 CMC, vol.58, no.2, pp.363-378, 2019

Research on the Relationship Between Garlic and Young Garlic Shoot Based on Big Data

Feng Guo[1], Pingzeng Liu[1,*], Wanming Ren[2], Ning Cao[3], Chao Zhang[1], Fujiang Wen[1] and Helen Min Zhou[4]

Abstract: In view of the problems such as frequent fluctuation of garlic price, lack of efficient forecasting means and difficulty in realizing the steady development of garlic industry, combined with the current situation of garlic industry and the collected data information. Taking Big Data platform of garlic industry chain as the core, using the methods of correlation analysis, smoothness test, co-integration test, and Granger causality test, this paper analyzes the correlation, dynamic, and causality between garlic price and young garlic shoot price. According to the current situation of garlic industry, the garlic industry service based on Big Data is put forward. It is concluded that there is a positive correlation between garlic price and young garlic shoot price, and there is a long-term stable dynamic equilibrium relationship between young garlic shoot price and garlic price fluctuation, and young garlic shoot price can affect garlic price. Finally, it is proposed to strengthen the infrastructure construction of garlic Big Data, increase the technological innovation and application of garlic Big Data technology, and promote the safety and security ability of the whole industry to promote the development of garlic industry.

Keywords: Big Data, big data in agriculture, granger causality test, big data platform.

1 Introduction

With the continuous development of the open access movement and the outbreak of massive information, the infiltration of the Internet has subverted the traditional mode of agriculture. The emergence and development of new technologies, such as sensors, Internet of things, cloud computing, Big Data, not only subvert the traditional manual labor mode, but also break the extensive traditional production mode, and turn to intensive, accurate, intelligent, and digitization. The Big Data in agriculture has been involved in arable land, breeding, sowing, fertilization, plant protection, harvest, storage and transportation, processing and selling of agricultural products, livestock production and so on. It can realize the management of crop planting, cultivation, and sales. It is a

[1] College of information science and engineering, Shandong Agricultural University, Tai'an, 271000, China.

[2] Shandong Provincial Department of Agriculture Information Center, Jinan, 250013, China.

[3] College of Information Engineering, Qingdao Binhai University, Qingdao, China.

[4] School of Engineering, Manukau Institute of Technology, Auckland, New Zealand.

[*] Corresponding Author: Pingzeng Liu. Email: lpz8565@126.com.

cross-industry and cross-professional data analysis and mining, which is of great significance for food security and industrial development [Wen (2013)].

Nowadays China has entered the ranks of the market economy, the market economy and social economy are closely related. The market economy is declining at once. For agriculture, the competition of agricultural products market is becoming increasingly fierce and the sale of agricultural products is increasingly difficult, especially for small agricultural products. In recent years, the prices of small agricultural products fluctuated sharply, with garlic as an example: from 2010, garlic prices fell down to 15.2 yuan/kg, and the lowest fell to 2.5 yuan/kg. Up to now, the price of garlic has gone through four and three falls, and the price of garlic is still very volatile, from 15 yuan per kg in early January 2017 to 5.4 yuan per kg in early 2018. The price of garlic into multiple levels increased or reduced, and traditional factors such as supply and demand are hard to explain. The fluctuation of garlic market will cause the market disorder of agricultural products, not conducive to market regulation, and even cause inflation and affect social stability.

How to effectively and accurately determine the future trend of garlic prices in the vast agricultural data? According to the price linkage mechanism of agricultural products, there is a certain relationship between young garlic shoot and garlic prices. In addition, in the process of investigating major producing areas such as Jinxiang, Lan Ling and Laiwu in China, the phenomenon that the price of young garlic shoot may have a certain influence on the price of garlic may be found in the process of inquiring about the enterprises and the rich planting experience of garlic farmers, but the extent and relevance of the impact are not very clear.

There are researchers have studied garlic and even its subsidiary young garlic shoot for facing the adverse effects of garlic price fluctuations on the market. Due to the restrictions of planting area and yield, foreign countries have relatively few descriptions of garlic and young garlic shoot price, and foreign research focuses on medical care and healthcare. For example, Talib studied the water extract of garlic and lemon effect on mice transplanted cancer of breast cancer, through the combination of research it is concluded that the water extract of garlic and lemon is a promising choice, can develop an anti-cancer food to increase traditional anti-cancer therapy [Talib (2017)]. [Ragavan, Muralidaran, Sridharan et al. (2017)] found that the effect of garlic oil nanoemulsion on rat fat was significantly reduced. It was concluded that garlic oil nanoemulsification can reduce toxicity and improve the efficacy of preventing and treating dyslipidemia. The planting area and output of garlic in China are the world’s first and export volume is more than 70% of the world's exports all the year round [Zhang (2009)]. Therefore, domestic scholars have more descriptions of the garlic and young garlic shoot prices, which are mainly reflected in the following aspects: one is the analysis of price fluctuations of single garlic and garlic products based on the nature of the theoretical review, and recommendations are made on the basis of analysis of price fluctuations. For example, Wang et al. [Wang, Xiong, Han et al. (2016)] made recommendations to the garlic market in 2017 by analyzing the garlic market situation in 2016 [Ma and Zhang (2016)] predicted the prospects for the young garlic shoot industry in 2016 through the 2015 business situation of young garlic shoot and proposed new the challenges faced by the Garlic industry during the period. Chen et al. [Chen and Tan (2017)] starts with the

