Research on Correlation between Farmer's Agricultural Income and Agricultural Output in China Based on Dynamic Analysis

CAO Kun *

School of Economics& Management, Southwest Jiaotong University, Chengdu 610031, China

Abstract In this paper, we study the decision mechanism of prices of agricultural products and output of agricultural products, and establish simultaneous equation model between farmers' agricultural income and the total output of agricultural products, to analyse the dynamic relationship between the two. The results show that farmers' agricultural income affects output of agricultural products via price, and is also affected by output of agricultural products; the output of agricultural products is determined by the prices of agricultural products in the previous period, and if the prices of agricultural products in the previous period rise, then the total output of agricultural products in the current period increases; the prices of agricultural products are affected by output of agricultural products and urban and rural residents' income, the urban residents' income having greater impact; the supply elasticity of agricultural products is greater than demand elasticity, therefore, the balance between price and output can not regress after being breached, needing the government to conduct macro-control.

Key words Agricultural income, Output of agricultural products, Dynamic correlation, China

There are diverse sources of farmers' income in China, which can be divided into two categories, agricultural income and non-agricultural income, according to the relationship between sources and agriculture. The agricultural income that also can be called the income from the primary income operated by the rural households, is the farmers' income obtained through engaging in production and management activities, taking family as the basic production unit, which includes farming income, forestry income, animal husbandry income and fishery income. The agricultural income obtained has an important share in farmers' net income. In the year 2009, approximately 40% of the net income of farmers in China is agricultural income.

Farmers' agricultural income is closely related to the development of agricultural industry. The existing researches hold that the major way to increase agricultural income is to promote the development of agricultural industry. For example, Liu Jinbao *et al.* research the impact of technological advances in agriculture on growth of agricultural income[1]; Fang Hong *et al.* analyse the forcing of building of productive public facilities in rural areas on the level of agricultural income[2]; Yu Mingjiang proves that the positive changes in agricultural structure is conducive to increase of agricultural income[3]; Zhu Linqiang researches the impact of the planting area of agricultural crops on agricultural income[4]; Li Hui *et al.* mainly research the impact of agricultural mechanization on the growth of agricultural income[5]; Yang Chunling *et al.* analyse the role of investments in basic agricultural construction, agricultural loans and agricultural insurance in promoting agricultural income[6].

However, these studies implicitly assume that farmers' agricultural income does not affect the development of agricultural industry. As far as I am concerned, under the regulation of prices of agricultural products and demand of agricultural products, there is a dynamic correlation between agricultural income and the total output of agricultural products. Under regulation of the market, the scale of agricultural industry expands, the output of agricultural products increases, and the prices of agricultural products decline, thus the farmers' agricultural income is affected; on the contrary, the growth of agricultural income will increase the income of rural households, and the increase in income will lead to increase in demand for agricultural products and rise in prices of agricultural products, attracting farmers to increase inputs into agriculture so as to augment the output of agricultural products[7].

1 Change in circulation system of agricultural products in China after reform

The price of agricultural products is the most important linking variable between farmers' agricultural income and output of agricultural products, and the research on correlation between the farmers' agricultural income and output of agricultural products needs to be established on the basis of analysis of pricing mechanism of agricultural products. The pricing mechanism of agricultural products is a part of circulation system of agricultural products. In the process of the reform and opening-up, the circulation system of agricultural products in China experienced a shift from planned economy to market economy, and this change can be divided into four stages.

1.1 The first stage: initial stage of reform of circulation system of agricultural products (1979 – 1984) Before the reform and opening-up, the circulation of China's agricultural

＊ Corresponding author. E-mail: 18615787560@163.com

products ran under the mode of plan control. After the Third Plenary Session of the Eleventh Central Committee, the reform target of speeding up agricultural development and improving supply capacity of agricultural products, promoted the gradual marketization of circulation system of agricultural products. The period 1979 – 1984 was adjustment period of the policy of state monopoly over purchase and marketing of agricultural products in China. In this period, the circulation system of agricultural products experienced the gradual transition from the planned way to marketization, which laid foundation for the establishment of market circulation system of agricultural products in China. The policy adjustment is mainly reflected in four aspects as follows. First, it reduced the types of agricultural products whose unified purchase and marketing are limited by the government. In the period 1979 – 1980, the scope of unified and fixed state purchase of agricultural products re-limited by the state stipulated: the products via unified purchase were four kinds of agricultural products (grain, cotton, oilseeds and wood), and the agricultural products purchased by state quotas were reduced to tobacco, tea, and other 125 varieties. As of the end of 1984, the types of agricultural products via unified and fixed state purchase were further reduced to 38. Second, the task of unified and fixed state purchase of agricultural products was eased, for example, the national food acquisition task in 1979 was reduced by 2.5 million t based on that of the previous year. Third, the purchase price of agricultural products was increased, and in the year 1979, the increase rate of national purchase price of grain, oilseed, cotton and other 18 kinds of farm and sideline products reached 24.8%. Fourth, the trade fairs in rural areas were liberalized gradually, and after the farmers completed the task of unified and fixed state purchase, the agricultural products were allowed to enter the market for free trade.

