

# Study on the Factors Influencing the Price Volatility of Agricultural Products in China

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**Abstract:** As a major country in the production and consumption of agricultural products, the price of agricultural products in China occupies an important position in the market price system. The fluctuation of agricultural product prices not only affects the development of national agricultural production, but also affects the growth trend of the national economy. This paper analyzes the reasons for the price fluctuations of agricultural products from three levels of supply, demand and international, and uses the grey relational analysis and VAR model to dynamically analyze the six main factors affecting the price fluctuations of agricultural products in China from 1978 to 2020. The study finds that there is a strong correlation between each influencing factor and the price of agricultural products, among which the consumer price index has the highest correlation with the price of agricultural products. At the same time, the per capita disposable income of urban residents and the consumer price index of urban residents have a positive relationship with the price of agricultural products, the price index of agricultural production means and the exchange rate index have a negative relationship with the price of agricultural products in the short term, and the output of grain and the price of agricultural products have a positive relationship in the short term. The relationship between GDP and agricultural product prices is not obvious.

**Keywords:** Agricultural products; Gray correlation; VAR; Influencing factors

## 1. Preface

As one of the birthplaces of farming civilization, China has a long history of agricultural planting and has always been a major producer of agricultural products. According to the announcement of the National Bureau of Statistics, since 2015, grain output has remained above 1.3 trillion catties for seven consecutive years. In recent years, with the occurrence of international natural disasters, international food prices have been on the rise, and domestic food security has prompted Chinese people to explore. As China's primary industry, agriculture is the foundation of all industries. The rationality of agricultural product prices not only affects the development of agricultural production, but also has an important relationship with the material interests between urban and rural areas and the stability of social and economic life. Since 2004, China has introduced a minimum grain purchase price policy to protect the interests of agricultural product producers and control the price balance. However, due to the continuous increase in the production cost of agricultural products, the fluctuation of agricultural product prices is still a test for the safety of Chinese agricultural products in the long run. Therefore, it is of great significance to maintain China's economic development by analyzing the fluctuation law of agricultural product prices and its influencing factors, and putting forward reasonable policy opinions.<sup>[7]</sup>

The price of agricultural products is one of the bases of the whole market price and occupies a special and important position in the whole price system. Whether the price of agricultural products is reasonable not only affects the development of agricultural production, but also plays a major role in the stability of the entire social and economic life. Looking up relevant information, it is found that there are many domestic studies on the influencing factors of agricultural products in recent years. Wang Yifei<sup>[6]</sup> analyzed the reasons for the fluctuation of grain prices in China from two aspects of domestic and foreign grain markets, selected the monthly data of 11 indicators such as international grain prices from 2004 to 2015, and used multiple regression analysis to explore the influencing factors of domestic grain prices. , the study found that the international crude oil price, the cost of growing grains and the broad money supply showed a significant positive correlation with the price of rice and corn, but the international

crude oil price showed a negative correlation with the price of soybean. Yu Tingting<sup>[9]</sup> explored the influence of financial factors on grain prices in Jiangsu Province by selecting four financial factors: money supply, exchange rate changes, futures, and stock market conditions. The application of VEC model test shows that China's currency market, foreign exchange market, and stock market have a long-term and stable impact on food price fluctuations, and the impact is mainly through the CPI of Jiangsu Province. Fu Rong<sup>[2]</sup> *et al.* used the smooth migration regression model STR to test the impact of the three variables on the prices of agricultural products by selecting the monthly data of the three variables of national economic growth rate, money supply growth rate and exchange rate from 1999 to 2017. The results show that the economic growth rate and money supply growth rate have a positive impact on the prices of agricultural products, and the impact of the exchange rate on the prices of agricultural products has changed from a negative inhibition to a positive promotion.

