Research on the Influencing Factors of the Added Value of the Primary Industry

Lili Pi *

Nanjing University of Science and Technology, Nanjing, China

* Corresponding Author Email: 3151829465@qq.com

Abstract. This paper takes the added value of China's primary industry from 1978 to 2021 as the research object, based on the Cobb-Douglas production function theory, using the cointegration analysis and Granger causality test method, systematically examines the impact of the number of employees in the primary industry, the total power of agricultural machinery and the total sown area of crops on the added value of the primary industry. The results show that the changes of the total power of agricultural machinery and the total sown area of crops have a significant positive impact on the added value of the primary industry, in which the added value of the primary industry changes 0.3922% in the same direction for every 1% change of the total power of agricultural machinery; For every 1% change in the total sown area of crops, the added value of the primary industry changes by 0.5869% in the same direction. However, the change of the number of employees in the primary industry has no significant impact on the added value of the primary industry, which reflects the increasing degree of agricultural mechanization in China and the realistic trend of labor transfer to the secondary and tertiary industries. Based on the empirical results, this paper puts forward some policy suggestions, such as increasing investment in agricultural mechanization, optimizing land use structure, strengthening agricultural infrastructure construction, deepening agricultural science and technology research and development and talent support, and formulating regional agricultural development strategies according to local conditions. This paper provides an empirical basis for understanding the growth mechanism of China's primary industry and provides a reference for formulating relevant agricultural policies.

Keywords: Value Added of Primary Industry; Total Power of Agricultural Machinery; Sown Area of Crops; Employment Population; Cointegration Analysis; Granger Causality Test.

1. Introduction

As the basic industry of the national economy, the primary industry provides raw materials, energy and labor support for the development of the secondary and tertiary industries. Its development level is directly related to the stability and growth of the country's overall economy. According to the Paddy-Clark law, with economic development, labor will shift from primary industry to secondary and tertiary industries, and the proportion of output value and employment of the primary industry tend to decline. Despite this, countries often still implement policies to protect and support agriculture in the process of industrialization in order to maintain the stability of basic industries.

Since the reform and opening up, the development of China's primary industry has made remarkable achievements, but it also faces challenges such as labor loss and insufficient input. Previous studies have shown that financial support for agriculture, agricultural mechanization, technological progress and other factors play an important role in agricultural output [1]. However, the systematic analysis of the impact of the number of employees in the primary industry, the total power of agricultural machinery and the sown area on the added value of primary industry is still relatively limited, especially the empirical research combining cointegration analysis and Granger causality test is relatively scarce.

Based on the national time series data from 1978 to 2021 and the theoretical framework of Cobb-Douglas production function, this paper adopts the method of cointegration analysis and Granger causality test to empirically test the impact of the above three variables on the added value of the primary industry, so as to provide empirical support for the formulation of China's agricultural policy.

The structure of the paper is as follows: the second part is the theoretical basis and research hypothesis, the third part is the data and methods, the fourth part is the empirical analysis, and the fifth part is the conclusion and suggestions.

2. Theoretical basis and research hypotheses

2.1. Theoretical basis

The research framework of this paper is based on Cobb-Douglas production function theory:

$$Y=A \times L^{\alpha} \times K^{\beta} \tag{1}$$

Where Y is the added value of the primary industry, L is labor input, K is capital input (including land and agricultural machinery), and A is the level of technological progress.

In agriculture, the representative factors of K can be the total power of agricultural machinery and sown area; L can be represented by the number of employees in the primary industry. Although technical progress A is difficult to quantify, its impact can be implicitly reflected in the long-run equilibrium analysis.

2.2. Research hypotheses

The greater the total power of agricultural machinery is, the higher the level of mechanical assistance available to the unit labor force is, thus improving the output efficiency of the unit labor force. Therefore, Hypothesis 1 is put forward:

H1: The total power of agricultural machinery is positively correlated with the added value of the primary industry;

The crop sown area reflects the scale of land input for agricultural production. Under the condition that other factors remain unchanged, the expansion of sown area means an increase in total output potential, so it is assumed that it is also positively correlated with the added value of the primary industry. Therefore, Hypothesis 2 is put forward:

H2: Crop sown area is positively correlated with the added value of the primary industry;

With the optimization and upgrading of China's economic structure, a large number of labor in the primary industry flows to the secondary and tertiary industries, and agriculture gradually moves toward mechanization and large-scale. Therefore, Hypothesis 3 is put forward:

H3: The number of employees in the primary industry has no significant impact on the added value of the primary industry.

