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The Spillover Effect of Agricultural Product Market Price Fluctuation Based on Fourier Analysis

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ABSTRACT

The stability of the original spillover effect model of agricultural product market price volatility is poor, resulting in the low degree of fitting between the results and the actual situation. In order to further clarify the spillover effect of agricultural product market price volatility, a research method of spillover effect of agricultural product market price volatility based on Fourier analysis is proposed. The authors collect sample data, eliminate missing data, and complete data storage. Wavelet transform is used to reduce the noise of the sample data, Fourier analysis is used to reconstruct the sample data, and the data with high degree of discretization is aggregated to output the data preprocessing results. The experimental results show that the method has strong anti-interference ability, good stability, high fitting degree between the results and the actual, and has reliability.

KEYWORDS

Agricultural Products, Fourier Analysis, Market Price Volatility, Spillover Effect, VAR Model

INTRODUCTION

Agricultural product futures are the earliest futures. The main reason is that the price of agricultural products will fluctuate greatly under the influence of factors such as season and climate. The hedger can offset the profit and loss of other markets through the profit and loss of agricultural product market, so as to reduce the risk of market price fluctuation (Senakpon et al. 2018), (Yang et al. 2017). In recent years, the sharp fluctuation of the price of agricultural products has attracted wide attention all over the world. The price of both food crops and cash crops will be affected by many factors such as production, climate, society, economy and policy. The volatility is very large. The sharp fluctuation of the price of agricultural products is not conducive to the stable growth of farmers' income. After 2000, with the development of emerging market economies such as China and India,

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the consumption demand of agricultural products has become the main driving force of global basic consumption. The price of agricultural products will inevitably bring great risks to the operation of domestic and foreign agricultural enterprises. With the continuous progress of economic globalization, the financial crisis occurred frequently after the 1990s. Any partial economic crisis will soon expand to other markets, making the risk of price fluctuation greater. Therefore, it is necessary to reduce the market risk brought by price fluctuation through the hedging function of futures market Wang, (2017), (Hamid et al. 2017), Mishra (2017).

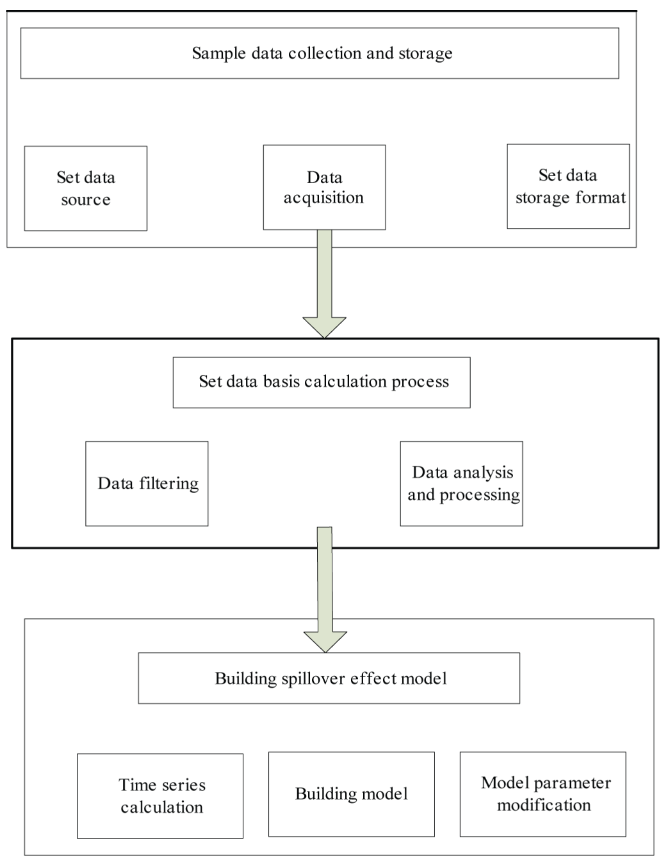
Volatility spillover effect refers to the mutual influence between different financial markets, and the market price fluctuation will be transferred from one market to another, which reflects the Granger causality between the second-order moments of yield conditions (Rudra & Saikat, 2017). The evaluation of tangential or spillover effects supports the hypothesis that knowledge spillovers are unlikely to occur amongst farmers in close vicinity to programme recipients, particularly within social networking sites. The lack of spillover effects supports the theory that financial crises are a key factor of technology acceptance among small - scale farmers in the Dominican Republic. In poor nations, agricultural initiatives may have partial mediation or spillover impacts, environmental health inefficiencies, and generalized linear consequences. The spillover effect of price fluctuation in agricultural products market may exist between different agricultural products markets or agricultural assets, such as soybean market, wheat market and integrated agricultural products market or agricultural products and other products. Due to the dynamic change of risk transfer intensity between different agricultural products markets or different agricultural assets in different periods, in addition to exploring the causal relationship between them (i.e., volatility spillover effect). They discovered that perhaps the real exchange and inventory market value have a two-way volatility beneficial impact. However, those other two-way disruptions are irregular to a certain extent, and therefore impact of exchange rate fluctuation on stock return volatility becomes less substantial than the effect of stock return volatility on exchange rate fluctuations. Own volatility spillovers are really a one-way causal connection among previous volatility shocks and existing variance in the very same marketplace. The term “cross volatility spillovers” refers to a one-way causal association involving historical volatility in one trends and competitive instability in the other. It is also necessary to use the correlation coefficient between different assets to see the degree of correlation between them in terms of quantity, so as to promote investors to make a better portfolio. In addition, when the markets are completely separated, due to the lack of linkage mechanism, the interaction between the markets is very weak, that is to say, the correlation is very small. Studying the dynamic correlation coefficient between the agricultural products market or the agricultural products assets can provide a basis for the judgment of the degree of market integration.

