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An Empirical Study on Fiscal Science and Technology Expenditure and Agricultural Economic Growth under Digital Economy

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Abstract

In order to promote the further development of agriculture and rural areas in the new era, on January 20, 2020, the central government issued the digital agriculture and rural development plan (2019-2025), which is committed to building a digital agriculture and rural areas, improving the transition from traditional productive forces to digital productive forces, so as to promote the high-quality development of the agricultural economy. Today's agricultural development still has many problems to be solved, such as low economic efficiency, traditional production methods, low level of information, lack of technical support and so on. The application of digital technology to the construction of agriculture and rural areas is conducive to the innovation of production methods and the improvement of productivity, promoting the economic growth of agriculture, so as to realize a modern agricultural power. Based on the statistical data of China from 2007 to 2018, this paper will conduct empirical research and dynamic analysis on the relationship between fiscal expenditure on science and technology and agricultural economic growth, and provide feasible countermeasures and Suggestions for the development of modern agriculture.

Keywords

Digital economy, Finance, Expenditure of science and technology, Technological progress, Agricultural economic growth, VAR model.

1. Introduction

From agricultural economy, industrial economy to today's digital economy, the human economic form has its unique performance in each historical stage. The economy of the 21st century is intelligent, informationized and digitalized, and it is precisely this kind of digital economy that enables China, which is in the transition from high-speed economy to high-quality economy, to achieve transcendent development under this historical opportunity.

The essence of digital economy lies in informatization, and the investment in information technology is its important driving force. China's digital economy has developed rapidly in recent years, growing from 27.2 trillion yuan in 2017 to 31.3 trillion yuan in 2018. And by 2030 it is forecast to account for more than half of GDP. It is not difficult to see that digital economy can promote the further development of China's economy and society, promote the transformation of economic development mode and model, and promote high-quality economic development.

As the foundation of the national economy, the development mode of agriculture should be transformed from tradition to modernization. At the present stage, there are some urgent problems in the development of China's agricultural economy, which are embodied in the following aspects: first, the overall quality of the population is relatively low. Farmers do not know much about the importance of education, the degree of education is low and the scope is small, most farmers have always had the traditional idea that money is more than learning.

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Second, the mode of production and operation lags behind. In the process of producing and managing agricultural products, Chinese farmers still follow the traditional mode of predecessors. According to the traditional experience to grow agricultural products, the income is not high, there is a risk of loss. Third, the technical innovation support capacity is insufficient. Although China's attention to agriculture has been very high, every year in agricultural technological innovation to invest a large number of resources, it is true that a batch of excellent research results, but not all of them can be applied to agricultural production. Fourth, market information is asymmetric. The change of information is rapid, but the level of rural informatization is not high. When farmers receive market information, they will make mistakes in production decisions due to the lag effect. Fifth, the workforce is ageing. With the acceleration of urbanization and industrialization, the development of agriculture is declining, the gap between towns and villages is becoming more and more obvious, and the young labor force is losing to cities. Nowadays, the combination of digital economy and agricultural development not only provides a new choice direction for the further development of digital economy, but also adds a new impetus to the growth of agricultural economy, promoting the modern development of agriculture and realizing rural rejuvenation.

2. Research Overview

In the 21st century, countries around the world have put emphasis on scientific and technological research and innovation to promote high-quality economic development. Many scholars at home and abroad have studied the relationship between technology and economic growth theoretically and empirically. Solo (1975) combined the harrod-dormer model and believed that technological progress was the key factor of economic growth. However, he took technology as an exogenous variable, which would have some deficiencies. Deng xiaoping (1988) proposed that "science and technology are the primary productive forces" according to China's actual development situation and the development trend of science and technology and in combination with the basic principles of marxism.

