Dynamic Relation Mechanism between Cotton Future Price and Stock Price of Related Listed Companies

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Abstract The Dynamic relation mechanism between ZCE cotton futures price and related listed company stock price has been studied based on the metastock historical data in January 1st, 2007 to September 1st, 2010, Johansen co-integration analysis, Vector error correction model, Granger causality test and variance decomposition method. The results indicated that: long-term equilibrium relationship existed between ZCE cotton futures price and Xinsai share stock price while which changed in the same tendency and speed in the long-term. Cotton futures price is the main reason for the changing of Xinsai share stock price. The lead-lag relationship in changing course had been confirmed that existed between ZCE cotton futures price and the Xinsai share stock price. Meanwhile, the forward pass mechanism of price changing information had been found only from the ZCE cotton futures market to the stock market while showing asymmetry. Conclusions of the study can be used for cotton and related corporate to hedge business risks by the cotton price changes.

Key words Cotton futures, Listed companies stock price, Relation mechanism, Vector error correction model, Granger causality test, China

On June 1, 2004, the Zhengzhou Commodity Exchange launched futures trade of cotton. By the end of December, 2008, the 37.809 million contracts of cotton futures were concluded(189.045 milliont), and the sales totaled 2 283.2 billion yuan. the future price of cotton in Zhengzhou is basically in accordance with international future price of cotton and the expectation index of cotton price(Cotlook A index), as well as in accordance with the Chinese cotton price index, which is used to mirror the domestic spot price. The functions played by the future market of cotton in spotting price and hedging and inflation-proofing have appeared primarily.

As an earlier future listed in China, the cotton future has been studied by mainly scholars in China. Their researches mainly focus on the following three aspects: the research on the dynamic relations between cotton future and spot market[1-2]; the effectiveness of cotton future market[3]; the analysis and discussion on the factors that affect the cotton future market[4]. The studies on the impacts of cotton future price on the performances of the listed cotton processing enterprises are rare. But in other fields of future and spot market, there are such researches, for example, the price relations between futures of sugar and stock price of sugar industry[5] and the research on the influencing mechanism between spot price index of gold and stock price of gold[6].

Owning to the mature future market, spot market and stock market of oversea markets, their functions in spotting prices and transferring value are well displayed. Therefore, there are many researches on the relations between price index made in view of the similar industry and the stock price of the relative listed companies. The most representative one is the research conducted by Tufanos (1998). He studied the risks of gold exploration industry in North America bought by the changes of gold prices. It is detected that every one percentage change of gold price would cause two percentage change of the stock price of gold exploration. But the risk reporting varies with time and companies[7]. By using GJR-GARCH method, Mazouz *et al.* conducted an empirical research, the results showed that future contract can improve the efficiency of stock market[8]. German *et al.* have conducted researches on the relations between oil future market and stock market. By using the copula mode, the dependence block diagram of oil futures and standard and Poor's 500 was drawn. The results show that the futures contract with 18 months has obvious backward functions to the stock market[9].

The paper takes the cotton future price in Zhengzhou Futures Exchange Company and the stock price of major cotton production and processing enterprises as the research variables. By using the ADF test, co-integration test, error correlation model and Granger causality test, the paper tries to research the dynamic influence mechanism of the two parties to predict market for the listed cotton enterprises and cotton future hedgers to provide the value investment.

1 Data source and research method

1.1 Data selection and data processing The effects of future price on the stock price of each big or small enterprise can be quantified over a weighted value. Due to the stock price of pillar enterprises has large weight, the future price has great impact on the stock price of pillar industries and the relations between the two become closer. Through observing the major businesses of agricultural products fields in the A share market in the recent five years, it is spotted that there are few companies who take cotton as major businesses and keeps long time except for Xinsai Stock and New Agricultural Development

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Company. Among the two companies, only Xinsai Stock has the average operation income over 50%, achieving 72.4%, in the consecutive five years. The businesses of the company involves many sections including cultivation of cotton, cottonseed, cotton seed, fuzz and the research and development of cotton. Xiansai Stock is the only listed enterprise which has whole industrial chain of cotton. From the year of 2008 to the first half of 2010, the average income of Xinsai Stock in terms of cotton listed top of each listed cotton companies. Hence, the Xinsai Stock is chosen as a listed cotton enterprise in the paper. The stock prices of Xinsai Stock are processed and the sample days with the fluctuation larger than 5% are eliminated(in order to eliminate the over fluctuation of stock price caused by short-term speculation)[6]. The stock price after handling is represented by *X*.

