The Asymmetric Effect of Fluctuant Agricultural Prices with Monetary Shocks

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Abstract

This study investigates the asymmetric effects of money supply shocks on irregularly fluctuate agricultural prices, which based on different economic stances of monetary actions. The asymmetric effects have been proved from theoretical mechanism and economic data. The flexible price accompanied with money supply past years shows that money supply is a vital element in the price fluctuation: LSTAR model has been established to shape economic cycle into two regimes and then seek out the different influence of price fluctuate. Moreover, the study found that price adjustment was later than money supply shocks and the price are more sensitive to tight monetary shocks.

Keywords

Money supply, LSTAR, Asymmetric effect.

1. Introduction

Agriculture has always been related to the people's livelihood economy. The healthy and orderly production and sales system of agricultural products is an important guarantee for social stability and economic prosperity. In recent years, with the prosperity of market-oriented economy, the price mechanism of agricultural products is more complicated, and the price changes of agricultural products are more sensitive to market fluctuations. Therefore, in order to more effectively and accurately stabilize prices and regulate economic development, the government's monetary policy measures are particularly important. Gu Guoda (2010) study shows that the conduction path of domestic agricultural product price fluctuations is asymmetric. The result of paper show that there are also asymmetries in the prices of agricultural products in different economic cycles. In recent years, the prices of agricultural products have been affected by many factors, so it is more practical and meaningful to study the true causes of agricultural product price fluctuations.

With the development of Chinese market economy, agricultural products are separated from the traditional agricultural products position, agricultural futures and agricultural financial derivatives appear. currency begins to meet speculation demand of agricultural products (QU Xue-ling, 2013). The price fluctuation of agricultural products is more flexible and nonlinear with the supply of money . Since 2003, China's agricultural products have experienced large price fluctuations, the prices of agricultural products have become more flexible and changeable, and simple monetary policies unable to maintain their balance and stability. In September 2011, the M2 has increased 38.4% compared with June 2009; the food consumption index has increased 29% before September 2011; Figure 1: Different The economic cycle of agricultural product price fluctuations does not show symmetrical fluctuations. So, Is the money supply a vital reason for the asymmetric fluctuation of agricultural products prices in different economic conditions?

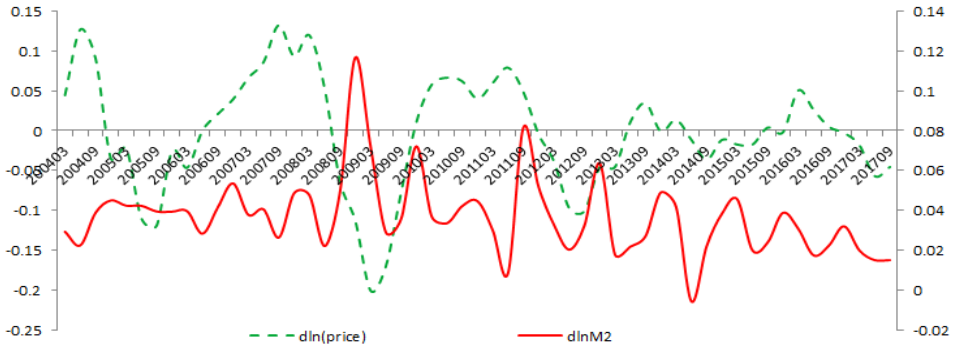

Fig.1 China's money supply M2 growth rate and food consumption index growth rate（200403---201709）

Based on price conduction paths ,the asymmetry of price volatility is: Chen Li-Hsueh (2005) shows that asymmetric price conduction exists between downstream processing in the crude oil and petroleum industries; Meyer and Von Cramon-Taubadel (2004) distinguish positive The asymmetric price transfer and the negative asymmetric price transfer, so the asymmetric price transfer in the agricultural product supply chain has been recognized by many scholars. Domestic research on price transmission focuses on: 1. Whether the conduction path is blocked (Li Xing-ping, Yan Xian-yu, 2004; He Xinhua, 2006) 2. The asymmetry of time lag of conduction path (Gu Guo-da, 2011; Gu Hai-bing, 2005).