analysis of the reasons for the rising price of garlic market in 2016 and its impact on the market in 2017. Through the analysis of the factors that affect the market development in 2017, the future market development trend and the price operation space are prejudged. The other is to study the single price fluctuation cycle, the transmission mechanism and fluctuation characteristics of garlic and young garlic shoot through the construction model. For example, Jiang et al. [Jiang and Wei (2007)] show that the temperature leads to the positive fluctuation of young garlic shoot in the flourishing period of young garlic shoot, and the short-term yield of young garlic shoot leads to the reverse movement of the price. Yao et al. [Yao and Zhou (2012)] through the construction of the ARCH model, showed that the price of garlic has obvious concentration and asymmetry, and the price decrease will cause the price fluctuation to be greater than the price increase. Qiu [Qiu (2013)] through the GARCH model shows that the price of garlic has a certain periodicity and trend, and it has the cluster and high risk, but it does not have the high return. Jiang et al. [Jiang and Cha (2016)] analyzed the causes of the domestic garlic boom and slump from the three transmission mechanisms of supply, price, money and Granger causality, and put forward the policy suggestions from the three aspects of market regulation mechanism, price warning mechanism, and benefit guarantee mechanism.

However, the current literature on the price of garlic and young garlic shoot mainly focuses on the analysis of price fluctuation, fluctuation characteristics and transmission mechanism of garlic or young garlic shoot, and the price relationship between young garlic shoot and garlic is rarely mentioned, and most of the research is through data level selection method, so the service guidance for garlic industry is limited. Therefore, on the basis of a Big Data platform for garlic industry chain established by the Shandong provincial agriculture department and Shandong Agricultural University, the price fluctuation of garlic and young garlic shoot in the market flow link is analyzed by using the garlic industry survey and industry analysis, and then using the co-integration test, the Granger causality test and other methods. On the one hand, the relationship between the two prices of garlic and young garlic shoot is explored to predict the fluctuation of garlic price and to provide a reference for the further analysis of the establishment of the garlic price warning mechanism. On the other hand, it provides data support for improving the garlic industry chain Big Data platform and promotes the promotion and improvement of Big Data in agricultural.

2 The development of garlic big data in China

2.1 Current situation of garlic industry

China is the largest producer of garlic in the world. The annual output of garlic is about 800~1000 ten thousand tons. At the same time, it is one of the main exporting countries of garlic. Chinese garlic occupies an absolute share in the international market. The annual share of garlic is close to 80%. It has a profound influence on the garlic trade in the world. Chinese garlic products are exported to Southeast Asia, Japan, the Middle East, the Americas, Europe, Russia and other countries and regions.

Abroad, garlic is highly valued because of its special nutritional value and health care function. Gil Roy, the hometown of American garlic, held garlic festival in the last week of July. It displays more than 100 kinds of exquisite food made from garlic for visitors to

taste. The Garlic Festival is also held every year in Israel. The United Kingdom has also set up the garlic Information Center on the Internet to provide the latest research developments on garlic.

In China, garlic is widely consumed and used as an export agricultural product. Before 2008, the wholesale price of garlic was 6-8 yuan per kilogram in the main producing area of China, and the wholesale price of garlic rose to 13-15 yuan per kilogram from 114% in summer, an increase of 114%. Large-scale production and industrialization are developing rapidly, and garlic village and garlic village emerge in endlessly. Chinese garlic is planted all over the country. The main producing areas are mainly concentrated in five provinces of Shandong, Jiangsu, Henan, Hebei, and Yunnan, including Jinxiang, Pizhou, Lan Ling, Laiwu, Zhongmu and Qixian County. Shandong province is the first garlic production area in China. Its three garlic areas are mainly produced in Jinxiang, Lan Ling, and Laiwu. The area, production, quality, quality and export of Jinxiang garlic are the first in the country. The annual export volume of garlic is more than 70% of the total garlic export in the country, and it has become the center of garlic planting, the distribution center, and the processing center, export center, price center.