3. Data source, processing and preliminary analysis

This paper selects the national annual data of the above four indicators from China Statistical Yearbook, China Statistical Yearbook for Regional Economy and China Rural Statistical Yearbook from the beginning of the reform and opening up to the present, namely from 1978 to 2021: the added value of the primary industry, the number of employees in the primary industry, the total power of agricultural machinery and the total sown area of crops. First of all, in order to eliminate the inflation factor, the data of the added value of the primary industry has been revised by the added value index of the primary industry.

The value added of the primary industry is used here instead of the total output value of the primary industry, because the value added refers to the added value created by the production process of permanent resident units and the transfer value of fixed assets, which reflects the value of the intermediate input in the production process of enterprises that exceeds this process.

Although it is obviously more reasonable to use agricultural added value than the added value of the primary industry, this paper does not use agricultural added value as the explained variable because there are many missing data of agricultural added value and the statistical caliber of the primary industry in the early stage overlaps with that of the primary industry, which leads to data errors.

Value added can be calculated either under the production method or under the income method. According to the production method, it is equal to the total output minus intermediate input, while according to the income method stipulated by the National Bureau of Statistics, the added value is the sum of the four components of labor remuneration, net production tax, depreciation of fixed assets and operating surplus. Among them, the labor remuneration refers to the total remuneration obtained by the labor for providing services to the enterprise, mainly including the wages, salary income, employee welfare, social insurance premium, public welfare fund and other various expenses included and listed in the current year's personal remuneration part; Depreciation of fixed assets refers to the depreciation of fixed assets drawn by the enterprise in the current year; Net production tax refers to the net amount of various taxes, surcharges and regulations levied by the state on the production and sales of products and production and business activities of enterprises after deducting production subsidies. The main deductible contents are policy loss subsidies, price subsidies and export tax rebates and other production subsidies for foreign trade enterprises; Operating surplus refers to the current year's operating profit plus subsidies [7]

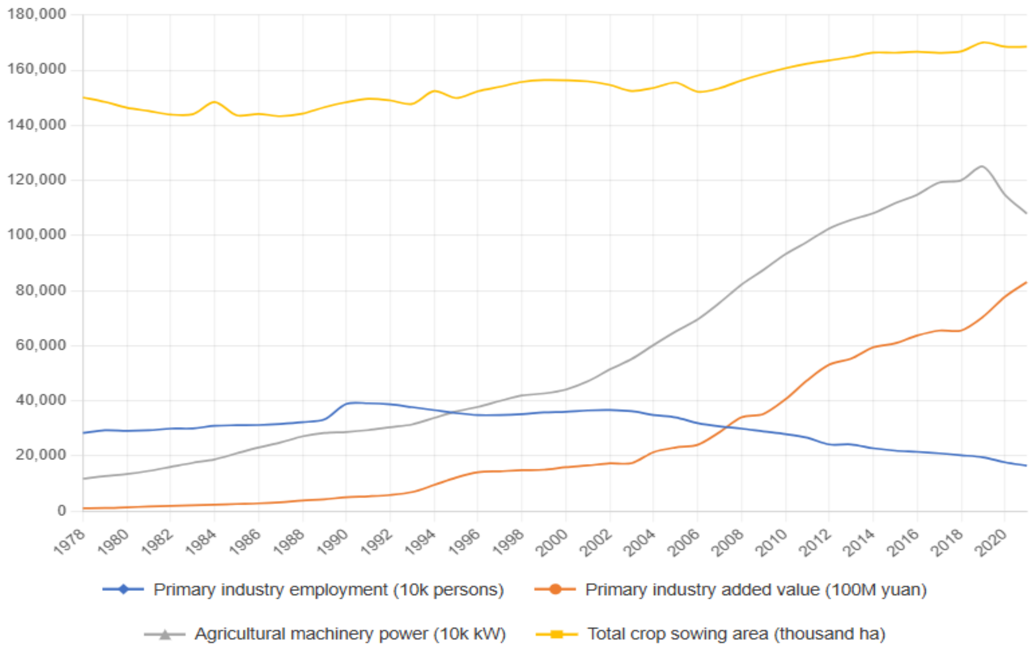

Fig 1. The original situations of the four indicators from 1978 to 2021.