Related researches on the relationship between financial expenditure on science and technology and economic growth include: liang changlai (2014) made a positive correlation between financial expenditure on science and technology and China's economic scale through statistical analysis, and concluded through empirical analysis that financial expenditure on science and technology was the main driving force of economic growth from 1997 to 2012. Xu saiyan (2019) adopted the measurement method of building SAR space autoregressive model, and concluded that the correlation between per capita financial expenditure on science and technology and per capita GDP was positive, and the financial expenditure on science and technology had a significant stable spatial spillover effect on per capita GDP. Xu li (2018), wang xiaofang (2016) et al., through dynamic analysis, found that fiscal expenditure on science and technology can drive economic growth, and it is sustainable, but its contribution is very low. Xu li and you zilei also believe that the effect of economic growth on fiscal expenditure of science and technology can take effect soon and maintain long-term stability, but the effect of fiscal expenditure on economic growth is obviously delayed. By using the VAR model, zhang wuyi and wang junhua (2019) concluded that fiscal expenditure on science and technology can promote economic growth in a short period of time, after which the impact will gradually weaken over time, but economic growth has no effect on fiscal expenditure on science and technology.

For the research on the correlation between science and technology and agricultural economic growth, many scholars use the soroyu method to calculate the contribution rate of the development of science and technology to agricultural economic growth, and conclude that technological progress can promote the development of agricultural economy, such as jin guosheng (2018) and shen tong fei (2019). Some scholars also studied from other perspectives:

ge chengli and liu wei (2019) used static panel model and system GMM to conclude that technological level has a significant effect on economic growth rate. Yu shihai et al. (2018) took the fiscal expenditure on agricultural science and technology as a substitute indicator of agricultural technological progress by using the data of China from 1999 to 2014, through the co-integration test and causality test, and concluded that agricultural technological progress was the one-way granger cause of agricultural economic growth. Liu zhanyan (2020) proposed theoretically that agricultural technological innovation could improve the level of agricultural economy, and suggested that agricultural departments in various regions increase the investment in agricultural technology, to promote the growth of agricultural economy. Hu yizhao et al. (2019) took the three indicators of per capita patent authorization, per capita total mechanical power, and per capita rural electricity consumption as the alternative indicators of technological innovation, established the VAR model for dynamic research, and concluded that rural technological innovation would promote rural economic growth in the short or long term.

The author from the digital economy to promote technological progress, in turn, affects the agricultural economy growth, the introduction of fiscal policy factors, the selection of fiscal spending as alternative indicators of technological progress, science and technology through the establishment of the VAR model, to study the technological progress and agricultural economic growth of the internal relations between, and put forward countermeasures and Suggestions to practicing, for the further development of digital agriculture and rural areas and rural revitalization has certain practical significance.

3. Empirical Analysis of Fiscal Expenditure on Science and Technology and Agricultural Economic Growth

3.1. Variable Setting and Data Source Analysis

3.1.1. Variable Setting

Financial science and technology expenditure (TECH). Technological progress cannot be separated from the capital expenditure of national finance, which plays an important role in the development of science and technology. Therefore, the expenditure of national finance on science and technology is selected as the substitute variable of technological progress.

Agricultural economic growth (OUTPUT). There are a lot of measures of agricultural economic growth, and most researchers use the total output value of agriculture, forestry, animal husbandry and fishery.

3.1.2. Data Source Analysis

The years studied in this paper are from 2007 to 2018, and the relevant data are from China statistical yearbook and China rural statistical yearbook. In order to prevent the occurrence of multiple collinear and heteroscedasticity in the model, lnoutput and lntech were selected as the two research variables of agricultural economic growth and fiscal science and technology expenditure.

3.2. Empirical Test

3.2.1. ADF Stationarity Test

In order to prevent the phenomenon of "false regression" caused by variable instability, the unit root test of lnoutput and lntech should be performed first, and then the possible relationship model and result analysis should be constructed. The following table shows the stationarity test results of lnoutput and lntech:

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Table 1: stability test of variables

The variable sequence	Break up the number	ADF test value	1% critical value	5% critical value	10% critical value	P values	The inspection results
lnoutput	1	1.387273	4.582648	3.320969	2.801384	0.5339	Not smooth
lnoutput	2	5.058044	4.582648	3.320969	2.801384	0.0057	smooth
lntech	1	1.621514	4.297073	3.212696	2.747676	0.4368	Not smooth
lntech	2	4.749383	4.420595	3.259808	2.771129	0.0065	smooth

It can be seen from table 1 that, by comparing the ADF test value with each critical value, at the critical value level of 5%, the sequence of lnoutput and lntech still fails the stationarity test after the first-order difference, that is, the first-order difference sequence of the two variables is an unstable sequence. However, after the second order difference, the sequences are stable.