In summary, the asymmetry of agricultural product price fluctuations in different economic cycles is less concerned. The price fluctuations in different economic cycles is the result of monetary policy implementation, and there are great significance to have an deeply understanding of asymmetric fluctuation mechanism for currency policies. Based on the LSTAR model, this paper distinguishes the process of economic fluctuation from “tightening period” and “expansion period”, analyzes the characteristics of agricultural product price fluctuations in different periods, and proves whether the agricultural product price fluctuations in different periods are asymmetric. In additional , whether short-term currency shocks could lead to overshoot of agricultural prices or not . Analyze the possible reasons for overshooting and provide a theoretical basis for stabilizing prices.

The following structure : The second part is literature review and analysis, analyzes the possibility of asymmetric effects of money supply shocks, and proposes theoretical assumptions; the third part introduces STAR model, finds the different between ESTAR and LSTAR; the fourth part proves exist of asymmetric with data; the last is the empirical conclusion.

2. Theoretical analysis based on literature

The transmission mechanism of monetary policy plays an important role in the implementation of monetary policy. Monetary policy achieves monetary policy points through money supply,interest rate adjustment, credit constraints, etc. Different transmission paths and operational tools means different function, which ultimately leads to the impact of monetary policy impact on the target. There is an asymmetry. For example, Garibaldi (1997) explores the asymmetric effects of monetary policy from the perspective of employment and analyzes the effects of interest rate changes on job creation and employment inhibition. Ravn & Sola (2004) argue that credit constraints have an important impact on the asymmetric effects of monetary policy: in different economic cycles, according to the financial accelerator model, the financial leverage and financial costs reflected in the corporate balance sheet have an output effect on the firm. The difference has finally led to the asymmetric effect of monetary policy in the macro economy. The monetary school represented by Morgan (1993), Kandil (1995), and Senda (2001) argues that the nonlinear price transmission mechanism is the main reason for the asymmetry of monetary policy.

Chinese research about the asymmetry of monetary policy involves different regions, industries. Zhang Zhijun (1999) proposed thatthe same monetary policy is not perfect to the coordinated development of the regional economy with the unbalanced development of Chinese regional

economy. Sun Tianqi (2004) and Ding Wenli (2005) have shown that there are significant regional differences in the effects of China's monetary policy. The asymmetry of monetary policy in different industry is also exits . Cao Yongqin (2011) selected the panel data of 30 industries to analyze the impact of monetary policy effects. The results show that the industry characteristics are significant, and the impact of monetary policy on various industries after transmission The difference is large; Yan Hongbo and Wang Guolin (2008) use vector autoregressive and impulse response functions to empirically analyze the asymmetric influence of China's monetary policy in the manufacturing industry.

Many domestic and abroad studies provide evidences for the asymmetric effects of monetary policy. The following is the asymmetry mechanism of monetary policy effects based on the price transmission: with the impact of monetary policy, the company will adjust the price and output to fix the principle of menu cost and distortion cost. the menu cost of price reduction is lower than the cost of price increase and the distortion cost has a nonlinear change with the inflation trend,which lead to the asymmetric price stickiness (Cao Yongqin, 2010). The viscous factor makes the price change upward during the economic expansion period. The flexibility is higher than the downward movement flexibility during the economic contraction, so there is a non-linear, disproportionate relationship between the direction and magnitude of monetary policy shocks and the fluctuations in real output (Kandil, 1995; Senda, 2001).

Based on above theory, asymmetric effects might be exist in the price fluctuation of agricultural products. liking the asymmetric study of monetary policy, whether there exist similar conclusions in agricultural products or not .It can be seen from Figure 1 that the prices of agricultural products in different economic cycles show asymmetric fluctuations, and Gu Guo-da (2011) divides the price transmission path of agricultural products into different region, Finds the asymmetric effects from the degree of conduction, time lag, and direction. Now, we use the STAR model to divide economic growth cycle into two regimes that can smoothly transition, and analyze the asymmetry of currency shocks on agricultural product price fluctuations under different regime.

