The Analysis of Spillover Effect and Dynamic Correlation between Egg Spot and Futures Market-- Based on the Data of the Agricultural Products Policy from Temporary Reserve to Direct Subsidy

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Keywords: Eggs; the Futures and spot market; Spillover effects; Dynamic relevance; the Policy of direct subsidies for agricultural products

Abstract: Based on the daily data of the egg futures and spot market prices from November 8, 2013 to August 9, 2019, the binary BEEK-GARCH model and DCC-GARCH model were used to analyze the spillover effect and dynamic correlation between the egg futures and spot market, under the policy of the corn temporary storage and direct subsidy. The results show that there are significant two-way mean spillover and fluctuation spillover effects between the egg futures and spot market under the policy of the corn direct subsidy. The futures market plays a leading role in price guidance and information spillover. The correlation coefficient of the egg futures and spot market has obvious time variability, and it is gradually rising after the implementation of the direct subsidy policy. It is suggested to improve the operation mechanism and market monitoring and early warning mechanism of the egg futures market, and establish the guarantee mechanism of "futures + insurance" to reduce the risk of farmers.

1. Introduction

The stability of agricultural prices is not only closely related to people's life, but also related to social stability and long-term orderly development. As a necessary agricultural and sideline product, eggs' output is strongly influenced by seasonal factors. In addition, they are not easy to be transported and stored, and their prices fluctuate more violently and frequently than other agricultural products. According to eggs' spot price fluctuation diagram from November 2013 to August 2019 (Fig.1), before the September 2016, the price of eggs has been at the high stage, which reached the highest (11.34 yuan/kg) by the end of August 2014. And then, this price rapidly dropped to 4.93 yuan/kg on May 26, 2017, which been down by 56.53%. The price of eggs began to rebound rapidly in June 2017. By the end of the month, the price of eggs had risen to 6.41 yuan/kg. That is up 30% in just one month, which is known as the "rocket egg".The volatility of egg price has seriously affected the People's daily life. In order to avoid market risks, the Dalian Commodity Exchange launched the first fresh agricultural products futures - egg futures contracts on November 8, 2013. It is hoped that the price discovery and hedging function of egg futures can stabilize the market expectation and protect the interests of farmers. Although egg futures in China have been widely concerned since the listing, most of the participants are speculators and a few of the participants are real participants in the laying industry. Moreover, In addition, the laying chicken industry in China is very dispersed in scale, mainly in small and medium-sized breeding, presenting the industrial characteristics of "small scale, large group" (Zhao Yifu and Qin Fu, 2013)[1], the participation of egg farmers in the futures market is also relatively low. Then, how much is the correlation degree of China's egg spot and futures market? Does the egg futures market play a role in price guidance? Are there spillovers between the two markets? The answers to these questions will provide beneficial market information for egg suppliers, investors and consumers, and provide a strong theoretical basis for government departments to improve the operation mechanism of egg futures market.

  DOI: 10.25236/iceesr.2021.112

Since 2008, China has implemented the policy of temporary storage of corn. The large-scale acquisition by the government has led to the rising price of corn, which has led to the rising cost of livestock feed and directly affected the price of eggs. In 2016, the state began to implement the direct subsidy policy for corn, giving corn producers appropriate subsidies, while the price of corn was subject to market fluctuation. The price of corn began to fall, and the price of eggs also showed a certain degree of decline. Different agricultural policy has different mechanism of action, the influence degree of the relationship between the spot and futures market may be also different. Therefore, the beginning implement time of the corn direct subsidy policy as the dividing line, analysis of the relationship between the spot and further market under the different policy background and analysis of the affect of the different policy to the relationship between the two markets, are of great significance to the formulation of agricultural policy.

