The Effect of Agricultural Commodities Prices Increase on Farmers' Income – An Empirical Study Based on VAR Model

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[Abstract] Over the past few years, Chinese agricultural commodities prices have fluctuated violently, which affected the people's lives, as well as farmers' income. The article, based on the VAR model and using the data from 1979 to 2010, analyzes the effect of agricultural commodities price increase on farmers' income, and finds that price fluctuations of agricultural commodities influence farmers' income remarkably. The increase in agricultural commodities prices will initially increase farmers' income, and then decrease them. Therefore, only stabilizing agricultural commodities price can ensure that farmers' income will increase steadily.

[Keywords] agricultural commodities price; farmers' income; VAR model; impulse response function; agriculture industrialization

Introduction

In recent years, agricultural commodities price experienced the phenomenon of "roller coaster" fluctuation. Learned from the national agricultural commodities wholesale market information network, the price of garlic, which gained the name "garlic you hard" because of the skyrocketing price, has fallen gradually since 2011. In December 2011, the average wholesale price of garlic was 3.27 yuan/kg, dropping 65.4% compared with the price of 9.45 yuan/kg in the same period in 2010. Since the middle of February 2012, onion prices have continued to rise. On March 18, the price of onions rose 80%, compared to the same period last year, and a new round of rising prices of agricultural commodities is brewing. Experience has shown that agricultural commodities prices and farmers' income are closely related. Farmers' income is the core of the "agriculture, rural areas and farmers" problems; therefore, studying the relationship between agricultural commodities prices and farmers' income has a very important significance.

Many economists have analyzed the price fluctuations of agricultural commodities. Early literature was mainly from the supply perspective, among which the supply response model was the most influential. The model applied the dynamic analysis method to the supply of agricultural commodities analysis, assuming the farmer did not respond to the last price, but the expected price, which depended on the last price to a certain extent (Nerlove, 1956). This theory has inspired the upsurge of national research on the agricultural supply response, especially on the response to price for farmers in developing countries. There was also some literature studying the prices of agricultural commodities from the demand perspective, such as the spatial price equilibrium model, which was one of the classic theories (Fox, 1953).

With the accelerating pace of world integration and industrialization, the impact and influence of external factors on the prices of agricultural commodities have been focused on. Macroeconomic policies, especially the monetary policy, could have a direct or indirect impact on agricultural prices and volatility levels (Lapp & Smith, 1992), and the non-neutrality assumption of money could also cause food price overshoot (Frankel, 1982).

There have been some debates on the relationship between the price of agricultural commodities and farmers' income. Some experts believed that the rise of agricultural prices would increase farmers 'income (such as Wen & Wen, 1997; Levin, et al., 2003; Shi, et al., 2009), but some experts denied it, as a price increase would increase the cost of agricultural commodities, and therefore, decrease the farmers' income (Chen & Lv, 1997); prices of agricultural commodities could not become the explained variable of the farmers' income (Zhang, & Liu, 2008); agricultural prices had less effect on the farmers' income in the steady period of agricultural commodities, while the sharp rise in prices of agricultural commodities would greatly restrict the rapid increase of farmers' income (Guo & Ma, 2007).

From the above research, there is no unified conclusion on the relationship between the agricultural commodities price and farmers' income. This article selected the data of China after the reform and opening up, with the aid of the VAR model, combining with Grainger Granger causality test and impulse response function, and studied the effect of the agricultural price increase on farmers' income. We also put forward some suggestions for the current macroeconomic regulation and control.

Model and Index Selection

The Vector Autoregressive (VAR) model, based on the statistical properties of data, is always used to forecast the interconnected time series system and analyze the dynamic impact of random disturbance on the variable system, thus explaining the effect of various economic shocks on economic variables formation. To examine the relationship between the agricultural commodities prices and farmers' income, it is necessary to choose the most representative indexes. The first index – the agricultural commodities price – is expressed by Producer Price Index (PPI) of agricultural commodities. The second index – farmers' income – is expressed by per capita net income index of rural residents. The data of Producer Price Index (PPI) of agricultural commodities for 1979-2009 are from the Information Network of the State Council Development Research Center; the data for 2010 are from the 2011 China Statistical Yearbook. The index is the ratio calculated by last PPI, which is stipulated as 100; the data of per capita net income are form 2011 China Statistical Yearbook, which is the ratio calculated by last per capita net income, which is stipulated as 100.

This article constructs the VAR model, with the data of national rural residents' per capita net income index and the national agricultural production price index in the years 1979-2011, studies their long-run equilibrium relationship on the basis of ADF test. We then take the Granger Causality test of the indicator variables, analyze the interaction mechanism between the two indicators through impulse response function, and finally provide the findings and policy recommendations.