In fact, each variable of the market does not exist alone. It affects and restricts each other with other variables or markets. To study the interaction between them, it is necessary to extend the single variable model to the multi variable model. The results show that the multivariable model can make full use of the information contained in the variance covariance matrix of the residual vector. Compared with the single variable model, the estimated parameters are more accurate. At present, the research on the volatility effect and dynamic correlation among variables mainly focuses on capital markets such as stocks, such as the research method of volatility spillover effect of China’s stock index futures and spot markets based on har-caw model Zhao et al. (2018), the research method of volatility spillover effect between financial markets based on Gumber’s two-dimensional Carr model and survival copula Carr model Wang, (2019), etc., while the research on agricultural products market However, there are few studies on the volatility spillover effect and dynamic correlation between basis risks. At present, from the existing research on basis risk at home and abroad, most of them study basis risk from the aspects of hedging function, single variable basis risk volatility, basis risk influencing factors and so on, which has the problem of poor stability. In view of the problem that the original research method of price volatility spillover effect has poor stability, this paper uses the Fourier analysis method and the multivariate model to analyze the price spillover effect and the dynamic correlation of agricultural products market, so as to explore the relationship between the volatility spillover effect and the leading lag, which has certain innovation.

ANALYSIS OF SPILLOVER EFFECT OF AGRICULTURAL PRODUCT MARKET PRICE FLUCTUATION BASED ON FOURIER ANALYSIS

The formulation of relevant policies in the agricultural sector has always been the basis and foundation of other policy-making, shouldering the important mission of meeting the basic needs of the whole society, and will affect the stability and future development of the country to a large extent (Nishimura & Sun, 2018), (Sierra et al. 2018). In recent years, the marketization of agricultural products and the internationalization of trade have been gradually deepened, followed by the impact of various external shocks on the price of agricultural products, and the spillover effect of agricultural product market price has gradually appeared and become more and more obvious. As an important price index in the field of national economy, the price of agricultural products has an important impact on a variety of economic indicators. Therefore, the significance of studying the spillover effect of agricultural product price fluctuation is not only that the agricultural economy plays an important role in the national economy, but also that it can provide some guidance for the construction of information monitoring and prediction system of bulk agricultural product market. The design structure of research method of spillover effect of agricultural product market price fluctuation based on Fourier analysis is shown in Figure 1.

Figure 1. Research flow of spillover effect of agricultural product market price fluctuation based on Fourier analysis



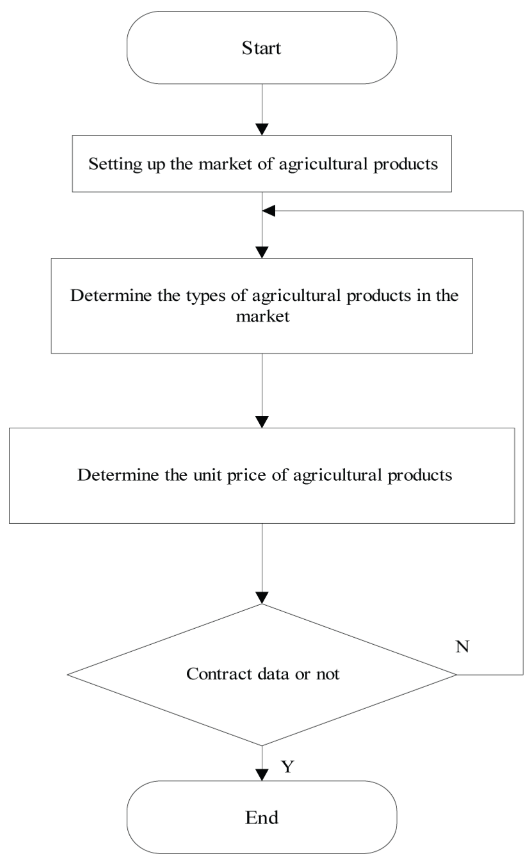
SAMPLE DATA COLLECTION AND STORAGE

To ensure the validity and timeliness of the data source and sample content in this study, set the data collection process, as shown in Figure 2.

The sample data comes from guotai'an financial database, agricultural products futures network and Fenghuang financial network. Since agricultural products contracts have a term, the contract will not exist after expiration. In order to ensure the continuity of data, this paper selects the latest agricultural product contract as the market price of the agricultural products. After the contract enters the delivery month, select the next most recent contract, so as to get a continuous agricultural product price time series (Bhowmik et al. 2018), (DeokJong & Sunvoung, 2017).

