Research on the Price Discovery Function of Stock Index Futures under the Relaxation of Trading System -- an Empirical Analysis based on VECM and IS Models

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Abstract. By establishing VECM model and information share (IS) model, this paper compared the price discovery relationship between stock index futures market and stock market in the pre- and post-restriction and relaxation periods of the trading system. The results show that the futures price dominates before and during the trading system restriction, while the stock index price dominates during the restriction period; the policy relaxation helps the futures market to play the price discovery function. Therefore, it is feasible and necessary for the government to relax the policy of trading mechanism. It should continue to be loosely and appropriately loosened. At the same time, the basic system reform should be accelerated.

Introduction

Since the official trading of CSI 300 stock index futures in 2010, the trading system of China's stock index futures market has been constantly reformed and improved. In the past nine years, CICC has made several adjustments to its trading system. The most obvious policy change was the stock market crash in 2015. The stock market crash of 2015 made stock index futures the target of public criticism. CICC has introduced regulation and restriction measures several times in a row to curb excessive speculation. After that, the intraday trading volume and position of stock index futures gradually shrunk to the previous "zero", and the liquidity nearly dried up. Until 2017, CICC successively released various policies to "loosen" the trading system, adjusted the regulatory standard of intraday excessive trading behavior from 10 hands to 20 hands, gradually reduced the proportion of trading margin, reduced the transaction fee of clearing positions to 0.069%, and relaxed the limit standard of opening positions.

However, data showed that the practice of restricting trading and clamping down on stock index futures has not improved the stock market slump, but has restricted the liquidity of stock index futures trading and inhibited the function, the most basic function, its price discovery function, of stock index futures. The frequent fluctuations of stock index futures market also affects the spot market to some extent.

As the market development of the SSE 50 stock index futures listed in April 2015 is still in the process of improvement and the market function may still have some defects, the impact of the change of trading system on the SSE 50 stock index futures is also worthy of the attention of the majority of market participants. An in-depth study of the function of futures market price discovery in this paper will greatly help market participants to make correct investment judgments efficiently.

Literature review

Foreign literature review. In 1987, Kawaller and Koch[1] first proposed the leading and lagging relationship between stock index futures and stock index. they believed that stock index futures dominated the price. In 1990, Stoll and Whaley[2] studied American MMI and S&P500 stock index futures and spot, and adopted a two-way regression model to study the leading and lagging relationship between stock index futures and spot. The results showed that the prices of MMI and S&P500 stock index futures were five minutes ahead of the spot index on average. In foreign

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empirical tests, the futures market price does not always guide the spot market price, may appear completely opposite situation. Wahab and Leshgari (1993) [3] first proposed the method of co-integration analysis to study the dynamic relationship between futures and spot of S&P 500 and FTSE-100 index. They found that S&P 500 and FTSE 100 index spot guided futures. Wei-Peng Chen et al. [4] made the same point.

Domestic literature review. Dongxiao Yang (2015) [5] used PT model to analyze high-frequency data of CSI 300 stock index futures and found that stock index futures had a high contribution to price discovery. Ying Geng (2017) [6] studied on the basis of SSE 50 stock index futures, and found that the change of SSE 50 stock index futures can cause the change of its underlying assets, and the SSE 50 stock index futures market has the function of price discovery. Feng He et al. (2017) [7] divided the daily data of CSI 300 stock index futures and index into four different market stages, and found that the price discovery ability of stock index futures was weaker than that of stock market, but in the period of market decline, the price discovery ability of futures market was stronger. Chengli Liu (2017) [8] using the high frequency data of SSE 50 , CSI 300 and CSI 500, and dividing the sample stage into three stages, found that stock index futures play a strong leading role in spot index in different market stages. Miao Hong and Dongxiao Yang et al. (2017) [9] adopted the k-order VECM model and IS model, and found that the stock index futures market dominates the overall price discovery.

