Analysis of the Dynamic Relationship among Financial Fund for Agriculture, Agricultural Output Value and Farmers' income

TIAN Cui-jie *

Tianjin Agricultural University, Tianjin 300384, China

Abstract By using the methods of co-integration, impulse response function and variance decomposition, I conduct the empirical research on the dynamic relationship among China's financial fund for agriculture, agricultural output value, and farmers' income from the year 1978 to the year 2009. The results indicate that the government's financial fund for agriculture plays the significant role in promoting agricultural output value and farmers' income in the long run, but this role of promoting is not prominent in the short run; in the mean time, agricultural output value plays insignificant role in promoting farmers' income and the government's financial fund for agriculture; farmers' income plays the significant role in promoting agricultural output value and the government's financial fund for agriculture.

Key words Fiscal fund for agriculture, Agricultural output value, Farmers' income, Co-integration test, Impulse response function, Variance decomposition, China

Agriculture is the basic industry of national economy, and the industry related with the livelihood of people. Using public fiscal expenditure to support agriculture and benefit farmers is the main macro-control measure in the world. Thus, using fiscal expenditure to support agriculture and increasing agricultural inputs are of great strategic significance in promoting the agricultural development of China and increasing farmers' income. In recent years, many scholars pay wide attention to the problems concerning fiscal expenditure for agriculture, and conduct empirical research on the impact of fiscal expenditure for agriculture on agricultural output value and farmers' income. They mainly adopt econometric methods to conduct calculation, such as CD production function method, VAR model analysis, co-integration analysis, Granger causality test, panel data model and so on. But few conduct research on the mutual relationship among fiscal expenditure for agriculture, agricultural output value and farmers' income. In addition, the mutual impact among variables may has time effect. By using Eviews software, I conduct co-integration test, variance decomposition and impulse response analysis on the three variables, so as to judge the short-term and long-term dynamic relationship. Corresponding countermeasures and suggestions are put forward to increase agricultural output value, increase farmers' income and promote the efficiency of fiscal expenditure for agriculture.

1 Variable selection, data source and research method

1.1 Variable selection and data source I select net income per capita of rural households to reflect the income level of farmers, denoted by S; I select the output value of the primary industry to reflect the state of agricultural output value, denoted by G; I select the national financial expenditure used for agriculture to reflect the level of fiscal expenditure for agriculture, denoted by Z. The variable data are selected from year data from 1978 to 2009, and all the data come from *China Statistical Yearbook*[1]. In order to overcome the heteroscedasticity phenomenon in time series, I take natural logarithm of all variables, expressed as ln$S$, ln$G$, and ln$Z$ respectively.

1.2 Research method I mainly use co-integration test, impulse response function, and variance decomposition to analyze the dynamic relationship between variables. These three methods are on the basis of VAR model. This model uses the simultaneous multi-equation form, not based on economic theory. In every equation of the model, the endogenous variables conduct regression on the lagged values of all endogenous variables, so as to estimate dynamic relationship of all endogenous variables.

1.2.1 Co-integration test. Co-integration test is the statistical description of long-term equilibrium relationship of non-stationary economic variables. Amid non-stationary economic variables, the long-term equilibrium relationship is called as co-integration relationship[2]. In the economic sphere, most of macroeconomic variables are non-stationary, so it seems that there is hardly any long-term equilibrium relationship, but in fact, the linear combination of certain given economic variables may be stationary, that is, there is long-term stable equilibrium relationship among them.

Co-integration test has two ways, namely EG two-step method and Johansen co-integration test method based on VAR model (the method chosen by me). The former conducts test based on regressed residual sequence for single equation and the variables are divided into two types of exogenous varia-

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* Corresponding author. E-mail: tcj2001@163.com

bles and endogenous variables; the latter, the test on the basis of the regression coefficient and multi-equations, is without classification of exogenous variables and endogenous variables. In general, the latter is better than the former, and the test effect of the latter is higher to some extent[3].