3.2.2. Johansen Co-integration Test

After ADF stationarity test, it was found that the time series of lnoutput and lntech were both second-order integral sequences. Therefore, Johansen co-integration test can be conducted on lnoutput and lntech to see whether there is a long-term equilibrium relationship between them. The test results are shown in figure 1 and figure 2. It can be concluded that, at the significant level of 5%, the trace test statistic is 25.47575 and the maximum eigenvalue test statistic is 23.05352 are both greater than the critical value, then the null hypothesis is rejected, so there is at least one co-integration relationship. Under the assumption that there is at most one co-integration relationship, the statistics of both tests are less than the critical value at the 5% level, and the probability is 0.1196, then this assumption is accepted. Therefore, there is a co-integration relationship between lnoutput and lntech.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.877025	25.47575	15.49471	0.0011
At most 1	0.197644	2.422234	3.841466	0.1196

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Fig.1: Trace test

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.877025	23.05352	14.26460	0.0016
At most 1	0.197644	2.422234	3.841466	0.1196

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Fig.2: Maximum eigenvalue test

3.3. Measurement Model Analysis

In this paper, the vector autoregressive model (VAR) is used to construct a function of the lag value of each endogenous variable, in an attempt to analyze the dynamic relationship between fiscal expenditure on science and technology and agricultural economic growth. The commonly used form of VAR model is:

$$Yt = \theta 1Yt-1+\theta 2Yt-2+\ldots+ \theta iYt-i+\beta Xt+\Sigma t$$

(which, t is time, Yt is a dimension of endogenous variable column vector, Xt to b d exogenous variables column, p for the model lag order, Ɛ t as random perturbation terms)

3.3.1. Selection of Model Optimal Lag Period and AR Root Diagram

The VAR models of lnoutput and lntech were constructed. As can be seen from figure 3, the optimal lag period of the VAR model was 1 according to the information criteria such as LR, AIC, SC and HQ. Therefore, the VAR (1) model can be established for stationarity test and impulse response function analysis. As can be seen from figure 4, all characteristic roots of the VAR (1) model are in the unit circle, indicating that the established vector autoregressive model is stable, and the relationship between agricultural economic growth and fiscal science and technology expenditure is in a stable state overall.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	14.92685	NA	0.000259	-2.585370	-2.524853	-2.651757
1	43.72814	40.32181*	1.88e-06*	-7.545628*	-7.364077*	-7.744789*
2	46.27716	2.549020	2.95e-06	-7.255432	-6.952847	-7.587367

* indicates lag order selected by the criterion

Fig.3: Selection of optimal lag period of VAR model

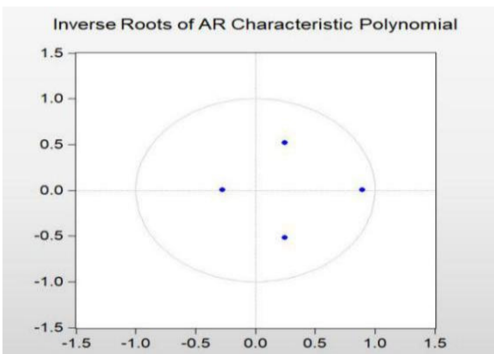

Fig.4: Stationarity test of VAR model

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3.3.2. Dynamic Analysis of Impulse Response

The impulse response function is generally used to measure the impact of a standard deviation shock of a random disturbance term on the current and future values of endogenous variables in the model. Now science and technology expenditure and agricultural economic growth are both given a shock, to study the interaction of the two indicators, through the impulse response function analysis of science and technology expenditure and agricultural economic growth between the dynamic mechanism of action.

