

Analysis of agricultural economic growth factors based on Cobb Douglas production

You Yang¹, Li Yang², ShouYi Liu^{1,*}

¹School of Economics and Management, Hebei North University, Zhangjiakou, Hebei 07500, China;

²Department of management, Anhui Vocational College of Defense Technology, Lu'an, Anhui 237011, China

Abstract. An empirical analysis of agricultural economic growth factors yields the main factors affecting agricultural economic growth. Based on the Cobb-Douglas function, a regression model is established to analyze the impact of production factors such as capital and labor on agricultural economic growth. After empirical analysis, it is concluded that investment is the main factor affecting agricultural economic growth. In some provinces, agricultural economic growth still uses extensive economic growth and belongs to the type of increasing returns to scale. Based on the results, three suggestions are made to promote the steady and rapid growth of the agricultural economy: increase the input of fixed assets in agriculture and attract capital from all walks of life to the agricultural production; optimize the agricultural labor force and increase human resources training; adjust the industrial structure and develop modern agriculture.

1 Introduction

Agriculture is the basis for the stability and further development of other industrial sectors of the national economy, and has made outstanding contributions to promoting national economic growth and increasing people's income. The No.1 document of the Central Government has focused on agriculture, farmers and rural areas for 17 consecutive years, effectively promoting the harmonious, sustained and stable development of the national economy.

Since the reform and opening up, the agricultural economy has achieved rapid development under the guidance of a series of laws, systems, and methods of the CPC Central Committee and various provincial committees and governments. The total agricultural economy has grown rapidly and the industrial structure has been continuously optimized. For example, the total output value of agriculture, forestry, animal husbandry and sideline fisheries in Shaanxi Province increased from 3.627 billion yuan in 1978 to 323.99 billion yuan in 2018. The total output value is 89.3 times that of 1978, with an average annual growth rate of 9.1%. Among them, the output value of agriculture increased from 3.09 billion yuan in 1978 to 224.496 billion yuan in 2018, an average annual increase of 8.7%; the output value of forestry was 10.462 billion yuan, an average annual increase of 13.2%; the output value of animal husbandry was 68.283 billion yuan, an average annual increase of 9.8%. The reason for the rapid growth of agricultural economy in Shaanxi Province is mainly due to increased investment and adjustment of labor structure. Therefore, the follow-up research mainly conducts empirical research and

quantitative analysis on the growth of agricultural economy from the aspects of capital and labor.

Many scholars have conducted many studies on agricultural economic growth. Cui Huiying and other methods have found that there is a long-term negative correlation between agricultural labor input, industrial structure adjustment and agricultural economic growth through co-integration test, vector error model correction and Granger causality test, which can combine agricultural labor input with industrial structure adjustment. Reasonably and quickly promote agricultural economic growth.^[1] Li Xiao conducted an empirical analysis of agricultural information and agricultural economic growth, and showed that agricultural information can promote agricultural economic growth. Starting from the mechanism of agricultural information's impact on agricultural economic growth, a Chinese agricultural information evaluation index system was constructed.^[2] Liu Fu and others studied the problems and paths of the agricultural economic growth mode in Liaoning Province, and believed that the agricultural economic growth mode will be changed from the previous quantitative type to the qualitative type, and proposed a path to accelerate the economic growth of Liaoning Province.^[3] Huang Hao conducted an empirical analysis of China's agricultural productive services and agricultural economic growth using the VAR model, and showed that there is a long-term equilibrium relationship between the two, which is expressed in the form of two-way interaction and mutual growth.^[4] Liu Qiong analyzed the economic growth of agricultural provinces in China based on a multi-layer statistical model, and obtained significant factors and indirect influencing factors affecting agricultural