Empirical Analysis

Variable Stationary Test

Time series should be stationary because the non-stationary time series is prone to a spurious regression problem. So we usually differentiate the time series to make it stationary. When the variables are stationary at the same order we can conduct the co-integration relation test. Therefore, the stationarity of the variables should be first tested before conducting co-integration analysis. This article uses the ADF test for the unit root of each variable. Statistical analysis software Eviews 7.1 is used to test the stationarity of variables income and price. The results are shown in Table 1.

Table 1. ***Result of ADF Test***

Variable	ADF Test value	Probability	Critical Value			Stationary or not
			1%	*5%*	*10%*	
Income	-2.886748	0.0584	-3.661661	-2.960411	-2.619160	Not stationary
D (income, 1)	-4.441538	0.0016	-3.689194	-2.971853	-2.625121	Stationary
Price	-3.424482	0.0176	-3.661661	-2.960411	-2.619160	Not stationary
D (price, 1)	-5.327975	0.0001	-3.670170	-2.963972	-2.621007	Stationary

Note: D (income, 1) and D (price, 1) stand for the first order difference of income and price separately

Test results show that the original income and price are not stationary variable under 1% significant level. Difference method is used and first order difference values of D (income, 1) and D (price, 1) are obtained. Sequence after first order difference is stationary under 1% significant level. According to the co-integration theory, sequences at the same order passing the stationarity test can use co-integration test to analyze their co-integration relationship.

Co-Integration Relation Test

Since income and price both belong to 1(1) series, we conduct co-integration analysis on the variables to

verify whether there is a long-term stationary relationship between them. Engle-Granger two-step method is adapted to study on the Co-integration relationship between the variables. By using the least square method, regression equation is established:

income =63.56852+0.461346 price+ et (1)
t = (6.513328) (5.094883)
R2=0.463882; DW =1.145280; F=25.95783

Results show the statistic value of DW is smaller than 2, which means the residual series may exist autocorrelation. Joining the first order lag, the distribution lag model of income and price is as follows:

income=22.35801+0.377938price+0.406644income(-1)+ 0.038890price(-1) + e_t (2)
t=(1.533208) (4.132859) (2.586024) (0.330338)
R^2=0.638759; DW =2.193090; F=15.91414

Then the autocorrelation of residual series is eliminated. The long-term relationship between income and price can be expressed as

income=22.35801+0.7025price+ e_t

The above equation shows that changes in price (the agricultural commodities prices) have a positive impact on changes in income (the farmers' income). When the agricultural commodities prices change by 1 percentage point, the farmers' income will change by about 0.7 percentage points in the same direction. The two variables have a long-term stationary equilibrium relationship. Then conducting unit root test on the residual error e_t in Equation (2). Results are as follows:

Table 2. ***ADF Test of Residual Series***

Variable	ADF Test Value	Probability	Critical Value			Stationary or not
			1%	*5%*	*10%*	
e_t	-5.942119	0.0000	-3.670170	-2.963972	-2.621007	Stationary

Results show there is a co-integration relationship because the residual series is stationary. Therefore, in the long run there is a significant positive correlation between the produce price level and the farmers' income.

Granger Causality Test

The previous test results show the existence of long-term stationary relationship between the agricultural commodities prices and the farmers' income, but cannot get their causal relationship, which should make use of Granger Causality test. With the estimated model, the Granger Causality test method can determine whether the agricultural commodities prices will affect the farmers' income using the F test. Similarly, whether the changes in farmers' income will affect the prices of agricultural commodities can also be tested. The above ADF test has proven that the two variables are stationary at the first order, consistent with the conditions of Granger Causality test. According to the AIC and SC criteria, selecting the optimal lag order as the first order, and using ordinary least squares (OLS), Granger Causality test results are as shown in Table 3.

Table 3. ***Result of Granger Causality Test***

Null hypothesis	F statistics	P value
PRICE is not the Granger Cause of INCOME	3.71407	0.0642
INCOME is not the Granger Cause of PRICE	0.60463	0.4433

Table 3 shows that price is the Granger cause of income, while income is not the Granger cause of price. Therefore, the changes in the price of agricultural commodities will affect the farmers' income, but the changes in farmers' income will not always lead to the changes in the price of agricultural commodities.