We can see from the definition of co-integration that co-integration test has close relationship with unit root test. Prior to testing the co-integration or long-term equilibrium relationship of a group of time series, we should first test integration order of time series. If there are only two variables, then the integration order of two variables should be the same. If the number of variables is more than 2, that is to say, the number of interpretation variables is more than 1, the integration order of the variables to be interpreted cannot be higher than the integration order of any interpretation variable; in addition, when the integration order of interpretation variables is higher than the integration order of variables to be interpreted, then there must be two interpretation variables at least whose integration order is higher than integration order of variables to be interpreted[2].

1.2.2 Impulse response function and variance decomposition. The idea of using time series to analyze the influencing relationship is to consider how the impact of disturbance term spreads to all the variables. In practical application, as VAR model is a non-theoretical model, and we do not need to conduct any priori constraint on variables, therefore, when analysing VAR model, it often does not analyse the impact of the change of one variable on another variable, but analyses the dynamic impact on system when one error term changes, or the model bears certain brunt. This analysis method is called as Impulse Response Function (IRF). It is to observe how the variables react to the impact in the model over time, and is used to measure the impact of brunt of one standard deviation from the random disturbance term on the current and future value of the endogenous variables. However, it is slightly too elaborate, for the influencing relationship between variables can be explained simply. Therefore, based on Vector Moving Average VMA (∞) model, Sims in 1980 advanced variance decomposition method, to grasp the influencing relationship between variables quantitatively but roughly. By analysing the contribution of each structure impact to change of the endogenous variables (usually measured by variance), it is further to evaluate the importance of the impact of different structures. Therefore, the variance decomposition gives the information of relative importance of each random disturbance term which can exert impact on the variables in VAR model[4].

2 Results and analysis

2.1 Co-integration analysis Prior to the establishment of VAR model, we should first test whether there is co-integration relationship in a group of time series, while before testing co-integration relationship, we must test non-stationarity (or integration) and integration order of variables.

2.2.1 Unit root test. When $\alpha=0.05$, $T=32$, *ADF* critical value of the unit root test regression equation including time trend term, is -3.57, while *ADF* value of the unit root test of variable ln*S*, ln*G* and ln*Z* is -2.68, -1.69 and -3.43, all bigger than -3.57, so the three variables are non-stationary series. Then we should further test non-stationarity of first-order difference sequence Δ ln*S*, Δ ln*G* and Δ ln*Z* of three variables and determine the integration order of them. Test results show that they are stationary series, that is, ln*S*, ln*G* and ln*Z* are first-order integration series.

2.2.2 Co-integration test. We use Johansen method to conduct co-integration test. Before testing, we should first determine the lag period *k* of VAR model, because if the lag period *k* is too small, then the auto-correlation of the error term is sometimes very serious, resulting in the inconsistent estimation of parameter, while if *k* value is too big, it can reduce the free degree, exerting direct impact on the effectiveness of the estimation of model parameter[2]. We usually judge the lag period based on the principle of statistic minimum value of AIC and SC of VAR model. The statistic of VAR model in period 0 to 4 established by me can be seen in Table 1. Apart from maximum likelihood statistic, the value in lag period 2 of other statistics (with * in the table) is the least, therefore, establishing VAR model in lag period 2 is sufficient to eliminate auto-correlation existing in the random error term.

Table 1 Lag period selection of VAR model on Ln*S*, Ln*G* and Ln*Z*

Lag period	Maximum likelihood estimate LogL	Test statistic LR	Final prediction error FPE	Akaike Information Criterion statistic AIC	Schwartz Criterion statistic SC	*HQ*
0	4.147 299	NA	0.000 185	−0.081 950	0.060 786	−0.038 314
1	128.657 8	213.446 6	4.86e −08	−8.332 702	−7.761 757	−8.158 159
2	146.624 0	26.949 24*	2.63e −08*	−8.973 142*	−7.973 989*	−8.667 691*
3	150.572 5	5.076 631	4.03e −08	−8.612 320	−7.184 958	−8.175 961
4	163.509 3	13.860 89	3.47e −08	−8.893 522	−7.037 952	−8.326 256

We use Johansen method to conduct co-integration test on relationship among Ln*S*, Ln*G* and Ln*Z*. The test results can be seen in Table 2.