The selection of future price is the consecutive price of cotton in Zhengzhou Exchange Company(the comprehensive index of consecutive time). The future price of cotton is represented by *Y*. In order to smoothly fluctuate the data, eliminate the heteroscedasiticity of time series and keep the co-integration and other relations, so the paper choose the natural logarithm of the two variables, that is ln*X* and ln*Y*. The data come from the Juyuan Database TM. The scale of the data ranged from the January 1, 2007 to September 1, 2010, and the days which have not exchanged were eliminated, and 713 samples were collected(data pairs).

1.2 Research method The whole correlation and interrelation of cotton future price of Zhengzhou Commodity Company and stock price of listed company are analyzed on the basis of co-integration, vector error modification model, Grange casualty test and variance decompositions *et al*.

2 Results and analysis

2.1 Test on the correlation of data

2.1.1 Correlation analysis. Correlation coefficient is the index used to describe the linear correlation degree of two variables ln*X* and ln*Y*. The higher absolute value of the correlation coefficient indicates the higher linear correlation degree between the two variables and the value scope of correlation degree is from −1 to 1. Through testing, in the time of sample data, the correlation coefficient between cotton future price ln*Y* and the stock price of Xinsai Stock was 0.854 2. The two have high correlation degree. The results show the cotton future price has strong correlation degree with the stock price of Xinsai Stock and the two items have the operation basis of hedging and inflation-proofing.

2.1.2 ADF test. In order to ensure the stability of time series and avoid spurious regression, in the first place, the ADF unit foot is tested. It can seen from the test results(Table 1) that the stock price of Xinsai Stock ln*X* and the cotton future price ln*Y* are all non-stationary time series, but after the first order difference , ln*X* and ln*Y* are stabilized, so the ln*X* and ln*Y* are integrated order. The ADF test on the residual series shows that the residual series is stable, so the residual series can be used to conduct coordination test and the residual items can be used as error modification items to establish vector error modification model.

Table 1 The ADF test of cotton futures price and Xinsai stock price

Variables	ADF value	Test type (*c*, *t*, *n*)	1% threshold limit value	Stable or not
ln*X*	−1.772 9	(*a*, 0, 0)	−3.443 7	No
ln*Y*	−1.794 3	(*a*, 0, 0)	−3.443 8	No
Δln*X*	−20.902 7	(*a*, 0, 0)	−3.443 7	Yes
Δln*Y*	−14.238 9	(*a*, 0, 0)	−3.443 8	Yes

Note: *c* is intercept item; *t* is the trend; *n* is the lagged coefficient.

2.2 Johansen coordination analysis Johansen coordination test refers to the time series of two variables and more than two variables are non-stable, but some of their linear combinations are stable, so the long term stable coordination relations exists among these variables.

Because the Johansen test is based on the VAR mode, so as for the VAR(*n*) model, the most appropriate lag period n of the model should be established when establishing model. The value of *n* should not be too small, for one third, the too small model is not enough to reflect the mutual effects among the variables; for another thing, the value should not be too large, or else, it will lead to the sharp decrease of freedom and directly affect the effectiveness of estimated parameter model. In order to select the appropriate lag period, the paper judges the period by using the FPE(Final prediction Error), SC information standard, AIC information standard and HQ(Hannan – Quinn) information standard[10]. The judgment results can be seen on Table 2.

Table 2 The analysis results of the lag-period of VAR model

Lagged futures	ln*L*	*FPE*	*AIC*	*SC*	*HQ*
0	2 132.077	2.34e−09	−9.216	−9.344	−9.251
1	5 013.512	3.24e−10	−18.365	−18.186	−18.932
2	4 152.771	3.17e−11 *	−19.338 *	−19.174 *	−19.763 *
3	4 987.223	3.67e−10	−18.286	−18.381	−18.765
4	5 123.471	2.97e−10	−18.942	−18.247	−18.158
5	5 134.678	2.44 e−10	−18.215	−18.721	−18.727

The analysis result of lag period of VAR model indicates that the four types of indexes all choose the lag period n as the result of. So the VAR(2) model is established.

