Stability of Spot price and Futures market for Agricultural commodity: based on the sugar products

ZiJian Yang [1,a]

[1]Anhui University of Finance and Economics, Bengbu, Anhui Province, China

[a]542742064@qq.com

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Abstract: The mechanism of the stability of spot price will be further analyzed on the basis of ARMA-GARCH model, selecting the daily data of the spot price and the futures price of sugar products. However, as the new factors appeared, it is inappropriate to analyze by GARCH model with dummy variable. Thus, the paper also establish the GARCH model with futures trading volume to verify the spot price stability function of the futures market and test the robustness of the model. The results show that the spot prices tend to be stable with the improvement of agricultural futures market, but different agricultural futures market are not the same.

The futures market of agricultural products is the earliest futures market in China, concerning soybean, corn, wheat, sugar and cotton. With the accession to the world trade organization, the Zhengzhou Futures Trading opened sugar futures market in January, 2006, aiming to provide a place to hedge sugar productions. However, in 2014, Zhengzhou Commodity Exchange of sugar futures prices fell sharply and rose sharply then. As the result, manufacturers has sold spots for the withdrawal from circulation of funds and faced the destruction.

In fact, the agricultural products futures market is originally designed to promote the sound development of the spot market [1].However, some scholars held that the futures price of agricultural products and the spot market is separated, and the futures market is not conducive to price stability. Therefore, the objective of this study is to explore the real association between the futures market and the spot price stability. Using a sample of sugar and cotton futures as representations and the daily trading volume as a proxy for the quantity of the futures market variable, we show that spot prices tend to be stable with the establishment and improvement of agricultural futures market.

The paper is organized as follows. Section I provides literature review and theoretical motivation for the empirical analysis. Section II describes the data and Section III discusses the empirical results and robustness tests. Concluding remarks are contained in Section IV.

Literature review

The function of spot price stability of the futures market of agricultural products. Traders often use futures prices based on the spot trading prices. For example, Chicago traders take soybean futures prices to price the spot transaction (plus or minus transport costs)[2].Consequently, futures prices have influence on spot prices.

If futures price guide the spot price, we need to further explore whether it plays the roles of reducing the spot price fluctuations. In the futures market, rational speculators would buy when

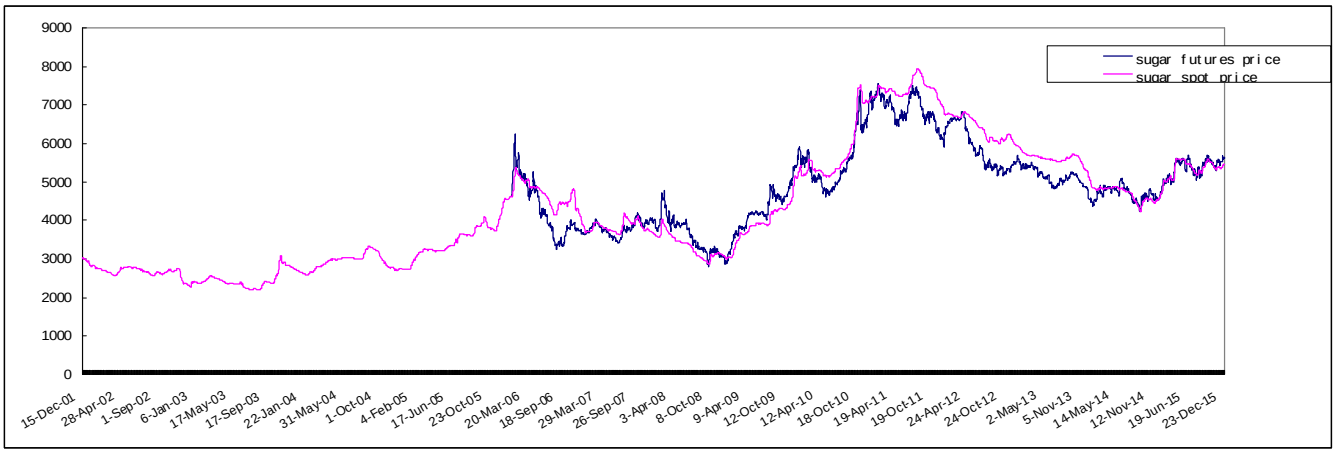
commodity prices were low and sell when commodity prices were high, which can stabilize the price volatility [3]. However, some scholars found that there are numerous speculators in the futures market, which also bring the uncertainty [4]. Therefore, they argued the stability is a kind of special situation. ZH Sun ,YQ Wang found that the stability of futures price also plays a guiding role for the spot price of the agricultural products, which consequently promoted the sound development[6]. ZY Pang and Lei Liu found that the fluctuation of the spot price of most agricultural has decreased after the establishment of agricultural futures market, using GARCH model and the fact that the comparative method[1],whereas Nan Yang found that of sugar futures market are not functional[4]. Therefore, the paper intends to further explore the relationship between sugar futures market and price stability.

