AN EMPIRICAL ANALYSIS OF SOYBEANFUTURES PRICE BASED ON GARCH MODEL

Ming-qingWU[1] Hong-guoSUN[1]*
[1] (Department of Mathematics and Finance, Hunan University of Humanities Science and Technology, Loudi, China
/*corresponding authorsunmathematics2007@163.com)

ABSTRACT:

This paper uses GARCH model to analyze the price of soybean futures. Firstly, the time series of soybean futures price is smoothed over a period of time. After analysis, it is judged that the series has heteroscedasticity and fluctuation aggregation. Therefore, the GARCH model suitable for the sequence is identified and analyzed. It shows that the application of GARCH model can effectively reflect the variation of the volatility of soybean futures prices, that is, the GARCH model can describe the fluctuation of soybean futures prices. This gives us a deeper understanding and grasp of the characteristics of soybean futures price volatility, and having important reference significance to the country's measures regarding the stability of the soybean futures market.

Keyword:*fluctuations in prices,soybeanfutures, GARCH model*

1 INTRODUCTION

With the rapid development of China's economic system, China's import and export trade has increased year by year. The laws in the prices of soybean futures have always been one of the concerns of China. As the main raw material of soybean product processing enterprises, the fluctuation of the price of soybeans will have a significant impact on the production and operation of the company. As a big consumer of soybeans, soy products processing companies certainly hopethat the lower the better the price of soybeans.This can reduce the company's production costs and improve the economic efficiency of enterprises.

But too low soybean prices will weaken the farmers' enthusiasm for planting,this led to a declining soybean supply in later stages. The decrease in the quantity and the unbalanced supply and demand in the market have resulted in the loss of the stability of soybean prices and irrational growth, thus it affecting the normal production and operation of enterprises. Therefore, maintaining the basic stability of soybean prices at a reasonable level, from the perspective of sustainable development, is beneficial to the production, operation and development of soybean product processing enterprises.

2. LITERATURE REVIEW

The concepts of autoregressive conditional heteroscedasticity (ARCH) and general autoregressive conditional heteroscedasticity (GA RCH) were first proposed by Engle (1982) and Bollerslev (1986). Now it is widely used. Liu Jiafu, Li Binglong, and Zhang Wenli (2009) used the GARCH (1,1) model to examine the fluctuation characteristics of soybean wholesale prices in China. The study found that during the period from 1999 to 2008, the wholesale price of soybeans in China showed a random walk trend, and its fluctuations had the characteristics of right thick tails and clusters. The price fluctuation had the ARCH effect, and the impact of fluctuation shocks attenuated slowly, and the recent fluctuations intensified. Wang Zhenyu (2014) uses the soybean futures of the Dalian Commodities Exchange and the Chicago Futures Exchange as representatives of China-US agricultural products, using GARCH-M, EGARCH and other models to analyze their daily closing price data, and studies the characteristics of price fluctuations and spillovers effect. The results show that there are autocorrelation, heteroscedasticity, and obvious agglomeration in the soybean futures return series between the two countries. Fang Yan and Li Lei (2016) used the GARCH model to conduct an empirical study on the fluctuation of soybean prices before and after the reform trial, and tested the difference in soybean price fluctuations before and after the implementation of soybean target prices. The empirical results show that the implementation of the soybean target price policy effectively reduces the clustering and asymmetry of soybean price fluctuations, eliminating the ARCH effect of the soybean market, stabilizing the soybean market in China, and conceivingto gradual return of soybean prices to market pricing.

3. GARCH MODEL OVERVIEW

According to the characteristics of the research object's historical data, it explores its internal fluctuation law, establishing a dynamic wave model, and using a method of fitting and parameter estimation is called time series analysis. Bollerslev (1986) proposed the GARCH model, which is a new prediction model that is used to better solve the problem of large ARCH lag period and many parameters of the estimation and little the accuracy of the estimation. The GARCH model has a lag value with a few conditional variances instead of many random disturbance term lags. This article only uses the GARCH(1,1) model to study the law of the volatility of the daily return price of soybean futures. The (1,1) in the GARCH(1,1) model is an autoregressive term with an order of 1 (GARCH term). And for the residual squared term (ARCH term) with a lag order of 1.The standard GARCH(1,1) model is as follows:

$$\hat{\pm}_t^2 = \mu + \sim\pounds_{t-1}^2 + \pm_{t-1}^2 \quad (1.1)$$

Equation (1.1) is called the conditional variance equation, which shows the conditional variance under the condition of time t. $\hat{\pm}_t^2$ Dependent on the square of the residual in time t-1, $\pounds_{t-1}^2$,(the ARCH term) and the predicted value of the previous period variance, $\pm_{t-1}^2$,(the GARCH item).

