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Asymmetric Impact of Economic Policy Uncertainty on Agricultural Prices

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Abstract: From the perspective of asymmetry, this paper uses the relevant monthly data from 2006 to 2021, and analyzes the impact of economic policy uncertainty on the prices of different agricultural products by constructing TVAR model. The empirical results show that: (1) The direction of the impact of economic policy uncertainty on agricultural prices has obvious asymmetry in the low uncertainty zone system and the high uncertainty zone system; (2) For grain and vegetable agricultural prices, the influence degree of high uncertainty zone system is less than that of low uncertainty zone system, while for meat agricultural prices, the influence degree of high uncertainty zone system is greater than that of low uncertainty zone system, that is, there is asymmetry of influence degree. Based on the above conclusions, this paper proposes to formulate differentiated economic policies for different economic states and strengthen the public's policy transmission and guidance of expectations and other policy suggestions.

Keywords: China's economic policy uncertainty; agricultural price; asymmetry; TVAR model

JEL Classification: E31; Q11; Q18

1. Introduction

At the Central Conference on Rural Work in 2021, China proposed to build a "dual circulation" development pattern in which domestic economic cycle plays a leading role while international economic cycle remains its extension and supplement (Xi, 2022), the strategic basis should be placed on expanding domestic demand. The rural areas have a huge space and can do a lot, so we should continue to make it a priority. "People depend on food", as a necessary guarantee of life, there has been a rigid demand for agricultural products. In addition, the proportion of industrial processing demand such as feed use and bioenergy is rising, which makes the correlation between agriculture and other industries improve. Therefore, Therefore, it is important to calm agricultural prices to maintain industrial development and the stability of the whole society.

Economic policy uncertainty means the unpredictable and evaluated economic risks arising from the unknown future development status of economic actors during the process of economic policy change and adjustment (Baker et al., 2016). At present, economic globalization is facing adverse trends, which have exerted a huge impact on the global economy and both show a downward trend. Governments around the world have to take

corresponding measures to contain the economic recession, and have introduced various stimulus policies. Of course, this is not limited to the current special period, such as the European Debt Crisis, Stock Market Crisis and other sudden events will force the government to adjust the policy. As for China, after entering the "new normal" in 2014, the economic growth decelerated and faced with more uncertainties. In order to optimize and upgrade the economic structure, the government frequently adopts a variety of macro policy combinations, such as supply-side structural reform and a series of policies ranging from loose money to prudent money. However, the effects of policy formulation and implementation to need time. Generally speaking, policy delay can be divided into internal delay and external delay. Internal delay refers to the time interval between the occurrence of destabilizing changes in the economy and the decision maker's formulation and implementation of appropriate economic policies. Extrinsic delay refers to the time interval between the implementation of economic policy and the effect of the policy on the economy to achieve the desired target. During this period, due to information asymmetry, the public cannot fully predict the future policy changes of the government, so the continuous changes of policies will greatly increase the level of uncertainty, aggravate the market volatility including agricultural products and increase the risk of macroeconomic operation. In this environment, the study of how economic policy uncertainty affect agricultural prices problem to promote the steady development of national economy has important practical significance.

The innovation of this paper lies in: First, by introducing TVAR model, economic policy uncertainty is divided into high and low degrees, and the difference of its impact on agricultural prices is studied from the perspective of asymmetry. Through empirical investigation, it is discovered that economic policy uncertainty has non-consistency in the direction and degree of impact on agricultural prices. Second, the research conclusions have certain reference value for the government to make policies. This paper further enriched the study on the characteristics of agricultural product price fluctuations, and could more comprehensively grasp the fluctuations of agricultural product prices in different economic environments, providing ideas for the government to reduce the impact of economic policy uncertainty on domestic agricultural product prices.

2. Literature Review

There are abundant researches on the fluctuation of agricultural prices. Most scholars use VAR model and its extended econometric model to analyze the influence degree of a single factor on agricultural prices. Through sorting out, this paper divides the influencing factors into two categories. One is including supply and demand relationship, production cost and other factors of agricultural products market itself. For example, Zhou (2014) believes that the consumption structure of agricultural products has changed rapidly in recent years, from traditional consumption demand to bioenergy demand. Yu (2021) analyzed the influence of various agricultural factor endowments on agricultural prices and found that land factors had the most obvious influence on agricultural products, while capital factors had a lower influence. Tang (2022) found that the circulation system of agricultural products could affect the price of agricultural products through such factors as supply and demand of agricultural

products, market expectations and operating costs. The other is other external factors such as natural disasters, international markets and changes in economic policies. Gu and Fang (2012) found that natural factors can affect the output of agricultural products and thus indirectly change the relationship between supply and demand, among which climate and cultivated land area were the two main influencing factors. Hua et al. (2020) analyzed through FAVAR model that international factors, including food, trade, energy and exchange rate, would also affect domestic food prices. From the perspective of agricultural product industry chain, Tan et al. (2018) argued economic policy uncertainty could affect the price of agricultural products by affecting different links of the vertical industrial chain.

