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Study on the Influence of Cotton Option Launch on The Price Fluctuation of Underlying Futures

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Abstract: This paper takes cotton options as the research object, and empirically tests the impact of cotton options on the price fluctuation of the underlying futures in the short and medium term by establishing the ARMA-GARCH model with the introduction of two dummy variables. The study found that the launch of cotton options increased the volatility of the underlying futures price in the short term, and increased the volatility in the medium and long term. After the launch of cotton options, the supply of national policies against the epidemic played a certain stabilizing role in the volatility of futures prices, but the policy effect has a time lag. Based on this, institutional investors should be encouraged to use cotton options and futures risk management, build a risk prevention and control mechanism for sudden public crisis events, popularize the knowledge of options and futures, and improve the transparency of cotton trading.

Keywords: Cotton options, Futures prices, Risk management, Financial supervision.

1. Introduction

Cotton is a national strategic bulk agricultural product, which is related to agricultural economy and high quality development of agriculture. Among them, whether the price of cotton is stable is an important standard for the healthy development of its industry. Its abnormal fluctuations will increase the uncertainty of producers' market expectations, which will increase the risks faced by the cotton industry. In order to make the steady and healthy development of cotton industry, the launch of cotton financial derivatives has become an inevitable trend. Derivative financial products are an important tool to stabilize the financial market, which can prevent and resolve financial risks well. However, investors are prone to some irrational behaviors such as speculation under the influence of the external environment, which may deviate from the original intention of derivative financial instrument innovation and aggravate the volatility of the financial market. Cotton options as a derivative financial instrument was officially listed on the Zhengzhou Commodity Exchange on January 28, 2019. Will its listing bring certain fluctuations to cotton futures prices? How big is the volatility? The discussion of these issues can provide a useful policy reference for the healthy development of cotton industry and further maintain the smooth operation of cotton derivative financial market.

2. Literature Review

As for the study of futures price volatility, scholars mainly start from two aspects: the impact of futures listing on spot market volatility and the impact of sudden external factors on futures price volatility. In terms of the impact of futures listing on spot price volatility, Gu Haifeng and Yayong Zhou(2019) found by means of wavelet analysis that the listing of CSI 500 stock index futures had a significant boost effect on spot price in the short term [1]. Based on the VECM model, Junlin Li et al. (2023) concluded that there is a good linkage between the domestic and foreign soybean futures markets and the domestic spot prices, and the soybean futures of Dalian Exchange have a greater impact on the domestic spot price discovery [2]. In terms of the impact of sudden external factors on the volatility of futures prices, Borgards et al. (2021) compared and analyzed the price behavior of 20 futures before and after the COVID-19 epidemic, and confirmed that different futures prices showed varying degrees of excessive volatility during the epidemic [3]. Xinyue Li (2023), with the help of the ACARR-X model, concluded that external shocks such as Sino-US trade friction and the novel coronavirus epidemic intensified the volatility of futures prices [4].

The research on the impact of option launch on futures price fluctuation mainly includes three viewpoints: expanding futures price fluctuation, reducing futures price fluctuation and no significant impact on futures price fluctuation. Luyao Li (2019) took soybean meal options as the research object and found that after the listing of soybean meal options, soybean meal futures price fluctuations decreased [5]. Robbani and Bhuyan(2005) studied the Jones Industrial index options and concluded that the increased volatility of futures prices was caused by the increase in irrational transactions of investors [6]. Mazouz (2004) pointed out that the listing of stock index options had no significant impact on the volatility of futures prices [7].

In summary, the existing literature mainly focuses on the impact of futures price fluctuations, index options and individual commodity options on the price fluctuations of underlying futures. There are few studies on the relationship between cotton option launch and the price fluctuation of the underlying futures, and few analyses on the short and medium term effects of cotton option launch on the price fluctuation of the underlying futures. In view of this, this paper constructs an ARMA-GARCH model introducing single and double dummy variables to explore the impact of cotton option launch on the price fluctuation of the underlying futures, which provides a certain reference for maintaining the smooth operation of the cotton derivative financial market and preventing and resolving financial risks.