As can be seen from figure 5, after an impact on lnoutput in this period, lntech will be subjected to a negative impact in the long term. The negative effect value received in the first two phases is stable at 0.027, and the maximum value in the third phase is 0.034. Then, it gradually drops down, and the curve is relatively stable, but the effect value tends to zero. This indicates that the growth of agricultural economy has a hindering effect on the increase of science and technology expenditure in this research stage, but the hindering effect is not very strong, and the negative influence of agricultural economic growth on science and technology expenditure has a lagging effect. The possible reason is that the original agricultural technical tools can continue to be invested in agricultural production and can still bring about the increase of agricultural economy, which makes the country decide to appropriately reduce the investment in agricultural technology at the level of fiscal policy and ease the burden of national financial expenditure.

As can be seen from figure 6, lntech was given an impact in this period, and the lnoutput will always receive a positive impact. In the first three phases, the response function of lnoutput showed a gradual rise. In the third phase, it reached a peak value of 0.032, and then gradually declined. In the seventh and eighth phases, it maintained a stable state with a value of 0.010, and then gradually decreased. It shows that the increase of financial expenditure on science and technology will promote the growth of agricultural output value in a short period of time, that is, the further development of technology can cause the growth of agricultural economy, but the intensity of this effect will gradually weaken with the passage of time. This may be because the application of technology to traditional agricultural production processes in the short term has an immediate impact on agricultural output. In the long-term production, the promotion effect of financial expenditure on science and technology on agricultural economic growth is weakened, which may be attributed to the following reasons: first, farmers have some experience in the use of technology, but their incomplete reception of market information leads to decision-making errors in the research and development of agricultural technology. At this time, although the financial investment in science and technology has been increasing, but some of the research and development of technological achievements can not successfully participate in the actual production and operation of agriculture. Second, the investment in science and technology is increasing, but some of the authorized patent results have not been truly utilized in the actual agricultural production, and remain in the research stage.

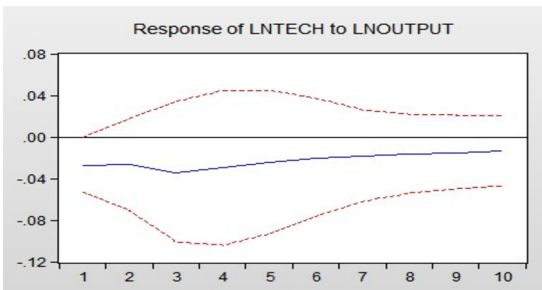

Fig.5: impulse response of lnoutput to lntech

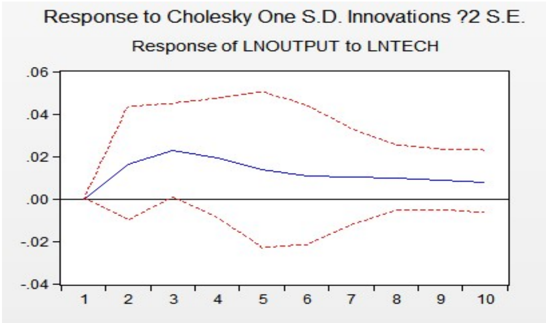

Fig.6: impulse response of lntech to lnoutput

4. Conclusion

Through the ADF unit root test, Johansen co-integration test, and impulse response function analysis, the relationship between financial expenditure on science and technology, namely, technological progress, and agricultural economic growth, is studied. The following conclusions are drawn:

Firstly, Fiscal expenditure on science and technology and agricultural economic growth are not stationary series, but they can be stable after second-order difference, and there is a long-term co-integration relationship between fiscal expenditure on science and technology and agricultural economic growth.

Secondly, according to the VAR model established by fiscal expenditure on science and technology and agricultural economic growth, it is concluded that the model is stable and all characteristic roots fall inside the unit circle when the lag is one stage, that is, the VAR (1) model is optimal.

Thirdly, In the research period of this paper, it is found that when both the fiscal expenditure on science and technology and the growth of agricultural economy are impacted in this period, the fiscal expenditure on science and technology will have a long-term positive effect on the growth of agricultural economy, that is, the increase of the investment in science and technology can promote the continuous development of agricultural economy by promoting the continuous progress of technology. However, the improvement of technology may weaken the promotion of agricultural economic growth due to the incomplete farmers' reception of market change information and the fact that the authorized patent results are not actually applied to production. The increase of agricultural economy will hinder the investment of national finance in agricultural science and technology to some extent, but this influence will gradually weaken with the advance of time, and the impulse response curve will tend to zero. This may be related to the fiscal burden of the state in different periods and the various relevant policies issued by the government in the current period. Because once the improvement of agricultural technology reaches the "bottleneck period", the government may turn its attention to the training of farmers on how to properly use technical tools, so as to consider reducing the investment in agricultural technology and relieve the financial burden, thus reducing the total value of national science and technology expenditure.