The setting of the GARCH model in the securities field has practical significance. The residual item reflects the fact that the actual value of the dependent variable deviates from the average value of the mean value equation. Therefore, we can use the invariant variance (ω) and the predicted value of the previous period variance ($\pm_{t-1}^2$) and the previous issue of new information ($\pounds_{t-1}^2$, which is the weighted average of lag value of the residual squared)to predict the variance of the current period. If the soybean's daily closing price returns unexpectedly increase or decrease by a large margin, people will increase the prediction of the next period's variance, so GARCH model can be used. Based on the data of historical futures trading days, the model analyzes and researches the fluctuating law of the yield rate of the soybean futures market.

4. EMPIRICAL ANALYSIS

4.1 Data Selection and Model Preprocessing

The data in this article selects daily data of closing prices of Dalian Exchange Soybean Futures (a0001) from January 4, 2012 to April 27, 2018, calculated in the largest wisdom trading software, with a total of 1,535 data. The closing prices are denominated in RMBand the soybean futures aretrading at 10 tons per hand. TheEviews 7.0 version was used for the measurement analysis. The timing chart for obtaining the sample data S1 is shown as follows:

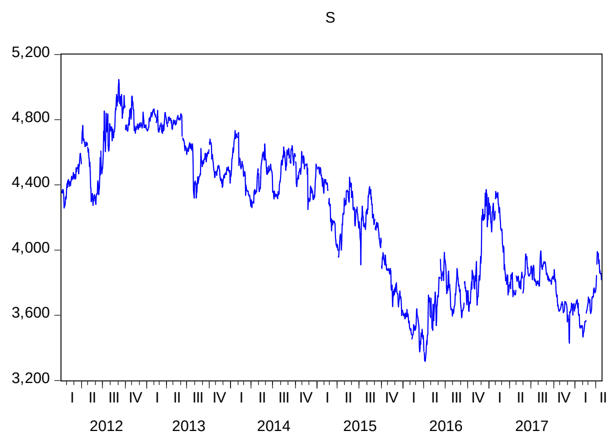

Fig1soybean futures price time series chart

Fig1 shows that before 2013, the price trend of soybeans showed a turbulent upward trend. From early 2013 to the middle of the first quarter of 2016, there was a clear downward trend. From the middle of the first quarter of 2016 to the beginning of 2017, there was an upward spiral. It showed a general downward trend in 2017, and a turbulent upward trend since 2018. From this,we can judge that the soybean futures price sequence is a non-stationary sequence.

Processing data: Taking the log yield and first-order differential to the daily closing price.

$$R_t = lnP_t - lnP_{t-1}$$

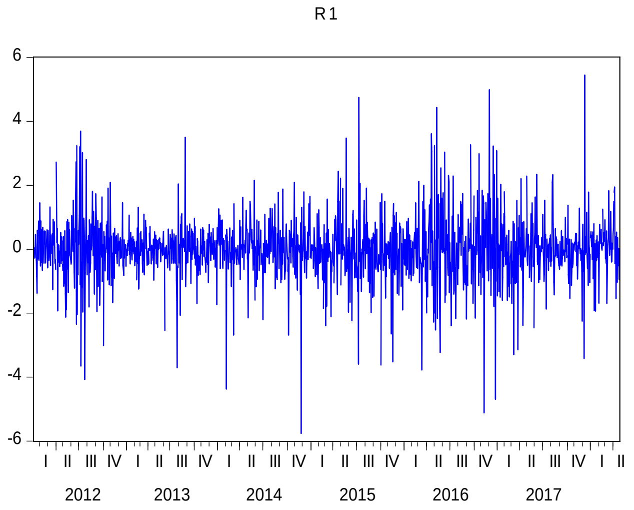

Fig2 soybean futures closing price first-order differential series R

As shown in Fig2, the data fluctuates roughly around a fixed value and can be initially determined to be a stationary sequence. In addition, the volatility of the soybean futures daily closing price in the period from 2012 to 2014 is relatively small, and the volatility in the second quarter of 2015 to 2018 is significantly enlarged. This is in line with the current market conditions. Closely clustered by the volatility line, we can see that the first-order difference sequence of the soybean futures price has obvious fluctuation aggregation (there is heteroscedasticity).

4.2 Descriptive statistics

Table 1- Descriptive statistics

	R
Mean	-0.008654
Maximum	5.448156
Minimum	-5.760276
Std. Dev	0.973086
Skewness	0.029103
Kurtosis	8.094186
Jarque-Bera	1658.901
Probability	0.000000

According to Table 1, the average daily yield rate is -0.008654, and the standard deviation is 0.973086, and the skewness is 0.029103, and the yield rate is right-biased, with a kurtosis of 8.094.136, which is higher than the normal kurtosis 3 large, showing the characteristics of peaks and thick tails, with obvious agglomeration effect. The J-B statistic is 1650.901, and its p value is 0. It further shows that the daily closing price of soybean futures is significantly below the normal distribution.The traditional normal hypothesis distribution cannot be interpreted and analyzed it, and it needs to establish non-normal distribution model.

4.3 Unit Root Test

In order to further confirm the stationarity of the first-order difference sequence, the unit root test (ADF) is introduced. The test result is shown in Table2.