* Corresponding author: xbliusy@163.com

economic growth. The relationship between them can effectively increase the speed of agricultural economic growth.^[5] Wen Hongmei studied the scale, structure and efficiency of rural finance based on the spatial panel DuPont model, and found that there is a spatial clustering feature between rural finance and agricultural economic growth.^[6] Zou Beizhan conducted theoretical analysis on the structural reform measures on the agricultural supply side and the effective transfer of agricultural surplus labor using the neoclassical macroeconomic growth model, and put forward many suggestions for the effective development of agricultural economic production and management activities.^[7] Yang Yang obtained the quantitative conclusion of the correlation between the two by measuring the contribution rate of scientific and technological progress to promote agricultural economic growth, and put forward countermeasures and suggestions to promote the agricultural economic growth of Hunan Province based on the mechanism analysis and calculation results.^[8] Denison decomposes the main factors affecting economic growth, and believes that the allocation of labor resources mainly depends on the transfer of labor. Scientifically and rationally shifting labor from the agricultural sector to the non-agricultural sector can promote the simultaneous growth of agriculture and other sectors.^[9]

In summary, scholars have made more in-depth research on the research of agricultural economic growth. Based on previous studies, this study took Shaanxi Province as an example, established a model based on the Cobb-Douglas economic growth theory, and used a production function to perform regression analysis on agricultural economic growth factors. The main factors of promoting agricultural economic growth and the function model of predicting agricultural output value are obtained.

2 Theoretical basis and model building

According to the analysis of the neo-classical economic growth model proposed by Robert Solow, under the condition that the external environmental factors are basically determined, the three core elements that affect agricultural economic growth are capital investment, labor force, and scientific and technological progress. Based on this theoretical basis, this study uses the mathematician Cobb and the economist Douglas to discuss the production function (Cobb-Douglas production function) created by the input and output relationship to conduct empirical analysis of agricultural economic growth factors.¹ Formating the title, authors and affiliations.

The production function is used to measure the change in output volume caused by changes in input factors such as capital and labor, that is, the production elasticity coefficient. The function expression is as follows:

$$Y = A \prod_{u=1}^n x_u^{a_u} \quad (1)$$

Y represents total agricultural output value; A represents the coefficient of scientific and technological progress; u represents the number of years; x represents the quantity of n elements, a_u represents the elastic coefficient with the n -th element. After converting it into the Cobb-Douglas production function, its function expression is:

$$Y = A(t)K^\alpha L^\beta \mu \quad (2)$$

Among them, Y represents total agricultural output, and $A(t)$ represents a certain level of technology, K represents the amount of capital input, L represents the amount of labor input, μ represents the random error term, α and β are the production elastic coefficients of K and L . The technical level is embodied as a fixed constant within a certain period of time.

To overcome the variance and correlation generated by time series data, take the natural logarithm on both sides of formula (2) to get formula (3):

$$\ln Y = \ln A + \alpha \ln K + \beta \ln L + \mu \quad (3)$$

Judging from the functional expressions of the above model, the main factors that determine agricultural economic growth are the input capital (generally refers to the net value of fixed assets), the number of labor and the overall technical level. According to the combination of A and B, there are three types:

(1) $\alpha + \beta > 1$, which explains that it is beneficial to increase the total agricultural output value by expanding the scale of agricultural production when the level of science and technology remains unchanged. At this time, the change in scale returns is an increasing trend.

(2) $\alpha + \beta < 1$, which explains that it is unfavorable to increase the total agricultural output value by expanding the scale of agricultural production while the level of science and technology remains unchanged. At this time, the change in scale returns is a decreasing trend.

(3) $\alpha + \beta = 1$, which explains that only by improving the level of science and technology can the total agricultural output value and agricultural efficiency be increased, and the scale returns at this time remain unchanged.

3 Model assumption

To calculate and analyze the model, the following assumptions need to be set: First, it is assumed that the input in agricultural economic production in Shaanxi Province is mainly in the two aspects of capital and labor, and other inputs are placed in random error term A. Second, labor expenditure and capital expenditure can be substituted for each other in production. Third, the two factors of labor and capital have a law of diminishing marginal returns. Fourth, the capital investment for agricultural economic growth in Shaanxi Province uses

the agricultural fixed asset input standard, and the number of labor is not easy to obtain. Therefore, the number of employees in the primary industry in Shaanxi Province is used to represent the agricultural labor input index.

