IOP Conf. Series: Materials Science and Engineering **322** (2018) 052056 doi:10.1088/1757-899X/322/5/052056

Volatility Spillover in Chinese Steel Markets

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Abstract: This paper examines volatility spillover in Chinese steel markets by comparing spillover effects before and after steel futures market established and finds some interesting change. Volatility spillover method based on multi-GARCH model are proposed. The results show that there is significant proof for spillover effects from B2B electronic market to spot market, and two-way effects between futures and spot market. Market policy planners and practitioners could make decisions according to the master of spillovers. We also find that B2B e-market and futures market can both provide efficient protection against steel price volatility risk, B2B e-market offer a broad-based platform for trading steel commodities over time and space since e-market role in information flow process is dominant.

1. Introduction

With the rapid development of E-business and modern logistics in China, information transfer among steel markets become more quickly. Trading in steel online platforms is an effective way to gather price information and mitigate risks besides helping the macro economy with better resource allocation. To better capture the price-risk transfer effect among different steel markets, research of the volatility spillover is very necessary. Steel B2B e-market and the futures market both can carry out forward transactions. Before the launch of steel futures, e-market and spot market, in which one's volatility was dominant in the process of information transfer? Since March 27, 2009, Shanghai Futures Exchange (SHFE) launched steel futures, what does the role of three types of market in the information transfer respectively? The present study is undertaken as a modest attempt to dwell on such questions. This paper's objective is to explore volatility spillovers in Chinese steel markets and compare the role of information flow for steel B2B e-market before and after the introduction of steel futures market.

2. Literature Survey

Price volatility is usually expressed in the variance of the condition of return equation on assets sequence of building model is widely adopted market volatility research tools [1-3]. In [4] "meteor shower" was used to describe the academia have sprung up a lot of studies which based on multi-variate GARCH models to study volatility spillovers. Many market volatility researches concentrate on two-market setting [5, 6]. In [7] Rittler analyzed the EU emissions trading system of the second phase of spot and futures prices of carbon conditional variances of causality by using BEKK-GARCH model. Of similar assets in more than two types of different market fluctuation overflow relatively few research literatures. This is mainly due to the market types of similar assets are usually futures and spot markets [8]. However, there do exist other types of market for the related assets transactions. Steel business-to-Business e-markets can somehow achieve the objective of collecting steel product information and discovering the equilibrium price. Hence, the study of three types of market volatility information transfer is very necessary.

3. Proposed Method

We construct a two-dimensional GARCH model in BEKK framework, which as follows:

$$H_t = C_0{}'C_0 + A'\varepsilon'_{t-1}\varepsilon_{t-1}A + B'H_{t-1}B \quad (1)$$

C , A and B are all 2×2 matrix. The number of the estimators is 11, less than two- dimensional GARCH model to estimate parameters of 21. Besides it can reduce estimators, BEKK-GARCH model also allows H_t probably not positive definite. The parameter matrices in this form will be the ARCH and GARCH variables is surrounded by be estimated parameters, this method can achieve the goal of makes a parameter matrix is qualitative.

In the form of matrix expansion, we can rewrite equation (1) to equation (2):

$$H_t = \begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix}$$

$$= \begin{bmatrix} c_{11} & c_{21} \\ 0 & c_{22} \end{bmatrix}' \begin{bmatrix} c_{11} & c_{21} \\ 0 & c_{22} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{1,t-1}\varepsilon_{2,t-1} & \varepsilon^2_{2,t-1} \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \quad (2)$$

$$\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}$$

$h_{11,t}$ and $h_{22,t}$ are the yield sequence of conditional variances in spot and electronic market, respectively. $h_{12,t}$ and $h_{21,t}$ are the conditions of the two sequences of covariance. a_{ij} measures the degree of new information transfer from i steel market to j steel market. b_{ij} measures volatility spillovers effects from i steel market to j steel market. Through the estimate of the parameter matrix A and B , we can capture the shocks and volatility across markets. Under the three types of steel market conditions, three-dimensional BEKK-GARCH (1, 1) model is constructed. We use this model to research three types of market and volatility spillover effects across the market. H_t is 3×3 order of conditional variances, and its matrix form is:

$$H_t = \begin{bmatrix} h_{11,t} & h_{12,t} & h_{13,t} \\ h_{21,t} & h_{22,t} & h_{23,t} \\ h_{31,t} & h_{32,t} & h_{33,t} \end{bmatrix}$$

$$= C_0{}'C_0 + \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}' \begin{bmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1} & \varepsilon_{1,t-1}\varepsilon_{3,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon^2_{2,t-1} & \varepsilon_{2,t-1}\varepsilon_{3,t-1} \\ \varepsilon_{3,t-1}\varepsilon_{1,t-1} & \varepsilon_{3,t-1}\varepsilon_{2,t-1} & \varepsilon^2_{3,t-1} \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} + \quad (3)$$

$$\begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} & h_{13,t-1} \\ h_{21,t-1} & h_{22,t-1} & h_{23,t-1} \\ h_{31,t-1} & h_{32,t-1} & h_{33,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