2.2 The development and application of garlic big data

Our country garlic industry focus on the strategy of "Internet+Big Data+Modern Agriculture", with the emphasis on the application of the Internet information technology, the garlic Big Data is vigorously developed. The Agricultural Internet of things, the electronic commerce of agricultural products and the comprehensive service of agricultural information are actively carried out to promote the integration of three agricultural industries and realize the leapfrog development of the traditional agriculture to the modern agriculture.

The application of garlic major data in China is mainly reflected in two aspects, which are related to the various links of the garlic industry chain, such as the equipment, the rural e-commerce, the wholesale market, the cold chain logistics, and the brand of agricultural products and so on. Under the premise of supporting government policies, rural e-commerce companies are innovating sales channels and relying on the e-commerce platform to make garlic circulate throughout the country and even export it abroad. The garlic industry has a large number of data and other modern Internet technology, with the gradual integration of various links in the industrial chain=the garlic whole industry chain, and the construction of the information platform covering the national garlic production area. The two is the construction of agricultural information service system related to garlic. Taking Jinxiang County of Shandong Province as an example, the China garlic industry information alliance has been formed and collected for 1998-2017 years. It covers the production data, demand data, circulation data, meteorological data, and the price index of production area in 6 main production areas of the country, including processing data, sales data, and sales data. Several industrial databases, including circulation data and export data, have been built and a query platform for soil testing and formula fertilization system has been built. Jinxiang has also built a series of real-time consultations on the agricultural science and technology application, the propaganda of Jinxiang agricultural information network, the network hotline, the price service of agricultural products, and the garlic information service, so as

to safeguard the legitimate rights and interests and effectively promote the harmony and stability of the rural society. In addition, Jinxiang county also has more than 3000 e-commerce enterprises, established an e-commerce service system covering the three levels of the county, town, and village, which has greatly promoted the integration of the three industries.

3 Data acquisition

During the process of data collection, this paper explores from 2010, after the garlic industry enters the high-speed development stage, the garlic price fluctuates frequently, and the price fluctuation of young garlic shoot has also changed a lot at the same time. Beginning in 2010, garlic prices fluctuate to a maximum of 15.2 yuan/kg, the lowest drop to 2.5 yuan/kg. Until now, the price of garlic is still fluctuating, from 15 yuan/kg in early January 2017 to 5.4 yuan/kg in early 2018. During this period, the price of young garlic shoot was also very large, reaching 10 yuan/kg at the highest and falling to 2.3 yuan/kg at the lowest. The price fluctuation of garlic and young garlic shoot has gone through "four rises and three falls", and the price fluctuation is similar. From the point of view of data analysis, young garlic shoot and garlic belong to the product of a kind of crop. Compared with other crops, the difference between young garlic shoot and garlic two is the smallest for some unquantifiable climatic factors and sudden factors. But garlic sprouts are shorter than garlic in the growth cycle, and harvest time is earlier than garlic. This provides the precondition for us to study the price of garlic in advance by studying the relationship between them.

The data used in this article is the average wholesale price of garlic and young garlic shoot in Shandong Province, spanning from January 2010 to December 2017, a total of 192 data. The original data source is the garlic industry chain Big Data platform. Shandong Province is a major garlic production area in China. Its annual output ranks first in the country. Its export volume and foreign exchange earning amount also account for more than 60% of the country's total. Its price has a significant impact on the price of garlic and young garlic shoot in the country [Cheng, Cui and Liu (2017)].

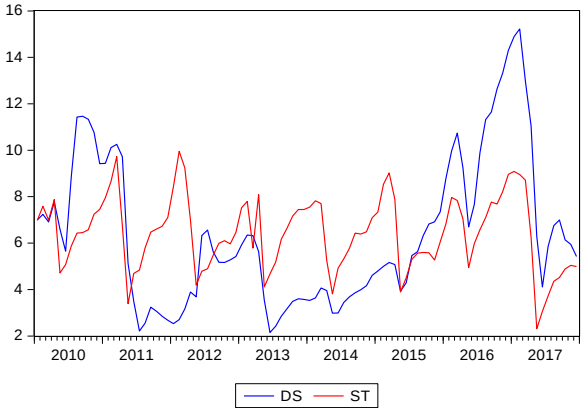

Figure 1: Average wholesale prices in Shandong province, 2010~2017 (Unit: yuan/kg)

In terms of data processing, this paper uses a differential method to reduce the data. This article represents X_t with garlic and Y_t represents young garlic shoot.

4 Methods

The purpose of this paper is to find the relationship between the price of garlic and the price change of young garlic shoot. According to econometric axioms, any economic data can be seen as the realization of this random data generation process. Therefore, the link between young garlic shoot prices and garlic price fluctuations can be considered as the research object [Hong (2001)].

