Research on the stabilizing effect of stock index futures on A-share market in China-- From the perspective of Shanghai A-share abnormal volatility

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Abstract. In addition to having the function of price discovery and hedging, stock index futures have attracted wide attention from scholars, due to its special systemic risk avoidance mechanism. China's stock index futures were launched in a short time, with the Shanghai and Shenzhen 300 index futures as a typical representative. This paper is based on data samples of the daily closing price of the IF300 index futures and The Shanghai Composite Index from 16 April 2010 to 17 October 2019.Used The GARCH model and the virtual variable regression model, it analyze the negative feedback effect of the IF300 index on the abnormal fluctuation of A-shares in the Shanghai Composite market. The research shows the IF300 index futures are highly correlated to the Shanghai Composite index, and the price has convergence, in the normal market. Under the abnormal situation of the Shanghai A-share market, the IF300 index futures have a relatively significant negative feedback effect, and it can play a role in stabilizing the Shanghai A-share stock market.

Keywords: Stock Index Futures; Stability Effect; GARCH Model; Virtual Variable

1 Introduction

On April 16, 2010, stock index futures were officially listed in China Financial Futures Exchange. As the first listed financial futures products in China, not only filled the vacancy of hedging in China's A-share market, but also marked the acceleration of China's financial innovation process. China's Shanghai Composite Index is 998 points at the end of 2005, it rised to 6124 points in October 2007, then down to 1664 points in 2008. The large fluctuations of the stock market, make investors have a strong demand for risk-averse financial instruments. The second big fluctuation of the Shanghai Composite Index was from 1849.6 points in May 2013 to 5178 points in June 2015, and then fell to 2560 points in February 2016, and has been fluctuating around 3000 points since then. From 2005 to 2008, the Shanghai Stock Index increased by 6 times and fell by nearly 4 times; from 2013 to 2015, the stock index increased by 2.8 times and fell by 2

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times. At this time, China's stock index futures have been launched for several years, and the reduction of the rise and fall multiple is A reflection of the stabilizing effect of stock index futures in the A-share market.

The function of stock index futures in theory: (1) price discovery;(2) Stock index futures can weaken the trading behavior, stabilize the market and reduce trading risks;(3) Stock index futures can reduce systemic risk;(4) Stock index futures can improve the operating efficiency of the securities market. Since the stock index futures came into in the 1970s, scholars still have different views on the stability of stock index futures on the spot market. Especially the emergence of the financial crisis, some scholars believe that stock index futures trading played a role in boosting.

2 Literature review

Scholars from various countries have roughly divided into three views. The first view is that stock index futures can stabilize the volatility of the spot market. Grossmans and Miller (1988) [1] believe that the listing of stock index futures attracts more investors to enter the market and brings more long-term capital, which improves the effectiveness of the spot market. Sung, Kwon and Park(2004)[2]conducted an empirical analysis on the trading data of Korean index futures and found that after the launch of stock index futures, as an effective hedging tool, the exchange of information in the spot market was enhanced, thus reducing the volatility of the spot market .Ma Xiaonan (2013)[3] selected before and after the launch of IF 300 stock index futures as the research interval and used GARCH model to conduct regression analysis on the daily return rate of stock index futures, indicating that the introduction of stock index futures in China reduced the volatility of the spot market to a certain extent. The second view is that stock index futures trading has no effect on the spot market. Pericli & Koutmos (1997) [4] made use of the daily return data of the Standard & Poor's 500 Index in the United States and established a model analysis and found that the volatility of the spot market did not change significantly after the listing of the stock index futures. Mou Hui and Yuan Shengxuan (2018) [5] selected daily closing data and high-frequency data of China's small and medium cap stock indexes and used GARCH model for empirical analysis, showing that stock index futures had extremely weak influence on the A-share market effect. The third view is that the effect of stock index futures on the spot market will increase the risk of the spot market. Lockwood(1990) and Damodaran (1990)[6] respectively used Standard & Poor's 500 index in different time periods as analytical data and different models as analytical methods. By comparing various indicators reflecting the spot market before and after the launch of futures, they showed that the listing of stock index futures led to increased volatility in the spot market. Li Jian (2013) [7] selected 15-minute high-frequency data of IF 300 stock index futures, processed the data, and used the EGARCH model for empirical analysis to find that compared with foreign futures markets, stock index futures in China had a more significant volatility effect on the spot market.