In summary, domestic and foreign scholars have conducted a large number of studies on the relationship between stock index futures and index. Although no consistent conclusions have been reached, most of them believe that the stock index futures market responds to new information faster than the spot market and is the main driving force of the price discovery process. However, a few domestic opinions hold that domestic stock index futures has a low contribution to price discovery. These research results provide useful references for us to deeply analyze the relationship between stock index futures and spot. However, there are still deficiencies in existing studies, which need to be further studied and improved. At present, most of the researches on the Chinese market are still in the period of the stock market crash. In 2017, the government issued a series of easing policies. The market's reaction to the easing of the trading system and the influence of stock index futures on the spot market will be quite different from the previous situation. Therefore, based on the influence of trading system policies on the market, this paper discusses the price guiding relationship between the SSE 50 stock index futures and the spot market, and makes some contributions to the improvement of the stock index futures trading system.

Methodology

The study employs the Hasbrouck (1995)[10] information share (IS) analysis to examine price discovery between the futures and stock index. Price discovery analysis is based on the econometrics of cointegrated vector autoregressions that can be expressed as:

$$R_t = \mathrm{c} + \sum_{k=1}^{p} \Gamma_k R_{t-k} + \alpha Z_{t-1} + \varepsilon_t \quad (1)$$

where $R_t = \begin{pmatrix} R_1 \\ R_2 \end{pmatrix}$ is a vector of yield (1 represents the futures market and 2 represents the stock market), $\Gamma_k = \begin{pmatrix} \tau_{k,11} & \tau_{k,12} \\ \tau_{k,21} & \tau_{k,22} \end{pmatrix}$ are matrices of autoregressive coefficients for short-term adjustment coefficient, R_{t-k} reflects the short-term effects of short-term fluctuations of various variables on dependent variables, Z_{t-1} is the error correction term$(\ln f_{t-1} - elns_{t-1})$ representing the deviation from the long-term equilibrium relationship between variables, $\alpha = \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix}$ is the error correction term coefficient, $\varepsilon_t = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix}$ is the residual vector.

On the basis of VECM model, the information share model proposed by Hasbrouck (1995) describes the contribution of different markets to price discovery by measuring the proportion of market information variance in the common factor variance. The common factor refers to the

common change trend of futures spot market. VECM model can be represented by a vector moving average process:

$$R_t = \Psi(1)\sum_k^t \varepsilon_t + \Psi^*(L)\varepsilon_t \quad (2)$$

Where $\Psi(1)$ and $\Psi^*(L)$ are matrix polynomials of lag terms, the first part on the right side of Eq.2 measures the long-term impact of residuals on prices, that is, the part of common factors in the price sequence, the second part represents the short-term price fluctuations and measures the short-term impact on prices. Hasbrouck (1995) defined the information share (IS) of the ith price sequence to be:

$$IS_i = \frac{\psi_i^2 C_{ii}}{\psi\Omega\psi'} \quad (3)$$

where ψ is any identical row of $\Psi(1)$, C is the lower triangular Cholesky factorization of Ω. Upper and lower bounds of IS_i are calculated by applying different order of the Cholesky factorization, and take the average value as the value of the information share of the market.. Where $\Omega=CC'$, the market with a large information share occupies a higher contribution to price discovery.

Data selection

In this paper, high-frequency data of intraday 5-minute transaction prices of SSE 50 index and IH were selected, and the sample period span was 16 April 2015 to 6 November 2017.

According to the time limit of the introduction of the policy, this paper divides it into three intervals:

(1)pre-restriction: from April 16, 2015 to June 12, 2015; (2)restriction periods: the first restriction policy was issued on July 8, 2015 and lasted until the end of the year. so the data was selected from July 8, 2015 to December 31, 2015; (3)relaxation periods: the first deregulation of the trading system on February 17, 2017 officially took effect, until the last deregulation measure on September 18, 2017, so the data on February 17, 2017 and November 6, 2017 were selected.