Granger causality test is based on the two time series X_t and Y_t, used to assess the observed value of X_t history for predictive value Y_t, the usefulness of this method from the Angle of conventional prediction research sequence of cause and effect, to be able to reflect on time has the relationship between the two time series [Granger (1969)]. This section combines Granger causality test and co-integration test to test the relationship between garlic and young garlic shoot price.

4.1 Stability test

In the analysis of price, we need to analyze and deal with time series. Whether it is multivariate regression analysis or model analysis of a single time series, it is necessary to test the stationarity of time series. For Stationary Sequences and non-stationary sequences, differential treatment is needed when modeling.

If the joint probability distribution of a time series does not vary with time, the time series is strictly stationary. If the mean, variance and covariance of time series variables do not change with time, it can be considered that the sequence is weak stationary (or wide stationary). Generally speaking, stationary means weak stationary. Generally, unit root test is used to verify the stationarity of sequences.

Suppose that the random process $\{y_t, t=1,2,\cdots,n\}$ satisfies $y_t = y_t - 1 + \varepsilon_t$, where ε_t is independent and identically distributed, and $E(\varepsilon_t)=0, D(\varepsilon_{2t})=E(\varepsilon_{2t})=\sigma_2<\infty$ is called y_t random walk process. It is assumed that the stochastic process $\{y_t, t=1,2,\cdots,n\}$ satisfies $y_t = \rho y_t - 1 + \varepsilon_t$, where ε_t is a stationary sequence with a mean of 0. When $\rho=1$, the characteristic polynomial of the lagging operator has a unit root, which is called y_t as the unit root process. It can be seen that random walk is a special case of unit root process. When $\rho<1$, y_t is a stationary sequence. When $\rho>1$, y_t is a non-stationary sequence. If the time series is nonstationary, but after a first-order difference becomes a stationary process, the sequence is called a first order single integer sequence, which is called $I(1)$. The unit root test is used to judge the sequence stationarity. If a sequence does not change to a stationary sequence no matter how many times the difference is, then the sequence is not a single integer sequence.

At present, the more influential methods used in unit root test are ADF test, PP test, KPSS test and NP test. The most commonly used methods are ADF test and PP test. ADF test and PP test method are used to verify the stability of the double test sample in this paper.

The ADF test is an extension of the DF test method. When the sequence residuals are not white noise, in order to eliminate the autocorrelation of the residual term, the lag term of the explanatory variable itself is added to the right of the regression model equal sign, and the lag term is considered as an exogenous variable to be tested again. This can effectively solve the time series problem with higher order autocorrelation.

There are three auxiliary equations in the ADF test:

(1) Non-intercept and non-trend terms

$$\Delta y_t = \rho y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-i} + u_t \quad (1)$$

(2) Only containing the intercept term

$$\Delta y_t = c + \rho y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-i} + u_t \quad (2)$$

(3) Contain intercept term and time trend term

$$\Delta y_t = c + \alpha_t + \rho y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-i} + u_t \quad (3)$$

The symbol indicates the first order difference operator of Δ, the c is the intercept term, the α_t is the trend term, the $\sum_{i=1}^{k} \gamma_i \Delta y_{t-i}$ is the k distribution lag term, the u_t is the stationary random error term, and the k is the maximum delay order of them u_t to satisfy the white noise. The smaller the information criterion based on Schwarz or Akaike, the better the model.

The ADF test has u_t basic assumptions for the three regression models: the variance of u_t is the same. So the ADF test is only applicable to the test of homogeneity of variance.

Later, Phillips and Perron carried out nonparametric correction of ADF test statistics and obtained PP statistics. The test using the PP statistics is called PP test. PP statistics not only take into account the heteroscedasticity of but also take account of the influence of autocorrelation errors and have the same distribution as ADF statistics. The auxiliary equation of PP test is similar to that of ADF test.

4.2 Co-integration test

The purpose of the co-integration theory is to consider whether there is a time series regression of non-stationary variables without causing errors.

This article uses the Engle-Granger test for co-integration testing. The idea of the EG test: assuming that these sequences are all zero-ordered (I(0)), first use these time series variables to perform the least squares (OLS) regression on each other, and then pass units such as the ADF test, the PP test, and the like. Root tests whether their residuals are zero-

ordered (I(0)) and if so, there may be a co-integration relationship between these variables.

4.3 Granger causality test

The Granger causality definition of Econometrics in the sense of time series: "To determine whether X_t causes Y_t, examine how far the current value of Y_t can be explained by the past value of Y_t, and then examine whether the added lag value can improve the degree of interpretation. If the lag value of X_t help to improve the interpretation of Y_t, then X_t is considered to be the Granger cause of Y_t".