Based on the existing literature, it is found that in the current analysis of the influencing factors of agricultural product prices, the influencing variables selected after analyzing the agricultural product price market do not consider the degree of correlation with their price variables. Regression analysis is performed directly, which may cause the quantitative relationship between some of the collected feature layer variables and the target layer variables to be inconsistent with the actual situation. At the same time, the short time range of the selected samples and the single level of variables in the research process of some scholars have also caused obvious differences in the conclusions. Therefore, this paper intends to analyze the main factors affecting the price fluctuations of agricultural products from 1978 to 2020 from the perspective of supply, demand and international level based on the actual situation of domestic agricultural development. Correlation degree, select the influencing factors with high correlation degree, use the VAR model combined with the impulse response graph to analyze the dynamic changes of the impact of each influencing factor on the price of agricultural products, provide a theoretical basis for promoting the production of agricultural products across the country, and provide a reference for the safety of agricultural products. 1 The main factors affecting the price of agricultural products.

### 1.1. Models for research

#### (1) Gray correlation analysis

Grey correlation analysis refers to a quantitative description and comparison method of the development and change of a system, and the degree of correlation between factors is measured according to the similarity or dissimilarity of development trends between two system factors.

This paper draws on other scholars' research on the price factors of agricultural products<sup>[4],[8]</sup>, we select the series of six factors indicators affecting the national agricultural price  $X_i = X_i(k) | k=1,2..43, i=1,2..6$  and the series  $Y = Y(k) | k=1,2..43$  of national agricultural product price index from 1978 to 2020, After performing dimensionless processing on the two sequences, they are then brought into formulas (1) and (2) in turn to calculate the two sequences. The correlation coefficient  $\xi_i$  and the correlation degree  $r_i$  between them, and sorted according to the correlation degree, to understand the influence degree of each impact index on the production price of agricultural products.

$$\xi_i(k) = \frac{\min_i \min_k |y(k) - x_i(k)| + \rho \max_i \max_k |y(k) - x_i(k)|}{|y(k) - x_i(k)| + \rho \max_i \max_k |y(k) - x_i(k)|} \quad (1)$$

$$r_i = \frac{1}{n} \sum_{k=1}^n \xi_i(k) \quad (2)$$

Among them.  $k = 1, 2 \dots 43, i = 1, 2 \dots 6$

#### (2) VAR model

The vector autoregressive model (VAR) was first proposed by Christopher Sims<sup>[1]</sup> in 1980 for estimating the dynamic relationship between joint endogenous time-series variables. In this time-delay method, the lag term of each variable is used as the independent variable of other variables for modeling analysis. Its model is as follows.

$$\begin{bmatrix} \text{app} \\ \text{pmp} \\ \text{gq} \\ \text{upcd} \\ \text{cpi} \\ \text{gdp} \\ \text{rate} \end{bmatrix}_t = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \\ a_6 \\ a_7 \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & \dots & b_{17} \\ b_{21} & b_{22} & \dots & b_{27} \\ b_{31} & b_{32} & \dots & b_{37} \\ b_{41} & b_{42} & \dots & b_{47} \\ b_{51} & b_{52} & \dots & b_{57} \\ b_{61} & b_{62} & \dots & b_{67} \\ b_{71} & b_{72} & \dots & b_{77} \end{bmatrix} \begin{bmatrix} \text{app} \\ \text{pmp} \\ \text{gq} \\ \text{upcd} \\ \text{cpi} \\ \text{gdp} \\ \text{rate} \end{bmatrix}_{t-1} + \dots + \begin{bmatrix} \sigma_{11} & \sigma_{12} & \dots & \sigma_{17} \\ \sigma_{21} & \sigma_{22} & \dots & \sigma_{27} \\ \sigma_{31} & \sigma_{32} & \dots & \sigma_{37} \\ \sigma_{41} & \sigma_{42} & \dots & \sigma_{47} \\ \sigma_{51} & \sigma_{52} & \dots & \sigma_{57} \\ \sigma_{61} & \sigma_{62} & \dots & \sigma_{67} \\ \sigma_{71} & \sigma_{72} & \dots & \sigma_{77} \end{bmatrix} \begin{bmatrix} \text{app} \\ \text{pmp} \\ \text{gq} \\ \text{upcd} \\ \text{cpi} \\ \text{gdp} \\ \text{rate} \end{bmatrix}_{t-k} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \\ \varepsilon_6 \\ \varepsilon_7 \end{bmatrix} \quad (3)$$

Where app is the production price index, pmp is the price index of agricultural production materials, gq is the grain production, upcd is per capita disposable income of urban residents, cpi is consumer price index, gdp is gross domestic product, rate is exchange rate index, k is the lagged order of endogenous variables, and  $\varepsilon_i$  is the random error term.