2. Literature review

At present, there are few researches on the fluctuation spillover of egg spot and futures market at home and abroad, most of which focus on the price fluctuation of egg futures market and spot market and the functional verification of egg futures market. For example, Wang Yanqing et al. (2015)[2] found that the price of egg futures fluctuated sharply from November 8, 2013 to March 31, 2015, so they applied the SADF foam test method to carry out foam test, and found that the price of egg futures during this period not only existed bubbles, but also lasted for a long time. Ling Zhenghua (2018) [3] also used ARCH model to analyze egg futures prices and found that there was significant asymmetry in the fluctuation of egg futures prices. Yan Zhenyu and Sun Yangxue (2018) [4]studied the changes of egg spot price from 2001 to 2016, and found that the fluctuation cycle of egg price was shortening and the frequency was accelerating, and they believed that the fluctuation of egg price was mainly affected by production cost, imbalance of supply and demand and seasonal factors.

With the development of egg futures market, researchers began to pay attention to functional verification of egg futures market. Through to the comparative analysis of the trade spot prices in the Chicago board, Larson, A, B (1967) [5] found that the egg futures prices had discovery functionon to the spot price. Through the empirical analysis, Li Kai, etc. (2014) [6], Yang Yue, etc. (2015) [7], Wang Yanqing and Wu laping (2015) [8] found that egg futures market in China is preliminary already has the price discovery function. But Li Juan and Zhao yifu (2017) [9] found that the dynamic relation of egg spot and futures market was smaller,and egg futures don't exit the price discovery function. The reason for completely contradictory conclusions is that they take different approaches. For example, Li Juan et al. (2017) [9] used the conclusion of dynamic correlation coefficient, while Li Kai et al. (2014) [6] and Yang Yue et al. (2015) [7] used the analysis of co-integration relationship. Although granger causality test, co-integration test, VAR model and other methods can analyze the guiding relationship between markets to a certain extent, this analysis is limited to the spillover effect on the horizontal state, and cannot reflect the volatility spillover effect between two markets. The BEEK-GARCH model can not only observe the mean spillover effect of the two markets, but also obtain the volatility spillover effect (Yu Bo et al., 2019; Wu Haixia and Wang Jing, 2012; Gao Qun and Ke Yangmin, 2016; Yang Wenjing, 2017; Serra ,2011; Yang et al.,2019; Weiping et al.,2019)[10-16]. Based on this, this paper adopts BEEK-GARCH model and DCC-GARCH model to investigate the spillover effect and dynamic correlation of egg spot and futures market.

In addition, some domestic scholars found that different agricultural products policies would affect the spillover effect and correlation of the spot and futures market for agricultural products (Ding Chengzhen and Xiao Haifeng, 2018; Wang Yanqing et al., 2017; Xu Xiangyun et al., 2016) [17-19]. Eggs are a by-product of chicken industry, and corn is the main ingredient of chicken feed. The change of national policy on corn is bound to affect the relationship between the egg markets.

Therefore, the possible innovations of this paper are as follows:

Firstly, the method is innovated. The BEEK-GARCH model and DCC-GARCH model are used not only to analyze the mean spillover and fluctuation spillover effects of egg spot and futures

market, but also to investigate the dynamic correlation between the two markets.

Secondly, Perspective is innovational. In the context of different agricultural products policies, this paper is committed to compare and analyze the impact of different policies on the spillover effect and dynamic correlation between egg spot and futures market.

3. Model construction and data sources

3.1. Model construction

From two aspects of spillover effect and dynamic correlation, this paper explores the interactive mechanism between the egg spot and futures market in China. The BEEK-GARCH model is used to test whether there is a pass-through relationship——spillover effect between the egg spot and futures market. The DCC-GARCH model was used to analyze the dynamic correlation between egg spot and futures market.

The BEEK-GARCH model is proposed by Engle and Kroner et al. This model is more accurate and effective than other methods, because it has fewer parameters to be estimated, can maintain the positive property of covariance matrix under weaker conditions, and can retain the variance-covariance matrix information of residuals.