1.2 The second stage: revoked unified and fixed state purchase and implemented "double-track system" on the food price (1985 – 1991) As the basic production organization pattern under household contract responsibility system in rural areas experienced dramatic changes, in conjunction with the role of reform of circulation system of agricultural products in spurring agricultural production, in the initial period of the reform and opening-up, the output of agricultural products increased rapidly. In 1984, the grain output in China reached 407.31 million t, increasing by 33.6% compared with that in 1978, and the output of cotton, and sugar also reached 6.258 and 47.8 million t, respectively. Due to the constraints of financial capacity, the state-owned enterprises of agricultural products were difficult to "digest" the growing production capacity of agricultural products, that is, under the unified purchase system of agricultural products, the state's financial capacity became the bottleneck of agricultural growth, thus the unified purchase system was badly in need of reform. As to the purchase of grain and cotton, The Document No. 1 *Ten Policies on Further Activating the Rural Economy* issued by the Central Government in 1985 brought up the change of unified purchase into contract ordering, The ordering of grain is based on thirty per-

cent of the original unified purchase price and seventy percent of the original price of purchase beyond state quota for valuation, and outside the ordering, the grain could be traded freely. This is "double-track system" of food circulation. "Double-track system" is the system design of implementing state purchase and marketing inside the plan, and market purchase and marketing outside the plan on the same product, in transitional process of economic system from planned economy to market economy in China. The "double-track system" of grain circulation implemented in China, specifically, refers to the two channels of grain procurement and marketing (unified ordering marketing, and bargaining purchase and marketing). Apart from grain and cotton, the purchase of pigs, aquatic products and other agricultural products by state quotas were also phased out. This document as a symbol, the traditional system of unified purchase and purchase by state quotas was gradually repealed, market adjustment mechanism of agricultural products was gradually established, and the planned purchase by contract ordering, and market purchase and marketing coexist.

1.3 The third stage: ordered agricultural products by contract and liberalized the sale price (1991 – 1993) Although the policy of "double-track system" regarding distribution channels of agricultural products is favorable to enhancement of circulation capacity of agricultural products and agricultural development, in the context of tight control over sales price of agricultural products in state-owned enterprises, the agricultural products by the state ordering and negotiated purchase, are sold at state fixed prices, thus there is a need to subsidize the difference between purchase and sale of agricultural products. The subsidies for agricultural products cause great pressure on the state finance. In order to ease the onerous financial burden, and at the same time, maintain prices of agricultural products and stir the farmers' agricultural production enthusiasm, China conducted the marketization reform of sales of agricultural products at the end of 1991, and relax control over the prices of grain, cooking oil and other agricultural products formerly marketed by the state-owned enterprises at state fixed prices. In 1991, the retail price of grain purveyed by the state-owned enterprises to urban residents was raised by 68%, and the price of cooking oil was raised by 170%. In 1993, China's cities stopped the implementation of rationing of grain and the planned sales, thus the food stamp system was canceled thereupon. In this period, the purchase of agricultural products was further loosened. In 1993, *Notice on Speeding up Reform of Grain Circulation System* promulgated by the State Council, required the state grain ordering price to be figured according to market prices, and at the same time revoked the state purchase of cooking oil. The reform of circulation system of agricultural products eased the inverted purchase and marketing of agricultural products, and further rationalized the relationship between all aspects in the circulation field of agricultural products.

1.4 The fourth stage: marketization circulation of agricultural products, and establishment of national macro-control mechanism (after 1994) After the year 1994, the agri-

cultural products achieved free trade and marketization circulation. The state should some measures, such as grain and food risk fund, the lowest price protection system of agricultural products, and special reserve system of agricultural products, to improve the function of macro-regulation, reduce fluctuations in market supply of agricultural products, avoid ups and downs of the market price of agricultural products, protect the farmers' efficient production, and promote the healthy development of agriculture.

2   Data source, index selection and research method

2.1   Data source   The data source is *China Statistical Yearbook* from 1994 to 2006, *China Survey Yearbook of Prices of Agricultural Products*, *Compilation of Agricultural Statistics over Three Decades of the Reform and Opening-up*, *China's Rural Household Survey Yearbook*, and *China Yearbook on City (Town) Life and Price*, and I select 16 years of data in the period 1994–2009.

