

Research Article

Research on Dynamic Impact of Monetary Supply on Agricultural Industry and Food Price

XiaoFei Zhao

School of Management, South-Central University for Nationalities, Wuhan 430074, China

Abstract: In this study, we study the impact of money supply changes on food prices by using VAR model. The model set and test are based on the rigorous analysis of co-integration relationship between money supply and food prices, then we make empirical analysis to study the impact of money supply changes to food prices. The result shows that there is a long-term stable relationship between money supply and food price. The money supply and output shocks have different impacts on food prices: the effect of money supply on food price is obvious. Also, the increase of money supply will promote the food price sustained growth in the long time. On the other hand, the increase of GDP will lead to the decline in food prices and make price level tends to be stable.

Keywords: Agricultural industry, co-integration test, food prices, monetary supply, VAR model

INTRODUCTION

Food price is the most important influence on the living standards of residents (Tai and Chao, 2014). However, pursuing the economic goals of the monetary policy to guide the influence trend of food price changes is an important part in maintaining stable and rapid development of the national economy (Sascha and Dieter, 2012; Mohamed and Nooman, 2012). The change of food price is practical significance for China to formulate relevant policies. Until now there is not much research literature of food prices and most scholars study how the CPI influences the economy (Christiane *et al.*, 2013). In the aspect of effect factors on food price, many scholars think that because of the existence of the futures market, food commodities tend to be very efficient and volatility of food price is very flexible (Garner, 1989; Cody and Mills, 1991), so they point the futures is an affecting factor of food price volatility. Also, some scholars point that macroeconomic or monetary factor tend to cause food price volatility, namely macro economy or changes of monetary variables lead to food price volatility (Barnhart, 1989; George and Warren, 1995). Just (1990) believe that interest rates and inflation have influence on to stored agricultural products and productive assets, which can affect the food prices.

The China scholars, Lu and Peng (2002) verify the causal relationship between China's rising food prices and inflation, nominal price volatility is due to inflation leading to social large-scale grain storage which is caused by the inflation expectations. In the effect of food prices on the economy, Zhao and Geng (2010) believes that food price immediate impact of CPI reached the maximum and the impact of food prices on

the CPI meet the cobweb theory, but contribution of food prices to inflation is smaller and the current is 20% and the long-term is 10%.

This study is based on the quantity theory of money in order to do some research on food prices. Friedman and Schwartz (1963) believes that the real money demand is a function of permanent income, which is relatively stable. The increase of exogenous money supply will form the purchasing power beyond the needs (Saghain *et al.*, 2002; Bond, 1984). In the long term, growth of exogenous money supply will eventually form the rise in prices (Robert and Julio, 1990; Ping, 1998; Blanchard and Quah, 1989). As the food price form the important part of CPI, the money supply will inevitably affect the changes in food prices (Michael *et al.*, 2003; Hu and Su, 2008; Wang, 2006). This paper studies the effect of money supply on food prices and put the output into the system and take the output as a reference and mainly studies the dynamic relationship between food prices, money supply and output and analyze the impact of money supply and output on China's food price shocks. In this study, the data selection is the growth rate of the Money supply (M2) from the first quarter of 1990 to the fourth quarter of 2013; Food Price growth rate (FP) and GDP growth rate (GDP); and data is from the China Statistical Yearbook and internet statistics database.

MATERIALS AND METHODS

Model construction: Vector Auto Regression (VAR) is a statistical model used to capture the linear interdependencies among multiple time series. An estimated VAR model can be used for forecasting and the quality of the forecasts can be judged, in ways that

are completely analogous to the methods used in unvaried autoregressive modeling (Lapp, 1990). VAR model is the simultaneous form of autoregressive model, A VAR (p) model of a time series y (t) has the form as:

$$A_0 y_{(t)} = A_1 y_{(t-1)} + \dots + A_p y_{(t-p)} + \varepsilon_{(t)} \quad (1)$$

The structure of VAR model is decided only by the number of variables and the lag length. For example, if a VAR model has two variables as y1t and y2t, as:

$$\begin{cases} y_{1,t} = c_1 + \pi_{11,1}y_{1,t-1} + \pi_{12,1}y_{2,t-1} + \mu_{1t} \\ y_{2,t} = c_2 + \pi_{21,1}y_{1,t-1} + \pi_{22,1}y_{2,t-1} + \mu_{2t} \end{cases} \quad (2)$$