3 Empirical research.

3.1 Data selection and explanation

This paper selects the daily closing price data of IF300 stock index futures and Shanghai Composite Index from April 16, 2010 to October 17, 2020. Taking the launch time of IF 300 stock index futures as the starting point, examines the impact of IF 300 stock index futures on the volatility of the spot market in China. China's stock market has two major composite indexes: Shanghai Composite Index and Shenzhen Component index. The fluctuation of two indexes has a high positive correlation, and the price range volatility of Shanghai Composite Index also has typical characteristics, so this paper chooses Shanghai Composite Index as one of the samples for analysis. Used the time series data model [8], in order to ensure the continuity of data, the missing data of the stock market on holidays are replaced by the daily closing data.

Variable setting: X represents the daily closing data series of IF300 stock index futures, X1 represents its daily yield series; Y represents the daily closing data series of the Shanghai composite index, Y1 represents the daily return series of the Shanghai composite index.

X1 sequence and Y1 sequence: $Y_{1T}=\ln Y_T-\ln Y_{T-1}$, $X_{1T}=\ln X_T-\ln X_{T-1}$

Introduces dummy variable D to define the abnormal volatility of A-share market with the absolute value of 3% daily return. When $D_1=0$, the A-share market is normal market, and the absolute daily return rate of Shanghai composite Index is less than 3%; When $D_1=1$, the Shanghai A-share market belongs to the abnormal volatility market, and the absolute daily return of the Shanghai Composite index is greater than or equal to 3%.

The convergence of the IF300 stock index futures and the Shanghai Index.

Analysis based on OLS model

Table 1. Regression results of IF300 stock index futures and Shanghai composite Index

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	0.800292	0.005838	137.0851	0.0000
C	294.3608	18.52526	15.88970	0.0000
R-squared	0.883500	Mean dependent var		2783.424
Adjusted R-squared	0.883453	S.D. dependent var		536.0944
S.E. of regression	183.0175	Akaike info criterion		13.25785
Sum squared resid	83001575	Schwarz criterion		13.26254
Log likelihood	-16437.73	Hannan-Quinn criter.		13.25955
F-statistic	18792.32	Durbin-Watson stat		0.019263
Prob(F-statistic)	0.000000			

The regression equation:

$$Y=294.3608+0.800292X$$

$$t=(15.88970)(137.0851)$$

$$R^2=0.883500\ F=18792.32\ n=2480$$

The result from table 1：the slope of the sample regression line is 0.800292, indicating that the explanatory power of IF300 stock index futures is 80.0292%. R^2=0.883500,indicating that the goodness of fit of the model is good, and it can be considered that the price of IF300 stock index futures is highly correlated with the price of Shanghai composite Index. F test for the regression equation: H_0:β_2=0, the significance level of 5%, $F_{0.05}$（1,2478）=3.84.It can be seen from Table 1 that F = 18792.32, which is greater than the critical value 3.84,The original hypothesis H_0：β_2=0 is rejected, indicating that the regression equation is significant.

T test: Null hypothesis H_0:β_1=β_2=0, when α=5%,$t_{0.025}$（2478）=1.96.As can be seen from Table 1, t（β_1）=15.88970, t（β_2）=137.0851, both t values are greater than 1.96, so the null hypothesis H_0:β_1=β_2=0 is rejected. the IF300 stock index futures do have a significant impact on the closing price of the Shanghai index. It can be seen that the IF300 stock index futures and the Shanghai Composite Index have a very significant correlation.

Empirical analysis of abnormal volatility of A-share market based on GARCH model.

ADF test.

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.631039	0.2663
Test critical values:	1% level	-3.961749	
	5% level	-3.411622	
	10% level	-3.127682	

*MacKinnon (1996) one-sided p-values.

Fig. 1. Unit root test for variable X

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-38.37492	0.0000
Test critical values:	1% level	-3.961749	
	5% level	-3.411622	
	10% level	-3.127682	

*MacKinnon (1996) one-sided p-values.

Fig. 2. Unit root test of first-order difference for variable X

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.436641	0.3603
Test critical values:	1% level	-3.961755	
	5% level	-3.411625	
	10% level	-3.127684	

*MacKinnon (1996) one-sided p-values.

Fig. 3. Unit root test of variable Y

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-20.04483	0.0000
Test critical values:	1% level	-3.961755	
	5% level	-3.411625	
	10% level	-3.127684	

*MacKinnon (1996) one-sided p-values.