The data of futures 15 minutes earlier and 15 minutes later are excluded to keep the correspondence between futures and stock data. All data were obtained from the Wind consulting database. In the data analysis, this paper adopts the form of logarithmic return rate, that is, $R_t = \log(P_t/P_{t-1}) * 100$.

Empirical results

Stationary test and co-integration test. In order to prevent false regression and information omission, the stationarity test should be carried out before establishing the model. The unit root test of the return rate sequence and the residual sequence is shown in table 1. Logarithm yield sequence is stationary series. Continue to use EG two-step method to carry out unit root test on the linear regression residual series of futures and spot rate series, and the results show that the residual differential sequence is listed as a stationary sequence, which indicates that there is a co-integration relationship between stock index futures and spot, so the influence of error correction term should be considered.

Table 1 ADF test results

Period	variables	t-Statistic	1% level	Prob.*	conclusion
Panel A: pre-restriction	RIH	-47.65444	-2.566139	0.0001	stationary
	RSZ	-48.61670	-2.566139	0.0001	stationary
	Residual	-27.69670	-2.566141	0.0000	stationary
Panel B: restriction periods	RIH	-76.98978	-2.565364	0.0001	stationary
	RSZ	-78.10850	-2.565364	0.0001	stationary
	Residual	-37.58955	-2.565364	0.0000	stationary
Panel C: relaxation periods	RIH	-94.04023	-2.565234	0.0001	stationary
	RSZ	-88.49993	-2.565234	0.0001	stationary
	Residual	-52.63656	-2.565234	0.0001	stationary

VECM model and the empirical results of price discovery. Firstly, the price discovery relationship between stock index futures and spot prices in three intervals is qualitatively analyzed, and the parameters of VECM model are estimated respectively. The results are shown in table 2.

Table 2 empirical results of VECM model in SSE 50 index and IH

variable	pre-restriction		restriction periods		relaxation periods	
	coeff	p	coeff	p	coeff	p
α_1	−0.80601	0.000***	−0.96944	0.000***	−1.17601	0.000***
$\tau_{1,11}$	−0.09139	0.247	0.02352	0.482	0.11418	0.119
$\tau_{2,11}$	−0.03751	0.427	0.03782	0.086*	0.07465	0.043**
$\tau_{1,12}$	−0.74336	0.000***	−0.67216	0.000***	−0.82413	0.000***
$\tau_{2,12}$	−0.36864	0.000***	−0.35431	0.000***	−0.44238	0.000***
c_1	−0.00016	0.987	−0.00018	0.975	6.87e−06	0.997
α_2	0.70887	0.000***	0.34418	0.000***	0.42318	0.000***
$\tau_{1,21}$	−0.27856	0.000***	−0.12468	0.000***	−0.12686	0.000***
$\tau_{2,21}$	−0.09921	0.010***	−0.04333	0.030**	−0.03360	0.015**
$\tau_{1,22}$	−0.39534	0.000***	−0.56196	0.000***	−0.46488	0.000***
$\tau_{2,22}$	−0.23723	0.000***	−0.29464	0.000***	−0.28045	0.000***
c_2	−0.00018	0.981	−0.00051	0.921	0.00002	0.988

Note: The subscripts ***, **, *, indicate statistical significance at the 1%, 5%, and 10%, respectively.

The results in table 2 show that before the trading system restriction, $\tau_{1,12}$ and $\tau_{2,12}$ are statistically significant at the 1% level, and the coefficient is negative, indicating that the IH is statistically negatively affected by the spot within 5-10 minutes. $\tau_{1,21}$ and $\tau_{2,21}$, $\tau_{1,22}$ and $\tau_{2,22}$ are statistically negative at the 1% level, indicating that the SSE 50 index is statistically negatively affected by itself and futures within 5-10 minutes. During the restriction period, $\tau_{2,11}$,statistically significant positive at 10% level, $\tau_{1,12}$ and $\tau_{2,12}$ statistically significant negative at the 1% level, show that the IH is positively affected by the first 10 minutes themselves and negatively affected by the first 10 minutes of the spot. $\tau_{1,21}$、$\tau_{2,21}$、$\tau_{1,22}$ and $\tau_{2,22}$ are statistically significant at the 1% or 5% level, and the coefficient are negative, indicate that the spot is statistically negatively affected by itself and the futures within the first 5-10 minutes. The relaxation periods are almost the same as the restriction periods.