5. Suggestions

The advance of science and technology has the most important role and significance for the country's economic development. China has always put science and technology research and development in the first place. Nowadays, digital economy accounts for an increasing proportion of GDP, and the popularization of digital and intelligent technologies has brought huge benefits to the national economy, which further intensifies the national investment in scientific and technological research and development. The government has always attached

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importance to and emphasized the development of agricultural economy. It is advisable to integrate digital economy into the development of agricultural and rural economy and try to improve the current situation of agricultural development through digital technology so as to realize rural rejuvenation. From the theoretical and empirical study of this paper, we can know that the increase of fiscal expenditure on science and technology can improve the growth of agricultural economy. In the digital economy, some feasible Suggestions are put forward in order to improve the conversion rate of financial expenditure on scientific and technological research and development, and to further stimulate the development of agricultural economy with innovative technological progress:

(1) We will continue to increase government spending on science and technology and strengthen management of expenditures.

Through the impulse response function, it is found that the increase of national investment in financial science and technology can affect the growth of agricultural economy, and it is a positive effect, but it is not that the more investment, the better. On the one hand, the government needs to optimize the structure of expenditure, expand the scope of financial subsidies for agricultural technology and avoid the waste of funds while increasing the total amount of funds for scientific and technological research and development. On the other hand, the government should strengthen the management of the expenditure of scientific research funds to prevent the unreasonable use of funds. By perfecting the budget evaluation system for project approval, the allocation of financial funds should be adjusted accordingly according to the evaluation results. In addition, a research project inspection team can be set up to regularly inspect the completion process of the project, so as to ensure the reasonable and true utilization of funds.

(2) We will continue to reform the supply side of agriculture and increase farmers' scientific and technological knowledge.

Agricultural supply-side structural reform is an important policy measure based on the supply-demand relationship of agricultural products over the years in China, which is the main route of modern agricultural and rural development. Therefore, it is necessary to adhere to the implementation of agricultural supply-side structural reform. To enhance farmers' knowledge of science and technology and their ability to use technological tools: first, local governments can strengthen the publicity of farmers' understanding of the importance of science and technology. They can consider holding a small discussion meeting on scientific and technological knowledge in various inhabitants, and then hold a competition for prizes and answers, so as to improve farmers' knowledge of science and technology. Second, regular training on the use of agricultural technical tools should be given to farmers to combine traditional agricultural production methods with modern agricultural production methods so as to deepen the degree of agricultural mechanization and improve the efficiency of agricultural production. This can make scientific and technological achievements applied to the actual production of agriculture, thus promoting the continuous development of the agricultural economy.

(3) Raise the level of agricultural informatization and improve the construction of agricultural infrastructure.

The imperfection, asymmetry and hysteresis of market information are one of the important restricting factors of agricultural development. First, a trading platform for agricultural products should be built on the Internet, where all kinds of agricultural products should have relevant profiles and quality testing certificates, which can not only facilitate consumers to choose and buy, but also solve the problem of unsalable agricultural products caused by production decision-making errors to some extent. The second is to build a cloud platform for agricultural technology promotion and agricultural information transmission, which enables

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farmers to learn about the use of various agricultural tools on the Internet and timely learn about climate change, laws and regulations, policy formulation and market supply and demand, so as to make correct production plans.

Agricultural infrastructure construction is an important supporting force for agricultural modernization, and improving agricultural infrastructure can promote high-quality and green development of agriculture. On the one hand, we will strengthen the construction of rural roads, power and water conservancy infrastructure to ensure smooth roads, electricity and safe drinking water for all. On the other hand, a survey team should be set up to conduct a quarterly field survey of rural residents to check whether the policies related to agricultural infrastructure have been implemented and whether they have truly benefited rural residents.

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