Then we change this formula into matrix form, as:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} \pi_{11,1} & \pi_{12,1} \\ \pi_{21,1} & \pi_{22,1} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix} \quad (3)$$

Assume that:

$$\Pi_1 = \begin{bmatrix} \pi_{11,1} & \pi_{12,1} \\ \pi_{21,1} & \pi_{22,1} \end{bmatrix}, \mu_t = \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix} \quad (4)$$

So that, formula (3) can be written as:

$$Y_t = c + \Pi_1 Y_{t-1} + \mu_t \quad (5)$$

This is the basic model of VAR, as the formula only has lagged endogenous variables, so that these lagged endogenous variables are asymptotic unrelated with μ_t . Then we can use OLS method to estimate each VAR formula and the parameter estimators that we gat will be consistent.

Stability conditions: The stability of the VAR model means that when we put an impulse to the innovation of on formula in the VAR mode, the impact of the effect will gradually reduce. The basic condition of stability is that: all the eigenvalue of Π_1 should be located within the unit circle. According to the formula 5, when $t = 1$, it should be:

$$Y_1 = c + \Pi_1 Y_0 + \mu_1 \quad (6)$$

And when $t = 2$, we calculate the formula with iterative method, as:

$$Y_2 = c + \Pi_1 Y_1 + \mu_2 = (1 + \Pi_1)c + \Pi_1^2 Y_0 + \Pi_1 \mu_1 + \mu_2 \quad (7)$$

So that, when $t = t$, it could be written as:

$$Y_t = (1 + \Pi_1 + \Pi_1^2 + \dots + \Pi_1^{t-1})c + \Pi_1^t Y_0 + \sum_{i=0}^{t-1} \Pi_1^i \mu_{t-i} \quad (8)$$

From the formula above, we can get that Y_t becomes a function to the vector μ , Y_0 and μ_t after the formula transformation. So we can analysis the impact result of these vectors to find out whether the VAR model is stable. If the VAR model is stable, it will satisfy the conditions as:

- If give one unit impulse to c at $t = 1$, when $t \rightarrow \infty$, the effect will have a Limit value as $(I - \Pi_1)^{-1}$
- If give one unit impulse to Y_0 , the effect will be Π_1^t when $t = t$ and will be gradually disappeared with time has been increased

From the analysis about VAR model, we can get that if the VAR model has the unit root, it will have the memory about impulse impact for a long time, so this VAR model is not stable. Also, the response of endogenous variables will not reduce with time increased in this case.

Data collection and analysis: In order to analyze how the money supply effect on the food price, we use STATA 12.0 software and make a statistical analysis of money supply, GDP and food price index data from the year of 1990 to 2013. We use the M2 data to represent the money supply, all data was collected from China statistical yearbook 2013, Chinese price information network and Caixin database. In order to eliminate the effect of heteroscedasticity, we performed logarithmic processing of data and named them as LnM2, LnGDP and LnFP.

RESULTS AND DISCUSSION

ADF unit root test: The unit root test was first put forward by David Dickey and Wayne Fuller, so it is also called DF test. DF test is a basic method in stationarity test, if we have a model as:

$$Y_t = \rho Y_{t-1} + \mu_t \quad (9)$$

DF test is the significance test to the coefficient. If $\rho < 1$, when $T \rightarrow \infty$, $\rho T \rightarrow 0$, that means the impulse will be reduced when the time is increased. However, if $\rho \geq 1$, the impulse will not be reduced with the time, so that this time-series data is not stable. The basic DF test model can be written as:

$$Y_t = \beta_1 + \beta_2 t + (1 + \delta)Y_{t-1} + \mu_t \quad (10)$$

If we add the lagged variable of ΔY_t in formula 10, then it will be called the augmented Dickey-Fuller test, so that ADF test model can be written as:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^m \Delta Y_{t-i} + \varepsilon_t \quad (11)$$

Table 1: Augmented Dickey-Fuller test (ADF)

Variable	Test statistic	Critical value 1%	Critical value 5%	Critical value 10%	Result
LnM2	-2.569	-3.750	-3.000	-2.630	Unstable
LnGDP	-1.571	-3.750	-3.000	-2.630	Unstable
LnFP	-1.957	-3.750	-3.000	-2.630	Unstable
d.LnM2	-3.099	-3.750	-3.000	-2.630	Stable
d.LnGDP	-3.867	-3.750	-3.000	-2.630	Stable
d.LnFP	-3.270	-3.750	-3.000	-2.630	Stable