In this study, the basic price data of agricultural products and the types of agricultural products in the market are selected. Species of plants, fodder, fruit, veggies, horticultural delicacies, livestock, animals, pigs, goats, horses, chickens, furbearing creatures, milk, eggs, and furs are all examples of agricultural commodities. Agricultural production is the sustainable utilization crops and livestock byproducts to improve person's existence. Food, pet food, and non-food goods are all made from crops and animal commodities. The data type is daily data, and the price of agricultural products is constantly adjusted according to the existing market price. In order to solve this problem and ensure the validity of the data, this paper will eliminate these missing data (Liu & Guo, 2019), (Etienne et al. 2017). Now, some agricultural products are selected as the samples in this study. The storage methods of agricultural product data samples are as follows.

Figure 2. Data sample collection process



DATA PREPROCESSING BASED ON FOURIER ANALYSIS

Because of the autocorrelation of the price fluctuation in the agricultural products market, before constructing the spillover effect model of the price fluctuation in the agricultural products market, it is necessary to reduce the noise of the collected sample data in order to eliminate the noise interference and improve the stability of the model. Wavelet transform is a highly adaptive method, which can process data through filter and eliminate the noise in high frequency signal to obtain the effective information in low frequency signal. A wavelet is a mathematical expression that divides a digital signal or functional into scale components. Each scale element may usually be assigned a range of frequencies. After then, every scaling element can be analyzed at a precision that corresponds to its size. We're using the scale wavelet to compute a combination of the data. We get an array of same fixed Length as that of the input for every level this manner. Specifically, the wavelet coefficients of different frequency distribution are obtained by decomposing the original data, and the noise is eliminated according to the size of the wavelet coefficients, and the data after de-noising is reconstructed to obtain the noise-free data information (Dhamija et al. 2017).

Select MATLAB as the tool of noise removal. In MATLAB, there are two methods to denoise data by wavelet transform: compression and denoising. Denoising methods are used to reduce additional noise present as many critical image elements as feasible. The reasoning is that because the wavelet transform is strong at energy compression, tiny coefficient seems to be more probable to be attributable to noise, whereas big values are much more attributable to key signal properties. The

Table 1. Sample storage mode of agricultural products

Storage information serial number	Store information content	Field name
1	Name of agricultural products	characters
2	Types of agricultural products	characters
3	Beans or not	characters
4	Wheat or not	characters
5	Spot or futures	characters
6	Data sources	characters
7	Market information	characters
8	Market number	data
9	Market characteristics	characters
10	Registration time	characters
11	Current price	data
12	Expected price	data
13	Current volume	characters
14	Expected volume	characters
15	Contract signing time	characters
16	Spot price	data
17	Futures prices	data
18	Registered person No	data
19	Authority of registration personnel	characters
20	Remarks	characters

data compression rate is a word being used evaluate the decrease in data reduction length caused by a compression algorithm that is used to describe physical compression of elements. Signal denoising is a natural regeneration approach that involves setting the variables of a noisy signal to something like a value that removes the majority of the noise while preserving the signal strength minimal factors that affect the quality. These differs from traditional straight low frequency filtration, that tries to distort the margins while reducing noise. Such complex approaches were the focus of a lot of research, and they've fueled recent advances in nonlinear approach (Manogaran et al. 2021). The similarities between the two are that they both need to zeroize the values with small absolute values. The difference is that noise elimination only deals with the high-frequency part after decomposition, i.e., processing the high-frequency part $e_{a+1}(b)$ of the data, not the low-frequency part $f_{a+1}(b)$, while the compression method deals with both the high-frequency part and the low-frequency part.

First of all, load the original yield fluctuation data in MATLAB software and draw the corresponding fluctuation trend chart, and select the basic wavelet $db1$, namely Haar wavelet. By changing the above processing results to image form, it can be seen that the return rate presents the phenomenon of cluster fluctuation, and also contains large noise interference.

Set the original sample data sequence $f_a \in Q_a$, after approximate calculation, we can get the feature sequence $o_g^a = (f_a, f_{a+1,g})$, and then get part of the feature f_{a+1} of f_a. And because of detail sequence $h_g^{a+1} = (f_a, e_{a+1,g})$, Part f_{a+1} containing f_a details are obtained. f_a is decomposed and expressed as $f_a = f_{a+1} + o_g^a + a$, which is also a decomposition of f_a, namely:

$$\begin{aligned} & f_a(b) = \sum_{a \in n} h_g^{a+1} f_a(b) = \sum_{a \in n} (f_a, f_{a+1,g}) \partial_a = f_{a+1}(b) + h_g^{a+1}(b) \\ & = \sum_{a \in n} h_g^{a+1} o_g^a + \sum_{a \in n} (f_a, e_{a+1,g}) \partial_a(b) \end{aligned} \tag{1}$$

where $\partial_a \left(b\right)$ is the approximate function of the data sequence. For the selection of adaptive decomposition threshold a, the value can be taken according to the different conditions of the original sequence when programming, but generally for functions with large amount of data and more complex, a is a negative integer with larger absolute value. In order to simplify the calculation process, the value of a can also be set to zero. When using MATLAB software, the best value of the parameter is usually selected by the software (Ghouse & Khan, 2017), (Li & Yang, 2018).