The mean VAR equation of this model is:

$$\begin{pmatrix} P_{1,t} \\ P_{2,t} \end{pmatrix} = \begin{pmatrix} u_1 \\ u_2 \end{pmatrix} + \sum_{j=1}^{n} \begin{pmatrix} \beta_{11,j} & \beta_{12,j} \\ \beta_{21,j} & \beta_{22,j} \end{pmatrix} \begin{pmatrix} P_{1,t-j} \\ P_{2,t-j} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{pmatrix} \tag{1}$$

$$\begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{pmatrix} | I_{t-1} \sim \mathrm{N}(0, H_t) \tag{2}$$

Where,$P_{1,t}$ and$P_{2,t}$ are respectively the futures price and the spot price of eggs; $u_1$andu_2 are constant terms; n is the lag order; $\beta_{1i,j}$and$\beta_{2i,j}$ are the influences of the futures and the spot price of eggs on itself and another market, reflecting the mean spillover effect of the spot and futures market.

$\boldsymbol{\varepsilon_{it}}$ is the conditional residual of variables, and its conditional variance-covariance matrix $\boldsymbol{H_t}$ is expressed as:

$$H_t = C'C + B'H_{t-1}B + A'\varepsilon_{t-1}\varepsilon'_{t-1}A \tag{3}$$

In Equation (3), C is the lower triangular matrix, A is the ARCH item coefficient matrix, reflecting the ARCH type spillover effect, and B is the GARCH item coefficient matrix, reflecting the GARCH type spillover effect, whose expansion formula is:

$$\begin{pmatrix} \mathrm{h}_{11,t} & \mathrm{h}_{12,t} \\ \mathrm{h}_{21,t} & \mathrm{h}_{22,t} \end{pmatrix} = \begin{pmatrix} \mathrm{c}_{11} & 0 \\ \mathrm{c}_{21} & \mathrm{c}_{22} \end{pmatrix}' \begin{pmatrix} \mathrm{c}_{11} & 0 \\ \mathrm{c}_{21} & \mathrm{c}_{22} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix}' \begin{pmatrix} \mathrm{h}_{11,t-1} & \mathrm{h}_{12,t-1} \\ \mathrm{h}_{21,t-1} & \mathrm{h}_{22,t-1} \end{pmatrix} \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix} + \begin{pmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{pmatrix}' \begin{pmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon^2_{2,t-1} \end{pmatrix} \begin{pmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{pmatrix} \tag{4}$$

Where, $\boldsymbol{h_{ij}}$ and $\boldsymbol{h_{ij}(i \neq j)}$ are the conditional variance and conditional covariance of the prices of the two markets.α_{ij} and β_{ij} respectively represent the ARCH type and GARCH type volatility spillover effect from the i market to the j market, reflecting the time variability and durability of the price fluctuations. If $\alpha_{ij} = \beta_{ij} = 0$, it indicates that there is no volatility spillover effect between the i market and the j market;If at least one of α_{ij} and β_{ij} is not equal to 0, it indicates the existence of volatility spillover effect from i market to j market. Similarly, if there is at least one non-0 of α_{ji} and β_{ji}, it indicates that the j market has volatility spillover effect to the i market. If any one of α_{ji},β_{ij}, andβ_{ji} is not equal to 0, it indicates that there is volatility spillover effect between the two markets. Take the egg spot and futures market for example, if there is at least one non- 0 of α_{12} and β_{12}, it indicates that the egg futures market has volatility spillover effect to the egg spot market. If at least one non- 0 of α_{21} and β_{21} , it indicates that the egg spot market has volatility spillover effect to the egg futures market. If any one of α_{21},β_{12}, and β_{21} is not equal to 0, it indicates that there is volatility spillover effect between the two markets.