2.2   Index selection   I take the total output value of agriculture, calculated according to comparable price in the year 1978 as the base year, as the statistical indicator of variable Q_t (output of agricultural products); use the production price indicator of agricultural products with the year 1978 as the base to signify P_t (prices of agricultural products); use the income from the first industry operated by rural households calculated at current prices to signify IRA_t (farmers' agricultural income per capita; use farmers' income per capita to subtract farmers' income per capita from the first industry operated by the households to signify IRB_t (farmers' non-agricultural income per capita); use rural residents' net income per capita in China to signify IR_t; use the indicator of urban residents' disposable income per capita in China to signify IU_t.

2.3   Research method   I adopt the empirical analysis method to conduct research.

3   Establishment of simultaneous equation model

The simultaneous equation model of the total output of agricultural products in China and farmers' agricultural income includes four parts: the equation of output of agricultural product; the equation of prices of agricultural products; the equation of agricultural income; definition equation of farmers' income.

3.1   Equation of output of agricultural products   With the reform of China's circulation system of agricultural products, after 1994, the prices of agricultural products were loosened, the system of state monopoly over purchase and marketing was repealed, and the market circulation system of agricultural products was established. In market environment, since the agricultural product a kind of product with long production cycle, when the production conditions are certain, the production decision-making of rural households is determined by the prices of agricultural products in the previous period. Therefore, the logarithmic model on the basis of the supply function is chosen to con-

struct equation of output of agricultural products. In the case of certain production conditions, the supply function is $Q_s = f(P_{t-1})$. The supply of agricultural products is the total output of agricultural products that the farmers are willing to provide in the current period, then the equation of output of agricultural products is as follows:

$$\ln Q_t = a_0 + a_1 \ln P_{t-1} + \mu_1 \qquad (1)$$

3.2   Equation of prices of agricultural products   Under the condition of agricultural products priced by the market, prices of agricultural products reflect the relationship between supply and demand in market. In the case of other conditions unchanged, when the demand for agricultural products is determined, the market price of agricultural products is determined by the supply of agricultural products. The more the agricultural products supplied by the market, the lower the market price of agricultural products, and likewise, when the agricultural products supplied by the market decline, the prices of agricultural products will rise. The function of prices of agricultural products is $P = g_1(Q_s)$. We further loosen up the assumption of unchanged demand for agricultural products, to examine the impact of income changes on prices of agricultural products. Increase in income will lead to increase in demand for agricultural products, so that the demand curve moves to the right, therefore, the function of prices of agricultural products is as follows:

$$P = g(Q_s, IU, IR)$$

where IU is urban residents' income and IR is rural residents' income. Similar to the equation of output of agricultural products, I choose logarithmic model to construct the equation of prices of agricultural products as follows:

$$\ln P_t = b_0 + b_1 \ln Q_t + b_2 \ln IU_t + b_3 \ln IR_t + \mu_2 \qquad (2)$$

3.3   Equation of agricultural income   The farmers' agricultural income is determined by two factors, namely output of agricultural products and sales price of agricultural products. Thereby the equation of agricultural income is constructed using logarithmic model as follows:

$$\ln IRA_t = c_0 + c_1 \ln Q_t + c_2 \ln P_t + \mu_3 \qquad (3)$$

3.4   Definition of equation   According to definition, farmers' income is the summation of agricultural income and non-agricultural income, thus there is the following equation:

$$IR_t = IRA_t + IRB_t \qquad (4)$$

By linking equation (1) – (4), we get the simultaneous equation model of farmers' agricultural income and the total output of agricultural products:

$$\begin{cases} \ln Q_t = a_0 + a_1 \ln P_{t-1} + \mu_1 \\ \ln P_t = b_0 + b_1 \ln Q_t + b_2 \ln IU_t + b_3 \ln IR_t + \mu_2 \\ \ln IRA_t = c_0 + c_1 \ln Q_t + c_2 \ln P_t + \mu_3 \\ IR_t = IRA_t + IRB_t \end{cases} \qquad (5)$$

The variables in model (5) include Q, P, IR, IRA, IRB, IU, P_{t-1}, where variable Q, P, IR, IRA are endogenous variable; IRB, IU are exogenous variable; P_{t-1} is endogenous predetermined variable. The exogenous variable and endogenous predetermined variable are both predetermined variable.

Through identification and judgement on simultaneous equation model, all equations in the model can be identified and the model is overidentified.

4　Estimation results of coefficient

As the model is overidentified, so I choose to use two stage least squares (TSLS) for estimation, and the estimates can be seen in Table 1.