In Table 2, as $LR=42.556\ 36>35.192\ 75$, so at 5% level, it rejects the null hypothesis when there is no co-integration equation, thinking that among the three variables, there is at least one co-integration equation; similarly, we should continue to test whether there is one co-integration relation or there are two co-integration relations among the three variables. Eventually we get the conclusion as follows: there are two co-integration equations among the three variables. The standardized co-integration equation is as follows:

$$\ln S=4.113\ 2+0.368\ 6\ln Z$$
$$(-6.39)\quad(-3.58)$$
$$\ln G=6.103\ 7+0.329\ 6\ln Z$$
$$(-8.34)\quad(-2.82)$$

Table 2 Results of co-integration test on Ln*S*, Ln*G* and Ln*Z*

Null hypothesis	Eigenvalue	Trace statistic	Critical value at 5% level	Conclusion
Rk(∏) =0 has no co-integration relationship	0.533 374	42.556 36	35.192 75	Reject null hypothesis
Rk(∏) =1 has one co-integration relationship at most	0.384 372	20.451 79	20.261 84	Reject null hypothesis
Rk(∏) =2 has two co-integration relationships at most	0.197 579	6.383 539	9.164 546	Accept null hypothesis

This shows that the economic system composed of the selected indicators, has the long-term equilibrium relationship. In the short term, due to random interference, these variables may deviate from the equilibrium value, but this deviation is temporary, and will eventually return to equilibrium, that is, the selected indicators is suitable for the aforesaid VAR model.

2.2 Impulse response analysis We continue to conduct impulse response function analysis on the above VAR (2) model, to estimate the impact of one random disturbance of China's financial fund for agriculture, agricultural output value, and farmers' income on the other endogenous variables. Only through the stable VAR model can we conduct impulse response analysis, while the sufficient and necessary condition of stable VAR model is that all eigenvalues of parameter matrix of VAR model are within the unit circle, or eigenvalues must be less than 1[5]. As shown in Fig. 1, all eigenvalues of parameter matrix of VAR model in this research are within the unit circle, so we can conduct impulse response analysis, and the impulse response function value of 3 variables in the lag period over a decade can be seen in Table 3.

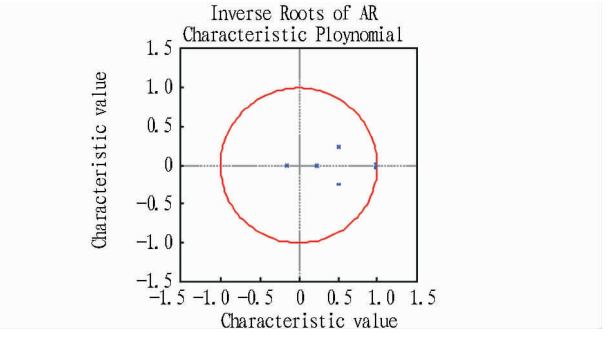

Fig.1 Stationarity test of VAR model

Table 3 Impulse response value in a decade of Ln*S*, Ln*G* and Ln*Z*

Order	Variable		1	2	3	4	5	6	7	8	9	10
①	ln*S*	ln*S*	0.049 5	0.079 8	0.094 1	0.099 7	0.100 7	0.099 9	0.098 7	0.097 4	0.096 4	0.095 5
		ln*G*		0.010 9	0.024 0	0.034 0	0.040 2	0.043 3	0.044 6	0.044 8	0.044 7	0.044 5
		ln*Z*		−0.005 2	−0.002 8	2.91E−05	0.002 1	0.003 2	0.003 4	0.003 1	0.002 6	0.002 0
②	ln*G*	ln*S*	0.070 4	0.092 1	0.100 3	0.103 3	0.104 0	0.103 3	0.102 1	0.100 7	0.099 2	0.097 8
		ln*G*	0.033 2	0.040 0	0.043 0	0.045 5	0.047 2	0.048 3	0.048 6	0.048 5	0.048 2	0.047 8
		ln*Z*		−0.001 0	−0.002 1	−0.002 2	−0.002 1	−0.002 0	−0.002 1	−0.002 3	−0.002 6	−0.002 9
③	ln*Z*	ln*S*	0.029 6	0.048 1	0.059 3	0.071 6	0.082 8	0.092 4	0.100 4	0.107 1	0.113 0	0.118 2
		ln*G*	0.039 0	0.023 8	0.012 9	0.009 4	0.011 4	0.015 8	0.020 9	0.025 7	0.030 0	0.034 0
		ln*Z*	0.102 6	0.075 8	0.066 6	0.058 5	0.053 6	0.050 5	0.048 2	0.046 2	0.044 3	0.042 3

