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Analyzing the Impact of Financial Support on Grain Yield Based on Multiple Linear Regression Models—Taking Shandong Province as an Example

Zhuo Liu*, Bowen Xue, Yihan Wang

Yanbian University, Yanbian, China
**Corresponding author: SilomyLiu@163.com*

Abstract: *The Twentieth Congress of the Communist Party of China (CPC) has brought the issue of food security back into the limelight. Grain production as a major indicator of food security issues plays an important role in the sound development of the country. In this paper, based on the data of Shandong Province from 2012 to 2020, a multiple linear regression model is set up by using stata software for empirical research to analyze the linear relationship between financial support and grain production. And further explore the utility destination of financial support on grain yield. The results show that: there is an obvious linear relationship between financial support and food production, and financial support has a positive effect on food production; the results of financial support transformed into agricultural infrastructure to play a role in the utility of the results are not significant; financial support can be indirectly ways to improve food production. Based on this conclusion, the paper makes reasonable recommendations.*

Keywords: *Food production; financial support; multiple linear regression; empirical analysis*

1. Empirical analysis of the impact of financial support on food production

1.1 Selection of indicators

(1) Financial support indicators

The indicators of financial support are intricate and complex, based on the purpose of this paper to study the impact of financial support on food production as well as data retention, this paper selects the number of people employed in the financial industry (x_1), the value added of the financial industry (x_2), and the balance of loans from financial institutions at the end of the year (x_3) as the indicators to measure financial support in Shandong Province. [1]

(2) Food production indicators

The indicator of grain production (y) in this paper is the total amount of grain produced during the calendar year, which is consistent with the indicator of grain production in the Statistical Yearbook of Shandong Province.

1.2 Data sources

In order to ensure the reliability of the data sources, all the data selected in this paper come from "National Bureau of Statistics" and "Statistical Yearbook of Shandong Province". Due to the lack of data of some indicators in the early years, in order to ensure the accuracy of the modeling, this paper selects the data of Shandong Province from 2012 to 2020 for the establishment of multiple linear regression model.

1.3 Multiple linear regression model

(1) Modeling

Due to the large difference in data magnitude between the variables (Table 1), in order to improve the fit of the model, the data were logarithmically processed, and the variables were redefined after logarithmic as lny, lnx_1, lnx_2, and lnx_3. According to the establishment method of the multivariate linear

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regression model and the definition of each variable, the model was established as follows:

$$lny_i = \beta_0 + \beta_1 lnx_1 + \beta_2 lnx_2 + \beta_3 lnx_3 + \varepsilon \quad (1)$$

In equation (1) lny is the explanatory variable i denoting time, β_0 is the regression constant, β_1, β_2, β_3 are the regression coefficients, and ε is the random error term.[2]

Table 1: Selection of financial support indicators and related variables

Explanatory variables (X)	Number of people working in finance (10,000)	x_1
	Financial value added (billions of dollars)	x_2
	Year-end loan balances of financial institutions	x_3
Explained variable (Y)	Grain production (million tons)	

(2) Regression analysis using stata

OLS regression was performed using stata software and the results are shown in Figure 1.

As can be seen from Figure 1, R2 is 0.9866 and Adj R2 is 0.9821, which is a good fit. f-value is 220.77, and its p-value is 0. F-test is passed, and the regression equation is significant as a whole. However, the t-test of each variable did not pass all, and there is multicollinearity between the independent variables.

Source	SS	df	MS	Number of obs	=	13
				F(3, 9)	=	220.77
Model	.074399203	3	.024799734	Prob > F	=	0.0000
Residual	.001011007	9	.000112334	R-squared	=	0.9866
				Adj R-squared	=	0.9821
Total	.07541021	12	.006284184	Root MSE	=	.0106

lny	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnx1	.0754205	.0488265	1.54	0.157	-.0350327	.1858738
lnx2	.2465374	.05968	4.13	0.003	.111532	.3815429
lnx3	-.1668967	.0888906	-1.88	0.093	-.3679811	.0341878
_cons	8.127557	.3670882	22.14	0.000	7.297145	8.957968

Figure 1: Regression results

(3) Multicollinearity test

Variable	VIF	1/VIF
lnx3	186.73	0.005355
lnx2	123.50	0.008097
lnx1	14.17	0.070577
Mean VIF	108.13	

Figure 2: VIF test results

As can be seen from Figure 2, the VIF values of each explanatory variable are above 10, indicating that the model suffers from severe multicollinearity.