Table 2: Granger causality test

Equation	Excluded	Chi ²	df	Prob>chi ²
LnFP	LnM2	19.3170	2	0.000
LnM2	LnFP	3.5566	2	0.169
LnFP	LnGDP	17.8530	2	0.000
LnGDP	LnFP	2.8363	2	0.242

Table 3: Johnson co-integration test

Rank	Parms	LL	Characteristic value	Statistic	Significant level 5%
0	6	99.43		20.949	15.41
1	9	109.60	0.620	0.616*	3.76

Data stable is the premise of establishing VAR model, an Augmented Dickey-Fuller test (ADF) is a test for a unit root in a time series sample. We use ADF unit root test to inspect LnM2, LnGDP and LnFP, the result as is shown in Table 1. Through the test results we can get that all data are non-stationary. Then we test on d.LnM2, d.LnM2 and d.LnFP and demonstrate that they are stable, so we can build the VAR model and use granger test and co-integration test.

VAR model: Vector Auto Regression (VAR) is a statistical model used to capture the linear interdependencies among multiple time series. An estimated VAR model can be used for forecasting and the quality of the forecasts can be judged. VAR model is the simultaneous form of autoregressive model, A VAR (p) model of a time series $y(t)$ has the form:

$$A_0 y_{(t)} = A_1 y_{(t-1)} + \dots + A_p y_{(t-p)} + \varepsilon_{(t)} \quad (12)$$

In this study, I use AIC, SC criterion to identify the lag length. From the result, we can get that the minimum AIC is in lag 2, so I choose lag 2 as the lag length. First, we bulid the VAR model of LnM2 and LnFP as 2:

$$LnFP = 3.433 + 0.11LnM2_{t-1} + 1.32LnM2_{t-2} + 0.83LnFP_{t-1} - 0.18LnFP_{t-2} \quad (13)$$

According to the formula, it can be seen that money supply promotes food price increase. LnM2 at lag 1 period increased one percentage can drive LnFP increase by 0.11%, LnM2 at lag 2 period increased one percentage can drive LnFP increase by 1.32%, so the effect of money supply on food price is obvious. Also, the increase of money supply will promote the food price sustained growth in the long time. Then, we build the VAR model of LnGDP and LnFP as:

$$LnFP = 1.145 - 1.04LnGDP_{t-1} - 0.48LnGDP_{t-2} + 1.32LnFP_{t-1} + 0.428LnFP_{t-2} \quad (14)$$

According to this formula, it can be seen that the increase of GDP will lead to a decline in food price. Ln GDP at lag 1 period increased 1% can drive LnFP decrease by 1.04%, LnGDP at lag 2 period increased one percentage can drive LnFP decrease by 0.48%, so the increase of GDP will lead to the decline in food prices and make price level tends to be stable.

At the same time, in order to analyze the relations between money supply, economic growth and food price, we use granger causality test to analyze this VAR model, the result is shown in Table 2. From Table 2, we can get that LnM2 is the reason to LnFP, which means the rising of money supply is the reason to the increase of food price. At the same time, LnGDP is also the reason to LnFP, so that the economic growth is also the reason to food price; this is also same to the conclusion above.

At the same time, we take Johnson co-integration test to analyze the long-term relations between financial system and food processing industry, the results is shown in Table 3. Co-integration is a statistical property of time series variables. Two or more time series are co-integrated if they share a common stochastic drift, if two or more series are individually integrated but some linear combination of them has a lower order of integration, then the series are said to be co-integrated.

According to the results, there exist at least one direct co-integration relationship between money supply and food price, which means that there exist a long-term equilibrium relationship between money supply and the rising of food price.