Matrix C is 3×3 order constant matrix, Matrix A is 3×3 order coefficient matrix of ARCH, Matrix B is 3×3 order coefficient matrix of GARCH; $h_{ij,t}$ represents conditional variances of interaction between different variables. The coefficient of $h_{12,t-1}$ reflects the degree of last period conditional variances influence each other. If the coefficient of $\varepsilon_{2,t-1}\varepsilon_{1,t-1}$ and $h_{21,t-1}$ are all positive, which shows that the spot market and e-trading market volatility present a convergence phenomenon. We use BFGS (Broyden-Fletcher-Goldfarb-Shannon) algorithm to estimate the coefficient value of the covariance matrix and its corresponding asymptotic standard error.

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4. Experimental Results

We conducted the research under two different sample periods: the first period is from November 1, 2004 to March 20, 2013 (sample interval Ⅰ), and the second is from March 21, 2009 to July 1, 2013 (sample interval Ⅱ). Table 1 describes the estimator results of unrestricted two-dimensional GARCH(1,1) model in BEKK framework.

Table.1 Estimates of Variance-Covariance Matrices Using Unrestricted Two-Dimensional BEKK-GARCH (1,1) Model

		Coefficient	Std. dev.	z statistics	p value
MU(1)		0.000439	0.000279	1.574022	0.1155
MU(2)		0.000318	0.000351	0.907807	0.3640
TETA(1)		0.023206	0.029524	0.786009	0.4319
TETA(2)		-0.024991	0.027731	-0.901162	0.3675
OMEGA(1)	c_{11}	0.001637	0.000467	3.501780	0.0005
BETA(1)	b_{11}	0.903406	0.009772	92.44807	0.0000
BETA(3)	b_{21}	-0.125513	0.010557	-11.88942	0.0000
ALPHA(1)	a_{11}	0.266940	0.013651	19.55512	0.0000
ALPHA(3)	a_{21}	0.334873	0.023354	14.33905	0.0000
OMEGA(2)	c_{21}	0.003334	0.000854	3.902046	0.0001
OMEGA(3)	c_{22}	7.29E-08	32.40818	2.25E-09	1.0000
BETA(4)	b_{22}	0.883644	0.011221	78.74628	0.0000
BETA(2)	b_{12}	0.015982	0.008821	1.811874	0.0700
ALPHA(4)	a_{22}	0.434918	0.026738	16.26585	0.0000
ALPHA(2)	a_{12}	-0.096226	0.018162	-5.298154	0.0000
Log likelihood		6509.007	AIC criteria		-11.97052
Num. of Estimators		11	SC criteria		-11.90154

It can be found that the estimated values of the diagonal elements of the coefficient matrix of the ARCH and GARCH terms are both significant at the 1% level. In terms of $|a_{21}| > |a_{12}|$, which shows that the influence of the pre-shock of e-market on the variance of steel spot market is significantly stronger than the impact of the pre-shock of steel spot market on the steel B2B e-market. The results indicate that steel B2B e-market plays an important role in the process of volatility information transmission.

In the sample interval Ⅱ, there are three types of steel market in China: futures market, spot market and e-market. Three-dimensional GARCH (p, q) model is constructed to adapt to the setting. The results of volatility spillover effects among three types of steel market are showed in Table 2.

Table.2 Estimates of Variance-Covariance Matrices Using Unrestricted Three-Dimensional BEKK-GARCH (1,1) Model