Since the reform and opening up, the added value of the primary industry in China has generally shown a steady growth trend (as shown in FIG. 1). In 2021, the added value of the primary industry is 81.58 times that of 1978. Since 2003, it has experienced a rapid growth stage, expanding its scale by nearly three times. The total power of agricultural machinery and the total sower area of crops also increased to different degrees, with the former increasing in a large range and the latter growing slowly in a fluctuating manner. Since the reform and opening up, the number of employees in the primary industry has experienced a slight increase and then started to decline, which is also in line with the Pedie-Clark industrial law mentioned above: with the development of economy, the relative proportion of the labor force in the primary industry will gradually decline and begin to transfer from the primary industry to the secondary and tertiary industries.

It can be intuitively found from Figure 1 that the two indicators of total power of agricultural machinery and total sown area of crops may have a positive driving effect on the change trend of the added value of the primary industry, which provides ideas for further tests. The added value of the primary industry since the reform and opening up is regarded as the explained variable, and the other three variables are regarded as explanatory variables respectively.

4. Granger Causality Test

Granger causality test is a hypothesis test that tests whether one group of time series can be used to predict another group of time series, that is, it is mainly applied to consider the causal relationship between two series and investigate whether sequence X is the cause of sequence Y. Firstly, it is necessary to estimate the degree to which the current Y value is explained by the value of its own lag period, and then to verify whether the explained degree of Y can be improved by introducing the lagged value of sequence X. If so, then we can think of sequence X as Granger cause of the sequence Y. At this time, the coefficient of the lag period of series X is statistically significant. In general, we also need to consider whether the sequence Y Granger-causes the sequence X [8].

If the time series X is regarded as the Granger cause of the time series Y, then the t-test and F-test of the lagged value of the series X can confirm that the X value provides statistically significant information about the future value of Y, that is, the information of the explained variable does have predictive power.

The premise of the Granger causality test is the stationarity of the time series, so it is necessary to first conduct the unit root test for the time series of this experiment. The concept of stationary time series mainly means that all statistical properties of time series will not change with the passage of time, which can also be approximately understood as that the mathematical expected value and variance of the time series do not change with the flow of time [9]. The most commonly used method for unit root testing is the augmented Dickey Fuller test (ADF test). The data used in this experiment will be tested for unit root under Eviews 13 software, and the null hypothesis is that the time series has unit root (that is, the experimental data is not stationary). Table 1 shows the results of the unit root test.

Table 1. Time series unit root test results

	Added value of primary industry(Y)	Number of employees in the primary industry(L)	Total power of agricultural machinery(M)	Total sown area of crops(A)
Statistics of t	0.2216	-0.9972	-1.6894	-3.1913
P value	0.9974	0.9338	0.7388	0.1000

It can be seen that the p values of each time series are greater than 1%, so the null hypothesis is accepted at the 99% confidence level, and it is believed that the added value of the primary industry (Y), the number of employees in the primary industry (L), the total power of agricultural machinery (M) and the sown area of crops (A) all have unit roots, that is, are not stationary, so further difference and test are needed. After the first-order difference of the above four time series (denoted by dY, dL, dM and dA respectively), the unit root test is carried out, and the results are shown in Table 2 below.

Table 2. Results of unit root tests for differenced time series.

	dY	dL	dM	dA
Statistics of t	-4.2519	-4.4950	-5.3528	-4.3157
P value	0.0083*	0.0045*	0.0004*	0.0073*

It can be seen from Table 2 that the p values of the time series after first-order difference are all less than 1%. Therefore, the null hypothesis can be rejected at the confidence level of 99%, and the time series after first-order difference is considered to be stationary, that is, the above four time series are first-order integrated, and the explained variables are the added value of the primary industry and the other three explanatory variables: The four time series of the number of employees in the primary industry, the total power of agricultural machinery and the total sown area of crops are integrated of the same order, so the subsequent cointegration test and Granger causality test can be carried out.

The cointegration test is carried out in the following section. The time series of these economic variables are generally non-stationary series, but there is often a long-run equilibrium relationship between the time series with cointegration relationship. From the perspective of economics, only when and only when there is a cointegration relationship between non-stationary variables can the regression model established with these variables be meaningful, and we can further believe that the changes of another variable can be affected by the changes of other variables in the long run.

Since the time series of the total power of agricultural machinery, the total planting area of crops, the number of employees in the primary industry and the added value of the primary industry are the first-order single integration, this paper uses the Engle-Granger two-step method to test their cointegration relationship. Firstly, we regress dY and dM, dY and dA, and dY and dL respectively, and then determine whether there is a cointegration relationship between the variables by testing the stationarity of the regression residuals.