Impulse Response Function Analysis

Impulse response function is used to measure the impact of the random disturbance of one standard deviation on current and future values of other variables, which can visually depict the dynamic interaction between variables. Figure 1 is the impulse response function of income and price. The horizontal axis represents the retrospective period number, per unit length representing 1 period, and this paper selects 10 periods; the longitudinal axis represents the size of the shocks between the variables. The solid line represents the pulse response function of 1 unit pulse, and the dashed line of both sides indicates the confidence interval boundary of double standard deviation.

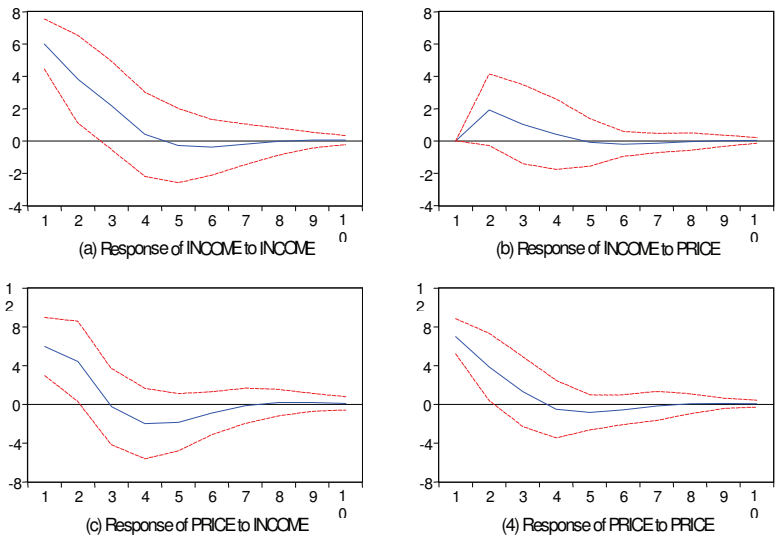

Figure 1. **Impulse Response Function**

Figure 1(a) indicates the time path of income to its own response function: the impulse effect is very large in the first period, and later gradually decreases, which suggest that farmers' income is associated with its lag period, but the association gradually weakens later.

Figure 1(b) is the response function of income to price: the impulse impact has no effect in the first period; it suddenly increases in the second period, and then decreases gradually, which indicates that farmers' income has a lagged effect on price fluctuations: the rise in farmers' income will affect the price of agricultural commodities, but the impact time is short.

Figure 1(c) indicates the response function of price on income, which is very large in the first period, then later gradually decreases, and appears negative effect in the third period. This suggests that the rise in agricultural prices will increase the farmers' income in the short term, and decrease it in the long run.

Figure 1(d) shows the response function of price to itself: the effect achieves the maximum in the first period, then later gradually decreases to be stationary, which indicates that the price level of agricultural commodities has association with its lag period, and this association will gradually weakens in the latter.

Conclusion and Suggestions

The empirical analysis with the relevant data from 1979 to 2010 shows that: (1) The stationary test and co-integration test prove that there is a long-term equilibrium relationship between farmers' income and agricultural commodities prices, with significant positive correlation. (2) The Granger causality test finds the one-way Granger causal relationship between the farmers' income and the agricultural commodities prices: changes in agricultural prices will lead to changes in farmers' income, while not vice versa. (3) The impulse response function indicates changes in the agricultural commodities prices have a greater impact on farmers' income, a rise in the agricultural price will increase the farmers' income in the early

stage, but later decrease it. So increasing the agricultural prices only has short effect on farmers' income, but it worsens the living standards of farmers in the long run. Only stabilizing the agricultural commodities prices can ensure the steady increase of farmers' income. In the current context, stabilizing the agricultural commodities prices can be from the following aspects:

Construct the Price Information Platform of Agricultural Commodities, and Reducing or Eliminating Agricultural Market Information Asymmetry

Market supply and demand information asymmetry is one of the reasons for price volatility. To stabilize the price level of agricultural commodities, the authorities should accelerate the monitoring and disclosure of relevant information, and in addition, they should crack down on speculative behavior. Competent authorities strengthen the agricultural commodities prices information platform construction, which involves information acquisition, information collection, information release and so on; they need to further expand and improve the agricultural market information network, to collect information about agricultural supply and demand, then spread it to farmers; focus on the information collection, publishing, and forecasting activities, provide an online trading platform for farmers and carry out information service relying on the agricultural sector, supply and marketing cooperative sector, as well as other farmers' cooperative organization.