3. Research Design

3.1. Model construction

The ARMA-GARCH model can more accurately describe the fluctuation process of financial time series rate of return. The general expressions of the ARMA-GARCH model introducing single and double virtual variables are as follows:

$$R_t = \varphi_0 + \sum_{i=1}^{m} \varphi_i R_{t-i} + \sum_{j=1}^{n} \theta_j \varepsilon_{t-j} + \varepsilon_t \quad (1)$$

$$\varepsilon_t = \sigma_t u_t \quad (2)$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \gamma_1 year + \gamma_2 zcgj \quad (3)$$

Formula (1) is the ARMA model, which is an autoregressive moving average process. In equation (2) u_t are random variables that obey the standard normal distribution. Formula (3) is the GARCH model with two virtual variables. α_i represents the degree of impact brought by external shocks; β_j indicates the degree of influence of the previous period on the current volatility. Taking the introduction of cotton options as the cut-off point, a time dummy variable year is introduced. Considering the impact of national policy supply on the volatility of futures prices after the outbreak of the novel coronavirus pneumonia epidemic, a second dummy variable zcgj is introduced on the basis of the time dummy variable year. The time dummy variable year said that in the case of national policy supply after the outbreak of the new coronavirus pneumonia epidemic, the introduction of cotton options on the impact of the underlying futures price fluctuations.If γ_1 is greater than 0 and significant, it indicates that the introduction of cotton options has expanded the volatility of futures prices in the case of national policy supply after the outbreak of the novel coronavirus pneumonia epidemic; If γ_1 is less than 0 significant, it indicates that the introduction of cotton options has reduced the price volatility of the underlying futures under the condition of national policy supply after the outbreak of the novel coronavirus pneumonia epidemic; If γ_1 is not significant, it is impossible to determine the impact of the introduction of cotton options on the price fluctuation of the underlying futures under the condition of national policy supply after the outbreak of the novel coronavirus pneumonia epidemic. The dummy variable zcgj said that after the introduction of cotton options, the impact of the policy supply to fight the epidemic on futures prices. If γ_2 is greater than 0 and significant, it indicates that after the introduction of cotton options, the policy supply to combat the epidemic has expanded the volatility of futures prices; If γ_2 is less than 0 and significant, it indicates that after the introduction of cotton options, the policy supply to fight against the epidemic has reduced the volatility of futures prices; If γ_2 is not significant, it is impossible to determine the impact of the policy supply against the epidemic on the volatility of futures prices after the introduction of cotton options.

3.2. Data specification

This paper selects 1771 daily closing prices of major cotton futures contracts from January 28, 2016 to May 15, 2023 as sample data. All data is from the Wind database. The sample data is divided into two analysis intervals. The first interval sample data is from January 29, 2018 to February 3, 2020, indicating the short-term effect of the introduction of cotton options on the volatility of the underlying futures price. The second interval sample data is from January 28, 2016 to May 15, 2023, indicating the medium and long term effect of the introduction of cotton options on the volatility of the underlying futures price. The first-order difference of the sample data is used to obtain the futures daily rate of return, which helps to enhance the stationarity of the series. The formula for the first-order difference is:

$$R_t = \ln P_t - \ln P_{t-1} \quad (4)$$

Where, R_t represents the futures yield on the t day, P_t represents the closing price on the t day. The results in Table 1 show that the mean and standard deviation of the futures yield series are smaller in the short period of the launch of cotton options, which preliminarily indicates that the launch of cotton options has the effect of stabilizing futures prices to a certain extent.

Table 1. Descriptive statistics

Sample	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera
Short term	-0.0004	0.0122	-0.2446	7.9343	495.8419
Medium and long term	0.0002	0.0141	-0.1798	7.2136	1318.9260

4. Empirical Results and Analysis

4.1. Stationarity test

In order to avoid the phenomenon of pseudo-regression, the ADF test is carried out on the return series respectively. The results in Table 2 show that the T-statistic values are all less than the corresponding critical values at the significance level of 1%, and the unit root null hypothesis can be rejected, which indicates that the return rate series have stationarity. Considering the minimum information criterion and parameter significance comprehensively, ARMA(1,1) is used as the mean regression equation for all return series.