After determining the lag period, the paper uses the maximum likelihood estimation to conduct coordination test on futures on the basis of ADF unit foot test. The results of the test can be seen on Table 3.

It can be seen that under the 5% significance level, the test on the statistics of the characteristic root has the only coordination relations, that is to say, the stock price of Xinsai Stock ln*X* and the cotton future price ln*Y* has an only coordination relations, which means that the two items has favorable correlations. And then, the VAR coordination relations can be obtained:

$$\ln X = 0.845 \ln Y - 6.575 \quad (1)$$

In formula (1), the coordination test results are: $R^2 = 0.713$,

$t=17.752$, $F=674.893$, and the maximum likelihood value is 2 015.677. each index can pass the statistics test.

Through formula, the following inference can be obtained:

In the first place, the stock price of Xinsai Stock ln$X$ has long-term and stable relations with cotton future price ln$Y$.

In the second place, due to the natural logarithm process conducted on the two time series, the coefficient of coordination equation is used to stand for elasticity. That is to say, when the cotton future price changes 1%, the stock price of Xinsai Stock will change 0.845% in the same directions.

Table 3 The Johansen coordination test of Cotton futures price and the stock price of Xinsai Stock

0 assumption	Statistics of the maximum eigen value	Statistics of the characteristic root	1% threshold limit value	5% threshold limit value	Conclusion
$r=0$	0.042 330	23.910 0	28.342 0	20.261 0	At least one coordination relation
$r\leqslant 1$	0.006 539	3.149 2	8.783 1	4.164 5	The only coordination

2.3 Vector error correction model(VECM) It can be seen from the structure and test of equation(1), the expression of the model is relative successful from the perspective of economic statistics. But VAR model can not deeply reveal the more complex long term and short term relations of the two items from economic connotation. So the expression of the error correction mechanism of coordination system of VAR model-VECM is needed. If several non-stationary variables have the coordination relations, then the error correction model(Granger theorem) would exist. The error correction items reflect the impact of the relations among variables, which deviates from the long term equilibrium state, on the short term change. Equation 1, demonstrates that the stock price of Xinsai Stock ln$X$ and the cotton future price has long term equilibrium relations, but affected by other disturbing factors, the equilibrium relations of the two items may deviate from each other in short term. For testing the possible short-term deviation degree, the vector error correction model of the stock price of Xinsai Stock ln$X$ and cotton future price ln$Y$ is established.

As the lag period of VECM is the lag period of first order difference variable of unrestricted VAR model and the paper has determined that the lag period of VAR model is 2, so the relevant lag period value of VECM should be 1. the specific estimation results are as follows:

$$\Delta(\ln X) = -0.041Eq_1 + 0.059\Delta\ln X(-1) - 1.384\Delta\ln Y(-1) - 0.001 \quad (2)$$

$$\Delta(\ln Y) = -0.011Eq_2 - 0.002\Delta(\ln X(-1)) + 0.487\Delta(\ln Y(-1)) - 0.000\,1 \quad (3)$$

In the equation, Δ is the first order difference of former variable; Eq_1 and Eq_2 are the error correction items of 2 and 3 respectively. Among the two items, $Eq_1 = \ln X(-1) - 0.785\ln Y(-1) + 5.139$ and $Eq_2 = \ln Y(-1) - 0.785\ln X(-1) + 5.139$.

Eq_1 and Eq_2 reflect the long term deviation degree of the stock price of Xinsai Stock ln$X$ to cotton future price ln$Y$ in short term. The coefficients of the two items describe the direction and speed of the stock price of Xinsai Stock ln$X$ and cotton future price ln$Y$ toward long term equilibrium level when the cotton future price deviating from long term equilibrium level caused by disturbance.

Through analyzing, the following inferences can be obtained:

In the first place, the adjustment coefficients of equation (2) and equation(3) are -0.041 and -0.011 respectively, which indicates that when deviating from the long term equilibrium level, the function of error correction items would adjust it reversely and the change tends to be stable.

In the second place, the absolute value of the error correction item of the difference of the stock price of Xinsai Stock is larger than the absolute value of error correction of the deference of cotton future price, which indicates that the stock price of Xinsai Stock and the recover speed of Xinsai Stock is faster than the cotton future price.