On the uncertainty of economic policy, the existing research mainly focuses on its impact on macroeconomic, business management and financial markets. For example, in terms of macro economy, Baker et al. (2016) built Economic Policy Uncertainty Index based on the frequency of newspaper reports, and found that the index would soar near major struggle events, which provided convenience for later scholars' research, and they concluded that the innovation of policy uncertainty predicted the decline of investment, output and employment. Domestic scholars Jin et al. (2014), Xu and Wang (2019) analyzed the impact of economic policy uncertainty on macro economy through FAVAR model and New Keynesian dynamic general equilibrium model respectively, and found that policy uncertainty was represented by negative demand shock leading to the decline of output, investment and price level. In terms of business operation, the increase of economic policy uncertainty will reduce enterprise investment (Rao & Yue, 2017), inhibiting enterprise innovation (Hao et al., 2016), increasing cash holdings (Li & Shi, 2016), Increase short-term financial assets and restrain corporate financialization (Peng et al., 2018). In financial markets, the uncertainty brought about by the change of economic policies will worsen the market environment and thus increase stock market volatility (Zhou & Jia, 2019) and influence banks' risk taking by changing banks' net liquidity position and credit scale (Hao et al., 2017). In addition, scholars have found that the impact of economic policy uncertainty on other macroeconomic variables is also related to its own degree, that is, the impact of economic policy uncertainty in different states has asymmetry. Van (2016) found that high macroeconomic policy uncertainty made oil prices more sensitive to oil supply and demand shocks, resulting in significant differences in the impact of uncertainty shocks at different levels. Liu et al. (2020) found that when the degree of uncertainty was low, it mainly showed a positive effect, while when the degree of uncertainty was high, it showed a negative effect. Hu and Chen (2020) analyzed the asymmetry of the degree of impact of economic policy uncertainty on housing price and stock market, and found that the degree of influence is greater when the degree of uncertainty is higher.

To sum up, the research perspective of influencing factors of agricultural price fluctuations has been expanding, gradually changing from internal factors related to production, sales and other links to external factors such as international market and macroeconomic policies. Meanwhile, scholars began to use nonlinear research methods to pay attention to the asymmetric effects of economic policy uncertainty impact under different states. Therefore, this paper intends to use TVAR model to study whether China's economic

policy uncertainty under different regional systems will have different effects on agricultural prices in terms of influence degree and direction.

3. Methodology

3.1. Threshold Vector Autoregressive Model (TVAR)

In recent years, nonlinear time series models have attracted wide attention from scholars due to their advantages of asymmetry and periodicity. TVAR model proposed by Tong in 1978 is one of the mainstream models. Based on the traditional VAR model, the nonlinear equation is introduced in this model, and the advantages of the two are combined to describe the asymmetric phenomenon in macroeconomic activities.

The model construction idea is as follows: Firstly, LR nonlinear test method is used to judge if threshold effect exists in the model. Secondly, the optimal threshold value of the model is determined by using grid search method, which allows the variable coefficient to change with the change of the threshold variable. Drawing on the practice of Balke (2000), the search range of the threshold value is set between 15% and 85% quantiles of the sample data. Finally, the optimal threshold was used as the boundary to divide several intervals, and the generalized impulse response was carried out on the research object.

- Principle of model

This paper takes the two-zone TVAR model as an example to introduce its basic principle. The case of the multi-zone system is an extended form of the two-zone TVAR model. The general expression of the model is as follows:

$$y_t = c_1 + A_1 y_t + B_1(L) y_{t-j} + (c_2 + A_2 y_t + B_2(L) y_{t-j})\, I\,(z_{t-d} > \gamma) + \mu_t \quad (1)$$

In Formula (1), y_t is the k×1 dimensional endogenous variable, denoted as ($y_{1t}, y_{2t} \ldots y_{kt}$), c_i, A_i and B_i are respectively the constant variable and the coeval coefficient matrix of zone i, and the coefficient matrix of the lag term of endogenous variable. j is the lag order of the TVAR model. μ_t is a K-dimensional perturbation variable and obeys a normal distribution of mean 0 and variance Σ. $I(\cdot)$ is the indicator function, z_{t-d} is the threshold variable and d is the number of lag periods of the threshold variable. γ is the threshold value, while $z_{t-d} > \gamma$, the indicator function $I(\cdot)=1$, the model expression; While $z_{t-d} \leq \gamma$ indicates that the function $I(\cdot)=0$.

