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An Empirical Study of China's Financial Stock Index Futures Effect on Stock Spot Market Based on CSI 300

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Abstract

Finance is the core of modern economy, and the capital market as a part of the whole financial system, it is the key to the development of a country's economy. In this paper, we analyze the impact of stock index futures on the stock market by using CSI 300 index. The result shows that the stock index futures not significant effects on the volatility of spot market; however, there exist a co integration relationship in both long term and short term. Granger causality analysis shows that the stock index future is not Granger cause to CSI 300, while the CSI 300 is Granger cause stock index futures. On this basis, we put forward relevant policy suggestions.

Keywords: *Stock index futures, Volatility, Financial markets, CSI 300, VAR model*

1. Introduction

Finance is the core of modern economy, so the financial development is the key to the development of a country's economy, and the capital market as a part of the whole financial system, its importance in the development of a country cannot say too much. Since China's reform and opening up, the economy has maintained a rapid growth trend, the overall strength of the economy and the international status has also been significantly increased, in which the continuous development of the financial system and improve the sustainable and stable development of the economy to provide adequate power [1]. As a part of the financial system, China's securities market has gone through more than 20 years, the relevant laws and regulations gradually perfect, the number of investors has been very large, the stock market has also been pivotal. A stock index future, which is the stock index futures, is a futures contract with the stock price index as the subject of the contract. Stock index futures itself is not a new thing, in the early 1990s, the United States has been the first to launch the first stock index futures contract, the value line composite index futures contracts, from then on, stock index futures in developed countries and emerging market countries to develop [2]. The stock market value of the total market value of the world's stock market in the forefront of our country, the introduction of the stock index futures has been repeatedly twists and turns, until 2010, the first stock index futures contract named the Shanghai-Shenzhen 300 index futures contract was officially listed on the Chinese financial futures exchange.

Shanghai and Shenzhen 300 index by the CSI's from Shanghai and Shenzhen Stock Exchange Market selected 300 A shares as a sample compiled index constituent stocks. CSI 300 stock index futures is the subject of the CSI 300 index futures varieties, in April in the Chinese financial futures exchange officially listed transactions. This is a major reform of China's capital market; the birth of financial derivative instruments such as stock index futures will be conducive to the establishment of a mature multi-level financial system, which will have a profound impact on China's capital market. Since the Shanghai and Shenzhen 300 stock index futures is the subject of the CSI 300 index, it is very important to clarify the introduction of Shanghai and Shenzhen stock index futures

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on the corresponding spot market prices. On the one hand, whether the introduction of stock index futures increased the volatility of the spot market, on the other hand, the relationship between the stock index futures and the corresponding spot market is what kind of, this is the problem that this paper tries to study.

2. Literature Review

2.1. Stock Index Futures

Stock index futures first developed in overseas mature market, so the earliest literature is overseas scholars on these futures contracts listed overseas to study. By comparing before and after the introduction of stock index futures, stock market volatility to determine the change in the end of the introduction of stock index futures on the volatility of the spot market produce what kind of impact, and analyze the reasons. In addition, index futures and index by contacting spot market prices, the relationship between research leading stock index futures and spot, that is, whether there is any function of price discovery, and the causes of this effect is. In our country before year 2000, rare empirical articles in this area, one of the few studies of the stock index futures are stuck on whether China should explore the development of futures of such derivatives. After 2000, the issue of stock index futures is more and more attention, becoming the focus of scholars. Hong (2012) pointed out the status at the time the stock market, the introduction of stock index futures for our policies to make a relatively simple design [3]. Hammoudeh (2014) development the theory by drawing on the experience in mature markets and emerging markets stock index futures [4], that the country is necessary and feasible development of stock index futures and stock index futures for development the problems are given recommendations. Jason (2005) research the S&P500 index futures from 1978 to 1989, confirmed that the introduction of stock index futures to reduce the volatility in the spot market [5]. On the contrary, there is some case studies show that the introduction of stock index futures to increase the volatility of the spot market. Algieri (2014) research S&P500 index of the spot found after the introduction of index futures [6], stock volatility, mainly because foreign investors probably competing holdings of US stocks and index funds. Antoniou (2005) through the FTSE100 index futures research [7], that futures markets have increased volatility in the spot market because the stock index futures will find new information itself, the impact of the spot market, thereby improving the flow of information in the spot market rate. Similarly, consider the introduction of stock index futures did not because a significant impact on the volatility of the spot market was confirmed most empirical research. Driffill (2006) study on Hong Kong's Hang Seng index futures, stock market volatility did not change significantly after the launch [8].