Fig. 4. Unit root test of first-order difference for variable Y

ADF test is conducted on variables X and variables Y, The T-test values of variables X in fig1 and Y in fig3 are -2.631039 and -2.436641, respectively, and the corresponding P-values are 0.2663 and 0.3603, that is, the sequences of variables X and Y are non-stationary. After processing the two-variable series in fig2 and fig4,it is found that the T-test values are -38.37492 and -20.04483 respectively, and the P-values are both 0.0000, that is, the first-order difference of variable X and variable series are both stationary series. Therefore, the return rate of IF300 stock index futures and Shanghai composite Index can be obtained by logarithmic processing of the daily closing price of variable X and variable Y.

Descriptive statistics.

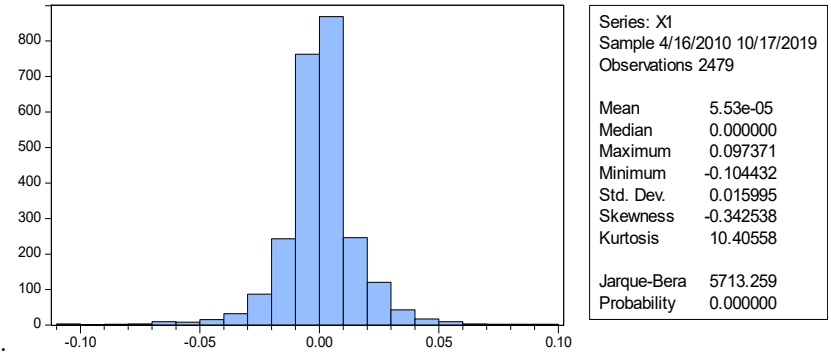


Fig. 5. Daily yield histogram and descriptive statistics of IF300 stock index futures

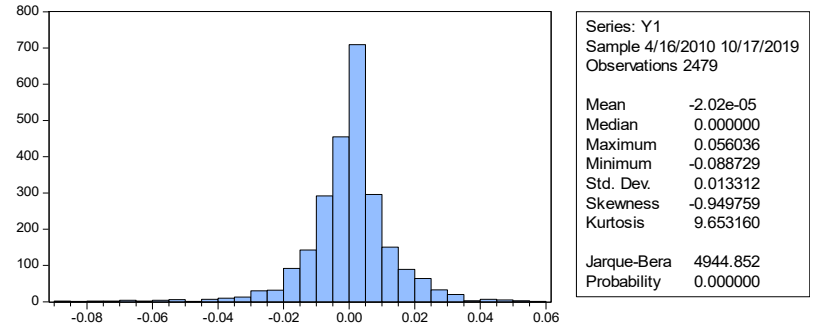


Fig. 6. Daily return histogram and descriptive statistics of Shanghai Composite Index

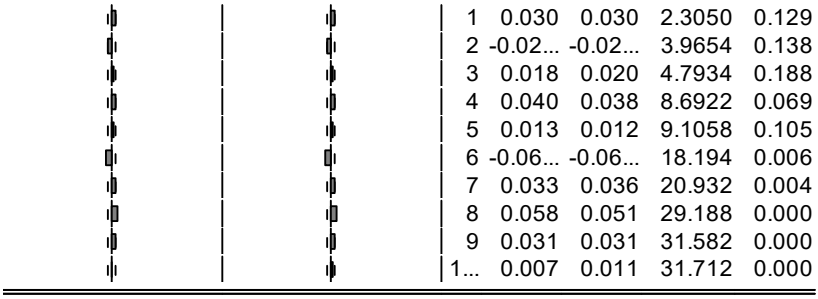
The data distribution from Figure 5 and Figure 6 has the characteristics of high cusp, The P value of IF300 stock index futures and Shanghai Composite Index daily return series is 0, rejecting the null hypothesis, that is, the two sample series do not obey the normal distribution.

3.2 Establish GARCH model

Suppose that the autoregressive equation of two sample sequence:

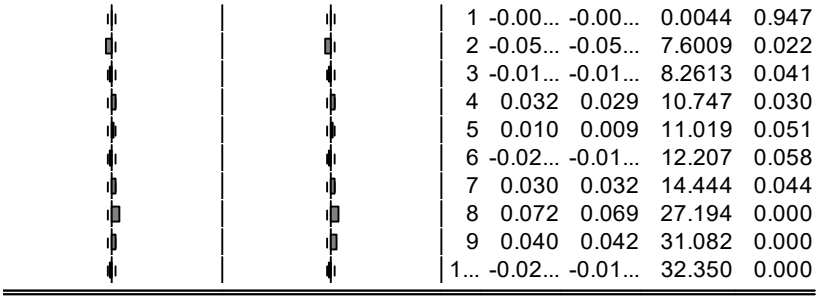
$$R_t^1 = c^1 + \sum_{i=1}^{n} \beta_i R_{t-1}^1 + \varepsilon_t \tag{1}$$