Based on this, this paper proposes the following null hypothesis for the fluctuation spillover

effect between the egg futures and spot market:

Null hypothesis 1: There is no volatility spillover effect on the egg spot market in the egg futures market, i.e.H_1: $\alpha_{12} = \beta_{12} = 0$

Null hypothesis 2: There is no volatility spillover effect on egg futures market in the egg spot market, i.e.H_2: $\alpha_{21} = \beta_{21} = 0$

Null hypothesis 3: There is no volatility spillover effect between egg futures market and spot market, i.e.H_3: $\alpha_{12} = \beta_{12} = \alpha_{21} = \beta_{21} = 0$

In order to further analyze the dynamic correlation between egg futures and spot markets, the DCC-GARCH model proposed by Engle was used in this paper to analyze the dynamic correlation between egg futures markets during the implementation of direct subsidy policy for agricultural products.

Its mean value equation is:

$$P_t = CX_t + \varepsilon_t \tag{5}$$

In Equation (5), $P_t = (P_{1t}, P_{2t})$, X_t is a K-dimensional explanatory variable, which may contain Pt hysteresis, C is a $2 \times k$ dimensional matrix , $\varepsilon_t = H_t^{1/2} V_t$, V_t and is a K-dimensional column vector, subject to T distribution.

$H_t^{1/2}$ is the Cholesky factor of covariance matrix H_t satisfying the time-varying condition, i.e

$$H_t = D_t^{1/2} R_t D_t^{1/2} \tag{6}$$

Where, D_t represents the diagonal matrix of conditional variance, the variance equation $\sigma_{i,t}^2$ on the diagonal follows a univariate GARCH model, that is, $\sigma_{i,t}^2 = S_t + \sum_{j=1}^{p_i} \alpha_j \varphi_{i,t-j}^2 + \sum_{j-1}^{q_t} \beta_j \sigma_{i,t-j}^2$, R_t is the time-variant relational number matrix, $R_t = diag(Q_t)^{-1/2} Q_t diag(Q_t)^{-1/2}$, $Q_t = (1 - \lambda_1 - \lambda_2) R + \lambda_1 \varepsilon_{t-1}^* \varepsilon_{t-1}^* + \lambda_2 Q_{t-1}$

where, λ_1 and λ_2 are non-negative parameters, both of which meet $0 \le \lambda_1 + \lambda_2 < 1$, and ε_{t-1}^* represent standardized residual column vectors $D_t^{-1/2} \varepsilon_t$.

The time-varying correlation coefficient between egg futures spot market is calculated as follows:

$$\rho_{ij,t} = \frac{h_{ij,t}}{\sqrt{h_{ii,t} h_{jj,t}}} \tag{7}$$

Where, $h_{ii,t}$ and $h_{jj,t}$ are diagonal elements of the matrix H_t, and $h_{ij,t}$ are off-diagonal elements.

3.2 Data sources and the trend of variables

3.2.1 Data Source

In this paper, high-frequency daily price data of egg futures and spot market are selected .The price of egg futures is selected from the closing price of the main contract price index of egg futures on Dalian Commodity Exchange, while the spot price is the national wholesale price of egg in the price information system of the National wholesale Market of agricultural products. Due to the difference of quotation units in the spot market, this paper unified the units into yuan/ton through conversion, and all data were sourced from Wind database.

In view of the consistency and comparability of the data, the sample time interval of this paper was selected from 8th November 2013 to August 9, 2019. After excluding holidays, weekends and unmatched data, 1392 samples were finally obtained.

After logarithmic processing and first-order difference, the data is expanded by 100 times. The processed futures data is represented by RF and spot data is represented by RS, which indicate respectively the yield rate of egg futures and spot data.

Since the main ingredients of chicken feed are corn and rice bran, the change of national corn policy will directly affect the change of egg price. In order to facilitate comparison of the different effects between corn purchases and direct subsidies policy spillover on the egg spot market and the different influence of dynamic correlations, the time zone is divided into two stages. The first stage is the purchase and storage period (on November 18, 2013 - June 19, 2016), which the country began to implement corn reserve policy. The second stage is the direct subsidies stage (on June 20, 2016 - August 9, 2019), that the state officially published to the society of “the Ministry of Finance on establishing a corn producer subsidy system implementation opinion "on June 20, 2016. It marks the formal implementation of the policy of direct subsidies to corn.

