

Research on Agricultural Total Factor Productivity and its Influencing Factors in the Central Plains

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Abstract

In the current era of promoting rural revitalization, it is very important to improve the efficiency of agricultural production and then improve the level of agricultural modernization, which will help achieve poverty alleviation and build a beautiful countryside. Focusing on the theme of the improvement of agricultural total factor productivity in the Central Plains region, this paper uses the agricultural production efficiency theory and the nonparametric index method of DEAP-Malmquist to construct a measurement model of agricultural production efficiency in the Central Plains region. Data, the agricultural total factor production efficiency (TFP) and its decomposition values, such as: pure technical efficiency index and scale efficiency change index, carry out horizontal and vertical comparative analysis, to explore the differences in agricultural productivity in various regions and their sources of growth. Then use the panel data regression model to analyze many influencing factors of agricultural TFP, such as: economic development level, labor quality and so on. Finally, according to the empirical results, some policy references are put forward to ensure the safety of grain production in the Central Plains and improve the level of agricultural modernization.

Keywords

DEAP-Malmquist; Agricultural Total Factor Productivity; Central Plains; Regression Model.

1. Preface

1.1. Introduction

Agriculture is the foundation of national economic development, and the development of agriculture is related to people's lives, social stability and economic development. As the main grain production area in my country, the Central Plains region focuses on the measurement and empirical research of agricultural productivity in the Central Plains region, and proposes some new ideas for improving agricultural production efficiency and realizing regional agricultural modernization. It will not only provide reference for the government to make plans and decisions, but also bring reference value to ensure food production security, develop regional agriculture, increase farmers' income, improve rural infrastructure, and then improve farmers' living standards. Relying on the improvement of TFP in the Central Plains will also help to achieve sustainable agricultural development in the Central Plains and promote the transformation of agricultural economic development.

1.2. Literature Review

At present, there is a certain research foundation for agricultural total factor productivity in my country and its various regions. After reviewing the literature, scholars have conducted research on the improvement of agricultural TFP from different perspectives: Chen Weiping, Li Gucheng, Yu Kang and others have used non-parametric methods to study China's agricultural total factor productivity; Pan Dan et al. analyzed the regional differences of TFP in China ; Zhao Wen et al. used Solow residual value method and other methods to study China's agricultural total factor productivity from the early days of the People's Republic of China to 2009 ; Gu Hai, Jiang Jiyu et al. used this method to analyze the changes in China's agricultural productivity from 1980 to 1995 and composition. In addition, Sun Feiruo carried out SPSS regression econometric analysis on the improvement path of agricultural modernization in Jiangsu Province ; Li Tianxiao explored the influencing factors of agricultural modernization in Jiangsu Province through multiple linear regression and factor analysis methods; Xiao Huimin and Zhu Xianglin analyzed the national agriculture based on SPSS multiple regression method. The main influencing factors of gross output value.

Although previous scholars have made a lot of contributions to the research on agricultural TFP, the research area is mostly limited to a certain province or China, while few scholars have studied the Central Plains, and the research years are relatively long, and they have not studied the agricultural TFP in recent years. In-depth systematic study of the situation. Finally, there is a lack of empirical analysis on external factors affecting agricultural TFP.

1.3. Innovation

Based on the perspective of agricultural input and output, and combined with the current situation of agricultural development in the Central Plains, this paper constructs the agricultural input and output index system in the Central Plains. It is planned to select indicators such as agricultural output value, farmers' income, agricultural electricity consumption and other indicators to measure and analyze the agricultural TFP in the Central Plains . Then, the panel data regression model is used to select several variables such as regional economic development level, labor quality, and government financial expenditure to carry out regression analysis on agricultural TFP, which enriches the empirical research on the influencing factors of agricultural TFP.

In addition, this paper attempts to expand and improve the research results of the existing literature from the following aspects : First, select the panel data of the Central Plains region in the past 8 years. Secondly, the key agricultural input and output indicators are screened out, and the dynamic and static analysis of agricultural TFP is carried out. Then, according to external environmental factors, such as: economic development level, labor quality, government financial expenditure, etc, Eviews quantitative regression analysis is carried out to find out the key factors affecting agricultural TFP. Finally, policy recommendations are put forward based on the measurement results.

2. Overview of the Study Area

The Central Plains, such as Henan Province and Jiangsu Province, are large and powerful agricultural provinces. Taking Henan Province as an example, the survey found that the rural population of Henan Province accounts for nearly 64% of the total population. It is an important grain producing area in the country, and the total grain output accounts for about 1/10 of the country . Henan has made great contributions to achieving the balance of national food supply and demand. However, the income level of farmers in Henan is still very low, and the economic development is very slow. In order to improve the economy and farmers' income in Henan Province and the entire Central Plains, it is particularly important to actively develop

agricultural level, develop agricultural modernization, and improve agricultural productivity. It is conducive to ensuring the safety of food production in the Central Plains region, and promoting the smooth operation of the national economy, thereby driving the development level of regional agriculture in the entire Central Plains region.

3. Research Methods and Data Sources

3.1. DEAP-Malmquist Method

Data Envelopment Analysis (DEA) method correlates multiple indicators with comparability and compares them with the production frontier. It has advantages in dealing with the effectiveness evaluation of multiple inputs and multiple outputs. The DEA method was used to evaluate the efficiency of rural infrastructure supply.