- Nonlinearity Test

The LR test method proposed by Lo and Zivot (2001) was used to test whether there was threshold effect in the TVAR model, and the Bootstrap sampling method was used to repeatedly sample 500 times to determine the threshold number and corresponding threshold value. The original assumption of LR test is that the sample data has linear characteristics, which is suitable for constructing the original linear VAR model. The alternative hypothesis is that the sample data has nonlinear characteristics, which is suitable for constructing the TVAR model based on zoning. The LR test statistic is:

$$LR_{01} = T(ln(det \widehat{\sum}_0) - ln(det \widehat{\sum}_1)) \quad (2)$$

In Formula (2), $\widehat{\sum}_0$ and $\widehat{\sum}_1$ are covariance matrices of linear VAR model and TVAR model respectively.

- Generalized impulse response

Different from the traditional impulse response function, TVAR model assumes that the variance matrix and covariance matrix are not fixed, and external shocks may cause the transformation of variable relations between regions.

$$GIRF(k,\mu_t,\Omega_{t-1}) = E(y_{t+k}|\mu_t, \Omega_{t-1}-E(y_{t|k}|\Omega_{t-1})) \quad (3)$$

In Formula (3), k is the duration of the impact response, μ_t is the random disturbance term, and Ω_{t-1} indicates the information contained in the system before the exogenous impact occurs at point t. y_{t+k} is endogenous variables, consistent with the endogenous variables involved in Formula (1).

- Model building

Based on the above model introduction, this paper intends to construct the benchmark TVAR model with economic policy uncertainty as the threshold variable, so as to analyze whether there will be heterogeneous effects of different degrees of economic policy uncertainty on agricultural prices. The model is as follows:

$$y_t = c_1 + A_1 y_t + B_1(L)y_{t-j} + (c_2 + A_2 y_t + B_2(L)y_{t-j})I(epu>\gamma) + \mu_t \quad (4)$$

In Formula (4), y_t specifically in this paper includes endogenous variables such as Economic Policy Uncertainty Index, agricultural price index, output growth rate and money supply growth rate. In this paper, epu is selected as the threshold variable, when epu$\leq\gamma$, i=1 indicates the low uncertainty zone system. When epu>γ, i=2 indicates high uncertainty system. Since the main objective of China's macroeconomic policy is to ensure stable economic growth and stable price level, combined with the existing literature, this paper chooses GDP as the control variable. In order to portray the dynamic changes of China's macro economy more completely, this paper further introduces the broad money supply (M_2) to control its influence on output and price level by referring to the practice of Tian and Lin (2016). A reasonable sequence of variables is an important prerequisite for building a good TVAR model. In this paper, the following three benchmark models are constructed: TVAR model {epu, growth, gm_2, gcpi} for grain agricultural products, TVAR model {epu, growth, gm_2, mcpi} for meat agricultural products and TVAR model {epu, growth, gm_2, vcpi} for vegetables agricultural products.

3.2. Variable Selection and Data Sources

Agricultural price variables. The price variable of agricultural products is represented by acpi. In order to better reflect the volatility of the market price of agricultural products, this paper selects the three most common agricultural prices, namely grain consumer price index (gcpi), meat consumer price index (mcpi) and vegetables consumer price index (vcpi).

Economic policy uncertainty variables. Baker et al. (2016) constructed Economic Policy Uncertainty Index by weighted calculation through three categories: news index, tax law

invalidity index and economic forecast difference index. The data source was the South China Morning Post, which has the largest circulation and the largest audience in Hong Kong, and the data information was obtained by screening keywords about the uncertainty of China's economic policy. For detailed construction process, refer to the paper of Baker et al.(2016) and corresponding webpage. The periodic peak of epu is the time when several major economic events occurred. The first time was from 2008 to 2009, Financial Crisis hit the world economy so hard that government had to introduce stimulus economic policies to restore the economy and thus inflationary pressures. The second, in 2011-12, was the domestic fallout of the European Debt Crisis and the leadership transition. In the third, around 2015, growth slowed and volatility in equity and currency markets created more certainty. The fourth was in 2018. The peak was marked by the China-Us trade friction, which had a great impact on China's trade import and export. The fifth was the COVID-19 pandemic in 2020, with epu reaching 935 . Therefore, in the event of uncertainty, the index will reach a high point in a stage, it is highly consistent with the trend of economic development, can accurately quantify the uncertainty in our country, so it is widely used by domestic and foreign scholars.