In order to ensure the validity of agricultural product information, $db3$ wavelet is selected, that is, Daubechies wavelet when $a = 3$ is used to process sample data. Efficiently maintained orthogonal wavelet transform were devised by Daubechies, and its structure has enabled discrete wavelet analyses appealing and practical. The insertion of good temporal again for state vector in Daubechies wavelets resulted in the creation of well coiflets. This study is a bridge between traditional limit equilibrium structures and Daubechies wavelets, and it can be used with the multilayered approach offered. There is no way of expressing the Daubechies wavelets in a closed form. The wavelets of Daubechies are orthogonal and biorthogonal, but not symmetry. After many experiments and analysis, the data distortion is low and the denoising effect is obvious after four level decomposition:

$$\begin{aligned} & f_a(b) = f_{a+4}(b) + o_{a+4}(b) + o_{a+3}(b) + o_{a+2}(b) + +o_{a+1}(b) \\ & = \sum_{g \in n} h_g^{a+2} f_{a+2,g}(b) + \sum_{g \in n} o_g^{a+1} e_{a+1,g}(b) \\ & = \sum_{g \in n} h_g^{a+4} f_{a+4,g}(b) + \sum_{g \in n} o_g^{a+4} e_{a+4,g}(b) + \sum_{g \in n} h_g^{a+3} f_{a+3,g}(b) \end{aligned} \tag{2}$$

Through the above formula, the data information can be denoised, but after comparing the original data and the denoised data, it is not difficult to find that the data has a certain degree of distortion, which is not conducive to the later data model construction and analysis. In order to solve this problem, we need to combine another way of data denoising: compression. After processing, the data sequence of agricultural products is set to band form. Since the compression effect depends on the set threshold, the threshold is set according to general experience (Auwal & Sanusi, 2017). When the threshold is set to 0.4048, only a small amount of noise interference is removed, although most of the original sequence components are retained, so it can be seen that the denoising effect is not good. When using the system default threshold of 2.651, it will get better denoising effect. Therefore, this paper uses this method to denoise the sample data. Through the above processing, set the original sequence of agricultural products and the threshold of denoising effect as shown in Table 2.

At this point, the denoising work of the original sample data series is all finished, and the denoised data is saved. In order to ensure the accuracy of the data, Fourier analysis is used to process the denoised data. Fourier analysis is widely used in signal processing and time series analysis. We address that issue by dividing it down into manageable jobs and handling for each of the components mentioned individually in terms of developing a model for forecasting the basic time - series data. A time-domain function is decomposed into another original signal using the Fourier transform. Simply, an audio waveform is divided through its component harmonics and loudness throughout the spatial domain. FT is a computational method that entails calculating the integration of a real or complex representation (Mi et al. 2010). Its basic idea is to transform the signal from time domain to frequency domain through mathematical transformation. The Fourier convergence analysis of the two-layer grid algorithm is used to complete the data reconstruction. Under the two-dimensional grid M_n, the Fourier expression of the iterative operator $M_n^N : u_{2h}(\bar{\partial}) \rightarrow u_{2h}(\bar{\partial})$ of the two-layer grid algorithm is as follows:

$$M_n^N(\bar{\partial}) = (R_n^N(\bar{\partial}))^t \left(I_h - \bar{I}_n^N(\bar{\partial})(\bar{Q}_n^N(\bar{\partial}))^{-1} \bar{I}_n^N(\bar{\partial})\bar{Q}_n^N(\bar{\partial}) \right) (R_n^N(\bar{\partial}))^{t^2} \quad (3)$$

The evaluation of a simulation's temporal convergence is a simple way for finding the hierarchical discretization inaccuracy. Originally, this feature had been used to accelerate rate of convergence of answers that may be utilized for grid divergence. The behavior of the answer error, measured by the difference between both the indefinite and precise solutions, determines the sequence of grid convergence. Among them, $\bar{Q}_n^N(\bar{\partial})$ and $\bar{I}_n^N(\bar{\partial})$ are the original data before filtering and the filtered data, and the progressive convergence factor t of the two-layer grid algorithm is determined by the spectral radius of matrix $M_n^N(\bar{\partial})$, namely:

Table 2. Original sequence and denoising threshold

Data series number	Information content	Set result
1	Data size	2000
2	Wavelet	Db3
3	Level	5
4	Select thresholding	Balance sparsity-norm
5	Retained energy	83.47%
6	Number of zeros	85.53%

$$\beta(M_n^{\ N}) = \sup \beta(M_n^{\ N}(\overline{\partial})) \tag{4}$$

Among them:

$$\beta = \sum_{k \in n} Q \exp(i * \partial * k) \tag{5}$$

In the above formula, $\beta(M_n^{\ N})$ is the spectral radius of $M_n^{\ N}(\overline{\partial})$, ∂ is the number of grids, β is the spectral radius parameter, k is the grid size, i is the grid expansion coefficient, and Q is the grid description parameter. In the two-dimensional coarse grid, the Fourier expression of the iterative operator $M_n^{\ N} : u_{2h}(\overline{\partial}) \rightarrow u_{2h}(\overline{\partial})$ of the two-layer grid algorithm is as follows:

$$M_n^{\ N,n}(\overline{\partial}) = (R_n^{\ N,n}(\overline{\partial}))^t \left(I_h - \overline{I}_n^{\ N,n}(\overline{\partial})(\overline{Q}_n^{\ N}(\overline{\partial}))^{-1} \overline{I}_n^{\ N,n}(\overline{\partial})\overline{Q}_n^{\ N}(\overline{\partial}) \right) (R_n^{\ N,n}(\overline{\partial}))^{t2} \tag{6}$$