First, the response of Ln*S* to all random disturbances can be shown in Section ① of Table 3. The response of it to one random disturbance of itself is most intense; there is also certain response to one disturbance of Ln*G* equation, but this response emerges from the second year and increases year by year. The response value increases from 0.010 9 in the second year to 0.044 8 in the eighth year, and this value dwindles and tends to be stable thereafter; the response to one random disturbance of ln *Z* equation is very small. The response emerges in the second year, and the response changes from negative to positive, and increases year by year, reaching the maximum in the seventh year, but the response value is only 0.003 4, and it decreases subsequently to some extent.

Second, the response of Ln*G* to all random disturbances can be shown in Section ② of Table 3. The response of it to the random disturbance of Ln*S* equation is most intense. The response in the year is 0.070 4, and increases year by year, reaching the maximum of 0.104 0 in the fifth year. The response begins to decrease in the sixth year, but in the tenth year, it is still 0.097 8; the response of it to the random disturbance of itself is big and stable. In addition to the response value of 0.033 2 in the first year, and the response value in other years is in 0.040 0 −0.047 8; the response of it to the random disturbance of Ln*Z* equation is negative, but the response is weak, reaching the maximum in the tenth year, with absolute value of 0.002 9.

Third, the response of Ln*Z* to all random disturbances can be shown in Section ③ of Table 3. The response of Ln*Z* to all the random disturbance is relatively big. The response of it to one random disturbance of itself decreases from 0.102 6 to 0.042 3 year by year; the response of it to the random disturbance of Ln*S* equation increases from 0.029 6 to 0.118 2 year by year; the response of Ln*G* equation to all random disturbances first decreases from 0.039 0 to 0.009 4 in the fourth year, and then increases from 0.011 4 in the fifth year to 0.034 0.

2.3 Variance decomposition The variance decomposition result of 3 variables in lag period over a decade can be seen in Table 4.

First, the variance decomposition result of ln*S* can be shown in Section ① of Table 4. The contribution of itself has a large proportion, and the contribution in the year reaches 100%. It dwindles gradually with time, but it still accounts for 86.44% in the tenth year; the contribution of ln*G* increases year by year, increasing from 1.32% in the second year to

13.48% in the tenth year; the contribution of ln*Z* is small, the maximum value is only 0.3% of that in the second year, and in most of other periods, it is less than 0.1%.

Table 4 Variance decomposition in a decade of Ln*S*, Ln*G* and Ln*Z*

Order	Variable		1	2	3	4	5	6	7	8	9	10
①	ln*S*	S.E.	0.049 5	0.094 7	0.135 6	0.171 7	0.203 1	0.230 5	0.254 7	0.276 4	0.296 1	0.314 3
		ln*S*	100.00	98.38	96.04	93.61	91.51	89.86	88.62	87.69	86.99	86.44
		ln*G*	0.00	1.32	3.77	6.27	8.39	10.05	11.29	12.22	12.93	13.48
		ln*Z*	0.00	0.30	0.19	0.12	0.10	0.09	0.09	0.09	0.08	0.08
②	ln*G*	S.E.	0.077 9	0.127 0	0.167 5	0.202 0	0.232 1	0.258 6	0.282 3	0.303 6	0.323 0	0.340 9
		ln*S*	81.79	83.23	83.74	83.75	83.53	83.25	82.97	82.71	82.50	82.31
		ln*G*	18.21	16.76	16.24	16.22	16.44	16.72	17.01	17.26	17.47	17.65
		ln*Z*	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.04
③	ln*Z*	S.E.	0.113 7	0.146 8	0.172 3	0.195 7	0.219 5	0.244 0	0.269 0	0.294 4	0.319 9	0.345 3
		ln*S*	6.80	14.82	22.60	30.88	38.80	45.76	51.58	56.32	60.19	63.37
		ln*G*	11.76	9.67	7.58	6.11	5.13	4.57	4.36	4.40	4.62	4.93
		ln*Z*	81.44	75.51	69.81	63.01	56.07	49.66	44.06	39.27	35.19	31.71