(4) Adjustment by stepwise regression

Due to the existence of serious multicollinearity in the model, the model was adjusted by stepwise regression method, and the main method was to regress the explanatory variable grain production with each explanatory variable in one-way regression respectively, to examine the goodness of fit, t-test, and F-test results, and to select the optimal explanatory variables to form the optimal multivariate linear regression model.

1) One-dimensional regression (math.)

The explanatory variables were separately regressed on the explanatory variables in a univariate regression and the results are shown in Table 2.

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Table 2: Univariate regression results

Lny	Coefficient	Std.err	t	P>|t|	R^2	F(1,11)	Prob>F
Lnx1	0.2998458	0.04577	6.55	0.000	0.7960	42.92	0.000
_cons	7.402281	0.1694096	43.69	0.000			
Lnx2	0.1378356	0.0057322	24.05	0.000	0.9813	578.20	0.000
_cons	7.446398	0.0443445	167.92	0.000			
Lnx3	0.1649038	0.0105016	15.70	0.000	0.9573	246.57	0.000
_cons	6.732898	0.113273	59.44	0.000			

As can be seen from Table 2, the t-test and F-test of the regression of grain production on each explanatory variable separately passed, and the values of R^2 were high, with a good fit. The economic significance from the regression coefficients of each variable is also reasonable, indicating that each explanatory variable can explain the explanatory variables well. Since food production has the best fit with financial value added (x_2), financial value added is taken as the first explanatory variable of the model.

2) Consider the remaining two explanatory variables

Based on the financial value added as an explanatory variable, the remaining variables of the number of employees in the financial industry and the year-end loan balance of financial institutions are added separately. Examining the results of t-test and F-test as well as the level of improvement of the model's goodness-of-fit, it is finally found that the model's goodness-of-fit when the number of people working in the financial industry is added to the model is 0.9813 and the t-test and F-test of the explanatory variables are also passed. Therefore, the number of employees in the financial industry is added to the model as an explanatory variable. The final regression model is:

$$\ln y = 7.4443 + 0.0257\ln x_1 + 0.1369\ln x_2 \quad (2)$$

The regression coefficients for the two explanatory variables of the model, the number of people working in the financial sector and the value added by the financial sector, are 0.0257 and 0.1369, respectively. Specifically, other things being equal, for every 1% increase in the number of people working in the financial sector, food production increases by 0.0257%, and for every 1% increase in the value added by the financial sector, food production increases by 0.1369%, resulting in a positive correlation between the two explanatory variables and food production.

(5) (math.) heteroscedasticity test

In order to eliminate the effect of heteroskedasticity, this paper uses stata software to conduct BP test to determine whether the regression equation exists heteroskedasticity. The results of BP test after regression are shown in Figure 3:

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H0: Constant variance

    chi2(2) =   0.24
Prob > chi2 = 0.8863
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Figure 3: BP test results

From Figure 3, P=0.8863>0.05, it is clear that the original hypothesis is accepted and there is no heteroskedasticity in this regression equation.

2. Analysis of empirical results and shortcomings

This paper analyzes the linear relationship between financial support and food production, and from the results of multiple linear regression, there is indeed a significant linear relationship between the two, financial support can affect food production to a certain extent, and the increase in the number of people working in the financial industry and the growth of the value added of the financial industry can promote the increase in food production. However, limited by personal ability and lack of data, this paper is still insufficient for the selection of variables, but simply through the increase in financial support and food production increase speculated that there may be a correlation between the two, and thus establish multiple linear regression model to analyze the relationship between the two.

In order to further explore the specific role of financial support to increase food production, this paper further selects some of the indicators to query their data and regress them on the number of people

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employed in the financial industry and the value added of the financial industry, and analyze the utility of financial support through the regression results.

3. Empirical analysis of the impact of financial support on agricultural infrastructure development

3.1 Selection of indicators and data sources

Agricultural infrastructure construction is a factor that directly affects food production, in order to analyze the impact of financial support on agricultural infrastructure, this paper selects some relevant indicators for empirical analysis. The financial support indicators are the number of employees in the financial industry and the value added of the financial industry above, and the explanatory variables of agricultural infrastructure construction indicators are selected as the total power of agricultural machinery, the capacity of village-run hydroelectric power stations, and the ownership of rural water pumps in Shandong Province. The variables are redefined as lnx_1, lnx_2, lny_1, lny_2, lny_3. The data in this paper are all from "National Bureau of Statistics" and "Statistical Yearbook of Shandong Province". The data in this paper are all from "National Bureau of Statistics" and "Shandong Province Statistical Yearbook".