The asymptotic convergence factor of the two-layer grid algorithm is determined by the spectral radius of matrix $M_n^{\ N,n}(\overline{\partial})$:

$$\beta'(M_n^{\ N,n}) = \lambda \sup \beta'(M_n^{\ N,n}(\overline{\partial})) \tag{7}$$

Among them:

$$\beta' = \sum_{k \in n} Q \exp(i^2 \partial * k) \tag{8}$$

where λ is the coarse mesh coefficient.

Then the coarse mesh discretization operator can be expressed as:

$$span\{\partial_{2h}(2\overline{\partial}^{\infty}, \overline{x}^{01})\} \rightarrow span\{\partial_{2h}(2\overline{\partial^{\infty}}, \overline{x^{01}})\} \tag{9}$$

$Q_{2h}(2\overline{\partial}^{\infty}, \overline{x}^{01})$ and $Q_{2h}(2\overline{\partial^{\infty}}, \overline{x^{01}})$ are Fourier representations of coarse mesh discrete operator $\overline{Q}_{N,n}(\overline{\partial})$, respectively. Among them, $2\partial^n = (2\partial^n{}_1, \partial^n{}_2)$, and $n \in N$.

The finite element approach demands the evaluation of multiple integers across the components into which resulting image is divided when discretizing a boundary-value issue. Even though the functional is understood, the integral might have to be approximated. According to the discretization degree of the coarse mesh operator, the data with higher discretization degree are aggregated and the output data preprocessing results are shown as follows:

$$R = f_a'(b) + M_n^{\ N}(\overline{\partial}) - \frac{M_n^{\ N,n}(\overline{\partial})}{\lambda} \times \left(\frac{\beta'}{\omega + \beta}\right) \tag{10}$$

where ω is the polymerization factor. Through the above formula, the sample data is preprocessed and used in the construction of spillover effect model of agricultural product market price volatility.

BUILD THE SPILLOVER EFFECT MODEL OF AGRICULTURAL PRODUCT MARKET PRICE FLUCTUATION

Based on the sample data and VAR model, the spillover effect model of agricultural product market price volatility is constructed. Use E-views software to select the order n of VAR model, and then check the stability of the model by determining whether the reciprocal graph of unit root is in the unit circle. The vector autoregression (VAR) is a popular method for predicting and assessing the dynamical influence of random disturbances on a relationship between variables. The strategy would be estimated using EViews. In the VAR window, EViews will show the prediction performance. The coefficient findings are displayed in a column by EViews. Each row in a table correlate to a predictor in the expression, so each column relates to an approximation in the VAR. The estimated coefficient, its confidence interval, and the statistic are all reported by E – views (Deepa et al. 2020). This is because in the subsequent modeling process, the stability of the model is an important condition affecting the output results of the model, and the economic relationship obtained is meaningless. Autocorrelation is a historical data analytic quantitative test. The goal is to determine how closely two possible values in the very same data collection correlate at different time scales. The autocorrelation coefficient is useful in two ways. It is capable of detecting non-randomness in a sample of information. If the data set's values aren't randomized, autocorrelation can aid the observer in selecting the best forecasting model (Oriuela et al. 2020). Suppose that $\{A\}$ and $\{B\}$ are the time series of agricultural products sold, and satisfy the first-order integration, $A_t = (1, A_{t1}, A_{t2}, ..., A_{tn})$. If there is a cointegration relationship between $\{A\}$ and $\{B\}$, a spillover effect model of agricultural product market price fluctuation is preliminarily constructed as follows:

$$M_t = \overline{w} = \Delta B_t - \wp \Delta A_t \tag{11}$$

Among them:

$$\Delta B_t = \sum_{d=1}^{c} \Im B_{t-1} + \sum_{e=1}^{c} \Im A_{t-1} + \delta M_t + I_t + K_t \tag{12}$$

In the formula, $\wp$ is the cointegration vector, representing the equilibrium state of the time series at this time; ΔB_t and ΔA_t are the first-order sale time difference of $\{A_t\}$ and $\{B_t\}$, indicating the strength of their increments. K_t and I_t are the i-th order series of $\{A_t\}$ and $\{B_t\}$ respectively, which are used to reveal the non-static characteristics in the process of time series change, $\Im$ is the regression coefficient, and δ is the autocorrelation coefficient. It is worth noting that if the value of $\wp$ is zero, it means that we do not pay attention to the changes brought by the lag sequence of $\{\Delta B_t\}$. $\Im$ is used to measure the speed of price adjustment in the short-term dimension. Its value is mostly negative, and the larger its absolute value is, the greater the adjustment speed required to return to the equilibrium level is.