In the Formula 1, R_t^1 and R_{t-1}^1 represent the rate of return on t day and t-1 day respectively, c^1 represents the constant, n represents the order of lag, and ε_t represents the residual series. Through autoregressive analysis of two sample determine the value of nsequences. The autoregressive results of the two samples are shown in the following figure.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.030	0.030	2.3050	0.129
		2	-0.02...	-0.02...	3.9654	0.138
		3	0.018	0.020	4.7934	0.188
		4	0.040	0.038	8.6922	0.069
		5	0.013	0.012	9.1058	0.105
		6	-0.06...	-0.06...	18.194	0.006
		7	0.033	0.036	20.932	0.004
		8	0.058	0.051	29.188	0.000
		9	0.031	0.031	31.582	0.000
		1...	0.007	0.011	31.712	0.000

Fig. 7. Autoregression of Shanghai Composite Index.



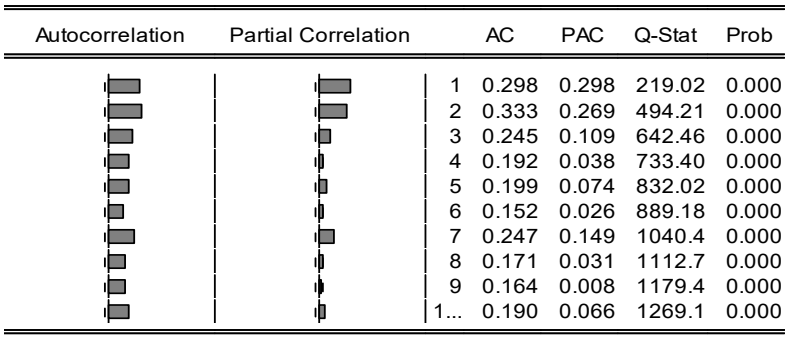
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.00...	-0.00...	0.0044	0.947
		2	-0.05...	-0.05...	7.6009	0.022
		3	-0.01...	-0.01...	8.2613	0.041
		4	0.032	0.029	10.747	0.030
		5	0.010	0.009	11.019	0.051
		6	-0.02...	-0.01...	12.207	0.058
		7	0.030	0.032	14.444	0.044
		8	0.072	0.069	27.194	0.000
		9	0.040	0.042	31.082	0.000
		1...	-0.02...	-0.01...	32.350	0.000

Fig. 8. Autoregression of IF300 stock index futures

From Figure 7 and Figure 8, we can see that the P-test values of the IF300 stock index futures series and the Shanghai Composite index series are both 0 when the lag is 8 orders, indicating significant autocorrelation, that is, both samples have significant autocorrelation with a lag of 8 orders. Therefore, the value of the lag order n is 8, and the autoregressive equation of the lag order 8 is established:

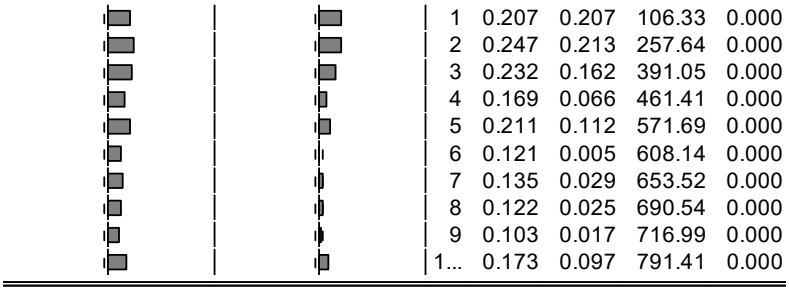
$$R_t^1 = c^1 + \sum_{i=1}^{8} \beta_i R_{t-1}^1 + \varepsilon_t \tag{2}$$

The residual square correlation table and graph were established for the autoregressive equation with a lag of 8 orders. The results are shown in the following figure:



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.298	0.298	219.02	0.000
		2	0.333	0.269	494.21	0.000
		3	0.245	0.109	642.46	0.000
		4	0.192	0.038	733.40	0.000
		5	0.199	0.074	832.02	0.000
		6	0.152	0.026	889.18	0.000
		7	0.247	0.149	1040.4	0.000
		8	0.171	0.031	1112.7	0.000
		9	0.164	0.008	1179.4	0.000
		1...	0.190	0.066	1269.1	0.000