Impulse-response analysis and cholesky variance decomposition: According to the results above, we can

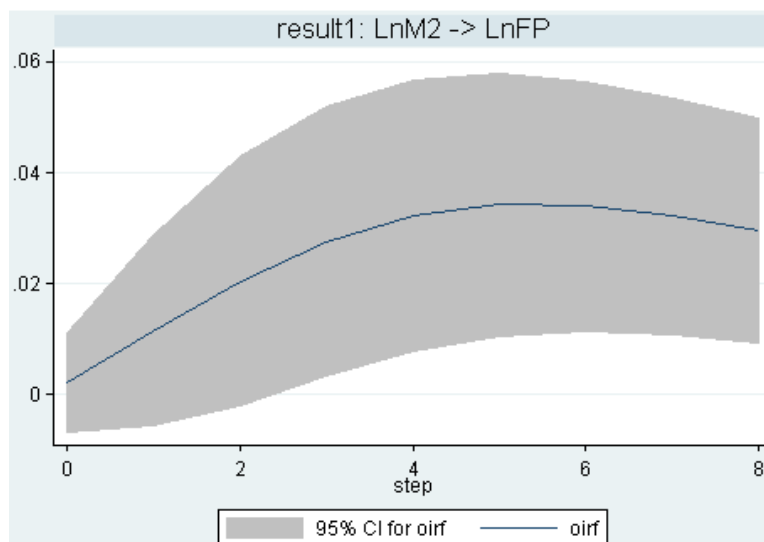


Fig. 1: Impulse-response analysis for LnM2 to LnFP

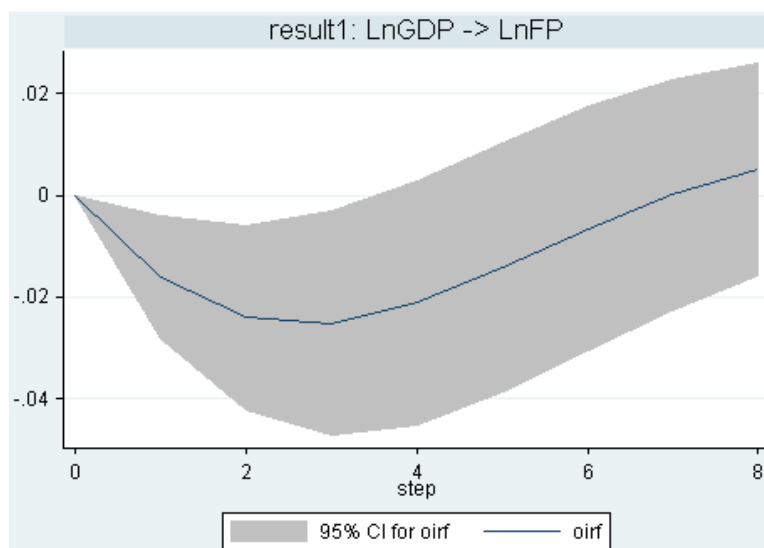


Fig. 2: Impulse-response analysis for LnGDP to LnFP

get that there exist a long-term equilibrium relationship between M2 and food price, also the VAR model is stable. In order to analyze the VAR model, we use Impulse-response function, the results is shown in Fig. 1 and 2. Figure 1 is the impulse-response analysis for LnM2 to LnFPE and Fig. 2 is the impulse-response analysis for LnGDP to LnFPE.

From Fig. 1, we can get that when LnM2 received one unit impact, it will lead LnFP increase currently, LnFP at $t = 1$ period is 0.0022 and then increased to 0.0115 at $t = 2$ period. LnFP will reach the max at $t = 5$ period and begin to be stable then. It illustrates there is long-term effect between money supply and food price. From Fig. 2, we can get that when LnGDP received one unit impact, it will lead LnFP decrease currently, LnFP is -0.016 at $t = 1$ period and then decrease to -0.024.

Finally, it will return to the basic situation at $t = 8$ period. According to the impulse analysis results, we can get that money supply will have significant influence to food price, it will promote the rising of food price; at the same time, economic growth will lead to a decline in food price and make price level tends to be stable.