3.2.2 Trend of variables

In recent years, the price of egg in China has fluctuated frequently. From November 8, 2013 to August 27, 2014, the price of egg continued to rise to the historical peak of 11.34 yuan/kg, with an increase of 36.63%. After that, the price of egg continued to decline in a fluctuating trend to 5.03 yuan/kg in mid-May 2017, with a decrease of about 44.36%. So far, the egg prices have also fluctuated frequently.

However, as an important part of people's diet structure, the frequent fluctuation of the egg price not only severely dampened the enthusiasm of the laying chicken industry producers, but also seriously damaged the interests of consumers, which is not conducive to the long-term development of the laying chicken industry.

Fig.1. The price trend of egg futures and spot market

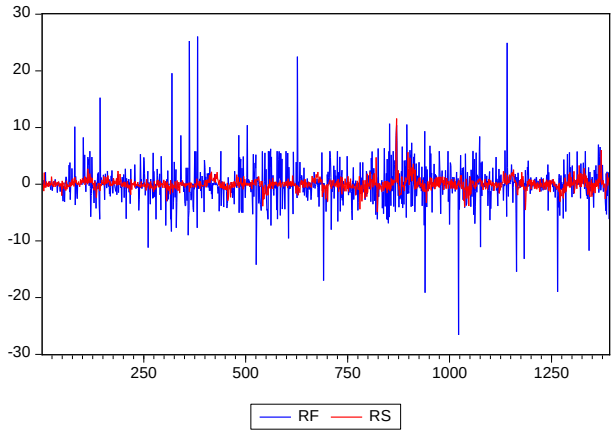

Fig.2. The volatility of yield on egg futures and spot market

Fig. 1 shows the futures and spot price trend of egg in China. As can be seen from the Fig. 1, the trend of the egg futures and spot price is basically the same until November 2016, with the overall trend showing a downward trend, and the trend of the egg futures price is also basically ahead of the

spot price, which shows that egg futures price have a certain price guiding effect on egg spot price, and egg futures market have a price discovery function. However, from the end of 2016 to the first half of 2017, there was a certain degree of divergence between the egg spot price and the futures price. It may be the influence of AVIAN influenza H7N9.

At the end of 2016, there was a widespread report on H7N9 bird flu, which inevitably caused consumer panic over laying chicken products, resulting in a drop in the demand for eggs, even a sharp drop. However, compared with the previous stock of eggs, there was no big change, and the supply of eggs was basically unchanged, which led to the oversupply of eggs on the spot, and the price of eggs on the spot dropped. In the later stage, as the eggs spot price will drop, producers of layers will lose money and their production enthusiasm will decline, thus leading to a decrease in the supply of eggs. As the shadow of avian influenza gradually passes, the demand for eggs will gradually pick up, the supply of eggs spot will be less than demand, and the price will also gradually rise. In the long run, the egg futures and spot price tend to be consistent. However, from Fig. 2, it can be seen the volatility of futures price yields is significantly larger than that of the spot price yield, which shows the speculation in egg futures market is still obvious. It may be due to the regulatory system of eggs futures market is not perfect.

On the whole, it is relatively calm in the eggs futures and spot market in the early, and positive and negative yields are relatively small. But in the middle period, there are large fluctuations in the egg spot market. In a short time, there are the greater positive and negative earnings, embodying the fluctuation agglomeration of the egg futures and spot price.

4. Empirical analysis

4.1 Statistical description

Table 1 is a descriptive statistical analysis of the yield rates in the egg futures and spot market in different periods.

Based on the perspective of standard deviation, the fluctuation range of the egg spot market is smaller than that of the futures market. Moreover, it can be found that the fluctuation range of the egg spot market in the direct supplement period was larger than others. From the perspective of skewness and kurtosis, the yield of egg futures and spot market presents left or right deviation in different periods, and the kurtosis of all variable sequences is greater than 3, and the JB value is significant at 1% level, This suggests that the price sequence of egg futures spot market is different from the normal distribution and presents the characteristic of peak and thick tail.