Christos (2014) study the dynamic relationship between the S&P 500 index futures and British FTSE100 index futures with their respective stock market index [9], the results show the existence of a long-term relationship between the two co-integration of spot and futures stock index, and both cause and effect relationship, But most of the time the spot price of lead futures prices. Francis (2006) find out FTSE100 index will be divided into three different periods [10], the results show that the entire period between the cash and futures at the same time having a sexual relationship, which both lead-lag relationships was not significant; however, for each period, the futures yield leading spot rate of return. Among them, namely the United Kingdom during the second major financial reform to 1987 before the stock market crash, but the leading spot futures, spot market, this is subject to the impact of lower transaction costs.

In addition to the above research methods, scholars visually compare before and after the introduction of the futures spot market trends, to study the impact of stock index futures on the stock market. Donald (2005) pointed out the use of data related to Hong Kong, Japan and South Korea before and after the introduction of stock index futures market [11]. The stock market index trend, the spot market volatility and trading volume tripartite face of changes before and after the introduction of stock index futures, stock market reaction is a comparative study of that individual stocks were the impact of the introduction of stock index futures is not consistent, which is before the launch of stock index futures spot market trends have a great relationship.

2.2. Program Trading

In China, it is a kind of transaction method, the experience of the transaction, or the observation of the data characteristics of a variety of trading market. The method itself does not necessarily have a strict mathematical logic or financial theory. Quantitative trading is a trading strategy that can obtain excess profits through modern statistical and mathematical methods, in the historical data to find out the probability of a superior. Quantitative trading is not necessarily to use a computer to send a signal. Algorithm trading refers to the method of determining the execution path, execution time, price and quantity of the best trading orders through computer system. Objective to study the main algorithmic trading is to reduce transaction cost big impact on the market, improve transaction efficiency. The range of application of the algorithm is very wide, whether it is a market maker, arbitrage trading or trend tracking transaction can reduce transaction costs through the algorithm. High frequency trading is a special kind of trading, which is quick to deal with market information such as market data, news data, economic policy and other fast trading. Each transaction high-frequency trading profit small, but because every day the huge trading volume, gather a little more, income is very considerable, and stability is very strong.

Procedural transactions can be used in a wide range of areas, almost all aspects of financial transactions. At present, it has a wide range of applications in the domestic: portfolio management, risk control, financial management, and high frequency trading and so on.

1) Portfolio Management: portfolio management is a combination of transactions in the management of the account. For example, the purchase of a basket of securities portfolio, or in different trading products to hedge the risk, or in the same trading products using different trading models to mix, *etc*. Procedural transaction is beyond the limits of human energy, and can monitor multiple markets in real time, so it is the best choice for portfolio management.
2) Risk control: the process of the transaction model in the design of the general will consider the risk control part, and thus in the use of the program can effectively overcome the artificial trade in extreme cases of irrational behavior. Using historical data to detect the risk level of the model, we can draw up the corresponding risk control strategy to control the maximum risk in the process of model operation.
3) Capital management: the process of the transaction can effectively use the historical data; it can be found that the best combination of different varieties, different trading models, can effectively improve the efficiency of the use of funds.
4) High frequency trading: high-frequency trading is refers to the artificial it is almost impossible to use in a very short time to market a slight change in seeking profit quantitative trading. High frequency trading is required for

high speed, so that some of the trading mechanism to set up the server set to the distance from the exchange is very close, in order to shorten the distance of the transaction instructions through the cable to reach the exchange server.

5) Trend Trading: trend trading is the most common mode of trading in china. In the current domestic procedure of the transaction has just started, most of the program trading model is based on trend, but also based on a large number of models on the basis of technical indicators, so the model has a great improvement in the structure of space.