Then, we make cholesky variance decomposition to the VAR model, the results is shown in Fig. 3 and 4. The cholesky variance decomposition also shows the same result, the contribution degree of LnM2 to LnFP is gradually increased. From Fig. 3, we find the contribution degree of LnM2 to LnFP at $t = 1$ period is 1.1% and then return back to 23% at step 4 and then reach 40% at step 6. This means that money supply has obvious interpretative strength to food price in the long-

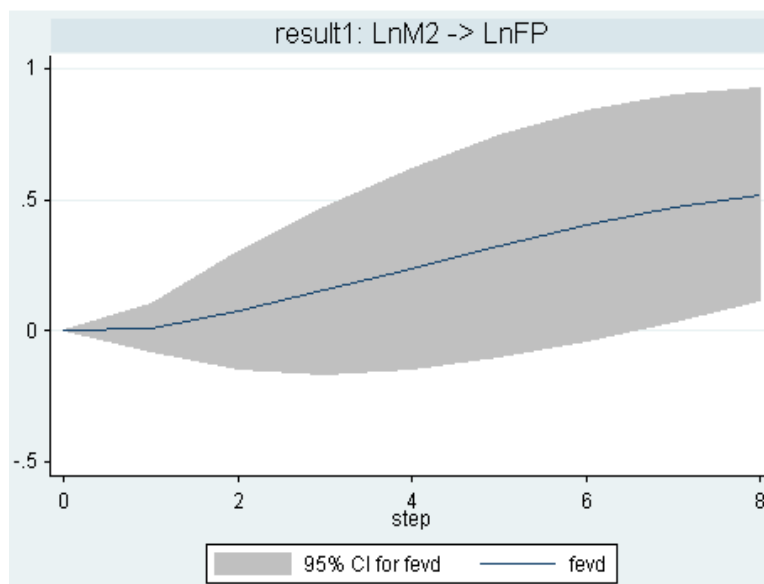


Fig. 3: Cholesky variance decomposition for LnM2 to LnFP

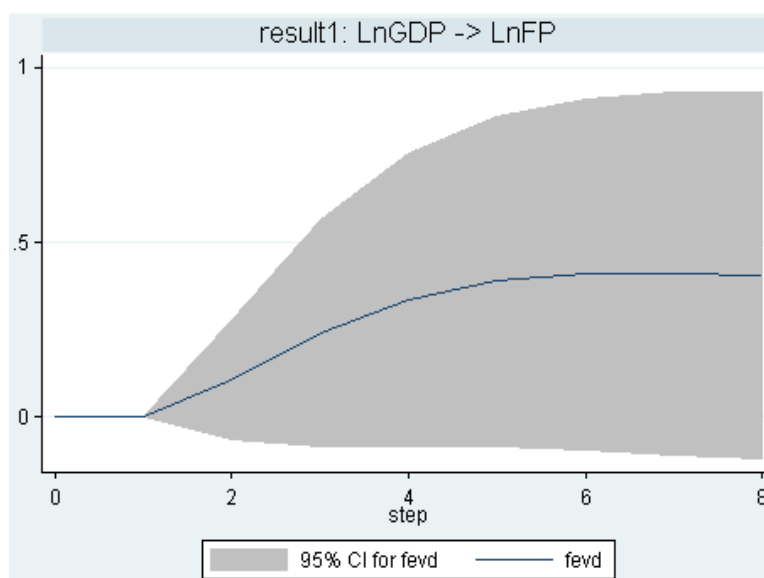


Fig. 4: Cholesky variance decomposition for LnGDP to LnFP

term. From the Fig. 4, we can find that LnGDP has a stable contribution degree to LnFP, the contribution degree of LnGDP to LnFP is reached 10.7% at step 1 and then increased 24% at step 2. This proves that the economic growth has a certain expansion to the decrease of food price. The result of variance decomposition means that both M2 and GDP has adequate contribution degree to the rising of food price and can be used to explain the food price fluctuations.

CONCLUSION

Above all, there are long-term interaction effects between China's money supply and food price. The

rising of money supply can promote food price grow continuously and the rising of GDP can promote the decline of food price. Also, the economic system and food industry have long-term stability of mutual promotion relationship. According to the data of 1990 to 2013, it can be figured out that effect of economic growth prompting food price decrease and achieve stability. Considering the importance of money supply and economic growth, it is necessary to pay more attention to the economic variables and optimize capital configuration, in order to promote the stability of food prices and the growth of the food industry. China also needs to pay attention to the increase of money supply

should be suitable for the industry development level and avoid excessive money supply in a short time.

It must be pointed out that the cause of food price changes is in many aspects, so that other important factors also need to be considered (Bessler, 1984; Choia and Róisín, 2013; Kosuke, 2001; Ansgar *et al.*, 2013). As a result of this study is mainly based on the quantity theory of money supply, output and the price of food between the dynamic relationship, therefore, other scholars may focus on other important factors for analysis of the effect of food price.

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