Table 1 Descriptive statistical results of egg futures and spot yield in different periods

Period	variable	mean	standard deviation	kurtosis	skewness	JB statistic
Total	futures price	0.0048	3.1977	0.6127	20.8462	182525.31***
	Spot price	0.0108	1.0172	1.3904	20.1818	17558.36***
Temporary storage	futures price	0.0008	3.2021	2.5215	22.9787	11109.82***
	Spot price	-0.0259	0.7185	-0.4750	6.2394	298.1942***
Direct subsidies	futures price	0.0081	3.1963	-0.9663	19.0753	8334.246***
	Spot price	0.0411	1.2086	1.5460	17.6724	7148.003***

Note: *** indicates 1% significance level.

4.2 Stationarity test

In order to avoid false regression, ADF test was used to investigate the stability of egg futures and spot rate of return.

It can be seen from Table 2 that all variable sequences reject the null hypothesis at the significance level of 1% and are stationary sequences.

Table 2 ADF stationarity results

Period	variable	(C, T, K)	t	the 1% threshold	P	result
Total	futures price	(0,0,0)	-40.2910	-3.4349	0.0000	stable
	Spot price	(0,0,4)	-9.2460	-3.4349	0.0000	stable
Temporary storage	futures price	(0,0,0)	-27.4708	-3.4406	0.0000	stable
	Spot price	(0,0,4)	-5.1617	-3.4406	0.0000	stable
Direct subsidies	futures price	(0,0,0)	-29.4339	-3.4388	0.0000	stable
	Spot price	(0,0,4)	-7.2207	-3.4388	0.0000	stable

4.3 Mean spillover effect test

Before the mean spillover effect test, VAR model should be built to determine the lag order. AIC, LR, SC, FPE and HQ were adopted for egg futures and spot yield series respectively, and the optimal lag period was determined to be phase 1 and phase 2 respectively. Therefore, VAR (1) and VAR (2) were models satisfying the stability conditions. Since all time variable series are stationary series, F statistic in Wald test is used to analyze the mean spillover effect between eggs markets, as shown in Table 3. From the overall sample period, the two-way mean spillover effect between the eggs futures and spot market is significant. From the perspective of different policy periods, only the eggs futures market has significant one-way mean spillover effect on the spot market in the temporary storage period, while the two-way mean spillover effect between the eggs futures and spot market in the direct replenishment period. Thus it can be seen that the eggs futures and spot market has a significant mutual price guiding relationship in both the general and direct replenishment period, but the guiding relationship shows a unidirectional tendency in the temporary storage period.

Table 3 Test of mean spillover effect in egg futures market

Period	Null hypothesis of period: the former has no mean spillover effect on the latter	Lag phase	F	result
Total	Eggs futures market-Eggs spot market	1	15.0396***	reject
	Eggs spot market-Eggs futures market	2	5.5332***	reject
Temporary storage	Eggs futures market-Eggs spot market	1	6.6033***	reject
	Eggs spot market-Eggs futures market	2	0.0887	accept
Direct subsidies	Eggs futures market-Eggs spot market	1	4.6464**	reject
	Eggs spot market-Eggs futures market	2	5.4811**	reject

Note: ***, ** and * respectively represent significant at the level of 1%, 5% and 10%

4.4 Test for spillover effects of fluctuations

In this paper, the bivariate BEEK-GARCH model is used to study the spillover effect between eggs futures and spot market. The BFGS algorithm is used to obtain the estimated coefficient results and the fluctuating spillover effect test results, as shown in Table 4. As can be seen from Table 4, the estimated coefficients of a11, a22 and b22 are all significant at 1% level, indicating that the price of eggs futures and spot market is significantly affected by its previous price. ARCH type fluctuation spillover effect exists in the eggs futures market, while ARCH type and GARCH type fluctuation spillover effect exists in the eggs spot market.