Granger's definition of causality is based on the premise that X_t and Y_t are stable sequences, that is, zero-order single integer is the Granger causality test. If X_t and Y_t are not stable sequences, Granger causality test method cannot be used to test the relationship between X_t and Y_t. Causal relationship. If X_t and Y_t are first order and there is no co-integration, Hassapisetal [Hassapisetal (1999)] proved that the causality can be determined by the standard F-test of the first-order difference model, That is, the first order differential Granger Causality method can be used to test variables [Hassapisa, Nikitas and Kyprianos (1999)]:

$$\Delta x_t = \sum_{i=1}^{q} \alpha_i \Delta x_{t-i} + \sum_{j=1}^{q} \beta_j \Delta y_{t-j} + \mu_{1t} \tag{4}$$

$$\Delta y_t = \sum_{i=1}^{s} \lambda_i \Delta x_{t-i} + \sum_{j=1}^{s} \delta_j \Delta y_{t-i} + \mu_{2t} \tag{5}$$

However, if X_t and Y_t have a co-integration relationship, the estimation equation at this time should be:

$$y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i x_{t-i} + \sum_{j=1}^{m} \beta_j y_{t-j} + \delta\varepsilon_{t-1} + \phi_t \tag{6}$$

$$x_t = \alpha_0 + \sum_{i=1}^{m} \alpha_j y_{t-1} + \sum_{j=1}^{m} \beta_j x_{t-j} + c\varepsilon_{t-1} + \mu_t \tag{7}$$

Formula (3) (4) is a constant term [Malliaris (2005)] ,

Error correction term: $\delta\varepsilon_{t-1}$, $c\varepsilon_{t-1}$ (From the regression equation $X_t = \alpha + \beta Y_t + \varepsilon_t$), Errors: ϕ_t , μ_t .

If part of (3) is significantly non-zero, they say Y_t is not a Granger cause of X_t ; if the part is significantly non-zero in (4), and then X_t is not a Granger cause of Y_t ; if both are present, then X_t and Y_t are not Granger causality.

5 Statistical test

5.1 Trend analysis of price fluctuations

The analysis of correlations between variables is the basis for empirical analysis. Only the following analysis of the two correlations makes sense. The specific results are shown in Tab. 1.

Table 1: The correlation coefficient between garlic price and young garlic shoot price

Correlation	DS	ST
DS	1	0.377902
ST	0.377902	1

As can be seen from the above chart, there is a positive correlation between the price of garlic and the price of young garlic shoot, which is 0.377902. According to Fig. 1, it can be seen that the fluctuation trend between the two is basically the same, rising or falling, but the volatility is inconsistent, and the price fluctuation of young garlic shoot has priority over the price of garlic.

5.2 Stability test

When both variables are non-stationary, the result of the Granger causality test may be falsified. Therefore, it is necessary to test the stationarity of the variables before the Granger causality test [Enders (2006)].

A formal unit root test was performed on two sequences of garlic price (X_t) and young garlic shoot price (Y_t), using Eviews9.0 for estimation. First, the ADF test is performed. For X_t and Y_t, the graph contains the constant term and the linear time trend term in the ADF test, and the hysteresis item is automatically selected according to Schwarz Info-Criter. The result is shown in Tab. 2. The ADF statistic of X_t is greater than the critical value at the significant level of 1%, that is, the raw data of garlic price has a unit root, which is an unstable sequence.

The ADF value of the first difference sequence X_t is less than the t statistic at the 1% significance level. The stationary sequence is shown in Tab. 3.

Table 2: Augmented dickey-fuller test for X_t and Y_t

Stability Test	ADF Test	Critical-Value	*T*-statistics	*P*-value
X_t	-3.008245	1%	-4.058619	0.13565
		5%	-3.458326	
		10%	-3.155161	
Stability Test	ADF Test	Critical-value	*T*-statistics	*P*-value
Y_t	-5.149601	1%	-4.058619	0.0003
		5%	-3.458326	
		10%	-3.155161	

Table 3: X_t augmented dickey-fuller test

Stability Test	ADF Test	Critical-Value	*T*-statistics	*P*-value
ΔX_t	-6.678250	1%	-4.059734	0.0000
		5%	-3.458856	
		10%	-3.155470	

In order to test the robustness of the results, the Phillips-Perron Test was performed again for X_t and Y_t. The results are shown in Tab. 4. The results show that both X_t and Y_t do not contain a unit root at a significant level of 1%, and are stable. Combining the ADF test and the PP test, it is found that the two sequences are first-order single integer sequences and are stationary.