3. Model Design

3.1. ADF Test

Unit root test plays a very important role in econometrics, and it is the basis of co integration analysis and Granger causality test. The unit root test is actually stationary test. The first step is to determine the order of each sequence, and the standard unit root test is the DF test of Dickey 1979.DF test has three forms of regression model, in model 1; it does not contain constant and linear time trend term:

$$Y_t = \gamma \cdot Y_{t-1} + \varepsilon_t$$

In model 2, it includes a constant term:

$$Y_t = \alpha + \gamma \cdot Y_{t-1} + \varepsilon_t$$

In model 3, it includes constant and linear trend terms:

$$Y_t = \alpha + \beta \cdot t + \gamma \cdot Y_{t-1} + \varepsilon_t$$

Among them, ε_t is random error, α is constant, if the received H0: $\gamma=0$, it indicates the presence of a unit root, for non-stationary sequence. Because this method cannot guarantee the residual term of the equation is white noise, the estimation of the test is not unbiased. Based on this, DF test is extended to form a ADF (Augmented Dicker-Fuller) test, which is currently widely used unit root test method, in the right side of the equation to join the lag, so ADF test becomes

$$Y_t = \alpha + \beta \cdot t + \gamma \cdot Y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

3.2. Co-Integration Test

In the field of economic research, some time series are non-stationary, but some linear combination of these time series is stationary. The definition of co integration is as follows, if the time series $y_{1t}, y_{2t}, \ldots y_{nt}$ is d order, namely I (d), there is a vector $\alpha=(\alpha_1, \alpha_2, \ldots \alpha_n)$, and make it as $\alpha y_t \sim$ I(d-b), α is the co-integration vector. There are two methods for co integration test, one is the co-integration test based on regression residuals, which is also called single equation co-integration test, that is E-G two step method; the other is based on the regression coefficient of complete information co-integration test, that is, Johansen co-integration test method. Johansen co integration test is a method of regression coefficient based on VAR model. The VAR model is firstly proposed to solve the problem of setting up the model by Sims in 1980. The setting of the VAR model is not based on the economic theory, but directly on the data itself. VAR model is used to model the multiple equations, and the model is used to model the endogenous variables in the model. In the non structural VAR model, no distinction between endogenous and exogenous

variables, all variables are considered as endogenous variables. VAR (P) model, which is composed of two variables, is described as follows:

$$Y_t = \sum_{i=1}^{p} A_i \cdot y_{t-i} + \beta \cdot x_t + \varepsilon_t$$

After the upper type difference:

$$\Delta y_t = \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \cdot y_{t-i} + \beta \cdot x_t + \varepsilon_t$$

Among them:

$$\prod = \sum_{i=1}^{p} A_i - I$$

$$\Gamma_i = -\sum_{i=1}^{p} \Gamma_i A_j$$

Johansen co integration test involves the characteristics of the root locus test statistic and the maximum eigenvalue statistics, which are derived from the eigenvalues of the matrix n. So the co-integration test of the equation is transformed into the rank of the matrix n, for characteristic root trace test statistics:

$$\eta_r = -T \cdot \sum_{i=r+1}^{m} \ln\left(1 - \lambda_i\right)$$

If significant, to reject the null hypothesis, that there is at least one co-integrating vector, then test the significant of η. So check it, get the maximum number of co integration vector.

4. Empirical Analysis

4.1. Data Source

In order to analyze the impact of the CSI 300 stock index futures on the spot market in Shanghai and Shenzhen 300 index futures, this paper selects the Shanghai and Shenzhen stock index futures on, that is, the data from April 16, 2010 to December 31, 2014, the data comes from the China Securities Index Co and the China Financial futures exchange, the sample statistics results are shown in Table 1. From the results of statistical test, both of them are not subject to normal distribution. From the statistical data, the Shanghai and Shenzhen 300 index futures price trend in the long-term and the spot market prices tend to be consistent, there may exist between the long-term stability of the relationship.

Table 1. Descriptive Statistics of the Spot and Futures in CSI 300 Index

index	Mean value	Stan.dev.	Skewness	Kurtosis	J-B statistics
SP	2917.32	285.59	-0.135	2.222	12.824
FCP	2926.94	292.13	-0.084	2.280	10.340

4.2. Stability Analysis

First, the autocorrelation function of the CSI 300 index and the index futures are respectively carried out respectively by using the auto correlation function test. Through the autocorrelation function chart, we found that the Shanghai and Shenzhen stock index futures have a serious self correlation. Through the correlation graph, we observe that the

partial autocorrelation function PAC, so the CSI 300 index and the index futures sequence exist obvious autocorrelation, is not stable, and has the characteristics of AR (P) sequence. Below, we have a ADF and PP test method for unit root test for the Shanghai and Shenzhen 300 index futures and index futures and their difference, and the test results are shown in the following table:

Table 2. ADF Unit Root Test Results

Time series	Test type	ADF test value	Significant level			result
			1%	5%	10%	
HS300	(c,t,0)	-1.195	-3.978	-3.419	-3.132	Not stable
HSIF	(c,t,0)	-2.084	-3.945	-3.732	-3.309	Not stable
ΔHS300	(c,0,0)	-20.951	-3.485	-2.867	-2.570	stable
ΔHSIF	(c,0,0)	-21.173	-3.452	-2.867	-2.571	stable

Table 3. PP Test Results

Time series	Test type	ADF test value	Significant level			result
			1%	5%	10%	
HS300	(c,t,5)	-1.956	-3.926	-3.428	-3.159	Not stable
HSIF	(c,t,4)	-2.140	-3.942	-3.473	-3.130	Not stable
ΔHS300	(c,0,4)	-21.956	-3.491	-2.875	-2.512	stable
ΔHSIF	(c,0,4)	-24.044	-3.439	-2.891	-2.501	stable

Through the above table, we know that the t statistic value of CSI 300 index and stock index futures is more than the critical value, the sequence is not stable, but the first order difference is far less than the critical value, the table shows that the sequence has been stable.

4.3. Co-Integration Test and Error Correction Model

Using the least square method to establish the regression equation of the CSI 300 index and the stock index futures:

$$HS\ 300 = \alpha + \beta HSIF + \varepsilon_t$$

Put into the data, the estimated results are:

$$HS\ 300 = 79.821 + 0.965\ HSIF + \varepsilon_t$$

$$t = (4.578) \quad (163.55)$$

$$R^2 = 0.9834 \quad DW = 1.8592$$

First use E-G two-step co-integration test: first of all, this regression residuals ε_t do ADF unit root test, the results are as follows:

Table 4. Residual Unit Root Test

Variable	Test type	ADF test value	Significant level			result
			1%	5%	10%	
ε t	(0,0,1)	-12.347	-2.457	-1.941	-1.512	Not stable

It can be seen that the residuals of the test statistic is far less than the value of the significance level of critical value. At the same time, the probability value of 0.000, show that the residuals have been stable, can be expressed ε_t~I (0), and according to the

definition of previous theories, we can think that the CSI 300 index and stock co-integration relationship exists between the two futures series, co-integration vector (I, -0.9695). Next, we establish error correction model of the ECM.

$$\Delta HS\ 300_{\ t} = 55.068 + 0.711 \cdot \Delta HSIF - 0.705 \cdot ecm_{\ t-1} + \varepsilon_t$$

$$t = \quad (10.673) \quad (15.026) \quad (-11.469)$$

$$R^2 = 0.3348 \qquad DW = 2.0972$$

Ecm_{t-1} is the error correction term; the size of the coefficient of the futures price reflects the deviation from the long-term equilibrium adjustment. The estimated value of the coefficient is -0.705, which indicates that the CSI 300 index when the short-term fluctuations deviate from the long-term equilibrium state, will be adjusted to 70.5% of the adjustment to the equilibrium state, adjust the intensity is great, the need to adjust the time is shorter. The coefficient of ecm_{t-1} is negative, and it fits the reverse correction mechanism of the error correction model, and the model is valid through t test.

4.4. VAR Model

Using Johansen co integration test, we first need to establish the VAR model to determine the lag order. Generally speaking, you can use the following indicators to determine the results are as follows:

Table 5. VAR Model of Hysteresis Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-5406.78	NA	1.17e+0.8	24.254	24.273	24.261
1	-4432.19	1936.06	1508270	19.9023	19.957*	19.923
2	-4424.85	14.527*	1488509*	19.8727*	19.9791	19.947*
3	-4423.96	2.082	1505548	19.9002	20.029	19.951
4	-4420.49	6.494	1510193	19.9034	20.688	19.946

As can be seen from the above table, in addition to the SC selection lag phase, the rest of the several indicators have chosen to lag behind 2. As the co integration test is actually a model of the non binding VAR model to get the model, the model of the lag period of the model is not constrained VAR model first order differential variables of the lag, so the co integration test to choose the lag phase, the test results are shown in the following table:

Table 6. Co-Integration Test

Unrestricted Cointegration Rank Test (Trace)				
No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob.**
None *	0.55379	48.60145	35.19275	0.0011
At most 1 *	0.43474	25.19932	20.26184	0.0096
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
No. of CE(s)	Eigenvalue	Max-Eigen	Critical Value	Prob.**
None *	0.727167	37.66795	34.80587	0.0221
At most 1 *	0.605452	26.97044	28.58808	0.0793