The factors affecting the price of agricultural products. There are two main factors affecting China's agricultural products spot prices. On the one hand, the main factor is the seasonal factors, which means that the spot price is high before harvest and the spot price is low after harvest. On the other hand, there is another important hand in China, which is the speculation on the spot product[5,6].As the result, the spot price of agricultural products will be related or not related to the various impact, which makes the relationship between the futures price and spot price uncertain. Therefore, this paper needs to smooth the original datas[7] for the correct results.

Data

The data set comprises daily prices of futures, daily prices of futures of spot and volume data for sugar products. The rationale for using sugar products is that the sugar futures are actively traded and perfect. Daily sugar futures prices from December 2001 to December 2015, F_t, are obtained from the Zhengzhou Commodity Exchange and daily spot prices, P_t, are from GSMN, concerning 3819 data in total. However, the spot price is affected by many factors (noises), so the author would smooth the data by the span of five moving average. Figure 1 lists the smoothing price of sugar futures and spot. Figure 2 reports the sugar fluctuation rate, which are also called daily sugar returns. Price volatility is generally refers to the possibility of the asset prices of future price deviating from what its expected value, which can be measured by the fluctuation rate. The rate is given by equation: $r_t = \lg(P_t) - \lg(P_{t-1})$. As shown in Figure 2, it has the volatility clustering.

Previous papers often explored the function of spot price stability of the futures markets by the facts of comparative law, which introduce dummy variables. However, the dummy variables can not reflect the market after the improvement of the futures market. Thus, the paper intends to quantify the sugar futures market indicators by trading volume. The reason why it can become a proxy is that trading volume only reflect the market situation when the futures market do not be shocked[8]. Daily transactions volume (number of futures traded during the day) for sugar futures is also taken from the Zhengzhou Commodity Exchange.



Fig,1 the smoothing price of sugar futures and spot

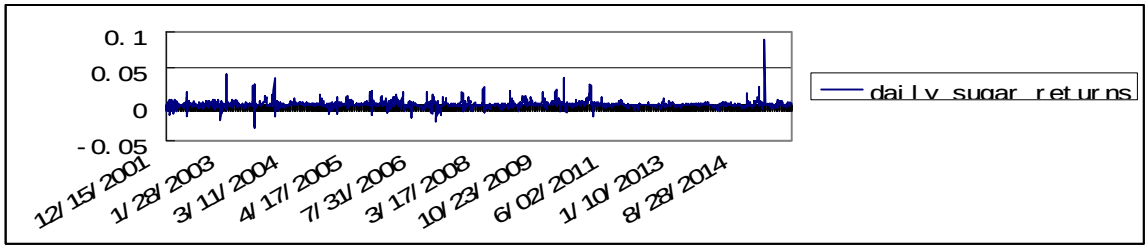


Fig.2 daily sugar returns

Model and Empirical Results

GARCH Model and Empirical Results. ADF test and co-integration test indicates that the futures price and spot price of sugar products are the same order of the whole, and there is a co-integration relationship between them at 5% significance level. Then the paper will further investigate whether the sugar futures decrease the spot price volatility.

