct regression analysis using EVIEWS software to derive the estimation results of models of different orders. Regression estimation was done for the four models ARMA (1, 1), ARMA (1, 2), ARMA (2, 1), and ARMA (2, 2), respectively, and the AIC and SC values corresponding to these four models were obtained, and the results are shown in Table 4-4.

**Table 4: AIC and SC values for each ARMA model**

| Models | AlC | SC |
|---|---|---|
| ARMA(1.1) | 3.913,342 | 3.919872 |
| ARMA(1.2) | 3 .913856 | 3 .922018 |
| ARMA(2.1) | 3.913857 | 3.922019 |
| ARMA(2.2) | 3 .912253 | 3.912047 |

Now determine the specific order of the ARMA model. The criteria for determining the AIC and SC values are to reach the minimum at the same time. By comparing the magnitude of the AIC and SC values of the four ARMA models, ARMA (1, 1), ARMA(1, 2), ARMA(2, 1) and ARMA(2, 2), it is found that the AIC and SC values of ARMA(2, 2) are the smallest, so the final ARMA model is ARMA(2,2). The specific formula is:

$$R_t = \alpha_0 + \alpha_1 AR(2) + \alpha_2 MA(2) + \varepsilon_t$$

Where $\varepsilon_t$ is the random perturbation term.

Next, the ARCH-LM effect test is performed, which is a test of the mean equation with a well-determined order, and the lag order is chosen to be 1st order, and the following are the results of the test.

**Table 5: Results of ARCH-LM effect test for the mean equation**

| ARCH-LM effect test | | | |
|---|---|---|---|
| F-statistic | 116.3943 | Prob, F(1.3826} | 0.0000 |
| Obs-squared | 113.0170 | Prob. Chii-Square (1) | 0.0000 |

From the test results, we can get that the concomitant probability of its F-statistic is 0, while the concomitant probability of the chi-square statistic is also 0. Therefore, there is a good reason to reject the original hypothesis, that is, to reject the hypothesis that there is no ARCH effect in the model, so the test results show that the ARCH effect of the residual series of the ARMA (2, 2) model is obvious, and the test results fully indicate that it is possible to construct a GARCH model for the CSI 300 stock index yield series to construct a GARCH model.

**Determining the order of the GARCH model**

The fitting effect was judged based on the AIC criterion and SC criterion, and the most suitable GARCH model order was selected by comparing the magnitude of the AIC, SC values of the conditional variance equation in the GARCH (1, 1) model, GARCH (1, 2) model, GARCH (2, 1) model, and GARCH (2, 2) model. The above statistical analyses were fitted in Eviews software.

**Table 6: AIC and SC values of test results**

| Models | AlC | SC |
|---|---|---|
| ARMA(1.1) | 3 .626251 | 3 .637683 |
| ARMA(1.2) | 3.626741 | 3.6.39800 |
| ARMA(2.1) | 3 .626721 | 36.39780 |
| ARMA(2.2) | 3 .626256 | 3.640943 |

From Tables 6, we can see that the best fit should be the GARCH (1, 1) model, so our base model is GARCH (1, 1), on which the daily return series of CSI 300 stock index is added in.

**4.7.2. Model building**

After establishing the GARCH (1, 1) model, it is necessary to estimate this model, and the estimated results are shown in Table 7.

 

**Table 7: Final parameter results of GARCH (1,1) model estimation**

| Conditional variance equation | | | | |
|---|---|---|---|---|
| Variables | Coefficient | Standard Error | Z-statistic | Concomitant probability |
| C | 0.131612 | 0.037631 | 3.497481 | 0.0005 |
| RESID(-1)^2 | 0.068636 | 0.004035 | 17.00867 | 0.0000 |
| GARCH(-1) | 0.924227 | 0.004442 | 208.0744 | 0.0000 |
| DF | -0.114 133 | 0.052149 | -2.188606 | 0.0286 |
| DT | 0.040258 | 0.045969 | 0.875772 | 0.3812 |
| DF· DT | -0.021578 | 0.005087 | -4.241723 | 0.0000 |

Using Tables 7, the conditional variance equation of the modified GARCH model is obtained as.

$$\sigma_t^2 = 0.131612 + 0.068636\varepsilon_{t-1}^2 + 0.9242276\sigma_{t-1}^2 + 0.9242276$$
$$0.040258DT - 0.114133DF - 0.021578\ DF \times DT$$

All coefficients of the model are significant at least at the 10% significance level, and the ARCH term coefficient of the variance equation α =0.068636>0, GARCH term coefficient β =0.924227>0, and the concomitant probabilities are all zero and satisfy $\alpha + \beta$ <1,indicating that the model proposed in this paper is reasonable and satisfies the GARCH model stability condition. We can see. α < β , the β A large value indicates that the market volatility is influenced by the old information for a long time. A small value indicates that the effect of new information on stock market volatility is small, i.e., when there is newly issued information in the market, the effect of new information on stock spot market volatility is less than the effect of old information on stock spot market volatility.

The residual series of the GARCH (1, 1) model are tested again for ARCH-LM effects.