Second, the variance decomposition result of Ln*G* can be shown in Section ② of Table 4. The contribution of Ln*S* has a large proportion, and the contribution in each period is in 81.79% – 83.75%; followed by itself, the contribution is in 16.22% – 18.21%, and the biggest contribution in that very year is 18.21%; the contribution of Ln*Z* is very small, and the maximum value is only 0.04% of that in the tenth year. The contribution in that very year is 0, the contribution in the second year is 0.01%, the contribution in the third year is 0.02%, and the contribution from the fourth year to the ninth year is 0.03%.

Third, the variance decomposition result of Ln*Z* can be shown in Section ③ of Table 4. The contribution of itself has a large proportion in the short run, and the contribution gradually decreases with the extension of time interval, decreasing from 81.44% in that very year to 31.71% in the tenth year; accordingly, the contribution of Ln*S* increases year by year, increasing from 6.80% in that very year to 63.37% in the tenth year; as against the former two, the contribution of Ln*G* has a relatively small proportion, decreasing year by year, from 11.76% in the first year to 4.36% in the seventh year. It increases to some extent from the eighth year to the tenth year, and it is 4.93% in the tenth year.

2.4 Comprehensive analysis We conduct comprehensive arrangement on the conclusion of co-integration and impulse response analysis and variance decomposition, which can be seen in Table 5. The analysis conclusions on the mutual relationship among the three variables by the above methods are basically consistent, according to Table 5.

Table 5 Relationship of Ln*S*, Ln*G* and Ln*Z*

Impact	Co-integration relationship	Impulse response	Variance decomposition
Ln*Z* on Ln*S*	0.368 6	Small,0 – –0.002 8(3) –0.003 4(7) –0.002 0	Small ,decrease progressively,0 –0.3%(2) –0.08%
Ln*Z* on Ln*G*	0.329 6	Small,increase progressively,0 – –0.002 9	Small,increase progressively,0 –0.04%
Ln*G* on Ln*S*		Relatively small,0 –0.044 8(8) –0.044 5	Relatively small,increase progressively,0 –13.48%
Ln*G* on Ln*Z*		Relatively small,first decrease then increase, 0.039 0 –0.009 4(4) –0.034 0	Relatively small,first decrease then increase,11.76% – 4.57%(6) –4.93%
Ln*S* on Ln*G*		Relatively big,first increase then decrease,0.070 4 – 0.104 0(5) –0.097 8	First increase then decrease,81.79% –83.75%(4) – 80.31%
Ln*S* on Ln*Z*		Relatively big,0.029 6 –0.118 2	Relatively big,increase progressively,6.8 –68.3%

3 Conclusion and discussion

First, in the long run, China's financial fund for agriculture plays strong role in promoting agricultural output value, and farmers' income, but in the short run, such role of promotion is not so prominent. It indicates that increasing the government's fiscal expenditure for agriculture is an inevitable choice for the government, which has been proved by the common practice around the world. But at present, the promotion role of Chinese government's fiscal expenditure for agriculture has not been fully played, the reason of which may be that the inputs degree of fiscal expenditure for agriculture is insufficient and the structure of fiscal expenditure for agriculture is not quite rational. So, first, we should spare no efforts to strengthen fiscal expenditure for agriculture; second, we should adjust the structure of fiscal expenditure for agriculture, and promote the capital efficiency of fiscal expenditure for agriculture. In terms of increasing farmers' income, we should strengthen the extent of direct subsidies for farmers. In terms of promoting agricultural production, we should increase subsidies for green methods of agricultural production, such as adopting high-quality seeds.