		Coefficient	Std. dev.	z statistics	p value
MU(1)		0.000439	0.000279	1.574022	0.1155
MU(2)		0.000318	0.000351	0.907807	0.3640
TETA(1)		0.023206	0.029524	0.786009	0.4319
TETA(2)		-0.024991	0.027731	-0.901162	0.3675
OMEGA(1)	c_{11}	0.001637	0.000467	3.501780	0.0005
BETA(1)	b_{11}	0.903406	0.009772	92.44807	0.0000
BETA(3)	b_{21}	-0.125513	0.010557	-11.88942	0.0000
ALPHA(1)	a_{11}	0.266940	0.013651	19.55512	0.0000
ALPHA(3)	a_{21}	0.334873	0.023354	14.33905	0.0000
OMEGA(2)	c_{21}	0.003334	0.000854	3.902046	0.0001
OMEGA(3)	c_{22}	7.29E-08	32.40818	2.25E-09	1.0000
BETA(4)	b_{22}	0.883644	0.011221	78.74628	0.0000
BETA(2)	b_{12}	0.015982	0.008821	1.811874	0.0700
ALPHA(4)	a_{22}	0.434918	0.026738	16.26585	0.0000
ALPHA(2)	a_{12}	-0.096226	0.018162	-5.298154	0.0000
Log likelihood		6509.007	AIC criteria		-11.97052
Num. of Estimators		11	SC criteria		-11.90154

In terms of the shock spillover from e-market to the other two markets, it can be found that there not only exist significant two-way shock spill overs between steel B2B e-market and steel futures market, but significant two-way shock spill overs between steel B2B e-market and steel spot market. The results also show that steel B2B e-market shock spill over to steel spot market is greater than the degree of e-market shock spill over to steel futures market.

In addition, the results show that the absolute value of b_{32} is bigger than b_{12}, which means that volatility spillover effects from steel B2B e-market to steel spot market is greater than the volatility spillovers from steel futures market to steel spot market. According to b_{21} and b_{23} estimator's results, there are significant volatility spill overs of spot market to e-market and futures market, and the degree of steel spot market volatility spillovers to steel futures market is slightly larger than that to steel B2B e-market. In summary, there do exist significant volatility information transfer phenomenon in three steel markets. Electronic trading market and futures market shock and volatility spillover to spot market are significantly greater than spot market shock and volatility spillover to these two markets.

5. Conclusion

Based on our empirical research, steel electronic trading market has a significant shock spillover effect on spot market, we can conclude that e-market exhibits a strong capability of transmitting information to spot market.

Chinese steel futures market is strongly influenced by its own volatility, and by its pre-shock as well. It indicates that steel futures market's own interpretation of news and the volatility are effective signals to predict its future volatility. There is a significant two-way volatility spillover between steel futures market and spot market, while there is only a weak one-way volatility spillover between futures market and e-market.

Considering that volatility information is an important signal of trading risk, and overflow of transaction risk is somehow a signal of market systemic risk, traders and policy planners need to grasp information of shock and volatility of steel futures market in time. To promote the construction of multi-level and modernized steel trading market system in China, effectively allocate market resources and promote the development of real economy, the government should pay great attention to the development of B2B e-market in steel market system.

6. Acknowledgement

In this paper, the research was sponsored by the Ministry of Education in China (MOE) Project of Humanities and Social Sciences (Project No. 15YJC790017), the project of Soft Science Foundation of Shaanxi Province, China (Project No. 2017KRM117), and the Fundamental Research Funds for the Central Universities (Project No. RW170157).

References

[1] Engle R. F., K.F., Kroner. Multivariate simultaneous generalized ARCH[J]. Econometric Theory, Volume 11, Issue 1, 1995, pp:122-150.
[2] Manera M., M., McAleer, and M., Grasso. Modelling time-varying conditional correlations in the volatility of Tapis oil spot and forward returns[J]. Applied Financial Economics, Volume 16, Issue 7, 2006, pp:525-533.
[3] Liu Q., Y., An. Information transmission in informationally linked markets: evidence from US and Chinese commodity futures markets[J]. Journal of International Money & Finance, Volume 30, Issue 5, 2011, pp:778-795.
[4] Engle R. F., T., Ito, and W.L., Lin. Meteor showers or heat waves? heteroskedastic intra-daily volatility in the foreign exchange market[J]. Econometrica, Volume58, Issue 3, 1990, pp:525-542.
[5] Wooldridge J.M. Cluster-sample methods in applied econometrics[J]. American Economic Review, Volume 93, Issue 2, 2003, pp:133-138.
[6] Shihabudheen M., P., Padhi. Price discovery and volatility spillover effect in Indian commodity market[J]. Indian Journal of Agricultural Economics, Volume 65, Issue 1, 2010, pp:101-117.
[7] Rittler D. Price discovery and volatility spillovers in the European Union emissions trading scheme: a high-frequency analysis[J]. Journal of Banking & Finance, Volume 36, Issue 3, 2012, pp:774-785.
[8] Engle R. Dynamic conditional correlation: a simple class of multivariate generalized autoregressive conditional heteroskedasticity models[J]. Journal of Business & Economic Statistics, Volume 20, Issue 3, 2002, pp:339-350.