Table2-First-order differential sequence unit root test

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-40.02767	0.0000
Test critical values:	1% level	-3.434409	
	5% level	-2.863220	
	10% level	-2.567712	

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

From the above test results, when the significance level was 5%, it was found that the unit root (ADF) test statistic of R was -40.02767 and less than the critical value of -2.886320, and its concomitant probability was p=0.0000<0.05.thus rejecting the null hypothesis .R does not have a unit root and is a smooth time series.

4.4 Model Identification

After confirming the stationarity of the sequence, the model needs to be identified next.According to the autocorrelation (AC) and partial autocorrelation (PAC) analysis results of soybean price first-orderdifference sequence.We can see that the lag of the price-yield rate itself has no impact on the current period. There is a fluctuation and aggregation in price yield rate. It cannot be modeled and analyzed using the ARMA model. The volatility model can be established. Comparing, TheGARCH(1,1) model works best.

4.5GARCH(1,1)Model Estimation

The GARCH (1,1) model was used to fit the daily return price of soybean futures, and the conditional variance equation (4.1) was obtained as follows:

$$\hat{\pm}_t^2 = 0.030666 + 0.056376£_{t-1}^2 + 0.912637\pm_{t-1}^2 \quad (4.1)$$

$$t \quad (6.353998) \quad (9.266755) \quad (92.0259)$$

The ARCH LM test is performed on the variance equation (4.1) obtained by the GARCH model, as shown in Table 3.

Table 3 - ARCH test

Heteroskedasticit Test ARCH			
F-statistic	0.260545	Prob.	0.6098
Obs*R-squared	0.260841	Prob.	0.6095

Table3 ARCH LM test of GARCH(1,1) fitting results

The companion probability at this time is 0.6098. Therefore, it accepted that the original hypothesis that the residual sequence does not have the ARCH effect indicates that there is obviously no condition heteroscedasticity in the GARCH(1,1) model.

The equation of variance shows that:

(1) By the equation of α+β=0.056376+0.912637=0.969013, it is gonging to be less than 1 indicates that the model is stationary andhave constant conditional variance. That the total coefficient issimilar to 1 indicates that the past information has a strong persistent impact on the current and future fluctuations of the yield rate.The emergence of market information has caused the yield rate to fluctuate. The fluctuation cannot be eliminated in a short time.

(2) The variance of the current period is mainly affected by theitselflag a phase . The coefficient is 0.912637, which indicates that the variance of one period of lag is 1 unit, and the variance of this period is 0.912637 units.It is very close to 1, which indicating that the impact has a long duration. The impact has long memory.

(3) The variance of the current period is affected by the random error term of the first phase of the lag. The influence coefficient is 0.056376 and the effect is relatively small.

5. CONCLUSION

This paper analyzes the statistical characteristics of the historical data of soybean futures, and seeks an appropriate fitting model for modeling and analysis. Based on the empirical analysis of the historical data of the daily closing price of soybean main contract through the GARCH model, the following conclusions can be drawn:

(1) From the time series chart of soybean futures (see Figure-1), we can see that the price trend of soybeans showed a turbulent upward trend before 2013, and there was downward trendfrom early 2013 to the middle of the first quarter of 2016. From the middle of the first quarter of 2016 to the beginning of 2017, there was an upward spiral.It showed a general downward trend in 2017, and a turbulent upward trend since 2018.

(2) In this paper, the data of the daily closing price of soybean futures over the past 6 years are selected. Through the analysis of EViews 7.0 statistical software, it is judged that the soybean market's daily closing price yield rate shows obvious heteroscedasticity and fluctuation aggregation. This also proves that applying the GARCH model can eliminate this heteroscedasticity and volatility clustering, and can effectively reflect the volatility change rule of the daily closing price of soybean futures, which reflects the fluctuation of soybean futures price.

(3) The current soybean price is affected by the information in the past to a large extent, and the fluctuation of the price yield rate of soybean futures caused by this information will continue for a long period of time and it will be difficult to eliminate in a short time. Relevant departments should formulate relevant policies in light of this phenomenon to stabilize the volatility of soybean futures and weaken futures market risk.

REFERENCES:

[1] Wang Jiangfeng. Wu Qunying.(2011). Analysis and Forecast of the Fluctuation of China's Stock Market Based on GARCH Family Model[J]. Economic Research Guide.(34):74-78.

[2] Zheng Hongjie. Chen Yichao. Jing Jing. et(2017).al. Research on Liquidity Prediction of Banking Money Management Based on GARCH Model[J]. China Bonds (3):23-29.

[3]CHU Hua.(2018). Prediction of China Cotton Price Index Based on GARCH Model [J]. Cotton Textile Technology.(3):73-76.

[4] Zhenyu Wang.(2014). Research on the Spillover Effects and the Characteristics of Agricultural Products in China and the United States: An Analysis Based on Soybean Futures Data [J]. Rural Economy. (5): 98-101.

[5] Wang Yan.(2015).Application of Time Series Analysis [M]. Beijing: China RenminUniversity Press.

[6] Zhang Chengsi.(2016). Econometrics: A Perspective of Time Series Analysis (Second Edition) [M]. Beijing: China Renmin University Press.