**1.2. Indicator Selection and Data Sources**

This paper explores the national agricultural product prices by selecting seven indicators from 1978 to 2020, including the national agricultural product production price index, agricultural production means price index, grain output, per capita disposable income of urban residents, consumer price index, gross domestic product, and exchange rate index. A dynamic analysis of the influencing factors and their impact on the price fluctuations of agricultural products. Taking the producer price of agricultural products as the explained variable Y, and other indicators are the explanatory variables Xi, the dynamic correlation between Y and Xi is calculated, and the variables with high correlation are selected to construct a VAR model, and the impact of each impact is intuitively analyzed through the impulse response graph. The influence of factors on the fluctuation of agricultural product prices and the changes in time trends. Among them, the data comes from "China Statistical Yearbook", EPS data platform, etc. Except for the production price index of agricultural products, the price index of agricultural production means and the consumer price index, all other indicators are measured in the form of growth index. The formula is: (this year's value/previous year's value) \*100. All indicator units are: %.

**1.3. Econometric analysis**

This paper collects the national agricultural product producer price index from 1978 to 2020 as an indicator to measure the national agricultural product price. Its trend is shown in Figure 1. The price of agricultural products has fluctuated greatly over the years, and there is no periodicity, which reflects the national agricultural product production price. The level and structure changes are complex, and the factors that affect price fluctuations are worth investigating. As can be seen from the figure, the price of agricultural products in 1994 fluctuated the most compared with the previous year, with a maximum value of 139.9<sup>[5]</sup>. The price of agricultural products in 1999 fluctuated the least compared with the previous year, with a minimum value of 87.8. This may be due to the effective adjustment of the national agricultural structure, and the overall stable operation of the agricultural economy and rural economy<sup>[3]</sup>.



Figure 1: Trend of national agricultural production 1978-2020

**I. Gray system dynamic correlation**

In order to quantitatively analyze the degree of dynamic correlation between variables and better distinguish the dominant factors, this paper uses SPSS software to analyze the dynamic correlation degree

of gray system for data samples. The analysis results are shown in Table 2.

It can be seen from Table 2 that the correlation between the six indicators and the agricultural production price index is high, greater than 0.70, and can be used in the VAR model. The highest price index, comprehensive evaluation of the six indicators is the consumer price index, which is as high as 0.838, which may be related to the fact that both are important indicators to measure inflation. On the contrary, the index with the lowest comprehensive evaluation is the exchange rate index, which is as low as 0.71, which may be related to the complex exchange rate formation mechanism in China and the intricate factors affecting the exchange rate. superior.

II. VAR Analysis

Substitute the sequence Y, X1, X2, X3, X4, X5, X6 into the VAR model to perform unit root test, cointegration test, Granger causality test and impulse response in turn.

(1) ADF unit root test

Before performing vector autoregression on the time series, in order to ensure that the variables are stable, there is no common trend, and avoid the occurrence of pseudo-regression, the Stata software is used to perform ADF tests on the variables. It was found that the variables Y, X1, X2, X3, X6 rejected the null hypothesis at the 5% confidence interval, and the series was stationary. However, the variables X4 and X5 do not have a unit root at the significance level, and the series is not stationary. Therefore, the first-order difference is performed on X4 and X5, and the results after the difference reject the null hypothesis to achieve the same-order stationary of all data.

(2) Co-integration test

In the case of ensuring that the variables satisfy the single integration of the same order, a 7-dimensional VAR model is established, and the lag order of the model is determined, so as to further determine whether there is a co-integration relationship between the variables to ensure the coordination of data. The cointegration test results are shown in Table 1.