However, from different periods, the spillover effect of fluctuation in the egg market is obviously different. The coefficients a12 and b12 of the temporary storage period model coefficient matrix are significantly different from 0 at the levels of 10% and 5% respectively, indicating that the egg futures market has significant one-way ARCH and GARCH type volatility spillover effect on the spot market, that is, the fluctuation of the egg futures market price will be transmitted to the spot market. However, a21 and B21 in the temporary storage period did not pass the significance test, which indicated that the eggs spot market did not have the volatility spillover effect on the

futures market. Wald test in Table 5 further confirms that there is only one-way volatility spillover effect between eggs futures and spot markets.

During the direct subsidy period, the fluctuation spillover effect changes. The direct subsidies period model coefficient matrix a12,b12, b21 are under the 5% level significantly different from zero, refused to the three original hypothesis, which shows that there are two-way ARCH and GARCH model volatility spillover effect on the eggs futures and spot market during the direct subsidies period. Further from the wald test results in Table 5 and compared with the temporary storage period, the one-way fluctuation spillover effect between the eggs futures and spot market turned into the two-way fluctuation spillover effect, indicating that the implementation of the direct subsidy policy had an impact on the fluctuation spillover effect between the domestic eggs futures and spot market.

From the perspective of the fluctuation spillover effect, the "market support" effect of the corn direct subsidy policy enhanced the fluctuation spillover effect between the domestic eggs futures and spot markets, making the information transfer between the eggs futures and spot markets more effective. The reason is that the temporary purchase and storage policy stipulated the purchase price of corn in the spot market, which greatly inhibited the fluctuation of corn price in the spot market, thus reducing the fluctuation of egg price to a certain extent, which affects the fluctuation spillover effect between egg futures and spot market.

Table 4 Beek-garch model estimation results

Parameters	Temporary storage	Direct subsidies	Parameters	Temporary storage	Direct subsidies	Parameters	Temporary storage	Direct subsidies
a11	0.9551***	0.5948***	b11	0.0004	-0.0136	c11	2.1625***	2.6776***
	(13.90)	(10.78)		(0.008)	(-0.15)		(28.97)	(31.33)
a12	-0.0228*	0.0336**	b12	0.0279**	0.1131***	c21	0.0405	-0.0594
	(-1.76)	(2.44)		(2.01)	(5.59)		(0.53)	(-1.04)
a21	-0.0675	-0.0912	b21	0.0382	0.4152**	c22	0.1809***	-0.000002
	(-0.17)	(-0.83)		(0.10)	(2.76)		(3.32)	(-0.000004)
a22	0.3006***	0.3789***	b22	0.9106***	0.8271***			
	(7.48)	(10.24)		(40.11)	(26.16)			

Note: ***, ** and * respectively represent significant at the level of 1%, 5% and 10%. The corresponding T value is in brackets.

Table 5 Test results of spillover effect in egg spot market

the original hypothesis	Temporary storage	result	Direct subsidies	result
there is no volatility spillover effect in the eggs futures market on the eggs spot market	Wald=4.8665*	reject	53.0736***	reject
there is no volatility spillover effect in the eggs spot market on the eggs futures market	Wald=0.036	accept	4.6274*	accept
there is no volatility spillover between the eggs spot market and the eggs futures market	Wald=4.8725*	reject	89.9017***	reject

WinRATS Pro8.0 software and the DCC-Garch model were used to analyze the dynamic correlation between the egg futures and spot market in different periods. The estimated results are shown in Table 6. The average correlation coefficient between the egg futures market and the spot

market is 0.1189, which is lower than 0.2, indicating that the degree of marketization is still not high. From the different periods, the correlation coefficient between markets increased from 0.0856 in the temporary storage period to 0.1208 in the direct subsidy period, indicating that the implementation of the direct subsidy policy was conducive to the improvement of the correlation between the egg futures and spot market.