Therefore, based on the above model, the parameter correction function of the spillover effect model of agricultural product market price volatility is constructed. The process of cointegration transformation is the transformation from vector autoregression function to parameter correction function. Firstly, an influence matrix $\Re$ is designed. No matter the form of parameter correction function is long-term or short-term, the influence matrix remains unchanged. The parameter modification function of the spillover effect model of product market price fluctuation is described as follows:

$$g(L)A_k = \frac{\eta A_{g-k} + \phi(L)A_k + \mu_t}{\Re} \tag{13}$$

Among them:

$$\phi(L) = (1-L)^{-1}(\eta(L) - \eta(L)L^k) \tag{14}$$

where A_{g-k} is the error correction term, A_k is the matrix coefficient of $r * A$ dimensions, μ_t is the matrix coefficient sequence of $A * m$ dimensions, $\phi\left(L\right)$ is the judgment function of equilibrium state, L^k is the correction coefficient, and η is the variance contribution rate.

At this point, the design of research method of spillover effect of agricultural product market price fluctuation based on Fourier analysis is completed.

SIMULATION EXPERIMENT ANALYSIS

In order to test the practical application performance of the research method of spillover effect of agricultural product market price fluctuation based on Fourier analysis, the simulation experiment is carried out. The overall experimental scheme is: set the environmental parameters, obtain the experimental sample data, take the literature [7] method and literature [8] method as the experimental comparison method, and compare the comprehensive performance of different methods. The specific experimental results are as follows.

Experimental Environment Setting

In this experiment, a large number of operations are involved. In order to ensure the accuracy of different methods, the hardware used in this experiment is set as a computer with 64G solid-state disk, 16G cache and 8-core high-speed processor. Set SQL 2016 database and high configuration MATLAB software in its internal to ensure the effectiveness of the comparison of experimental results.

Sample Data Design

Set the experimental environment as the agricultural product market of a city. According to the sample collection standard of the design method in the paper, the types of agricultural products selected in the experiment are shown in Table 3.

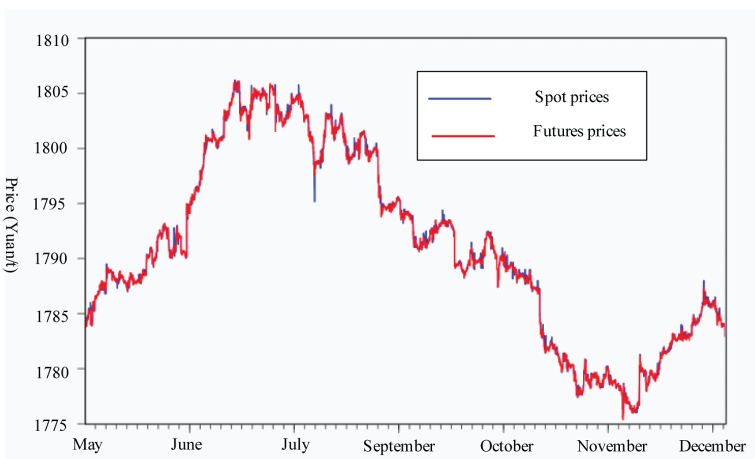
Take the corn in Table 3 as an example to analyze the corn price trend from May to December 2019, as shown in Figure 3.

Analysis of Figure 3 shows that corn prices fluctuated greatly from May 2019 to December 2019. In June and July, corn prices peaked and then declined slowly. After November, corn prices rose slightly. Using the above agricultural product market information as the data base of this experiment, the test experiment is completed by processing and collecting the above data information.

Table 3. Information of agricultural products in peak season

Serial number of agricultural products	Serial number of agricultural products	Types of agricultural products
1	Rice	Cereals
2	Corn	
3	Wheat	
4	Sweet potato	Tubers
5	Potato	
6	Soybean	Peas and beans
7	Peas	
8	Broad bean	
9	-	Leafy vegetables
10	-	Rhizome
11	-	Bud and Seedling
12	-	Cauliflower
13	-	Fruit and vegetable
14	-	Fungi
15	-	Cucurbits

Figure 3. Corn price trend from May to December 2019



Sample Data Design

1. **Anti-interference performance comparison:** Noise interference is an important factor affecting the stability of the spillover effect model of agricultural product market price volatility. Therefore, the noise interference of different methods in the process of building the spillover effect model is compared, and the comparison results are shown in Figure 4.

It can be seen from the analysis of Figure 4 that the noise interference amplitude of reference (Zhao et al. 2018) method changes between 5dB-63dB, which is the highest and the worst anti-interference ability among the three methods. The noise interference amplitude of reference Wang, (2019) method changes between 5dB-18dB, while the noise interference amplitude of the proposed method is always lower than 16dB, which has strong anti-interference ability and can ensure the stability of the model.

2. **Stability comparison:** The stability of different methods is tested by determining the degree of dispersion and aggregation of characteristic roots. If not, it indicates that the method is stable, if not, it indicates that the method is unstable. The stability comparison results are shown in Figure 5.