Macroeconomic variables. Since GDP data only has quarterly accounting and annual accounting but no monthly accounting, data distortion and other problems may occur if low-frequency quarterly data is changed to high-frequency monthly data. Therefore, referring to existing literature, this paper adopts the year-on-year growth rate of industrial added value (growth) instead of GDP to reflect economic output, while the money supply is represented by the year-on-year growth rate of broad money supply (gm2). To avoid seasonal problems, year-on-year figures are used.

Due to massive data required for reasonable estimation of TVAR model, this paper selects the monthly data from 2006 to 2021. The seasonal adjustment method of Census X12 was used to process the epu time series to eliminate the influence of seasonal factors. Secondly, the logarithm of epu, gcpi, mcpi and vcpi is taken to avoid heteroscedasticity problem. In addition to epu derived from the official website of Economic Policy Uncertainty, the three agricultural product price variables, growth and gm_2 all come from the National Bureau of Statistics.

4. Results

4.1. Unit Root Test Results

TVAR model requires all variables to be stationary series, this paper adopts two commonly used methods, ADF test and PP test, to test the stationarity of all economic variables. As shown in Table 1, after first-order difference, all variables are stationary series at the significance level of 1%. To ensure the comparability between the linear model and the nonlinear model, the optimal lag order of the three TVAR models is the same as that of the respective linear VAR models. That is, the optimal lag orders of {epu, growth, gm_2, gcpi}, {epu, growth, gm_2, mcpi} and {epu, growth, gm_2, vcpi} are respectively order 3 lag, order 3 lag and order 2 lag.

Table 1. Stability test results

Variable	ADF test statistics	PP test statistics	Conclusion
epu	-18.314***	-6.285***	smoothly
growth	-4.581***	-4.689***	smoothly
gm_2	-5.412***	-13.560***	smoothly
gcpi	-10.807***	-10.979***	smoothly
mcpi	-4.436***	-7.287***	smoothly
vcpi	-4.369***	-6.814***	smoothly
cpi	-8.377***	-14.853***	smoothly
epi	-8.742***	-8.471***	smoothly
icpi	-8.700***	-8.934***	smoothly

Note: *** represents a significance level of 1%.

Table 2. Results of cointegration test

Model	Null hypothesis	Eigenvalue	Trace statistics	The 5% threshold	P values
Model 1	None	0.100	25.736	15.495	0.001
	At most 1	0.031	5.932	3.841	0.015
Model 2	None	0.068	22.783	15.495	0.003
	At most 1	0.050	9.620	3.841	0.002
Model 3	None	0.184	45.977	15.495	0.000
	At most 1	0.039	7.488	3.841	0.006

Table 3. LR Nonlinear test results

Model	Number of thresholds	LR test statistics	P values	Threshold value
Model 1	1	102.334	0.040**	5.45
	2	209.245	0.004***	
Model 2	1	118.102	0.008***	6.26
	2	202.620	0.020**	
Model 3	1	93.173	0.002***	4.62
	2	147.576	0.010***	

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

4.2. Cointegration Test

Considering that the use of differential data for empirical analysis is prone to information loss and economic meaning decline of the original data. Therefore, this paper further uses Johansen co-integration test to determine if there is a co-integration relationship between variables in the benchmark TVAR model. If it passes the co-integration test, the original data will be used; if it fails the co-integration test, the first-order difference data will be used. As shown in Table 2, the three benchmark TVAR models all have two co-integration relationships at the 5% confidence level and all pass the co-integration test. Therefore, the original data can be used in this paper for subsequent impulse response analysis.

4.3. Nonlinearity Test

As shown in Table 3, in the three TVAR models, the P values of threshold number 1 and 2 are all less than 0.05, which indicates that the data in this paper are nonlinear.