Further, it can be seen from the graph of dynamic correlation coefficient between egg markets (Fig. 3.) that the correlation coefficient fluctuates to a certain extent and shows significant time variability. For example, around the Spring Festival or during holidays, namely February and May 2014, May 2015, January 2017 and January 2018, the spot market of egg futures shows a high correlation degree. From the perspective of different policy periods, the correlation coefficient of the market in the temporary storage period fluctuates less, indicating that the market correlation is relatively stable. However, in the early stage of the implementation of the direct subsidy policy, the correlation coefficient fluctuated greatly, the value also increased significantly, indicating that the implementation of the direct subsidy policy made the egg price gradually return to the market and the market correlation degree significantly improved.

Table 6 Descriptive statistics of dynamic correlation coefficients between the egg futures and spot market in different periods

Period	mean	maximum	minimum	standard deviation
Total(N=1391)	0.1189	0.4911	-0.1165	0.0253
Temporary storage(N=628)	0.0856	0.3714	-0.1245	0.0328
Direct subsidies(N=736)	0.1208	0.3553	-0.0962	0.0244

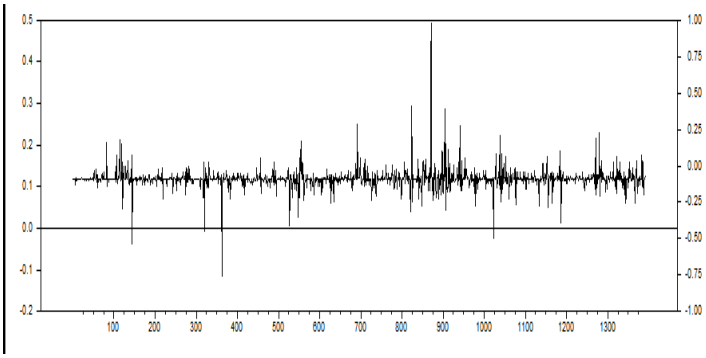

Fig.3. Dynamic correlation coefficient between the egg markets

5. Conclusions and policy suggestions

Based on the daily high-frequency price data of egg futures and spot market from November 8, 2013 to August 9, 2019, this paper uses binary BEEK-GARCH model and DCC-GARCH model to analyze the volatility spillover effect and dynamic correlation between egg futures and spot market. In order to reflect the impact of corn policy on this effect, taking the implementation time of corn direct subsidy policy as a dividing line, the fluctuation spillover effect and market correlation degree difference of egg futures and spot market under corn temporary storage policy and direct subsidy policy are respectively compared and analyzed, and the conclusions are as follows:

First of all, in the long run, the trend between the eggs futures price and the spot price is consistent, but the futures market has a sharp degree of price volatility, and the volatility concentration is significantly higher than the eggs spot price. The basis of volatility in both markets is large, especially in the futures market, which indicates that the speculation in the market is serious.

Secondly, from the perspective of mean value and volatility spillover effect, there are differences in the transfer direction and significance degree between the two markets in different periods. Throughout the study period, the egg futures and spot prices exist two-way guided the mean

spillover effect, but under the implementation of the corn temporary storage and direct subsidy policy, the spillover effect appears in different degrees and directions. In particular, under the store policy, there is only one-way guide and significant one-way ARCH and GARCH model volatility spillover effect on an egg futures market to the spot market. Under the direct subsidies policy, the egg stage is two-way guided the mean spillover effect and the ARCH model, GARCH model volatility spillover effect between the futures and spot price. This indicates that the "market support" effect of the corn direct subsidy policy enhances the fluctuation spillover effect between the domestic egg futures and spot markets, making the information transmission between the egg futures and spot markets more effective.

Finally, from the perspective of dynamic correlation, the egg spot market is positively correlated on the whole, with a relatively low degree of correlation. The correlation coefficient has obvious time-varying characteristics, showing a high degree of correlation before and after the Spring Festival or during holidays. From the perspective of different policy periods, the implementation of direct subsidy policy has significantly improved the correlation degree of egg spot market.

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