Table 1　Estimation results

Coefficient	Estimated value	Standard error	T statistic	Probability
a0	4.891 080	2.408 697	2.030 591	0.049 7
a1	0.618 765	0.388 608	1.592 261	0.120 1
b0	20.966 400	2.617 127	8.011 227	0.000 0
b1	−4.222 766	0.603 233	−7.000 228	0.000 0
b2	1.634 223	0.432 434	3.779 128	0.000 6
b3	0.934 701	0.328 542	2.844 997	0.007 3
c0	−2.474 961	0.459 811	−5.382 565	0.000 0
c1	0.662 378	0.052 323	12.65 949	0.000 0
c2	0.623 394	0.074 647	8.351 205	0.000 0

Substitute coefficient estimates into equation (1) − (3), and get expression (6) as follows:

$$\begin{cases} \ln Q_t = 4.89 + 0.62 \ln P_{t-1} \\ \ln P_t = 20.97 - 4.22 \ln Q_t + 1.63 \ln IU_t + 0.93 \ln IR_t \\ \ln IRA_t = -2.47 + 0.66 \ln Q_t + 0.62 \ln P_t \end{cases} \quad (6)$$

The sign of all coefficients of estimates is in line with economic theory. Apart from coefficient a_1, t test of coefficient estimates of the rest variables is significant at the level of 5%. The estimation effect of model is good.

As to the second equation in expression (6), the coefficient estimate of is 4.22, which means that when the income is constant, the elasticity of output of agricultural products to price is 4.22, and calculate the reciprocal of it, to get the price elasticity of demand at 0.24.

5　Conclusions

From analysis, we can draw the following conclusions.

First, from the equation of output of agricultural products, farmers' agricultural production decision-making hinges on prices of agricultural products in the previous period. If the prices of agricultural products in the previous period rise, then the farmers will choose to increase agricultural inputs, the total output of agricultural products in the current period increases, and the production price elasticity of agricultural products is 0.62.

Second, from the equation of prices of agricultural products, the prices of agricultural products are affected by output of agricultural products and urban and rural residents' income. In the case of constant yield, increase in urban and rural residents' income will lead to increase in consumer demand for agricultural products, and rise in prices of agricultural products. The elasticity of prices of agricultural products to urban residents' income is 1.63, and the elasticity of prices of agricultural products to rural residents' income is 0.93. The urban residents' income has greater impact on prices of agricultural products than rural residents' income.

Third, assuming that the other conditions remain unchanged, from the equation of prices of agricultural products, we can know the change of prices of agricultural products arising from output of agricultural products, and this change occurs along the fixed demand curve, therefore, we can get the price elasticity of demand of agricultural products, only needing to work out the reciprocal of estimated coefficient of the variable of output of agricultural products. We get the following results: the price elasticity of demand is 0.24; the price elasticity of supply known is 0.62; the elasticity of supply is greater than the elasticity of demand. Therefore, based on cobweb theory model, the balance between price and output can not regress after being breached. It needs the government to conduct macro-control on the market of agricultural products, so as to avoid the gradual exacerbation of fluctuations in price and output.

Fourth, the rural residents' agricultural income is affected by the total output of agricultural products and prices of agricultural products. Under the circumstance that the prices of agricultural products remain unchanged, if the output of agricultural products increases, farmers' agricultural income will increase; under the circumstance that the output of agricultural products is fixed, the prices of agricultural products rise, and farmers' agricultural income increases. Contrarily, farmers' agricultural income also has impact on output of agricultural products by virtue of price.

References

[1] LIU JB, LIU H. Correlation analysis of agricultural technological progress and increase of farmers income[J]. Chinese Rural Economy, 2004(9): 26 −37. (in Chinese).

[2] FANG H, CAO MH. An empirical study on the influence of the construction of rural base on the installation on agricultural income in villages and towns in the west of China[J]. Journal of Shandong Agricultural University: Social Science Edition, 2006(2): 45 −48. (in Chinese).

[3] YU MJ. Agricultural structure and farmer income association quantitative analysis[J]. Journal of Huainan Teachers College, 2007, 9 (42): 26 −29. (in Chinese).

[4] ZHU LQ, SHEN SY, WENG ZL. The influence of agricultural policy and related variables on the agricultural income of farmers in Jiangxi and its countermeasures[J]. Journal of Jiangxi Agricultural University: Social Sciences Edition, 2008, 7(4): 58 −62. (in Chinese).

[5] LI H, ZHONG MS. Quantitative study on agricultural mechanization to increase of farmers income[J]. Economic Research Guide, 2010 (16): 51 −52. (in Chinese).

[6] YANG CL, ZHOU XX. Research on factors influencing farmers' agricultural income[J]. Collected Essays on Finance and Economics, 2010(2): 13 −18. (in Chinese).

[7] JOHNSON DAVID GALE. Agricultural, rural and peasant problem in economic development[M]. Translated by LIN YF, ZHAO YH. Beijing: Commercial Press, 2004. (in Chinese).