3.2 Stata regression analysis

The correlation between the variables was examined by performing a cubic regression analysis using stata software. The results are presented in Table 3 below.

As can be seen in Table 3, the fit of the regression between financial support and each of the selected indicators of agricultural infrastructure is low. From the regression coefficients, some of the variables are negatively correlated with each other, and the t-test F-test also fails. It can be seen that there is no obvious linear relationship between financial support and agricultural infrastructure development. The impact of financial support on agricultural infrastructure is not obvious.

Table 3: Three regression results

	Coefficient	Std.err	t	P>|t|	R^2	F(2,10)	Prob>F
Lny1					0.2292	1.49	0.2722
Lnx1	-0.4564159	0.278438	-1.64	0.132			
Lnx2	0.1429341	0.1152754	1.24	0.243			
Lny2					0.3972	3.29	0.0796
Lnx1	0.085468	0.0806053	1.06	0.314			
Lnx2	-0.0659591	0.0333712	-1.98	0.076			
Lny3					0.4142	3.54	0.0690
Lnx1	0.1561594	0.0321215	-2.57	0.028			
Lnx2	-0.0825627	0.1260658	30.51	0.000			

4. Impact of financial support on the interests of food producers

4.1 Variable and Data Selection

From the above it can be seen that the impact of financial support on the construction of agricultural infrastructure is not significant, the role of financial support is more to provide funds and other aspects, so this paper will next choose and finance, capital and more similar indicators to carry out regression in order to explore the utility of financial support on food production. In this paper, we will generalize it as "grain producers' interests", and its indicators are agricultural insurance premiums, labor compensation level, rural residents' consumption level, and grain sales volume. The data for all variables come from the Statistical Yearbook of Shandong Province. Again, the data are logarithmized to account for differences in data magnitude.

4.2 Stata regression analysis

The above variables were redefined as lnx_1, lnx_2, lny_1, lny_2, lny_3, and lnx_4. The two variables of financial support were analyzed in a linear regression analysis with each of the four variables of food

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producers' interests using stata software. The results are shown in Table 4.

Table 4: Four regression results

	Coefficient	Std.err	t	P>|t|	R^2	F(2,10)	Prob>F
Lny1					0.9804	250.37	0.0000
Lnx1	.656649	.2774298	2.37	0.039			
Lnx2	.874089	.114858	7.61	0.000			
Lny2					0.9796	240.44	0.0000
Lnx1	.3916989	.206243	1.90	0.047			
Lnx2	.6705656	.0853862	7.85	0.000			
Lny3					0.9944	890.10	0.0000
Lnx1	.7950011	.112296	7.08	0.000			
Lnx2	.5503599	.0464914	11.84	0.000			
Lny4					0.9165	54.85	0.0000
Lnx1	.492216	.1736723	2.83	0.018			
Lnx2	.1340531	.0719016	1.86	0.092			

From Table 4 it can be seen that the fit of regression between financial support and food producers' interests of the four variables are very high F-tests are passed, and t-tests of the variables are also passed, so it is considered that there is a clear linear relationship between the two. From the regression coefficients, there is a positive effect of financial support on the interests of food producers.[3-4]

5. Conclusions and recommendations

5.1 Conclusion

The regression analysis of this paper was carried out three times, in the first multiple linear regression analysis this paper analyzed the linear relationship between financial support and food production finally through the establishment of regression models found that there is a positive relationship between the two.

5.2 Relevant recommendations

(1) Strengthening financial literacy among rural residents

Rural residents often have little knowledge of financial matters and are not able to make effective use of the financial support provided by the Government, so improving rural residents' knowledge of the basics of finance will enable them to make better use of financial support for production activities in order to increase food production.

(2) Strengthening the capacity to translate financial support into agricultural infrastructure

As can be seen from the above, the ability of financial support to translate into direct productivity remains limited, and the factors that have the greatest impact on food production continue to be those that have a direct effect on agriculture, such as mechanized farming tools, water and electricity. Financial support provides a large amount of funds, and the effective conversion of these funds into agricultural infrastructure will have a greater impact on food production. Investing these funds in the research and development of new agricultural machinery, strengthening the construction of new and green agriculture, and ensuring the supply of water and electricity resources and high-quality fertilizers for food cultivation will be effective measures.

(3) Improving the financial system

Only the formation of a complete financial system can ensure the maximization of financial support. First of all, a complete financial evaluation system should be established, so that the flow of funds and the route of the role of finance become transparent.[5]

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