Table 1: Co-integration test results

Number of steps	Eigenvalue	Covariance rank trace test	5% significance level
0		312.0428	124.24
1	0.96476	184.907	94.15
2	0.86059	110.0349	68.52
3	0.74447	58.1872	47.21
4	0.55894	27.0813*	29.68
5	0.37919	8.9655	15.41
6	0.14279	3.1106	3.76

In the vecrank command of the cointegration rank test, the trace test including the constant term and the time trend term was selected, and it was found that only when the cointegration rank was equal to 4, the trace statistic is 27.0813, which was less than the critical value under 5% significance. Note that there is only one linearly independent cointegration vector. At the same time, the test of the largest eigenvalue also shows that the null hypothesis of "cointegration rank is 0" is rejected at the level of 5%, but the null hypothesis of "cointegration rank is 1" cannot be rejected.

(3) Stability test

The impulse response between variables is reliable only if the VAR model is stable. The stability of the VAR system is judged, and it is found that all eigenvalues fall within the unit circle, so the VAR model established in this paper is stable, and the variables are also in long-term equilibrium.

Table 2: Granger causality test table

Explained variables	Explanatory variables	p-value
Y	ALL	0.000
X1	ALL	0.000
X2	ALL	0.000
X3	ALL	0.000
X4	ALL	0.000
X5	ALL	0.000
X6	ALL	0.000

(4) Granger's causality test

The Granger causality test of all variables was performed in turn to explore whether there was a causal relationship between the variables. The results are shown in Table 2. It was found that each variable and the other variables were Granger causes, and the p-values were all 0.000, less than 0.05.

(5) Impulse Response

In order to more intuitively show the dynamic influence mechanism between variables, the orthogonalized impulse response function of the explained variable and the explanatory variable is calculated, and the orthogonal impulse response graph is shown in Figure 2.

As can be seen from Figure 3.1 and Figure 3.5, the per capita disposable income of urban residents and the growth of the consumer price index have positive effects on the production price index of agricultural products. The per capita disposable income of urban residents increases, and the consumption of agricultural products also increases; the consumer price index increases, which shows that the consumption level of residents has been improved, and the prices of agricultural products have also changed positively.

It can be seen from Figure 2.2 that when the GDP is positively impacted, the overall change in the producer price index of agricultural products is not large. Although the growth rate of GDP has increased and people's income levels have increased, the market's control over the supply of agricultural products has always been greater than the expansion of reproductive productivity brought about by changes in demand.

As can be seen from Figure 2.3, when the price index of agricultural means of production had a positive impact in the early stage, the production price of agricultural products showed a small negative feedback, and with the increase of the period, the production price of agricultural products gradually recovered. This is mainly because the government has always strictly controlled the prices of agricultural products, and has given certain policy support in stabilizing the prices of agricultural products and supporting agricultural production. Under the support of a series of policies such as grain subsidies, fixed-price purchases, and tax reduction and exemption, the prices of agricultural products dropped slightly.

As can be seen from Figure 2.4, as grain output increases, the demand for agricultural products also increases, causing prices to rise in the short term, but in the long run, subject to market control and policy support, prices will return to an equilibrium level, avoiding the supply of agricultural products is greater than the demand, resulting in the collapse of agricultural prices.