Second, the agricultural output value plays insignificant role in promoting farmers' income, indicating that simply by increasing the agricultural output value to increase farmers' income nearly gets nowhere, so we should broaden the sources of income for the farmers, increase non-agricultural employment approaches, adjust the industrial structure to develop non-agricultural industries as quickly as possible, and increase

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terpart assistance of one subject with one village or one project. This "one subject" can be a county, city, or province with a more developed economy and can also be a social organization or enterprise. The "collaborative construction" is also "providing aids in construction" and able to achieve the intensive consolidation of such elements as labor, capital, materials, information and management. Efforts need to be taken to make the NRC construction enjoy the collective attention and participation of the whole society and become a "heart-winning project". Besides, in actual practices, the government should tighten the screening procedure on the subjects that are admitted into the NRC construction and establish a complete supervision and management mechanism.

4.3 Intensify science and technology input while attaching equal importance to economic and social benefits The ultimate purpose of intensifying the construction of New Rural Communities and advancing the building of new socialist countryside is to liberate and develop the rural social productivity in China through modifying and reshaping the internal structure of the rural areas. The economic base determines the superstructure, which indicates that the attaining of economic benefits still needs to be emphasized on in NRC construction and the dynamic integration of economic and social benefits should be achieved by intensifying science and technology input, making adjustment of industrial structure, as well as conducting industry upgrading. During industry adjustment and upgrading, the development of competitive and characteristic industries should be given more impetus while modern intensive agricultural production bases and agricultural products deep-processing enterprises ought to be established as a way to prolong the agricultural production chain, convert the traditional production concepts and agricultural production modes, as well as enhance the comprehensive agricultural production capability and the income of the rural residents. Furthermore, infuse low-carbon concepts into the construction of NRCs and take efforts to turn the new communities into the epitome of the organic ecological system of the rural society, with a view to building those communities that are "abundant in yielding and comfortable to live in" and would still not be outdated in 30 years.

4.4 Broaden fund-raising channels while completing the supervision mechanism Relying solely on the rural residents to raise their own funds or on the public financial support would make the funds of NRC construction strained while the operation of "Hope Primary School" into a famous charity brand and the mode of reconstruction in the Wenchuan earthquake stricken area offer us new thinking on the issue. Through publicity, appeal to all lines of the society to actively take part in the donation and building of NRCs and to support rural construction in the most immediate approach. Encourage the developed enterprises and districts to establish partnerships with the communities and provide assistance in their construction. Exert efforts to broaden fund-raising channels while completing the public supervision system and mechanism in the entire fund "raising-managing-utilizing" process. The principles of "small expenditures spent before publicized" and "large expenditures withdrawn after open application" should prevail in common practices and strive to carry out the "sunny finance" project at the village level. The aim is to make the establishment of a fund supervision and management mechanism which ensures the NRC construction funds are superintended by everyone synchronize with all the construction work of NRCs and eventually to guarantee the funds are fully utilized in the actual NRC construction.

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farmers' income sources, such as property income.

Third, farmers' income plays significant role in promoting agricultural output value. This indicates that farmers are the principal investors in agricultural production. If farmers' income is increased, it can increase the inputs in agriculture, so as to promote the increase of agricultural output value, so we must do everything possible to increase farmers' income, and improve farmers' ability to invest.

Fourth, admittedly, there are many inadequacies in the model. First, from the model results, the agricultural output value and farmers' income both play the role in promoting fiscal expenditure for agriculture to some extent, and the role of the former is smaller, but in fact, this promotion role may not be direct. Because fiscal expenditure for agriculture is mainly impacted by macroeconomic situation, government revenue and national fiscal policy, when the economic aggregate grows rapidly, agricultural output value, farmers' income, tax and other economic variables generally grow rapidly. Therefore, the key to increasing fiscal expenditure for agriculture is still to promote the economic aggregate to grow rapidly and steadily. Second, as the three variables are affected by many factors, so simple equation is far from able to determine the relationship among the three, and the model is yet to be improved.

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