According to the test results, when the threshold number is 1 and 2 in Model 1, the corresponding significance level is 5% and 1%, respectively, which is more suitable for the two-zone TVAR model. However, when the threshold number is 1 and 2 in model 2 and model 3, the corresponding significance level is 1% and 5% respectively, which is more suitable for the three-zone TVAR model. Therefore, the two-zone TVAR model is selected uniformly in this paper to facilitate comparison. Secondly, the threshold values of economic policy uncertainty are 5.44, 6.26 and 4.62 respectively.

4.4. Impulse Response Analysis

As shown in Figure 1, after estimating the parameters of TVAR model, the prices of grain agricultural products, meat agricultural products and vegetable agricultural products are analyzed respectively under the low uncertainty zone system and the high uncertainty zone system according to the threshold values obtained above. According to the impulse response results of the benchmark TVAR model, whether in the zone system of low

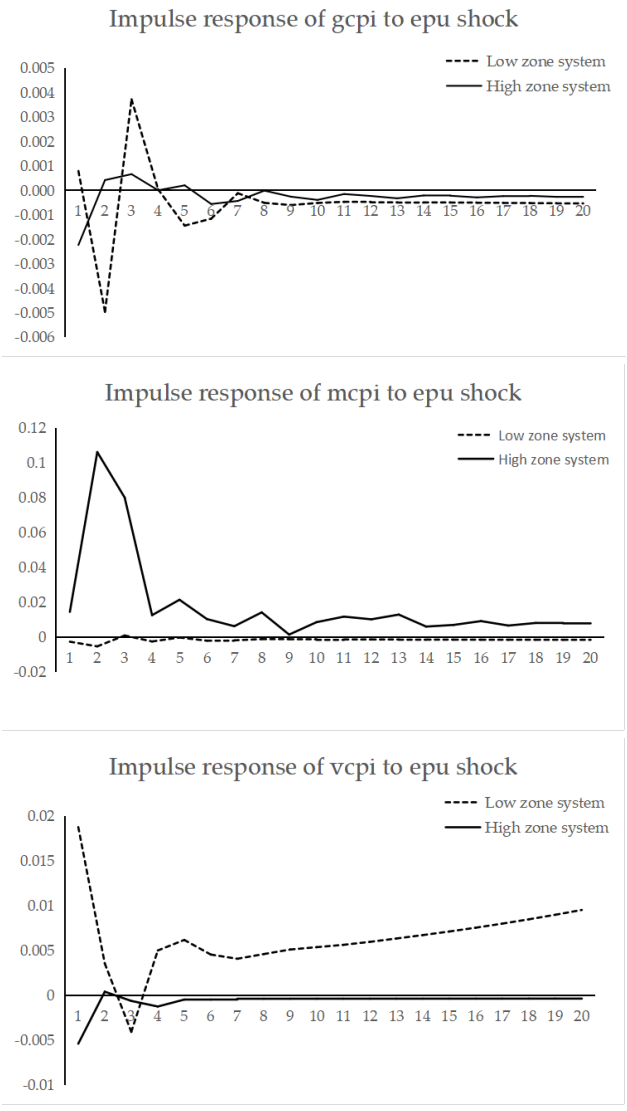

Figure 1. Three kinds of agricultural prices to economic policy uncertainty refers to the impulse response of shocks

uncertainty or in the zone system of high uncertainty, the impact of economic policy uncertainty on the price of agricultural products decreases significantly over time.

In the case of low uncertainty zone and high uncertainty zone, the response direction has obvious asymmetry. First, in the low uncertainty zone system and the high uncertainty zone system, the response direction has obvious asymmetry. Among them, for the price of grain agricultural products, when epu is given a positive impact of one unit standard deviation, the price under both kinds of block system presents an alternating impulse response, but the response direction is different. The first period of low uncertainty block system presents a positive response, while the first period of high uncertainty block system presents a negative response. For the price of meat agricultural products, the price response is mainly negative in the low uncertainty zone system, while it is mainly positive in the high uncertainty zone system. For the price of vegetable agricultural products, the influence direction of economic policy uncertainty on the price is just opposite to that of meat agricultural products, and the response is mainly positive in the low uncertainty zone system, and mainly negative in the high uncertainty zone system.