Hypothesis: Different economic growth cycles, money supply has an asymmetric effect on agricultural product prices .

3. The model

The models for studying the transformation of different regime mainly include Markov mechanism transformation model, threshold autoregressive model and smooth transformation autoregressive model. The main difference about the three models is the information processing in the mechanism transformation structure. Both the Markov conversion model (MSR) and the threshold autoregressive model (TAR) imply an assumption that the financial time series jumps directly from one mechanism to another, The jump is discrete. However , the economy has a smooth gradual process from the recession to the prosperity. The smooth transition autoregressive model (STAR) can be smoothly converted between mechanisms. Therefore, the STAR model can better simulate the real economy in economic research.

3.1 STAR(p) model

$y_t = \phi x_t^{'} + (\theta x_t^{'}) \mathrm{G}(\lambda, \mathrm{c}; \mathrm{s}_t) + \mu_t \quad x_t = (1, \mathrm{y}_{t-1}, \mathrm{y}_{t-2} ..... \mathrm{y}_{t-m})$

$\mathrm{G}(\lambda, \mathrm{c}; \mathrm{s}_t)$ is transfer function, conversion variable s_t , λ reflects the speed of transition from one state "0" to another state "1", threshold parameter c ,it determines the threshold of the state transition when the value of the conversion variable is lower or bigger than the threshold .There are two forms of STAR models:

(1) LSTAR logistics star(p) $\mathrm{G}(\lambda, \mathrm{c}; \mathrm{s}_t) = [1 - \exp(-\lambda(\mathrm{s}_t - \mathrm{c}))]^{-1} \quad \lambda > 0$

(2) ESTAR exponential star(p) $\mathrm{G}(\lambda, \mathrm{c}; \mathrm{s}_t) = [1 - \exp(-\lambda(\mathrm{s}_t - \mathrm{c})^2)] \quad \lambda > 0$

Refer to Teräsvirta(1994)[8], Establish an auxiliary regression and then perform a hypothesis test:

$v_t = \beta_1' z_t + \beta_2' z_t s_t + \beta_3' z_t s_t^2 + \beta_4' z_t s_t^3 + \eta_t$

v_t is the Least squares regression of $y_t = \alpha' z_t + v_t$, $z_t = (1, y_{t-1}, \cdots, y_{t-p})$。 Choose the transfer variable and then just do as follow:

$H_{03} : \beta_{4j} = 0$

$H_{02} : \beta_{3j} = 0 \mid \beta_{4j} = 0$

$H_{01} : \beta_{2j} = 0 \mid \beta_{3j} = \beta_{4j} = 0$

According to Van Dijk（2002）[9],If the P value of H_{02} is the smallest, the ESTAR model should be established; if the P value of H_{03} or H_{01} is the smallest, the LSTAR model is established.

3.2 LM linear test

There are a large number of parameters in the STAR model. In order to find the optimal LSTAR or ESTAR model, we must find the best conversion and threshold parameters. This paper uses Taylor expansion to gradually fit the nonlinear model based on linear null hypothesis.

3.2.1 LSTAR

$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + \varepsilon_t$

$$y_t = \phi x_t^{'} + (\theta x_t^{'}) G(\lambda, c; s_t) + \mu_t \qquad (1)$$

LSTAR $G(\lambda, c; s_t) = [1 - \exp(-\lambda(s_t - c))]^{-1}$ $\lambda > 0$

ESTAR $G(\lambda, c; s_t) = [1 - \exp(-\lambda(s_t - c)^2)]$ $\lambda > 0$

The linear null hypothesis and alternative hypothesis of equation(1) are

$H_0 : \lambda = 0$, （y_t linear）

$H_1 : \lambda > 0$, （y_t nonlinear）

Helper function

$$v_t = \beta_1' z_t + \beta_2' z_t s_t + \beta_3' z_t s_t^2 + \beta_4' z_t s_t^3 + \eta_t \qquad (2)$$

First, making a regression for equation (2) to obtain the result of $\hat{\varepsilon}_{it}$ and $SSR_i^0 = \sum \hat{\varepsilon}_{it}^2$, $i = y, \pi, m, r, l$

Then, other regression is needed , $\hat{\varepsilon}_{it}$ is Dependent variable, X_{it} and $z_t X_{it-1}$ are independent variables. the residual μ_{it} and $SSR_i^1 = \sum \mu_{it}^2$ have been obtained .