The GARCH model of Bollerslev restricts the conditional variance of a time series to depend upon past squared residuals of the process.[8] Then the paper introduced the dummy variable to the GARCH model based on the data of daily sugar returns. Such a model for daily sugar returns is given below:

$$r_t=\alpha_0+\sum[i\rightarrow p,i=1]\ \alpha_i r_{t-p}+\sum[j\rightarrow q,j=1]\ \beta_j\varepsilon_{t-q}+\varepsilon_t\ ,\ \varepsilon_t=\sqrt{h_t}*v_t\ ,\ v_t\sim N(0,1) \quad (1)$$

$$h_t=a+\sum[i\rightarrow p,i=1]\ b_p\varepsilon^2_{t-p}+\sum[j\rightarrow q,j=1]\ c_q h_{t-q}+dD_0 \quad (2)$$

The variable D_0 is the dummy variable, representing that the sugar futures market established in January, 2006. While D_0=1, representing the establishment of sugar futures market in the following, D_0=0, representing the establishment of sugar futures market in the previous. If d>0 with significance, then we conclude the initial establishment of sugar futures market intensified the spot price volatility, if d<0 with significance, then we conclude the futures market is established to reduce the volatility of the spot price. To motivate the empirical tests of return, we further introduced the trading volume, T_t , to the GARCH, such another model for daily sugar returns is given below:

$$h_t=a+\sum[i\rightarrow p,i=1]\ b_p\varepsilon^2_{t-p}+\sum[j\rightarrow q,j=1]\ c_q h_{t-q}+eT_t \quad (2')$$

The Box-Ljung Q-statistic, constructed for maximum lag of 20, tests for residuals of model (1). The Q statistics are generally large and statistically significant. Thus the paper introduced the model (2),(2'). Table 1 reports the estimated coefficient and asymptotic t-statistics of the model

(1),(2),(2').The parameters are estimated using numerical techniques to maximize the likelihood function. The coefficients, $a+d>0, b_1>0, c_1>0, b_1+c_1<1$,meet the covariance stationary conditions. LM ARCH test for the residual sequence after GARCH model indicates the elimination of the ARCH effect.

In model (2), the coefficient on dummy variable, d, is not significantly positive for sugar futures, as unpredicted. This inference may due to the fact that the other factors affecting the spot price, including macroeconomic conditions, speculation, etc., but the inference indicate that the introduction of dummy variable is not appropriate, suggesting that the emergence of new factors. Such as trade volume.

In model (2'),the coefficients are all significant, and the coefficient of the trading volume ,e, is significant at 0.1% level, which is -2.92E-12.The results indicates that the spot price fluctuation becomes smaller as trading volume increase. In addition, b_1+c_1 close to 1, which indicates that the impact of the conditional variance to go through a long time to disappear. The model(2') also proves that the trading volume of sugar futures is more suitable as an alternative for futures market than virtual variables.

Table 1

Maximum Likelihood Estimates of GARCH Model with dummy variable or trade volume

Co.	(1),(2)	(1),(2')
α_0	0.0002	0.0002
	(0.8138)	(0.8138)
α_1	0.5120***	0.5120***
	(31.6446)	(31.6446)
α_2	0.1679***	0.1679***
	(9.3522)	(9.3522)
α_3	0.0383*	0.0383*
	(2.3692)	(2.3692)
a	1.13E-06	9.62E-06***
	(1.4960)	(30.8124)
b_1	-	0.1500***
		(6.9296)
c_1	0.9208***	0.6000***
	(17.4001)	(25.9795)
b_1+c_1	0.9208	0.75000
d	-3.78E-07	-
	(-1.4952)	
e	-	-2.92-12***
		(-212.8587)
AIC	-8.5615	-8.5665
Likelihood	163434.5	10219.6

*statistically significant at 5%,**statistically significant at 1%,*** statistically significant at 0.1%

Robustness test Firstly, the paper change sample period reduced to early December 2010 to 2015 by the end of December, then repeat the inspection.