It can be seen from the analysis of Figure 5 that only a part of the characteristic roots of the method in reference (Zhao et al. 2018) fall within the unit circle, most of them fall outside the circle,

Figure 4. Anti-interference performance comparison

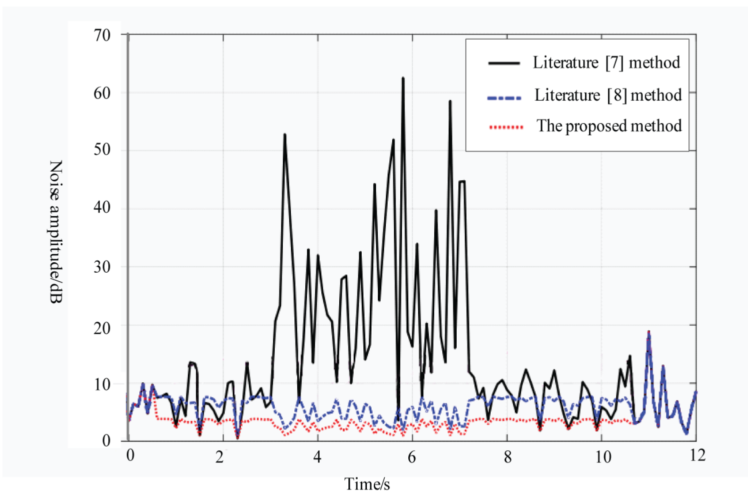
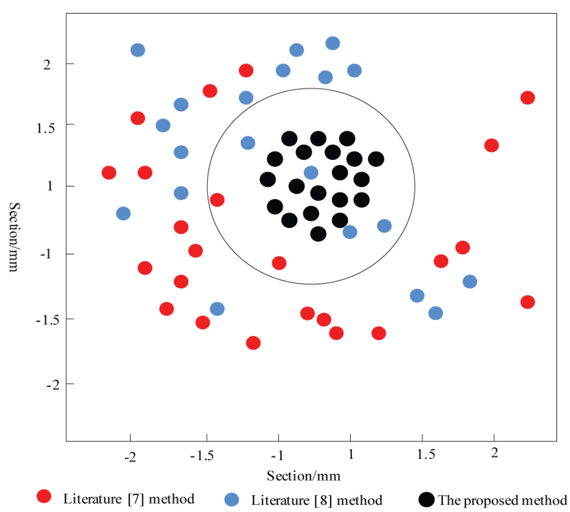


Figure 5. Market experiment results of agricultural products in peak season



and they are relatively scattered and poor in polymerization, so the method is not stable. In reference Wang, (2019), only a part of the characteristic roots of the method falls in the unit circle, most of them are outside the circle, and the characteristic roots are relatively scattered, so it shows that the method is not stable. In the stability test of this method, we can see that the characteristic roots are all in the unit circle, and the distribution is relatively dense, so this method is more stable than the traditional method.

3. **Correlation coefficient significance comparison:** On the basis of the above experiments, the significance of correlation coefficient is compared. The higher the significance is, the more the model can reflect the autocorrelation characteristics of agricultural product market price volatility, and the more accurate the analysis results of spillover effect of product market price volatility are. The comparison results are shown in Figure 6.

From the analysis of Figure 6, it can be seen that in different model orders, the significance value of half of the correlation coefficients of literature (Zhao et al. 2018) method and literature Wang, (2019) method is lower than 0, and some of the coefficients show negative correlation, which seriously affects the accuracy of model output results. Although the proposed method has some negative correlation, on the whole, the correlation coefficient of this method is significantly higher than that of the literature.