Finally, $LM_i = T(SSR_i^0 - SSR_i^1)/SSR_i^0$ is calculated for each i, where T is the number of sample observations. Under the null hypothesis, LM_i obey the chi-square distribution.

3.2.2 Linear test of ESTAR

$G(\lambda, c; s_t) = [1 - \exp(-\lambda(s_t - c)^2)]$ $\lambda > 0$

The ESTAR linear test is roughly similar to the LSTAR linear test, except that the logarithmic transfer function is Taylor. Helper function：$v_t = \beta_1' z_t + \beta_2' z_t s_t + \beta_3' z_t s_t^2 + \beta_4' z_t s_t^3 + \beta_5' z_t s_t^4 + \eta_t$。 The disadvantage of the ESTAR model is $\lambda \to 0$ or $\lambda \to \infty$, the function of G degenerates to a constant value (0 or 1), that means the ESTAR model degenerates to linearity; the LSTAR model becomes a TAR model at same time.

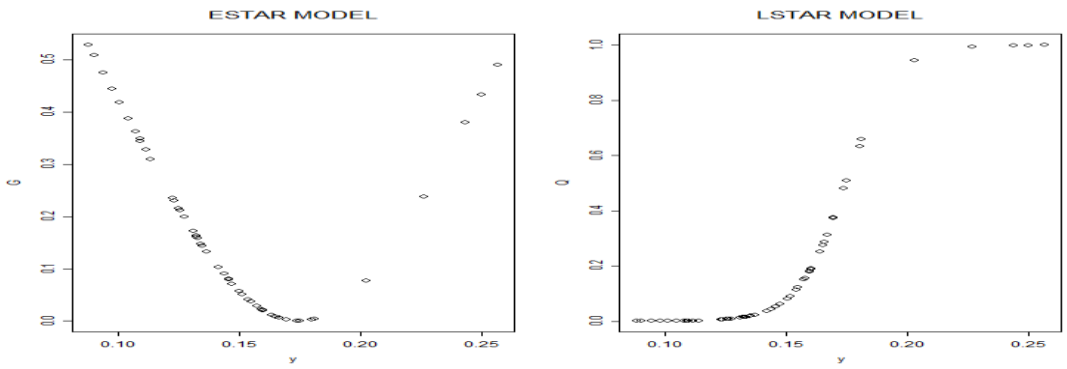

Fig.2 the transfer function of STAR

4. Empirical test

4.1 variables

The data of paper include food consumer index, broad money supply M2, credit, exchange rate, and industrial production index. The sample uses quarterly data from the first quarter of 2004 to the third quarter of 2017. (The original data can be found in the China Statistical Yearbook and the statistics of the Survey and Statistics Department of the People's Bank of China.) The food consumption index is used to describe the price fluctuation of agricultural products. The broad money supply M2 is used to reflect the supply of money in each period. The Stationarity test shows that there is no unit root after the logarithm of the original data and the difference.

4.2 Model estimation and setting

Liu Jinquan (2006) and Wang Liyong (2010) show that the division of the two regimes or the three regimes is fix the state characteristics of Chinese actual economic cycle fluctuations. The STAR model is fitted by R software, the result shows that two regimes is perfect

Table 1 the result of regime

Regime 3 is NOT accepted (p-Value = 0.804261)			
	Testing linearity	2 regime	3 regime
Period	gamma = 100 , th = 0.1754	0.02381129	0.804261

Table 2 LM test

H0	H3	H2	H1
P value of LM test	0.8102	0.9422	0.0412

Accepting H3 and H2 from table, H1 means rejecting the null hypothesis of the linear model and selecting the LSTAR model. To further determine the model type, a residual test is performed on the fitted equation of the model.