**Table 8: Results of ARCH-LM test for GARCH (1, 1) model**

| **ARCH-LM effect test** | | | |
|---|---|---|---|
| F-statistic | 0.442751 | Prob. F(1.3826} | 0.5058 |
| Obs-squared | 0.442931 | Prob , Chi-Squair(1) | 0.5057 |

From the test results, the concomitant probability of the F-statistic is 0.5058 and the concomitant probability of the chi-square statistic is 0.5057, both of which are greater than the 10% significance level. This result indicates that there is no ARCH effect in the series after the GARCH (1, 1) model is fitted, and there is no ARCH effect in the modified GARCH model established in this paper.

The results of the model in Table 7 show that the coefficient of the dummy variable DF is negative with a probability value of 0.0286, and the 5% level of significance is significant, did reduce the volatility of the stock market.

The dummy variable DT, which represents the introduction of stock index futures restrictions, has a positive coefficient intestine, corresponding to a probability value of 0.3812, which does not pass the significance level test, which indicates that, during the 15-year period from 2005 to 2022, the volatility of the Chinese stock spot market did not change after the restriction of stock price index futures trading in that time period, but after the implementation of stock price index futures trading The implementation of restrictions significantly reduces the volume, turnover, and position of stock index futures, which indirectly suggests that the implementation of restrictions on stock index futures makes stock index futures do not have a negative impact on the volatility of the Chinese stock market.

The coefficient of the cross term DF×DT of variable DF and variable DT is purely -0.021578 with a concomitant probability of 0, which passes the significance test, i.e., this result indicates that when the trading of stock price index futures is restricted, it enhances the attenuating effect of stock index futures trading on the volatility of Chinese stock market, and, there is some improvement in the volatility of Chinese stock market after the introduction of stock index futures.

**GARCH Modeling by Time Period**

The CSI 300 stock index futures were launched on April 15, 2010, so the CSI 300 index was divided into two intervals in chronological order, the first interval is before the launch of futures (January 4, 2005 to April 15, 2010) and the second interval is after the launch of futures (April 16, 2010 to December 30, 2022). The return series for each of these two intervals are treated analytically by another GARCH modeling, and the results are shown in Table 9.

 

**Table 9: Parameters of the GARCH model**

| Time Period | Before the launch of CSI 300 stock index futures (2005.1.1-2010.4.15) | After the launch of CSI 300 stock index futures (2010.4.16-2022.12.30) |
|---|---|---|
| C | 0.033384 | 0.012060 |
| α | 0.070304 | 0.059517 |
| β | 0.927787 | 0.934385 |

Table 9, Represents the information parameter, which reflects the speed of information transmission to the spot market; p represents the persistence parameter, which reflects the persistence of the impact. From the empirical test results we can see that. s value was 0.070304 before April 15, and according to the data in the table we can see that its value decreases to 0.059517 after the launch, which indicates that the stock index futures trading reduces the speed of information transmission to the spot market, and, when the launch of the stock index futures restrictions will further contribute to the weakening of the speed of information transmission to the spot market from stock index futures trading.

The results show that the value of the persistence parameter p in the GARCH model is 0.927787 before the launch, and after the launch the value of the persistence parameter p in the GARCH model increases to 0.934385. The larger coefficient of the persistence parameter p indicates that the impact of old information on the stock market is more persistent, and also when the CSI 300 stock index futures are launched, it enhances the historical information on price volatility in the stock market.

## CONCLUSIONS AND INSIGHTS

The results of the empirical tests in this paper show that the introduction of stock price index futures trading can significantly reduce the volatility of the stock market referred to by the spot market in the near future, while the introduction of restrictions on futures trading can further enhance this volatility-reducing effect, which indicates that the implementation of stock price index futures trading and the introduction of restrictions on stock index futures have played a role in effectively stabilizing stock market volatility. This finding suggests that the implementation of stock price index futures trading and the introduction of restrictions on stock index futures have played a role in effectively stabilizing stock market volatility. In response to the accusation by many experts and scholars that the implementation of stock index futures trading in China was the culprit of this year's stock market crash, the results of the empirical tests of abnormal stock market volatility show that this view is still not entirely valid, and the real culprit of the abnormal stock market volatility is still in the Chinese stock market. We still believe that the infrastructure of the Chinese stock market needs to be strengthened. We should also note that as the stock index futures market continues to deepen and evolve and develop, the stock index futures market itself, as a financial futures derivatives market, should still make continuous efforts to improve itself and gradually form a mature stock index capital futures market service system that will play an important role in promoting China's financial real market economy. To sum up, I think we can discuss the policy suggestions to promote the mature and stable benign development of China's stock market from the following three aspects: strengthening the infrastructure of the stock market, strengthening the infrastructure of the stock index futures market and ensuring the harmonious operation of both futures and spot markets.

The findings of this paper are drawn from the analysis of stock market data in China and have implications for other countries as well. That is, the two levers of stock index futures and legal policies should be fully utilized to balance the stock spot market and prevent large ups and downs in the spot market.

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