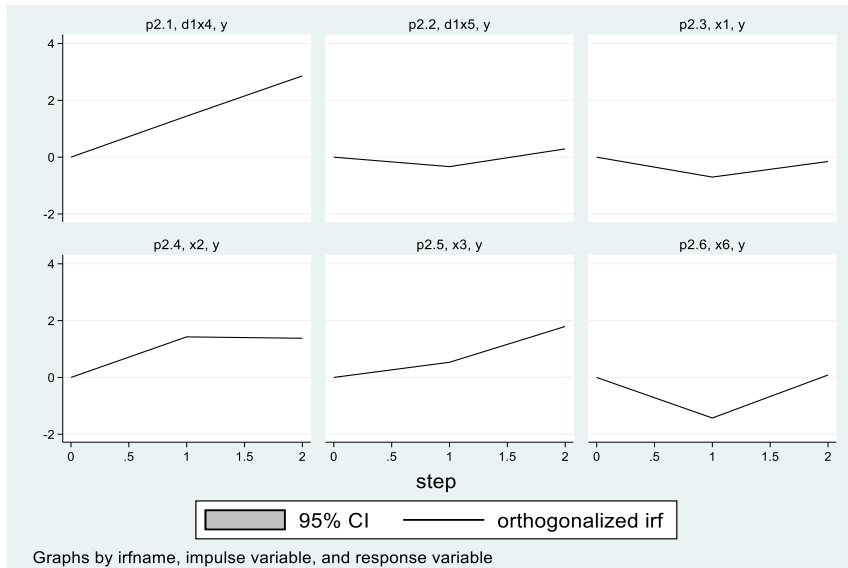


Figure 2: Impulse response diagram

It can be seen from the graph2.6 that with the upward movement of the exchange rate, the agricultural production price index will appear to rise now and then fall. The reason is that the appreciation of the RMB will enhance the purchasing power of the international market and reduce the competitiveness. Under the pressure of the decline in the price of imported agricultural products, the price level of domestic agricultural products will also decline. However, in order to get rid of the influence of inflation, under

the operation of China's exchange rate formation mechanism, The prices of agricultural products gradually recovered

## 2. Conclusions and Recommendations

### 2.1. Conclusion

From 1978 to 2020, the price of agricultural products in the country fluctuated greatly. Among the six factors that affect price changes, the correlation with the price of agricultural products is in descending order: Consumer Price Index > Agricultural Means of Production Price Index > Grain Production > Urban Per Capita Disposable Income > Gross Domestic Product > Exchange Rate Index. At the same time, the per capita disposable income of urban residents and the consumer price index have a positive impact on the production price index of agricultural products, while the price index of agricultural production means and the exchange rate index have a negative impact on the price of agricultural products in the short term. Grain output has a positive impact on the producer price index of agricultural products in the short term. The impact of GDP on the producer price index of agricultural products is not obvious.

### 2.2. Recommendation

(1) At the technical level, establish a long-term national crop germplasm resource bank, actively introduce excellent varieties, actively explore and apply smart agricultural technologies, and reduce human input while increasing the output of agricultural products. In terms of supply and demand, in order to reasonably control the production cost of agricultural products in the short term, increase the production output of agricultural products, and maintain price equilibrium, it is necessary to appropriately change the supporting levels such as irrigation and fertilization according to different types of agricultural products, so as to make up for the shortfall in production. board, and establish production protection zones. At the same time, in recent years, natural disasters have occurred frequently in various places, and it is necessary to strengthen the construction of a dynamic detection and early warning system, carry out evaluation and monitoring of agricultural product production, and reduce losses caused by agricultural disasters. Accelerating the market-oriented operation of agricultural products, promoting the "Internet +" network-wide transmission method, increasing the popularity of regional products, and realizing the complementarity of regional agricultural industries are conducive to solving the loopholes in the price fluctuations of agricultural products caused by insufficient supply.

(2) At the policy level, strengthen the settlement and promotion of agricultural support policies, especially some policies that benefit farmers with threshold standards or specific groups. Favorable policies to benefit farmers not only help narrow the economic gap between urban and rural areas, but also prescribe the right medicine for price fluctuations of agricultural products. Considering the ecological characteristics of different regions, combined with the economic development status, for relatively poor areas, subsidies for agricultural production can be increased, including subsidies for the purchase of agricultural machinery and equipment, and subsidies for improved varieties. Appropriately reduce or exempt taxes for agricultural production enterprises, and encourage more young people to return to the countryside to start businesses, better control the price of agricultural production materials and stimulate the supply and demand of agricultural products. At the same time, for some provinces with backward technologies like the northwest region, the subsidy policy for product technical training can be promoted, the market structure of business monopoly can be broken, the balance of supply and demand can be adjusted, and the market price formation mechanism can be further improved.

(3) At the economic level, further accelerate the improvement of the socialist market economic system and maintain the state of economic growth. In the short term, control the normal fluctuation of the per capita disposable income of urban residents and the consumer price index to ensure rational consumption of residents. Maintain the "lowest price purchase of grain", while ensuring adequate food supply, rationally adjust the import and export volume of agricultural products, control inflation, stabilize the RMB exchange rate market, and maintain a reasonable rise and fall of agricultural product price.

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