* denotes rejection of the hypothesis at the 0.05 level

From the above table, we can see that the trace statistic is 48.60145 and the maximum characteristic value is 37.66795, which indicates that there exists co-integration

relationship between HS300 and HSIF at the 5% confidence level, and only one co-integration equation. The co-integration coefficient can be standardized, in which only one co integration relationship is considered, and the co integration equation is obtained:

$$Z = HS\ 300 - 0.9783\ HSIF - 54.0311$$

Through the unit root test, Z is a stable time series. Similarly, the co integration equation can be expressed as:

$$HS\ 300 = 0.9783\ HSIF + 54.0311$$

4.5. Grainger Causality Test

Based on the co-integration relationship, we examine the causality between HSIF and HS300. Granger causality test has two: first, HS300 is not a Granger HSIF, the two is HSIF Granger HS300 is not the cause of the, the corresponding F statistics and the corresponding P values are calculated. Due to the lag of the choice of different, the test results may also be different. The results are shown in Table 7

Table 7. Grainger Causality Test

H0 hypothesis	Lag	F statistics	Pvalue
HSIF is not the Grainger cause of HS300	1	1.615	0.204
HS300 is not the Grainger cause of HSIF	1	37.91	1.E-61
HSIF is not the Grainger cause of HS300	2	2.660	0.0710
HS300 is not the Grainger cause of HSIF	2	19.63	9.E-62
HSIF is not the Grainger cause of HS300	3	2.152	0.092
HS300 is not the Grainger cause of HSIF	3	13.19	7.E-61
HSIF is not the Grainger cause of HS300	4	1.904	0.108
HS300 is not the Grainger cause of HSIF	4	10.64	8.E-57

As can be seen from the above table, in the selected lag period, at the 5% level, the rejection of the HS300 is not the cause of HSIF, accepted the HSIF is not the cause of HS300 Grainger. Therefore, the stock index futures is not the cause of the Shanghai and Shenzhen 300 index, the CSI 300 index is the Grainger reason for the stock index futures. This shows that the Shanghai and Shenzhen 300 index still determines the trend of the stock index futures, and the general stock index futures lead to the conclusion of the stock index is different. This empirical index futures data and Shanghai and Shenzhen stock index futures are the daily closing price, long-term, stock index futures and spot market is highly relevant, and the price of stock index futures is dependent on the spot market trend, and with the maturity date of the futures, the price is also natural to the spot market. But in the short term, the price of stock index futures may be ahead of the spot market price, and this need to capture the high frequency data, the conclusion of the high frequency data will be more reliable.

5. Conclusion

Through quantitative analysis, Metrology and Inspection visits before and after the introduction of stock index futures, spot market prices fluctuated. Paper selected from stock index futures market date to 2014 data, the establishment of a vector auto regression model (VAR), and on this basis to establish a vector error correction model (VECM). In order to investigate the order and the information content between stock index futures and spot, we preclude the use of the Granger (Granger) causality test. Finally, we use the impulse response function and variance decomposition analysis to examine how outside information is propagated to the Shanghai and Shenzhen 300 stock index futures market and the spot market, as well as to measure the contribution of a variety of information on

both the price fluctuates. Empirical evidence shows that CSI 300 index futures volatility impact on the spot market is not significant. The results show that after the introduction of stock index futures, the influence of interference factors effect will soon be absorbed by the market weakened, thereby reducing the effect of fluctuations in persistent interference, that means the transmission of information more efficiently.

However, the new information in the stock index futures market and the spot market and thus not passed to increase the volatility of the spot market. About the relationship between stock index futures and the CSI 300 Index, whether long term or short term, there exist cointegration relations between these variables. At the 5% significance level, the Stock index futures is not Granger cause to CSI 300, while the CSI 300 Index is Granger cause stock index futures, that is one way the CSI 300 Index stock index futures Grand Jay reason index futures price discovery function in the short term, but in the longer term, the spot market still plays a decisive role in the foundation. In the short term, stock index futures priced first action, the information on the market's reaction faster than the spot market, mainly due to stock index futures market liquidity, low transaction costs, the leverage is good, two-way trade, the implementation of high efficiency so that new information can be reflected in the trend in the market faster. But in the long term, spot market pricing still dominates the market, stock index futures based on the CSI 300 Index as the underlying, the price depends on the price of the spot assets, and as futures approaching expiration date, its price is naturally to Convergence of the spot market price, stock market, stock index futures market still determine the trend.

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