In the third place, the lagged difference coefficient of the stock price of Xinsai Stock ln$X$ to cotton future price is positive, which indicates that in short term dynamic relations, the increase of the lagged items of cotton future price ln$Y$ will facilitate the rise of stock price of Xinsai Stock. The possible reasons that caused the results might be that investors have digested the information of cotton future prices after a long time period's analysis and judgment. Besides, the investors have led to their prediction on the performance growth of the cotton production and processing companies caused by the rise in cotton price[11].

In the fourth place, the coefficient of the difference lag order of cotton future price ln$Y$ to the stock price of Xinsai ln$X$ is negative, which indicates that in short term dynamic relations, the lagged items of the stock price of Xinsai Stock will affect the rise of cotton future price. The uncertain prediction of investors may be accountable for the results, for due to the continuous growth of stock price of cotton production and processing companies, the investors feel the uncertain of the cotton market, and then they withdraw their capitals to ensure the obtained profits.

2.4 Granger causality test In order to test the causality between the stock price of Xinsai Stock ln$X$ and the cotton future price, the Granger causality test is conducted on the two time series. The results can be seen on Table 5. The Granger causality test shows that under the 5% significance level, the function of cotton future price in leading the stock price of Xinsai Stock is significant, while the stock price of Xinsai Stock ln$X$ does not lead the cotton future price ln$Y$. The results demonstrate that the cotton future price ln$Y$ plays the role of detecting directing the price. Through directly affecting the spot price of cotton, the cotton future price affects the performance of the listed companies[1-2], and then the stock price will return to its real worth.

2.5 Variance decomposition Another tool used for analyzing the dynamic characteristics of VAR dynamic system is variance decomposition. In 1995, Hasbrouck(1995) put forward

that when investigating the VAR Model, the way of predicting the variance decomposition can be adopted to research the dynamic features of the model selected. The though pattern of variance decomposition is to decompose the mean-square errors to the contributions made by each variable impulsion, which is the proportion of the contribution made by each variable impulsion to the total contribution. The method can be described into the mutual functions of the stock price of Xinsai Stock ln$X$ and the cotton future prices. The specific results can be seen on Table 5.

Table 4 Results of Granger Causality Test

Original assumption	F statistics	Probability	Whether leadingor not
The cotton futures price ln$X$ does not lead the stock price of Xinsai Stock	7.673 56	0.000 52	Leading
The stock price of Xinsai Stock ln$Y$ leads the cotton futures price	2.351 26	0.084 00	Do not lead

Table 5 Results of variance decomposition

depreciation	Results of ln$Y$ variance decomposition		Results of ln$X$ variance decomposition	
	ln$Y$	ln$X$	ln$Y$	ln$X$
1	100.000 0	0.000 000	0.707 880	99.292 12
10	87.169 86	12.830 14	3.653 950	96.346 05
20	74.192 23	25.807 77	3.306 569	96.693 43
40	66.798 02	33.201 98	3.626 912	96.373 09
60	52.488 03	47.511 97	7.137 454	92.862 55
80	39.835 39	60.164 61	11.966 91	88.033 09
100	37.892 90	62.107 10	16.203 37	83.796 63
110	36.130 16	63.869 84	17.896 22	82.103 78
120	36.076 13	63.923 87	18.314 00	81.686 00

The results of the variance decomposition demonstrate that:in the first palce, when the lag period of the stock price of Xinsai Stock equals 1, 100% of the change of the price comes from its own. The changes will decline and the short term change of the stock price comes mainly from the stock itself. 65% to 100% of the change of the stock price of Xinsai Stock ln$X$ comes from itself , but the impacts of itself will decline. But from the long term perspective, the changes of the stock price of Xinsai Stock ln$X$ come from the cotton future price ln$Y$. The results are in accordance with the research results of GUO Yan-feng *et al.*[6]. From the perspectives of middle or long term, the expiration of contracts and the expectation of stock investment will lead to the change of stock price, so the cotton future price ln$Y$ is accountable for the changes of stock price of Xinsai Stock and the impact of cotton future price on stock price will surpasses the impact of the stock price itself in the 62 trade day. After that, the impacts of cotton future price on stock price will increase stably and maintain the proportion of over 60%.