Table 3 Ljung-Box test

p-value	Thvar(Ljung-Box Test)			Residuals		
	M2	Credit	rate	AIC	var	MAPE
ESTAR	0.7686	0.8169	0.8145	-301	0.00312	101.6%
LSTAR	0.6716	0.7171	0.9052	-396	0.00056	11.6%

It can be clearly seen from Table 3 that the residual AIC value, volatility, and MAPE of the LSTAR model are superior to the ESTAR model. Therefore, the LSTAR model is used to analyze the fluctuation effect of agricultural product prices. The threshold is 0.1754 and the transfer parameter is 100. c>0.1754 is the economic expansion period, c<0.1754 is the economic contraction period.

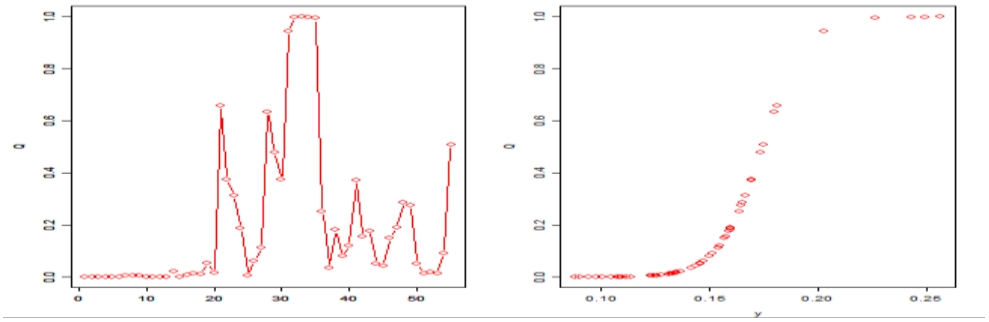

Fig.3 The transfer trajectory and transfer function of money supply

4.3 Generalized pulse effection

Except food consumption index , other variables are used as conversion variables to perform pulse analysis on the model. The following results can be obtained:

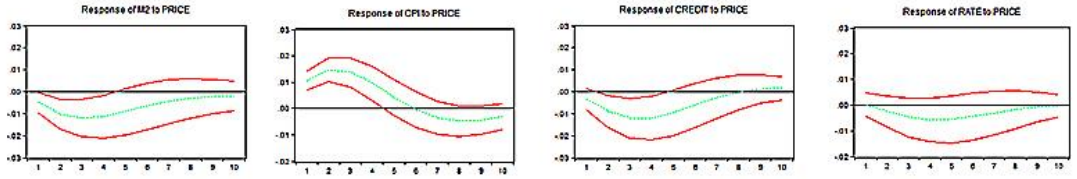

Fig.4 Impact of M2, CPI, credit and rate

The price of agricultural products is more sensitive to the impact of money supply and household consumption index, and price fluctuations is relatively large than usual . This is consistent with the actual situation. The daily consumption of residents is more sensitive to the fluctuation of agricultural product prices, and the rational consumers will fix their consumption in the face of violent fluctuations in prices. Observing the impact of household consumption index on agricultural product price fluctuations, it can be seen that the positive impact is stronger than negative, consumers are more sensitive to the price increase of agricultural products than decrease of agricultural products.

For the money supply and credit shock, the performances in the above picture are similar. They all reach the bottom of the valley after the impact, and there is a negative value, and then return to a stable state similar to the initial test value. That is to say, after accepting short-term money supply and credit shock, agricultural product prices have an asymmetric effect. Agricultural product price fluctuations are more sensitive to negative impacts, and agricultural product price fluctuations are asymmetric for positive and negative shocks. In addition, short-term exchange rate shocks has little impact on agricultural product price fluctuations.