Table 4: Phillips-perron test for ΔX_t and ΔY_t

Stability Test	PP Test	Critical-Value	*T*-statistics	*P*-value
ΔX_t	-5.630240	1%	-4.058619	0.0000
		5%	-3.458326	
		10%	-3.155161	
Stability Test	PP Test	Critical-Value	*T*-statistics	*P*-value
ΔY_t	-12.74229	1%	-4.058619	0.0000
		5%	-3.458326	
		10%	-3.155161	

5.3 Co-integration test

According to the PP test, it is known that X_t both Y_t the first-order single integer sequences are stationary. Using EG two-step method to perform co-integration test [Engle and Granger (1987)].

First: we use the Y_t independent variable to perform least-squares regression on X_t to obtain the regression coefficient. $\alpha = 0.774674$, $\beta = 1.414661$

The regression equation is as follows：

$$X_t = 1.414661 + 0.774674 Y_t + \varepsilon_t \tag{8}$$

Calculate Residual Estimates ε ,

$$\varepsilon = X_t - 1.414661 - 0.774674 Y_t \tag{9}$$

Second, the residual value X_t is obtained to test the residual sequence X_t of the above model, and the ADF unit root test is used to determine whether it is a stationary sequence. The test results are shown in Tab. 5.

Table 5: Residual Sequence ADF Test

Test sequence	ADF-Statistics	Confidence level	Critical value
Residual sequence	-7.802523	1%	-4.058619
		5%	-3.458326
		10%	-3.155161
variable	Coefficient		
R^2	0.9821267165		
After adjustment R^2	0.9796053039		
F-Statistics	15.66059		

From Tab. 5, it is found that the ADF statistic is less than the critical value of 1%, indicating that the residual sequence does not contain a unit root at a significant level of 1%, so the residual sequence is a stationary sequence, indicating that the garlic price there is a co-integration relationship between young garlic shoot prices Model Estimated R^2 =0.9821267165，the high degree of goodness of fit indicates that the model is well-fitted and there is a long-term equilibrium relationship between the two:

$$X_t = 1.414661 + 0.774674 Y_t + \varepsilon_t \tag{10}$$

From this, it can be concluded that there is a long-term stable dynamic equilibrium relationship between garlic price fluctuations and young garlic shoot price fluctuations.

5.4 Granger causality test

According to the Augmented Dickey-Fuller Test and the Phillips-Perron Test, both the price of garlic and price of young garlic shoot are first-order single integer sequences. The Granger causality test is performed. The lag period is 5, and the test results are shown in Tab. 6.

Combining the F statistics with the P value, it can be seen from Tab. 5 that in the lag phase 1 to 5, the young garlic shoot price is the Granger cause of the garlic price, and the garlic price is not the Granger cause of the young garlic shoot price.

Comprehensive Tab. 5 shows that the causal relationship between young garlic shoot and garlic prices is single, and the best lag period is 2. In the short term, young garlic shoot has a great impact on garlic price fluctuations. When the lag period is 2, the maximum impact is due to garlic and young garlic shoot. The time between the listing must be determined.

Table 6: Granger causality test between garlic and young garlic shoot price

Lag period	Zero hypothesis	*F*-statistics	*P*-value	Decision making
1	Young garlic shoot is not the granger cause of garlic.	3.61380	0.0605	refuse
	Garlic is not a Granger cause of young garlic shoot	0.10374	0.7481	agree
2	Young garlic shoot is not the granger cause of garlic.	3.62676	0.0307	refuse
	Garlic is not a Granger cause of young garlic shoot	0.04323	0.9577	agree
3	Young garlic shoot is not the granger cause of garlic.	3.03109	0.0337	refuse
	Garlic is not a Granger cause of young garlic shoot	0.39529	0.7567	agree
4	Young garlic shoot is not the granger cause of garlic.	2.31363	0.0643	refuse
	Garlic is not a Granger cause of young garlic shoot	0.06994	0.9909	agree
5	Young garlic shoot is not the granger cause of garlic.	1.83014	0.1165	refuse
	Garlic is not a Granger cause of young garlic shoot	0.17030	0.9728	agree

6 Service guidance of garlic big data

Big Data is a natural phenomenon of low-cost driving by Internet information technology, such as Internet extension, Internet of things, mobile Internet and cloud computing. Especially for large agricultural data, it is a collection of data with the characteristics of large capacity, multiple types, fast access speed and high application value. It is a new generation of information technology and service industry to discover new knowledge, create new values, enhance new abilities and eventually fall to the service of agricultural industry by collecting, storing and analyzing data of large numbers, scattered sources and diverse formats [Wang (2018)].

1) Establish and improve the price monitoring and early warning mechanism, and improve the market information release system.

The price of the market is closely related to the consumer, and there will be different price sensitive points and hot spots in different periods, especially between the same industry and the same type. The price monitoring and warning mechanism must follow the market price hotspot and the sensitive point in time, and extract the trend of price change with the tendency and density from the method of data analysis in time. It will provide valuable thinking for the government's macro decision making.