4 Data sources and processing

This study takes shaanxi Province as an example. In order to make the indicator data truly authoritative, the data collected are all from shaanxi Economic Yearbook from 2010 to 2017. The total output value of agriculture, forestry, animal husbandry and sideline fishery Y (100 million yuan) represents the total agricultural production, the total investment in agriculture, forestry, animal husbandry and fishery society K (100 million yuan) represents the total input of agricultural capital, and the number of primary industry employees L (Ten thousand) represents the total agricultural labor inputs, P (2001=100) is the price index. The data of shaanxi's agricultural production value, capital, labor force and production price from 2010 to 2017 are shown in Table 1.

Table 1. 2010-2017 shaanxi Province's GDP, Capital, Labor Force, and Production Price.

years	Y	K	L	P
2010	1 669.1	290.2	855.5	121.7
2011	2 063.8	393.2	824.2	113.8
2012	2 309.5	496.1	796.5	102.6
2013	2 569.8	682.5	779.0	107.4
2014	2 748.6	891.4	782.6	102.1
2015	2 821.6	1 239.5	789.0	96.3
2016	2 994.8	1 421.8	791.3	98.0
2017	3 077.6	1 831.4	789.7	98.4

Note: The data comes from "China Economic Yearbook" (2010-2017).

4.1 Model assumption

The formula (3) obtained in the above model construction is a multiple linear regression model. This model can find the best function expression of the data by calculating the sum of the squares of the minimized errors. Therefore, this study uses Eviews10.0 software and uses ordinary least squares (*OLS*) to perform sample regression analysis on the data in Table 1. The final model regression results are as follows:

$$\begin{aligned} \hat{Y} &= 33.459749 + 0.210492 \ln K - 2.666561 \ln L \\ t &= (12.295\ 01) \quad (11.010\ 88) \quad (-6.789\ 123) \\ R^2 &= 0.992\ 031 \\ \bar{R}^2 &= 0.988\ 843 \\ D.W. &= 2.878\ 280 \\ F &= 311.2\ 004 \end{aligned}$$

4.1.1 Goodness-of-fit test

R^2 of the model regression equation is equal to 0.992 031, the adjusted \bar{R}^2 is 0.988 843, both values are greater than 0.8, which shows that the model has a good fit for the sample data, and 99% of the variance can be explained by the explanatory variables.

4.1.2 T test

Original hypothesis: $H_0: b_0=b_1=b_2=0$, $H_1: b_0, b_1, b_2$ are not all 0. According to this model, the significance level is given $\alpha=0.05$, check the table for the critical value $t_{0.05/2}(5)=2.571$.

$$|t_0|=12.29501>t_{0.05/2}(5)=2.571$$

It shows that the assumption of 0 intercept term is rejected at 95% confidence.

$$|t_1|=11.01088>t_{0.05/2}(5)=2.571$$

Rejecting the original hypothesis, the investment in agricultural fixed assets is significant at 95% confidence, that is, it is the main explanatory variable of the total agricultural output value, and α is in the interval (0.1613, 0.2596) centered on 0.2105 with 95% confidence.

$$|t_2|=6.789120>t_{0.05/2}(5)=2.571$$

Rejecting the original hypothesis, the number of employees in the primary industry is significant at a confidence level of 95%, which is the main explanatory variable of the total agricultural output value, and β is in the interval (-3.6764, -1.6567) centered on -2.6666 with 95% confidence.

It can be seen that there is a regression relationship among investment, labor force and total agricultural output value, and it can be judged that the linear relationship of the original equation is significant in general.