Using Eviews 13 software, with dY as explained variable and dA as explanatory variable, using OLS regression model, the output results are as follows:

$$\begin{aligned} dY &= 1654.7960 + 0.5869dA \\ &\quad (0.5828) \qquad (2.8314) \\ &\quad (0.0000) \qquad 0.0071) \end{aligned} \tag{2}$$

With dY as the explained variable and dM as the explanatory variable, the OLS regression model with the constant term is first used.

$$\begin{aligned} dY &= 0.3922dM \\ &\quad (3.9930) \\ &\quad (0.0003) \end{aligned} \tag{3}$$

With dY as the explained variable and dL as the explanatory variable, the OLS regression model is used, and the output results are as follows:

$$\begin{aligned} dY &= 0.3922dM - 0.8258dL \\ &\quad (6.1572) \quad (-3.6470) \\ &\quad (0.0000) \quad\ (0.0007) \end{aligned} \tag{4}$$

In order to test the stationarity of the regression residuals, the ADF unit root test is conducted on the residual series obtained from the above OLS regression. The test results are shown in Table 3 below:

Table 3. Results of ADF unit root test for residual series

Variables of interest	Statistics of t	P value	Conclusion of test
Resid1	-2.5697	0.0114	stationary
Resid2	-3.8099	0.0005	stationary
Resid3	-3.6172	0.0006	stationary

The test results show that the residual series obtained by the three OLS regressions do not have unit roots and are stationary series, indicating that there is a cointegration relationship between the added value of the primary industry and the number of employees in the primary industry, the total power of agricultural machinery and the total planting area of crops, which can be used for the next Granger causality test.

Next, we use the time series after first-order difference: the number of employees in the primary industry (dL), the total power of agricultural machinery (dM) and the total sown area of crops (dA) to do the Granger causality test with the added value of the primary industry (dY). The test results are shown in Table 4 below.

Table 4. Granger causality test results of each explanatory variable and the added value of the primary industry.

Null hypothesis	Lag period	Value of F	P value	Whether the null hypothesis is accepted
dM does not Granger cause dY	7	3.1400	0.0197	reject
DL does not Granger cause dY	7	2.4995	0.1220	accept
dA does not Granger cause dY	7	6.5382	0.0038	reject

It is worth noting that the Granger causality test of the time series after first-order difference is whether the changes in the total power of agricultural machinery and the total sown area of crops (increase or decrease in agricultural technology investment) can predict the future changes (increase or decrease) in the added value of the primary industry and whether the changes in the number of employees in the primary industry can predict the future changes in the added value of the primary industry. While the Granger causality test for the original time series is whether the values of the number of employees in the first industry, the total power of agricultural machinery, and the total sown area of crops can predict a certain value of the first industry's added value in the future. The Granger Causality test of the original time series is whether the number of employees in the primary industry, the total power of agricultural machinery and the total sown area of crops can predict a certain value of the added value of the primary industry in the future.

By analyzing Table 4, it can be seen that the null hypothesis that the change trend (dM) of the total power of agricultural machinery time series cannot predict the change of the added value (dY) of the primary industry is 0.0197, which is less than 5%. Therefore, the null hypothesis is rejected at the 95% confidence level, and it is believed that the change of the total power of agricultural machinery and the change of the added value of the primary industry statistically indicate the existence of a causal relationship. Similarly, with a lag of 7 periods, the p value of the null hypothesis that the change trend (dA) of the time series of total sown area of crops cannot predict the change of the added value of the primary industry (dY) is 0.0038, less than 1%. Therefore, the null hypothesis is rejected at the confidence level of 99%, and it is believed that the change of total sown area of crops and the change of the added value of the primary industry, statistically indicating the existence of a causal relationship. This is consistent with the previous analysis and the reality. When the government increases capital investment in rural infrastructure construction and agricultural frontier technology, including increasing the total power of various agricultural power machinery owned by various agricultural enterprises and units and used in various agricultural sectors, and reclaiming wastelunds to increase the area of crops, agricultural output will naturally increase.

However, the change in the number of employees in the primary industry is not the Granger cause of the change in the added value of the primary industry, which is also in line with reality. When the economy develops to a certain level, the labor force flows out from various sectors of the primary industry and flows to the secondary and tertiary industries, which does not mean that the added value of the primary industry will decrease accordingly. This is because various sectors of primary industry can make up for the vacancy of production factor input caused by labor loss through a series of technological innovations, increasing capital investment and other measures, and even the convenience and cheap productivity brought by the mechanical revolution will only promote layoffs in the primary industry.