The reason for this asymmetric effect may be that, in theory, economic policy uncertainty does increase the public's uncertainty about future economic conditions and should indeed dampen agricultural prices from both consumer and producer perspectives. However, according to the impulse response in this paper, whether under the zone system of low uncertainty or high uncertainty, the price of agricultural products will still have positive fluctuations in the next 20 years. There may be two reasons for this: First, as the primary industry, agriculture is an essential consumption in people's daily life. When economic policies are adjusted, market participants may have panic emotions and irrational decision-making behaviors, such as hoarding or dumping, which will lead to price fluctuations. Second, in recent years, with the deepening degree of financialization of agricultural products market, in the economic environment with high uncertainty of economic policies, investors in the futures market of agricultural products, especially grain, take it as an opportunity for investment returns, and there is a certain degree of speculation, which leads to increased demand for financial investment in agricultural products market, especially food products. Therefore, the influence direction of the increase of economic policy uncertainty on the price level of agricultural products is uncertain, that is, the price of grain agricultural products is dominated by negative influence in the low uncertainty zone system and positive influence in the high uncertainty zone system. And the price of meat agricultural products is dominated by positive influence.

Secondly, in the low uncertainty zone system and the high uncertainty zone system, the response degree has obvious asymmetry. Among them, for grain agricultural products and vegetable agricultural products, the impact degree of low uncertainty zone system on their prices is obviously greater than that of high uncertainty zone system. In the low uncertainty zone system, the absolute values of the maximum price response of grain agricultural products and vegetable agricultural products are 0.0053 and 0.019 respectively when facing the positive impact of economic policy uncertainty. However, in the high uncertainty zone system, the absolute value of the maximum response of grain agricultural products and

vegetable agricultural products prices is -0.003 and 0.005 respectively when facing the positive impact of economic policy uncertainty. For meat agricultural products, contrary to the above two types of agricultural products, the absolute value of the maximum response of meat prices is 0.005 in the low uncertainty zone system, while the absolute value of the maximum response is 0.106 in the high uncertainty zone system.

The reason for this asymmetric effect may be the different price transmission mechanism of different kinds of agricultural products. The low uncertainty zone system generally corresponds to the economic boom period, when market participants have a higher understanding of the trading rules and related policy information of the agricultural market, and producers and consumers will make transactions according to their existing psychological cognition. Therefore, sudden changes in economic policies will bring great fluctuations to the agricultural market. On the other hand, the high uncertainty zone system corresponds to the economic depression period. As rational economic man, the market participants have anticipated that the economic environment is unstable, and the degree of price fluctuation will not be too large. For grain and vegetable agricultural products, the measures of "stable production and supply" have been vigorously promoted. China is basically self-sufficient, so the price fluctuation of grain and fresh vegetable agricultural products is greater when the low uncertainty zone system is adopted. The domestic production of meat agricultural products is insufficient, need to import from other countries through international trade channels. Secondly, as the world's second largest economy, when China's economic environment is in the zone system of low uncertainty, the global economic environment is basically in a prosperous period. When our economic environment is in the zone system of high uncertainty, the global economic environment is basically in the downturn period. Xu et al. (2018) found economic policy uncertainty during the period of the high degree of impact on the degree of trade will be significantly higher than the low period, so the price of meat agricultural products fluctuates more in the period of uncertainty.

5. Conclusions and Discussion

Based on an asymmetric perspective, this paper uses Economic Policy Uncertainty Index and the monthly data of agricultural prices in China from January 2006 to December 2021. By constructing the two-zone threshold vector autoregressive (TVAR) model, the asymmetric effects of the uncertainty impact of China's economic policies on the prices of different kinds of agricultural products under different economic conditions of low and high uncertainty degree were studied. The results show that: First, the impulse response directions of economic policy uncertainty impact on agricultural prices are different in the low uncertainty zone system and the high uncertainty zone system. Secondly, the impact degree of economic policy uncertainty impact on agricultural prices has obvious asymmetry in the low uncertainty zone system and the high uncertainty zone system. For grain agricultural products and vegetable agricultural products, the influence degree of low uncertainty zone system is obviously greater than that of high uncertainty zone system. For

meat agricultural products, the influence degree of high uncertainty zone system is obviously greater than that of low uncertainty zone system.

Based on the above research conclusions, this paper puts forward the following policy suggestions: (1) In view of the obvious difference in the impact of economic policy uncertainty on agricultural prices at different levels, we should effectively distinguish different stages of economic policy uncertainty and formulate differentiated policies in different economic states. (2) The price impulse response of different kinds of agricultural products is different, so the specific analysis should be made according to the specific categories of agricultural products in the formulation of policies. (3) Due to the incompleteness of the public's policy information, changes in economic policies will influence their psychological expectations of market participants. Therefore, the transmission of policy information between the government and other economic subjects is particularly important. The government should strengthen the guidance of the public's expectations, increase the public's participation in policy making, and ensure that policy information is as open and transparent as possible.

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