In the three periods, the error correction coefficients of the stock index futures equation are significant, indicating that the stock index futures will correct the deviation of the forward price equilibrium when the forward price relationship deviates. On the adjustment direction, the error correction coefficients stock index futures equation are negative, and the error correction coefficients of the spot equation are positive, show that when the relationship between futures and spot prices deviates, both stock index futures and spot prices can correct the deviation between futures and spot prices. At the same time, it also shows that both futures and spot markets have a

good pricing effect and the arbitrage mechanism of futures and spot can play a good role. In terms of the adjustment speed, the three periods are all $|\alpha_1| > |\alpha_2|$, which means that the SSE 50 index futures market has a faster reaction and adjustment speed to deviate from the long-term equilibrium relationship. The equilibrium adjustment is more dependent on the change of the futures market, and the futures market is more capable of price discovery.

Price discovery contribution measurement. Then, according to the results of the VCEM model, the information share model (IS) is used to calculate the price discovery contribution of the three interval stock index futures and index. Table 3 lists both the upper bound, lower bound and the average of upper and lower bounds.

The empirical results show that the IH plays a dominant role in the price discovery before and during the easing of the trading system restrictions, with the price contribution of 50.50% and 51.75% respectively. During the period of trading system restriction, the price contribution of IH is only 39.01%, while the spot price contributed 60.99%, and the index price dominated.

Table 3 the contribution of SSE index and futures prices

Period	Asset	Upper bound	Lower bound	Average of bounds
Panel A: pre-restriction	IH	90.98%	10.02%	50.50%
2015.4.16-2015.6.12	SZ50	9.02%	89.98%	49.50%
Panel B: restriction periods	IH	73.84%	4.18%	39.01%
2015.7.8-2015.12.31	SZ50	26.16%	95.82%	60.99%
Panel C: relaxation periods	IH	92.62%	10.88%	51.75%
2017.2.17-2017.11.6	SZ50	7.38%	89.12%	48.25%

The above results show that futures prices dominate both before and during the period of trading system restrictions, while index prices do dominate during the period of trading restrictions, indicating that trading system restrictions do inhibit the function of futures price discovery, and further policy easing may be needed.

Conclusion

Based on the intraday high frequency data of SSE 50 index and futures within 5 minutes during the period of the policy easing of the trading system, and by comparing the period before and during the trading system restriction, this paper makes an in-depth discussion on the price discovery relationship between them, and draws the following conclusions: (1) both stock index futures and spot stocks have autocorrelation and cross-correlation, both of which have the function of price discovery. However, according to the price contribution calculated by IS information share model, before and during the period of restriction, futures are more capable of price discovery, and futures occupies a dominant position. During the period of restriction, the index is more capable of price discovery and dominates. (2) Both futures and spot market have a good pricing effect, and the forward arbitrage mechanism can play a good role. In terms of adjustment speed, the results are consistent with the price contribution calculated by IS information share model.

The above conclusions lead to the following recommendations: (1) we should continue to relax policies in an appropriate and reasonable manner. After the price discovery function of stock index futures was weakened under strict trading restrictions, it recovered within nearly one year after the policy was gradually relaxed, indicating that the relaxed policy was effective. (2) Fundamental institutional reform should be accelerated. First, strengthen the institutional matching between the stock index futures market and the spot market to maintain their linkage. Second, continue to improve the variety system of stock index futures to ensure the demand of various investors for hedging tools.

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