Fig. 9. Correlation table of residual score of IF300 stock index futures



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.207	0.207	106.33	0.000
		2	0.247	0.213	257.64	0.000
		3	0.232	0.162	391.05	0.000
		4	0.169	0.066	461.41	0.000
		5	0.211	0.112	571.69	0.000
		6	0.121	0.005	608.14	0.000
		7	0.135	0.029	653.52	0.000
		8	0.122	0.025	690.54	0.000
		9	0.103	0.017	716.99	0.000
		1...	0.173	0.097	791.41	0.000

Fig. 10. Residual square correlation table of Shanghai Composite Index

According to Figure 9 and Figure 10, the P-value of the residual square is 0, which is very significant. It can be concluded that the residual sequence of two samples has a significant ARCH effect. Therefore, the GARCH model can be used to analyze the samples.

When D_1=0, the absolute value of daily return of Shanghai Composite Index is less than 3%. When D_1=1, the absolute daily return of Shanghai Composite Index is greater than or equal to 3%.The estimated results of this model are shown in Table 2.

Table 2. GARCH model estimation results after adding virtual variables

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X_1	0.774671	0.005120	151.3108	0.0000
D_1	-0.012901	0.003771	-7.690928	0.0000
C	-0.004702	0.007816	-0.0601619	0.9520
Variance Equation				

C	0.002514	0.000444	5.649640	0.0000
RESID(-1)^2	0.097680	0.005977	16.34192	0.0000
GARCH(-1)	0.900170	0.005681	158.4429	0.0000

R-squared	0.672234	Mean dependent var	-0.002024
Adjusted R-squared	0.671969	S.D. dependent var	0.013312
S.E. of regression	0.007625	Akaike info criterion	-7.765510
Sum squared resid	0.143939	Schwarz criterion	-7.751434
Log likelihood	9631.349	Hannan-Quinn criter.	-7.760397
Durbin-Watson stat	2.647426		

$$Y_1=0.004702+0.774671X_1-0.012901D_1$$

$$t=（0.007816）（0.005120）（0.003771）$$

$$R^2=0.672234$$

When $D_1=0$, that is, the absolute daily return of Shanghai Composite Index is less than 3%, the model：$Y_1=0.004702+0.774671X_1$

When $D_1=1$, that is, the absolute daily return of Shanghai Composite Index is greater than or equal to 3%, the model ：$Y_1=-0.008199+0.774671X_1$

The slope of the above two models is 0.774671, but the intercepts of the models are different, which are 0.004702 and -0.008199 respectively. When the absolute daily return of SSE index is greater than or equal to 3%, that is, $D_1=1$, and the spot market fluctuates abnormally, the intercept term of this model is -0.008199, indicating that the IF300 stock index futures have A negative feedback effect on the Shanghai A-share market when the spot market fluctuates abnormally.

4 Conclusion

Through empirical analysis, it is found that IF300 stock index futures can reduce the volatility of A share market under the abnormal volatility of the stock market. Therefore, the launch of stock index futures plays a positive role in improving China's financial risk management tools and financial market system. From the empirical analysis of abnormal fluctuations in the A-share market, the stability test confirms that the return series of IF300 stock index futures and Shanghai Composite Index are both stable. Therefore, it is necessary to process the logarithm of the sample data to obtain the series of daily logarithm return, so as to achieve the purpose of stability. After the introduction of dummy variablesit can be shown that the IF300 stock index futures have A negative feedback effect on the abnormal fluctuation of Shanghai A-share market. From the perspective of Shanghai A-share abnormal fluctuation, stock index futures can reduce the volatility in the spot market abnormal fluctuation. As A highly positive correlation of Shenzhen A-shares, whether it is highly consistent with the conclusion of the Shanghai A-share market can be further verified. Although China's stock index futures market has not developed for a long time, it has been moving forward in accordance with the

original direction of the country's vision. Of course, compared with the foreign mature market, the basic function of China's stock index futures has not been fully played. The stabilizing effect of stock index futures on the spot market remains to be verified.

Subject

Exploration and Practice of the training mode of" Digitalization, Full Chain and Double Empowerment "for financial and Economic Talents in Higher Vocational Colleges" Wuhan Polytechnic University-level scientific research Project [2022YJ009]

Research on the Innovative Practice of Classroom Teaching in Hubei Vocational Education Enabled by Digital Technology Hubei China Vocational Education Association 2023 Project [HBZJ2023336].

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