Table 2. Stationarity test results

Sample	T-statistic	1% critical value	5% critical value	10% critical value	P-value
Short term	-21.1782	-3.4436	-2.8673	-2.5699	0.0000
Medium and long term	-42.7879	-3.4338	-2.8630	-2.5676	0.0000

ARCH LM test is performed on the residual of the return series. The results in Table 3 show that the residual square

sequences are not random and all have ARCH effect. Therefore, it is necessary to build GARCH model for further fitting.

Table 3. ARCH LM test results

Sample	F-statistic	Prob.F	Obs*R-squared	Prob.Chi-Square
Short term	3.1312	0.0774	3.1239	0.0772
Medium and long term	83.7862	0.0000	80.0837	0.0000

4.2. Result analysis

In order to study the short and medium term effects of cotton option launch on the price fluctuation of the underlying futures, this paper first establishes the ARMA-GARCH model with dummy variables of cotton option launch time for two series respectively. The dummy variable year is: before the launch of cotton options (January 28, 2016 - January 27, 2019) $year = 0$ and after the launch of cotton options (January 28, 2019 - May 15, 2023) $year$ =1. According to the white paper "China's Actions against the Novel Coronavirus Epidemic" released by The State Council Information Office, this paper has identified January 20, 2020 as the time for intensive provision of anti-epidemic policies. Considering that the policy supply of the country after the outbreak of the novel coronavirus pneumonia epidemic may have an impact on the volatility of futures prices, this paper introduces the policy supply dummy variable zcgj on the basis of the dummy variable of the launch time of cotton options. The dummy variable zcgj is: before the outbreak of COVID-19 and the intensive supply of national policies (January 28, 2016 - January 19, 2020) $zcgj = 0$ and after the national policy supply (January 20, 2020 - May 15, 2023) $zcgj$ =1. Considering the minimum information criterion and parameter significance comprehensively, the ARMA(1,1)-GARCH(1,1) model is established to determine the final return series.

Table 4 shows that the sum of α_1 and β_1 is close to 1, indicating that the fitting process is relatively stable. All the P-values in the ARCH LM test results were significant at the significance level of 1%, which indicated that the ARCH effect had been eliminated after fitting, and the model was effective as a whole. γ_1 is greater than 0 and significant, and the launch of cotton options is small in the short term, which indicates that under the condition of national policy supply after the outbreak of the novel coronavirus pneumonia epidemic, the launch of cotton options has expanded the volatility of the underlying futures price in the short term, and the volatility has intensified in the medium and long term. The possible reason is that the listing time of cotton options is short, the market cognition is not very high, and there are many retail investors in China, more speculative, the risk management function of cotton options has not been effectively played. In the short term of the launch of cotton options, γ_2 is not significant, and it is impossible to determine the impact of the supply of anti-epidemic policies on the volatility of futures prices after the launch of cotton options. It may be because the anti-epidemic policy in the short term of the introduction of cotton options has just been released, and the effect of the policy has a time lag, so it can not be accurately measured. In the medium and long term after the launch of cotton options, γ_2 is less than 0 and significant, indicating that after the launch of cotton options, the policy supply to fight against the epidemic has played a certain stabilizing role in the futures price. The reason may be that after the outbreak of the novel coronavirus, the country has adopted a series of policies such as issuing special loans and increasing rediscount support to deal with the impact of sudden public health events such as the epidemic, which has stabilized the volatility of futures prices to a certain extent.

Table 4. The results of introducing two dummy variables

Variable	Short-term effect Coefficient	Medium and long term effect Coefficient
φ_1	0.4963 (0.6335)	-0.2800 (0.1899)
θ_1	-0.5142 (0.6231)	0.3641** (0.1852)
α_0	5.64E-06*** (1.78E-06)	7.86E-05*** (2.97E-06)
α_1	0.0304*** (0.0084)	0.3060*** (0.0139)
β_1	0.9225*** (0.0220)	0.6234*** (0.0116)
γ_1	2.11E-06* (1.18E-06)	1.61E-05*** (3.48E-06)
γ_2	0.0002 (0.0002)	-1.39E-05*** (2.89E-06)
F-statistic	0.0838	0.2054
Prob.F	0.7723	0.6505
Obs*R-squared	0.0842	0.2056
Prob.Chi-Square	0.7717	0.6502

Note: ***, ** and * are significance levels of 1%, 5% and 10% respectively, with standard error values in brackets. The same below.