Secondly, the paper establish GARCH-M model. In spot market of sugar, the agricultural products of speculation will affect the daily return of sugar [5]. Therefore, the spot will be affected by the measure of expected risk and return. The paper introduces the GRARCH-M model, which

can avoid the influence of expected risk in sugar spots. Such a GARCH-M model for daily sugar returns is given below:

$$r_t=\alpha_0+\theta\sqrt{h_t}+\varepsilon_t\ ,\ \varepsilon_t=\sqrt{h_t}*\ v_t\ ,\ v_t\sim N(0,1) \qquad (1')$$

Thirdly, the paper expands the cotton samples. The data set comprises daily prices of futures and spot and volume data for cotton products. Daily cotton futures prices from January 2015 to January 2016 are obtained from the Zhengzhou Commodity Exchange and daily spot prices are from SCI99.ADF test and co-integration test indicates that the futures price and spot price are the same order of the whole, and there is a co-integration relationship between them at 10% significance level. Then, the paper established ARMA-GARCH (1,1) to then repeat the inspection.

Table 2 reports the estimated coefficient and asymptotic t-statistics of the models of test. Firstly, the empirical results are consistent with the findings above, e<0, which shows that the conclusion is robust. Secondly, the result of test.2 indicates that people will assume the expected risk in the spot market of agriculture.

Table 2

Robustness Test by Maximum Likelihood Estimates of GARCH Model

Co.	Test.1	Test.2	Test.3
α_0	0.0002	-0.0036***	-0.0002***
	(0.8138)	(6.3167)	(0.2007)
θ	-	0.8666***	-
		(-4.5028)	
α_1	0.5120***	-	0.8393***
	(31.6446)		(7.7006)
α_2	0.1679***	-	-
	(9.3522)		
α_3	0.0383*	-	-
	(2.3692)		
β_1	-	-	-0.7184***
			(-5.1594)
a	1.07E-05***	1.89E-05***	4.05E-07***
	(35.2822)	(17.5068)	(30.8124)
b_1	0.1500***	0.1500***	0.1500***
	(5.0839)	(7.7599)	(3.0746)
c_1	0.6000***	0.6000***	0.6000***
	(25.3120)	(15.6012)	(7.6744)
b_1+c_1	0.7500	0.7500	0.75000
e	-3.25E-12***	-5.74E-12***	-1.08E-12
	(-79.7361)	(326.4732)	(-571508.8)
AIC	-8.4955	-7.7411	-11.6806
Likelihood	6031.546	9237.238	1423.189

*statistically significant at 5%,**statistically significant at 1%,*** statistically significant at 0.1%

Conclusions

This paper provides empirical support for the exploration that the spot price of agricultural products tend to be stable and sustainable with the establishment and improvement of agricultural futures market.

In addition, the paper finds some other interesting results. Firstly, the paper established ARMA-GARCH model with a dummy variable to explain the Arch, however, the estimated coefficient of dummy variables in GARCH model is not significant. The author argues the reasons that there are many new factors influencing the futures markets with the establishment of China's sugar futures market. Therefore, we introduce the trading volume to solve the problem. From the results of the empirical study, it shows that as trading volume increase, the volatility of the spot market is smaller. This also proves that the index of the futures trading volume is more suitable as an alternative than dummy variable. Secondly, we find that people will assume the expected risk in the spot market of agriculture. Lastly, the paper find that different agricultural futures market have reduced the fluctuation in the different degrees. This may be due to differences in the legal system and speculators heterogeneity. Thus, the results properly motivate us to better understand the necessities of the futures market and spot market.

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