The relationship between the price of young garlic and the price of garlic was related, and the relationship reached the maximum at two months, which could predict the fluctuation of garlic price to provide a good reference for the monitoring and early warning of garlic price [Xu, Jin and Fang (2014)].

2) Strengthen industrial information guidance and improve market circulation mechanism.

The basic reason for the abnormal fluctuation of the garlic market price lies in the nonstandard of the agricultural product market system. The relevant subjects in the industrial chain have great differences in the ability to handle information and the ability to grasp information, it will easily lead to blindly follow the trend and drive up prices. In the long run, the market price mechanism will be disturbed and the price fluctuation of agricultural products will be abnormal.

In order to ensure the stable price of garlic, it is necessary to accelerate the promotion and construction of the garlic industry chain Big Data platform, and strengthen the guidance of garlic production and sales, so as to realize the transparency of the industry information, and reduce the blind market behavior of raising prices because of asymmetric information, and realize the balance of supply and marketing for garlic, and ensure the balanced operation of the garlic market.

3) Strengthen the supervision of garlic market price, stabilize the market trading mechanism, and crack down on the illegal market price mechanism such as speculation of idle funds.

Since the economic crisis, China has adopted a loose monetary policy. As the market liquidity is abundant and the stock market is low, our agricultural products are in a state of tight balance. The long-term preservation of agricultural products such as garlic can easily become a venture capital target. This kind of illegal behavior seriously undermines the market price regulation, and impacted the institutional mechanism of the market, and seriously affected the market system and the overall stability of the garlic price. Take the garlic industry chain Big Data platform as the core, and strengthen the construction of basic Internet of things equipment. Strengthen supervision over all aspects of the garlic industry chain, and effectively implement the functions of market supervision. Give full play to the role of the government and the market, and give full play to the market vitality under the action of the regulation of value, and promote the stability of the garlic price.

4) Improve the garlic industry chain Big Data platform to promote the development of garlic industry.

With the rapid development of a new generation of information technology, such as mobile Internet, cloud computing, Big Data, and the Internet of things, various types of massive data have been formed quickly, which provides an effective way to solve the difficulties and problems in the development of agricultural Big Data in China. However, due to the low-value density of agricultural Big Data, the development and utilization are insufficient, which can not meet the needs of agricultural development.

With the garlic industry chain Big Data platform as the core, using advanced information technology such as cloud computing and the latest infrastructure of the Internet of things, we can accelerate the popularization of automation and intelligent production, and realize product quality and safety throughout the process of tracing, and the garlic industry chain information query can be traced. Strengthen data analysis methods, and accurately predict garlic market demand, and strengthen garlic production and marketing information monitoring. Promote garlic innovation data sharing and efficient industrial management,

and promote the development and application of garlic Big Data, and promote the upgrading and development of garlic industry.

7 Conclusion and expectation

7.1 Conclusion

This article uses the unit root test, co-integration test, Granger causality test and other measurement methods to empirically analyze the average monthly wholesale prices of garlic and young garlic in Shandong Province from 2010 to 2017. The following conclusions are obtained:

① The price of garlic is positively correlated with the price of young garlic shoot. The fluctuations of the prices of garlic and garlic are basically the same, but the price fluctuation of young garlic shoot precedes the price of garlic.

② There is a co-integration relationship between garlic prices and prices of young garlic shoot, which proves that there is a price-guidance relationship between them. Overall, they are in a long-term and stable dynamic equilibrium relationship.

③ There is a clear Granger causality between the price of garlic and the price of garlic. In the short term, the price fluctuation of young garlic shoot has a significant impact on the price of garlic, and the impact is greatest at two months; the fluctuation of garlic prices has no effect on the price of young garlic shoot. In the long term, the price fluctuations of young garlic shoot will have less effect on garlic prices, but the impact will be lower and lower.

7.2 Expectation

① strengthen the construction of garlic Big Data infrastructure, and enhance the accumulation of garlic Big Data.

In order to provide the basis for the realization of efficient data analysis, strengthen the infrastructure construction of garlic data, including the Internet, Internet of things and other network facilities, sensor equipment, mobile terminal and other hardware facilities.

② Increase garlic Big Data technology innovation and application transformation efforts.

Based on the garlic industry service, actively cooperate with relevant research units and Big Data enterprises to provide industrial services. Start a series of key agricultural data technologies, such as data mining, deep learning, association analysis, management and processing, and launch a series of garlic major data products, and innovate and improve the agricultural promotion and service methods of large data.

③ Improve garlic industry safety guarantees ability, enhance public sentiment monitoring and early warning ability.