Establish an Agricultural Price Regulation and Compensation Mechanism, and Stabilize the Price Levels of Agricultural Commodities

An increase in agricultural prices will adversely affect the farmers' income and rural economy, so it is necessary for the government to regulate and intervene in order to maintain price stability. Currently, the government prefers post intervention to prior intervention in agricultural market intervention. So in order to stabilize the prices of agricultural commodities, we can establish a stationary price adjustment and compensation mechanisms of agricultural commodities, execute a minimum purchase price policy for primary agricultural commodities, raise the minimum purchase price substantially, raise farmers' enthusiasm to promote the stable development of major agricultural commodities, make use of a variety of control means to strengthen the price monitoring of the major agricultural commodities and find the harbinger of major agricultural price fluctuations in time, to enhance the government's ability of price regulation; establish long-term interests of the compensation mechanism, and compensate the area with agricultural development potential according to the contribution.

Strengthen the Rural Market Circulation System, and Reduce the Circulation Cost of the Agricultural Commodities

At present, most of China's agricultural commodities circulation is still in the traditional mode: agricultural commodities should experience production, circulation, and ultimately go to consumers, and they need to go through a series of intermediate links: processors, distributors, wholesale market, farmers market or supermarket, and finally the agricultural commodities arrive in the hands of consumers, which lead to prices increase of two or three times. It is necessary to promote the market circulation of agricultural commodities through various of forms, and actively promote the agricultural commodities – supermarket docking, agricultural commodities – school docking, agricultural commodities – wholesale market docking, to reduce the circulation of agricultural commodities and lower the costs; continue to play an important role in large market and distributors, set up the specialized organization representing the interests of farmers, and play the role of the broker of agricultural commodities, to improve the negotiating capacity of farmers and dealers to depress the prices of agricultural commodities.

Improving the Overall Agricultural Production Capacity, and Protect the Effective Supply of Agricultural Commodities

Inadequate supply of agricultural commodities is the intrinsic reason for agricultural prices increases, while improving the comprehensive agricultural production capacity can ensure the effective supply of

agricultural commodities. So it is necessary to improve agricultural basic production conditions, such as water conservancy, and enhance agricultural ability to resist natural risks; to speed up agricultural technology innovation and technology transfer, promote agricultural technology service, and improve the science and technology content of agricultural production; to improve the standardization and branding of agricultural commodities, and promote the standardization of agricultural varieties and specifications; to promote the agriculture industrialization, accelerate the transformation of traditional agriculture to modern agriculture, lead farmers to carry out specialized, standardized, large-scale and intensive production, and promote agricultural modernization.

References

Bai, T. T. (2012). Agricultural prices reappear "agitation." *Economic Reference Daily*, 2012/03/20 (in Chinese).

Chen, H. S., & Lv, T. (1997). Effect of the prices change of Agricultural Price on Farmers. *China Rural Survey*, 2, 39-43(in Chinese).

Fox, K. A. (1953). A spatial equilibrium model of the live-stock-feed economy in the United States. *Economitrica*, *41*, 547-566.

Frankel, J. A. (1986). Expectations and commodity price dynamics: The overshooting model. *American Journal of Agricultural Economics*, *68*(2), 344-348.

Fu, J. W. (2011). Study on the abnormal price increase of the agricultural products and building a sound and effective price mechanism of the agricultural products. *Journal of Central University of Finance & Economics*, 2, 68-72 (in Chinese).

Guo, S., & Ma, Y. M. (2007). Study on the effect of agricultural price trend on the farmers' income. *Inner Mongolia Statistics*, *3*, 18-20 (in Chinese).

Han, C., & Xia, Y. H. (2011). Demonstration analyze on price fluctuation of farm products and policy suggestion at present. *Ecological Economy*, *7*, 117-120. (in Chinese).

Lapp, J. S., & Smith, V. H. (1992). Aggregate sources of relative price variability among agricultural commodities. *American Journal of Agricultural Economics*, *74*(1), 1-9.

Li, W., Li, X., & Wang, S. G. (2003). Effect of agricultural price change on the farmers' income in poor areas. *China Rural Survey*, *12*, 18-21 (in Chinese).

Nerlove, M. (1956). Estimates of elasticities of supply of selected agricultural commodities. *Journal of Farm Economics*, *38*, 496-509.

Shi, M. J., Wang, Y., & Zhu, X. Z. (2009). Effect of energy and food prices fluctuation on urban and rural economic relationship. *Chinese Rural Economy*, *5,* 4-13 (in Chinese).

Wen, L., & Wen, T. J. (1997). Comparative analysis on Chinese grain supply cycle and price. *Management World*, *4*, 169-176 (in Chinese).

Zhang, W. L., & Liu, H. B. (2008). Establishment of the long-term mechanism to increase farmer income supported by financial policy. *Journal of Agrotechnical Economics*, *2*, 80-84 (in Chinese).