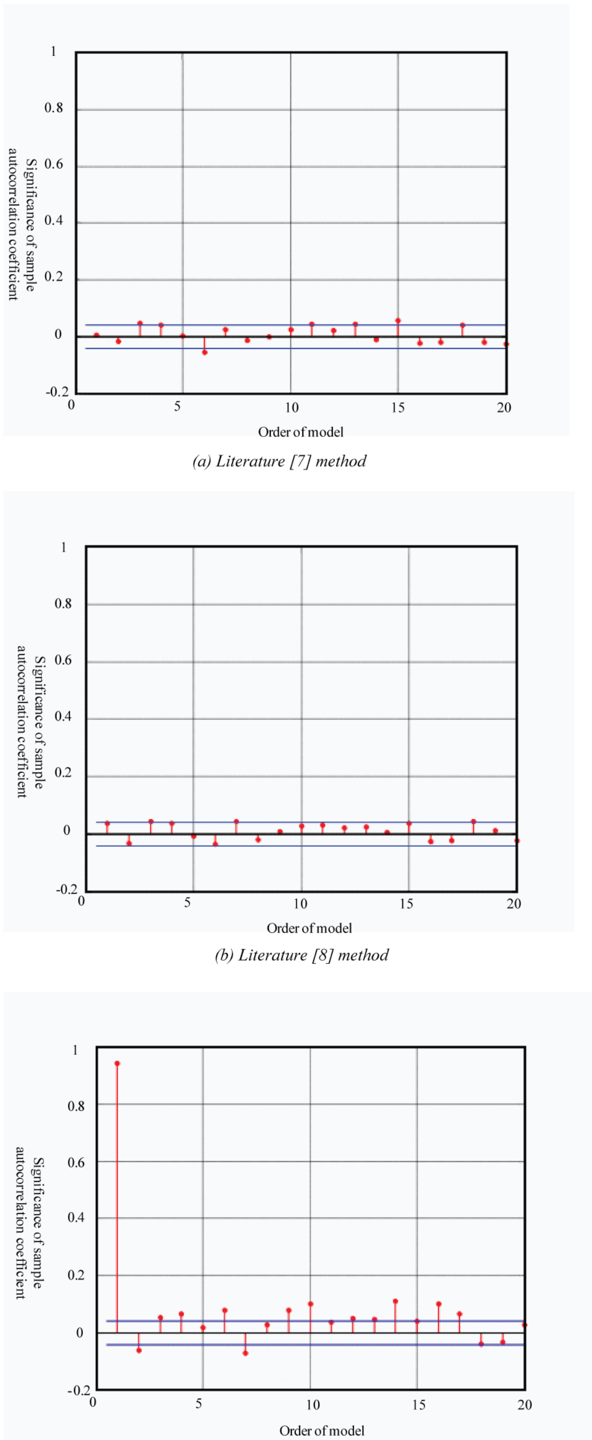
4. **Variance contribution rate comparison:** On the basis of the above experiments, we compare the results of spillover effect analysis of agricultural product market price volatility by different methods, that is, variance contribution rate. Variance contribution rate refers to the proportion of variation caused by a single common factor in the total variation, indicating the influence of this common factor on the dependent variable. The higher the variance contribution rate is, the more accurate the analysis result of spillover effect of agricultural product market price volatility is. The comparison result is shown in Figure 7.

Analysis above shows that the method of literature (Zhao et al. 2018) the variance contribution rate of change range is 45%-76%, the method of literature Wang, (2019) the variance contribution rate of change range is 45%-67%, is the lowest in the three methods, and the research methods of variance contribution rate range is 47%-83%, is the tallest of the three methods, so that the results obtained with this method the actual fitting degree is high, can get more accurate agricultural products market price volatility spillover effects analysis results.

CONCLUSION

The increase of the price fluctuation of agricultural products will cause the price fluctuation of competitive crops and agricultural and sideline products in the same industrial chain to change. In this respect, although there are many explanations for its principle in relevant studies, there is no unified answer in the academic circle. In order to solve the problem of low fitting degree between the research results of traditional agricultural product market price volatility spillover effect and the actual situation, a research method of agricultural product market price volatility spillover effect based on Fourier analysis is proposed. The experimental results show that the method has strong anti-interference ability, good stability, high fitting degree between the results and the actual, and has reliability with 83% on comparison with the existence. According to the results of this study, the following suggestions are proposed:

Figure 6. Correlation coefficient significance comparison

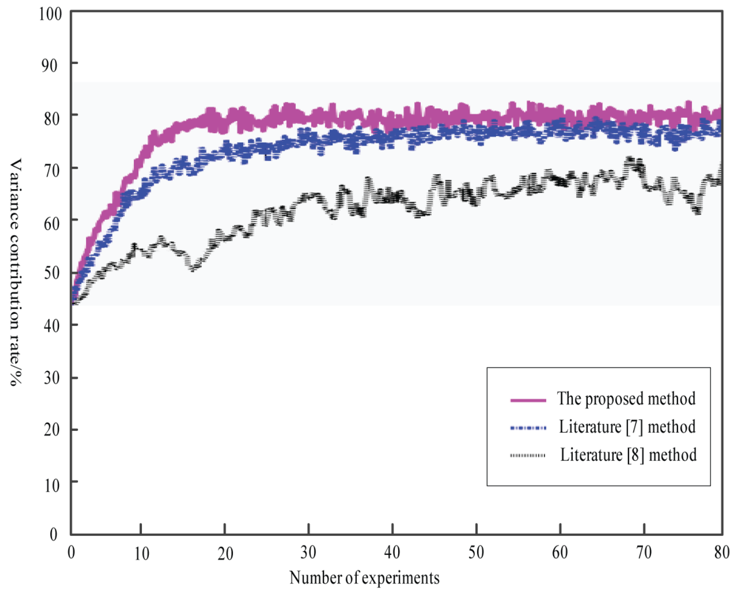


(a) Literature [7] method

(b) Literature [8] method

(c) Proposed method

Figure 7. Comparison of variance contribution rate



1. **Strengthen information disclosure:** The effect of volatility spillover mainly depends on the transmission of information. The accuracy, effectiveness and timeliness of information play an important role in the exertion of volatility spillover effect between markets. If agricultural products market wants to play the function of price discovery and hedging, it needs to rely on a perfect information disclosure system;
2. **Improve market supervision:** To a certain extent, volatility spillover effect can play the function of price discovery, and effective supervision can prevent the cycle of price volatility from aggravating to a certain extent, and protect the interests of enterprises and individuals.

Future research which has looked into the effectiveness of agricultural commodity global demand and supply in a number of countries, specifically at the specific agriculture commodity stage, using both price discovery and volatility spillover.

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