4.4 The asymmetric effects of money supply shocks

the equation of different regimes :

$$y_t = \phi x_t^{'} + (\theta x_t^{'})\,\mathrm{G}(\lambda, \mathrm{c}; \mathrm{s}_t) + \mu_t$$

$$\mathrm{G}(\lambda, \mathrm{c}; \mathrm{s}_t) = [1 + \exp(-\gamma(\mathrm{s}_t - \mathrm{c}))]^{-1} \qquad \lambda > 0$$

Smoothing parameter: gamma = 100 Threshold Value: th=0.1754

$$\mathrm{G}(\mathrm{m}_{t-1}) = (1 + \exp[-th(\mathrm{m}_{t-1} - gamma)])^{-1}$$

Low regime: $y_t = 0.00077 + 0.92939\mathrm{m}_t - 0.57889\mathrm{m}_{t-1} G(\mathrm{m}_{t-1}) + u_t$

High regime: $y_t = -0.06528 - 0.43362 m_t - 0.39807 m_{t-1}\,\mathrm{G}(\mathrm{m}_{t-1}) + u_t$

The coefficients of the transfer variables under two regimes are 0.92939 and (0.43362), and the coefficients of the transfer function are (0.57889) and (0.39807). Therefore, in the economic depression state, the money supply is more sensitive to the price fluctuation of agricultural products than during the economic expansion period. That is to say, the influence of different regional currency supply on agricultural product price fluctuations is asymmetric.

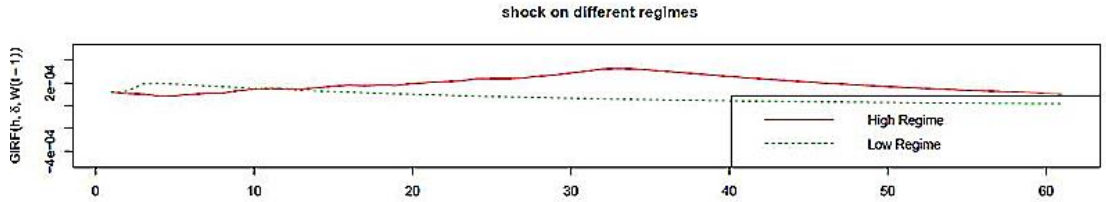

Fig.5 asymmetric effect of shock on different regimes

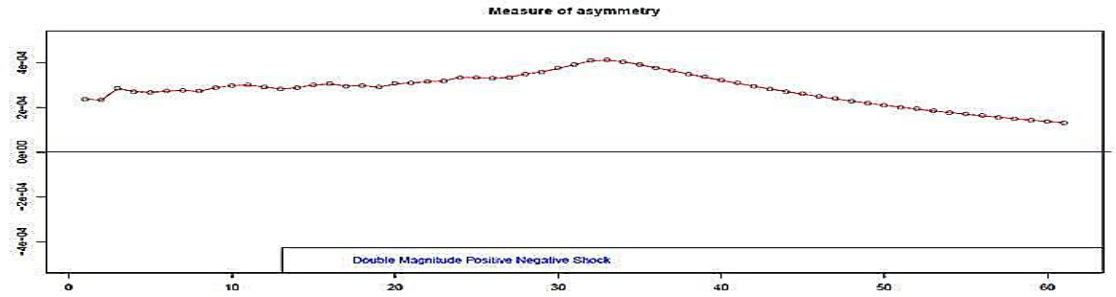

Fig.6 asymmetric of shock on money supply

5. Conclusion

Using the agricultural product price index, money supply, household consumption index, credit and other data to construct the LSTAR model, this paper examines the asymmetric effect of agricultural products prices from three ways: the trajectory of regime system, the estimation coefficient of fitting equation and the impulse response. In different economic growth cycles, the asymmetric effect of money supply on agricultural product price fluctuations is exist, and the impact of money supply lead to overshooting of agricultural product prices. From the above theory and empirical evidence, we can draw the following conclusions.

(1) The first regime is a state in which threshold value is less than 0.1754, that is, the economic depression state; the anther regime is a state in which threshold value is greater than 0.1754, and the economic performance is expansion.

(2) In the state of economic depression, the fluctuation of money supply to agricultural product price is more sensitive than that in economic depression (0.93>-0.43; |-0.59|>|-0.40|), that is, Symmetrical effect of agricultural product price fluctuations is exist in different regimes.

(3) Symmetrical effect of agricultural product price fluctuations under the positive and negative shocks on money supply and credit is exist .and there is a time lag in the adjustment of agricultural prices with currency shocks.

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