4.3. Robustness test

In order to ensure the credibility and validity of the research conclusions, this paper constructs a GARCH-M model to test the robustness of the above fitting results. Considering the minimum information criterion and parameter significance comprehensively, the GARCH-M (1,1) model is established for both yield series. The GARCH-M (1,1) expressions introducing two virtual variables are as follows:

$$R_t = \varphi_1 R_{t-1} + \rho_1 \ln\sigma_t^2 + \varepsilon_t \quad (5)$$

$$\ln\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \ln\sigma_{t-1}^2 + \gamma_1 year + \gamma_2 zcgj \quad (6)$$

Equation (5) is the mean value equation. Equation (6) is the variance equation. Where $\ln\sigma_t^2$ can be replaced by σ_t^2 or σ_t; ρ_1 represents the reward for taking risks. Robustness test results Table 5 shows that the symbols of γ_1 and γ_2 in the introduction of double dummy variables GARCH-M (1,1) are the same as those in the introduction of double dummy variables ARMA(1,1)-GARCH(1,1), with the same significance, no matter in the short or medium term of the introduction of cotton option. On the whole, the regression results of this paper are relatively robust, which strengthens the conclusion that the introduction of cotton options has an impact on the price fluctuation of the underlying futures in the short and medium term.

Table 5. Robustness test of cotton option launch effect

Variable	Short-term effect Coefficient	Medium and long term effect Coefficient
φ_1	-0.0137	-0.0205
	(0.0508)	(0.0256)
ρ_1	1.64E-05	-6.05E-05*
	(6.36E-05)	(3.46E-05)
α_0	5.84E-06***	1.76E-05***
	(1.93E-06)	(1.77E-06)
α_1	0.0304***	0.1227***
	(0.0082)	(0.0102)
β_1	0.9207***	0.7979***
	(0.0230)	(0.0153)
γ_1	2.19E-06*	6.93E-06***
	(1.22E-06)	(1.90E-06)
γ_2	0.0002	-3.97E-06**
	(0.0002)	(1.88E-06)
F-statistic	0.0627	0.3686
Prob.F	0.8024	0.5439
Obs*R-squared	0.0629	0.3689
Prob.Chi-Square	0.8019	0.5436

5. Conclusions and Recommendations

In this paper, the ARMA-GARCH model with two dummy variables is established to empirically test the impact of cotton options on the price fluctuation of the underlying futures in the short and medium term. The main conclusions are as follows: (1) The launch of cotton options intensified the price volatility of the underlying futures in the short term, and the volatility intensified in the medium and long term. (2) After the launch of cotton options, the supply of national policies to fight against the epidemic played a certain stabilizing role in the volatility of futures prices, but the policy effect has a time lag.

Based on the above research conclusions, this paper puts forward the following suggestions. (1) Encourage institutional investors to use cotton options and futures to manage risk. Through preferential policies or institutional incentives, gradually optimize the structure of investors in the futures market, improve the professional level of investors, and reduce the occurrence of irrational behaviors such as speculative trading. Actively use cotton options and cotton futures hedging tools to reduce the exposure of entities to the wind direction. (2) Establish a risk prevention and control mechanism for unexpected public crises. Focus on and monitor the risk impact of sudden public crisis events on the cotton futures market, transform post-prevention to pre-prevention, improve the management information system equipment, and accurately and effectively regulate the risk management of cotton options and cotton futures market. (3) Popularize the knowledge of options and futures and improve the transparency of cotton trading. Knowledge related to cotton options and futures was vigorously publicized through Weibo and public accounts, and special lectures were held for key groups such as state-owned enterprises and listed companies. Prudently operate the information release and disclosure of the futures market, improve the management system of market participants, and improve the transparency of cotton trading information.

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