5. Conclusions and Policy Recommendations

Based on the analysis and measurement of the number of employees in the primary industry, the total power of agricultural machinery and the total sown area of crops on the added value of the primary industry from 1978 to 2021, the conclusion is that the changes of the total power of agricultural machinery and the total sown area of crops have a significant impact on the changes of the added value of the primary industry. Optimize land use structure: Improve the land ownership system, promote the construction of the land transfer market mechanism, and concentrate land resources on large-scale operation entities to increase the output rate per unit area.

3. Strengthen agricultural infrastructure construction: Accelerate the construction of infrastructure such as farmland water conservancy, irrigation systems, and rural roads to provide solid guarantees for agricultural mechanization operations and the transportation of agricultural products.

4. Deepen agricultural science and technology research and talent support: Increase investment in agricultural research, promote the development and promotion of high-yield and high-efficiency crop varieties, and strengthen the training and incentives for agricultural technical talents.

5. Formulate differentiated regional agricultural development strategies based on local geographical conditions, climate characteristics, and development stages: Based on the different geographical conditions, climate characteristics, and development stages of different regions, formulate differentiated agricultural development support policies to improve the efficiency of resource allocation. Every 1% change in the total power of agricultural machinery can cause 0.3922% change in the same direction of the added value of the primary industry; Every 1% change in the total sown area of crops can cause the added value of the primary industry to change by 0.5869% in the same direction, while the number of employees in the primary industry has no significant impact on the added value of the primary industry regardless of the original value or the change trend.

Based on the above conclusions, this paper puts forward the following policy suggestions.

1. Increase the investment and promotion of agricultural mechanization: the government should continue to promote the subsidy policy of agricultural machinery, encourage the introduction and application of advanced and efficient agricultural machinery equipment, and improve the utilization rate and operation efficiency of agricultural machinery.

2. Optimize the structure of land use: improve the land right confirmation system, promote the construction of land transfer market mechanism, make land resources concentrated to large-scale operation subjects, and improve the output rate per unit area.

3. Strengthen agricultural infrastructure construction: accelerate the construction of irrigation and water conservancy, irrigation systems, rural roads and other infrastructure to provide a solid guarantee for agricultural mechanization and agricultural product transportation.

4. Deepen agricultural science and technology research and development and talent support: increase investment in agricultural research and development, promote the research and development and promotion of high-yield and efficient crop varieties, and strengthen the training and incentive of agricultural technical personnel.

5. Formulate regional agricultural development strategies according to local conditions: formulate differentiated agricultural development support policies based on geographical conditions, climatic characteristics and development stages of different regions to improve resource allocation efficiency.

References

[1] An Guangshi. The PROBLEM of our country is financed to AGRICULTURAL input and COUNTER measure ponder [J]. Chinese Rural Economy,1999(09):44-48.

[2] Wang Fengxiao. Combined prediction and structure analysis of the Added value of the primary industry in Kashgar. Statistics and Management,2018(12):22-25.

[3] Chen, Y. & Yan, R. Forecasting the added value of primary industry based on matlab BP neural network in Henan and Sichuan Province [J]. China Informatization,2018(07):102-104.

[4] Liu Hongjie. China's fiscal support for agriculture and the development of primary industry: 1978-2006: an econometric analysis based on VAR model [J]. Journal of Nanjing Agricultural University (Social Science Edition),2008(03):38-43.

[5] Wu, Q. Research on the Dynamic Relationship between agricultural Expenditure and agricultural output growth in China: an empirical analysis based on time series data from 1978 to 2010 [J]. Journal of Fujian Agriculture and Forestry University (Philosophy and Social Sciences Edition),2012,15(04):48-53.

[6] Liu Hongjie. Research on the impact of financial Support for Agriculture on the Value added of the Primary Industry in China :1952-2006[J]. Journal of South China Agricultural University (Social Science Edition),2008(03):41-48.

[7] Li, Y. & Wang, Y. Correlation analysis and grey prediction of the added value of primary industry in Henan Province [J]. Anhui Agricultural Sciences,2009,37(32):16004-16005+16054.

[8] Huang Runpeng, Zuo Wenming, and Bi Lingyan. Stock market prediction based on microblog sentiment information [J]. Journal of Industrial Engineering and Engineering Management, 2015, 29(01):47-52+215.

[9] Granger CWJ. Investigating causal relations by econometric models and cross-spectral methods[J]. Econometrica,1969,37(3):424~438.

[10] Meng, Z. & Meng, H. An empirical study on the relationship between financial support for agriculture and farmers' income in Shanxi [J]. Chinese Urban Economy,2011(03):57+59.

[11] Li, P. & Jia, Weili. Analysis on the effect of financial agricultural input on farmers' income after the reform and opening up [J]. Taxation and Economy,2010(03):49-56.