4.1.3 F Inspection

Original hypothesis: $H_0: b_0=b_1=b_2=0$, $H_1: b_0, b_1, b_2$ are not all 0. According to this model, the significance level is given $\alpha=0.05$, The first degree of freedom is 2, and the second degree of freedom is 5, check the table for the critical value, $F_{0.05(5)}=5.79$, $F=311.2004>F_{0.05(5)}$.

It can be seen that the overall model regression is more significant.

4.1.4 D.W. Inspection

Obtained by querying D.W.

Inspection table: $\alpha=0.05, n=8, k=2, d_l=0.559, d_u=1.777$.

By comparison: $d_u=1.777 < D.W. = 2.878 < 4 - d_l = 3.441$.

This shows that the time series data used in this regression analysis does not have first-order sequence correlation, and the parameter estimates of each explanatory variable are credible in the econometric theoretical analysis.

5 Conclusions and Suggestions

Based on the Cobb Douglas function, the regression analysis model is established to get the regression equation of the total agricultural output value, analyze the different influence degree of investment and labor on the agricultural economic growth, and put forward the opinions and suggestions to promote the agricultural economic growth.

5.1 Conclusion

After empirical analysis of agricultural economic growth by Cobb Douglas production function, we can see that since 2010, agricultural economic growth mainly depends on investment, and a large amount of investment in agricultural fixed assets has laid a solid foundation for agricultural economic growth. The agricultural economic growth of Shaanxi Province shows extensive economic growth mode, and $\alpha+\beta>1$ shows that the agricultural economic growth of Shaanxi Province belongs to the type of increasing returns to scale, and the agricultural economic development has the characteristics of scale economy in general. Under the existing level of science and technology, it is advantageous to expand the production scale to increase the output, so the total agricultural output value can be increased by expanding the agricultural production scale. However, labor input is negatively related to agricultural economic growth. In this year, the total number of agricultural labor force is decreasing. A large number of employees in the primary industry are transferred from the primary industry to the secondary and tertiary industries, and the number of agricultural employees is decreasing.

To sum up, investment is the main factor to promote agricultural economic growth.

5.2 Suggestions

According to the results of the regression model, in order to make the regional agricultural economy grow steadily and rapidly, we can start from the following three aspects according to the main factors affecting the agricultural economic growth:

First, increase investment in agricultural fixed assets and attract capital from all walks of life to agricultural production. Capital investment plays a significant role in promoting agricultural economic growth. Increasing investment in fixed assets will accelerate the speed and process of agricultural economic growth. Increasing investment in agricultural fixed assets is a solid foundation for agricultural modernization and Rural Revitalization. We should integrate and optimize the investment in agricultural assets, and take the investment in agricultural fixed assets as an important guarantee area. Provincial government departments can issue relevant welfare policies to encourage the investment of capital from all walks of life in regional agricultural production and create a good living and development environment for investors.

Second, optimize agricultural labor force and increase human resource training. In recent years, a large number of agricultural labor force has been transferred to other industrial sectors. We should establish and optimize the new mechanism of professional personnel training and retention, cultivate excellent professional and technical personnel for agricultural production and economic growth, and assign special personnel to promote agricultural production and accelerate agricultural economic growth. We will implement the training system for vocational farmers, expand educational resources, guide science and education personnel to enter villages and households to carry out training, improve the quality of agricultural labor force, and enable grass-roots agricultural workers to use scientific and reasonable agricultural production methods for production.

Third, adjust the industrial structure and develop modern agriculture. The traditional extensive agriculture will be eliminated in the new agricultural development period, and will turn to intensive management. According to the resource endowment of each region, we should develop the industrial structure suitable for the resource characteristics of each region according to the local conditions, accelerate the growth rate of agricultural economy, and the agricultural development has entered a new era. We should adapt to the development needs of the times, actively adjust the industrial structure, and guide the development of agriculture to modernization.

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Corresponding Author: Liu Shou-yi, E-mail: xbliusy@163.com.

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