In the second place, the changes of cotton future price ln$Y$ comes from itself and maintain the proportion of over 80% and the impact of the stock price ln$Y$ of Xinsai Stock is limited. The results indicate that the cotton materials of the downstream factories have little impacts on the cotton future market as raw materials. The proportion of the impact maintains around 19%, and the conclusion is similar to the conclusion drawn by HUANG Fei-xue *et al*[5].

3 Conclusions and suggestions

3.1 Conclusions In the first place, Johansen test and vector error correction model show that there is long term balanced relations between the stock price of Xinsai Stock and the cotton future price and the changing trend and changing speed of them parallel with each other. The further consideration on the high correlation of the stock price of Xinsai Stock and the cotton future price implies that the cotton future market of Zhengzhou Commodity Company has the functions of hedging.

In the second place, the Granger causality test shows that under the 5% significance level, the leading role played by cotton future price on the stock price of Xinsai Stock is prominent. Cotton future price has the functions of detecting and directing price to the stock price of Xinsai Stock.

In the third place, the results of variance decomposition show that cotton future price of Zhengzhou Commodity Company has lead-lag relationship with the changing trend of the stock price of Xinsai price. The lag period is about 62 days. The process is single and asymmetric, to be specific, the information of price change is transmitted by cotton future market to cotton stock market in positive way.

In the fourth place, the vector error correction model demonstrates that the recovery speed of the stock price of Xinsai Stock affected by external factors is faster than the recovery speed affected by cotton future price. In short term, the stock price of Xinsai Stock may restrict the cotton future price in the same direction.

3.2 Suggestions Firstly, the development of cotton futures is conducive to changing the inferior position of Chinese cotton price in the world cotton price making system. The superior price of Chinese cotton formed by the stable operation of cotton futures has certain impacts on the cotton price in the international market, as well as effectively protects our national interests and the interests of Chinese cotton-related enterprises.

Secondly, the decision-makers of cotton companies should pay close attention to the price change and future trend of cotton future price and select useful information for production and operation, hedging and maximum stock price of enterprise value of stock.

Thirdly, deal makers and investors in stock market can predict the changes of the stock price of cotton companies according to the changes of cotton future price. In the meantime, when the stock price of cotton companies fluctuating greatly, the cotton futures or other related financial tools should be applied to hedge risks or the profits bought by the fluctuation can be obtained.

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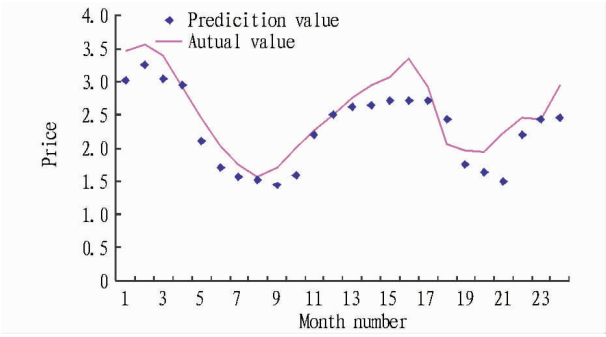

Fig. 4 The prediction result of the neural network model based on genetic algorithm

Table 1 The error distribution comparison of the two models %

Model	Absolute error		
	<20	<15	<10
BP neural network model	66.7	50.0	25
Genetic algorithm network model	91.7	58.4	25

The above results shows that when the absolute error of prediction data is within 10%, the two models have similar prediction function; when the absolute error of prediction data is within 20% and 15%, the genetic algorithm of neural network model is more accurate than BP neural network model, especially when the absolute prediction error is within 20%, the genetic algorithm of neural network is significantly more accurate than BP neural network model. The genetic algorithm of neural network shows good generalization capability.

4 Conclusion

In the paper, the neural network prediction model of vegetable market price is established by applying genetic algorithm. Taking the market price of mushroom is wholesale market of Beijing City as an example to mock and predict. The prediction results of genetic algorithm neural network model and that of traditional BP network are compared. The results show that genetic algorithm neural network has high accuracy, which indicates that the method can be one way for predicting the market price of vegetable with the non-linear time series. The research can only be used in predicting the price alone, considering other major influencing factors into consideration to improve the prediction results of vegetable needs further studying.

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