In accordance with the requirements of synchronous planning, implementation and construction, the construction of the whole industry chain security system should be strengthened, including infrastructure, information system, and data resources. At the same time, Big Data technology should be applied to enhance the monitoring and warning ability of major public opinion.

Acknowledgments: This work was financially supported by the following project: Shandong independent innovation and achievements transformation project (2014ZZCX07106); The research project "Intelligent agricultural system research and development of facility vegetable industry chain" of Shan-dong Province Major Agricultural Technological Innovation Project in 2017; Monitoring and statistics project of agricultural and rural resources of the Ministry of Agriculture.

References

Chen, M. J. (2017): Analysis of the situation of China's garlic market in 2017. *China Vegetables*, vol. 8, pp. 8-11.

Cheng, Y. Y.; Cui, J. M.; Liu, W. L. (2017): The current situation and Countermeasures of garlic industry in Jinxiang County. *Rural Science and Technology*, vol. 32, pp. 16-17.

Enders, W. (2006): *Applied Econometrics-Time Series Analysis, 4th Edition*. Higher Education Press.

Engle, R. F.; Granger, C. W. J. (1987): Co-integration and error correction: representation, estimation, and testing. *Econometrical*, vol. 55, pp. 251-276.

Granger, C. W. J. (1969): Investing causal relations by econometric models and cross-spectral method. *Econometrical*, vol. 37, pp. 424-438.

Hassapisa, C.; Pittis, N.; Prodromidis, K. (1999): Unit roots and Granger causality in the EMS interest rates: the German Dominance Hypothesis revisited. *Journal of International Money & Finance*, vol. 18, no. 1, pp. 47-73.

Hong, Y. M. (2001): The position, function, and limitation of econometrics. *Economic Research*, vol. 5, pp. 142.

Jiang, H.; Cha, W. H. (2016): The cause of the price fluctuation of garlic in China and the study of its policy regulation. *Price theory and practice*, vol. 10, pp. 112-115.

Jiang, X.; Wei, C. (2007): Temperature change and garlic price fluctuations in the economic analysis. *Journal of Anhui Agricultural Sciences*, vol. 13, pp. 4050-4052.

Lee, D.; Yang, S. G.; Kim, K.; Kim, B. J. (2018): Product flow and price change in an agricultural distribution network. *Physica A: Statistical Mechanics and Its Applications*, vol. 490.

Ma, Y. S.; Zhang, P. (2016): Analysis of operating conditions of garlic industry in China in 2015 review and 2016 outlook. *Storage and Process*, vol. 16, no. 4, pp. 132-138.

Malliaris, A. G. (2005): Economic uncertainty. *Instabilities & Asset Bubbles*, pp. 291-293.

Qiu, S. Q. (2013): Analysis of the fluctuation cycle and characteristics of garlic price in China. *Statistics & Decision*, vol. 15, pp. 97-100.

Ragavan, G.; Muralidaran, Y.; Sridharan, B.; Nachiappa, G. R.; Viswanathan, P. (2017): Evaluation of garlic oil in the aNano-emulsified form: optimization and its efficacy in high-fat diet induced dyslipidemia in Wistar rats. *Food and Chemical Toxicology*, vol. 105.

Rosegrant, M. W.; Kasryno, F.; Perez, N. D. (1998): Output response to prices and public investment in agriculture: indonesian food crops. *Journal of Development Economics*, vol. 55, no. 2, pp. 333-352.

Talib, W. H. (2017): Consumption of garlic and lemon aqueous extracts combination reduces tumor burden by angiogenesis inhibition, apoptosis induction, and immune system modulation. *Nutrition*, pp. 43-44.

Wang, S. W.; Xiong, L.; Han, S. Q.; Wu, J. Z. (2016): 2016 China garlic market situation analysis and future market outlook. *Agricultural Outlook*, vol. 12, no. 11, pp. 4-6.

Wang, X. B. (2018): Focus on cohesion to promote the development of agricultural Big Data application. *Economic Daily*, vol. 15, pp. 1-11.

Wen, F. J. (2013): Strategic significance and synergistic mechanism of agricultural data research. *Higher Agricultural Education*, vol. 11, pp. 3-6.

Xu, Z. L.; Jin, G. Y.; Fang, J. X. (2014): Thinking of perfecting the market price monitoring and early warning work-Taking Zhejiang Province as an example. *Prices Monthly*, vol. 12, pp. 24-27.

Yao, S.; Zhou, Y. H. (2012): Analysis of the price fluctuation characteristics of garlic in China-based on the empirical analysis of the ARCH model. *Price: Theory & Practice*, vol. 10, pp. 54-55.

Zhang, J. G. (2009): Study on China's garlic export situation and development. *Issues in Agricultural Economy*, vol. 30, no. 9, pp. 95-99.