The Malmquist index was proposed by the Swedish economist Sten Malmquist in 1953. It was originally used to calculate the changes in the consumption index. Until 1992-1994, Fare et al. used the DEA method established by Charnes et al in 1978 to study the Malmquist index. Exponential nonparametric linear programming algorithm. The Malmquist index proposed by Fare et al. Its expression is:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)} \right]^{\frac{1}{2}}$$

In (x^{t+1}, y^{t+1}) and (x^t, y^t) represent the input and output vectors of the $t+1$ and t periods, respectively, D^{t+1} , D^t Represent the technical efficiency level of the $t+1$ th period with reference to the t th period technology, respectively. According to Fare 's analysis, under the assumption of constant returns to scale, the change in total factor productivity (Total Factor Productivity Change,TFPCH) by the technical efficiency change (Efficiency Change,EC) and technical changes (Technical Change,TC) are composed of two parts. which is $TFPCH = TC \times EC$, when $TC > 1$ When, it means technological progress; when $TC < 1$ Indicates technological regression; when $EC > 1$ When the technical efficiency is improved; when $EC < 1$ Explain the decline of technical efficiency. The technical efficiency change is composed of pure technical efficiency change (Pure Technical Efficiency Change,PC) and Scale Efficiency Change,SC) consists of two parts, namely $EC = SC \times PC$, so that it can be obtained $TFPCH = TC \times SC \times PC$. If the M index is obtained > 1 , it indicates that the efficiency is improved; if the obtained M index < 1 , the efficiency is reduced.

3.2. Data Sources

The study focuses on three provinces and cities in the Central Plains, namely: Shangqiu City, Zhengzhou City, Kaifeng City, Luoyang City in Henan Province, Huaibei City, Suzhou City, Bozhou City in Anhui Province, and Xuzhou City, Huaian City, and Suqian City in Jiangsu Province. The city is the decision-making unit, using the panel data of agricultural input and output from 2013 to 2020 to conduct dynamic and static analysis of agricultural total factor productivity, and use DEAP 's Malmquist index method to calculate its agricultural total factor productivity, technological changes and changes in technical efficiency., The software used is DEAP2.1 software. In order to ensure the accuracy and validity of the data, the data sources used in this paper are based on the provincial statistical yearbooks.

3.3. Indicator Selection

Taking into account the main characteristics of agricultural production inputs and outputs in the Central Plains, as well as the relative importance of production factors in the agricultural production process and the availability and accuracy of indicators, and through in-depth research on existing literature, the results of various factors are integrated. For consideration,

this paper adopts the following indicators. The variables selected in this paper for the calculation of agricultural total factor productivity in the Central Plains mainly include two types of indicators: input and output. The output indicators are: total agricultural output value, farmers' income, and total grain output. Input indicators are: (1), labor input. Calculated based on the number of employees in the primary industry. (2), energy input. Calculated based on the total annual rural electricity consumption of each city. (3), mechanical power input. Calculated based on the total power of agricultural machinery.

4. Measurement and Analysis of Agricultural Total Factor Productivity in the Central Plains

4.1. Static Analysis of DEAP Model

Using the static analysis of DEAP software, based on two cross-sectional data in 2013 and 2020, the agricultural input-output indicators of 10 cities in the Central Plains were analyzed for agricultural total factor productivity, and the comprehensive efficiency of agricultural total factor productivity was obtained respectively. CRSTE (technical efficiency without considering returns to scale), pure technical efficiency VRSTE (technical efficiency when considering returns to scale), scale efficiency SCALE (scale efficiency when considering returns to scale). The measurement results are as follows in Table 1:

Table 1. Static analysis of DEAP

city	2013 _				2020 _			
	Overall efficiency	pure technical efficiency	scale efficiency	returns to scale	Overall efficiency	pure technical efficiency	scale efficiency	returns to scale
Shangqiu	0.760	1.000	0.760	drs	1.000	1.000	1.000	_
Zhengzhou City	0.825	0.877	0.941	drs	1.000	1.000	1.000	_
Kaifeng	0.965	0.969	0.996	drs	1.000	1.000	1.000	_
Luoyang City	0.926	0.995	0.930	drs	0.855	0.870	0.982	irs
Huaibei City	1.000	1.000	1.000	-	1.000	1.000	1.000	_
Suzhou City	1.000	1.000	1.000	-	0.828	0.830	0.997	irs
Bozhou	1.000	1.000	1.000	-	1.000	1.000	1.000	_
Xuzhou	1.000	1.000	1.000	-	1.000	1.000	1.000	_
Huaian city	1.000	1.000	1.000	-	1.000	1.000	1.000	_
Suqian	0.987	1.000	0.987	drs	0.880	0.890	0.989	drs
average value	0.946	0.984	0.961		0.956	0.959	0.997	

1) From the comprehensive efficiency index, the comprehensive agricultural efficiency in the Central Plains in 2013 and 2020 both reached the DEA effective level, 0.946 and 0.956, respectively, showing an overall growth trend and in a higher category. From the analysis of each city, it can be concluded that Shangqiu City did not achieve DEA effectiveness in 2013, but achieved DEA effectiveness in 2020, and its technical efficiency has grown rapidly. However, the comprehensive efficiency index of different cities, such as Luoyang City, Suzhou City, and Suqian City, has declined. These three cities should focus on increasing investment in agricultural technology innovation and strive to improve agricultural technology efficiency. In addition, the overall efficiency of the rest of the prefectures remained stable or increased gradually. Among them, in these two research time periods, Huaibei, Bozhou, Xuzhou, and Huai'an all achieved technical effectiveness, indicating that the four cities are at the forefront of

agricultural production, and they have invested heavily in agricultural technology, realizing the most technical resources. optimal configuration.

2) Pure technical efficiency decreased by 2.5% from 2013 to 2020. In 2020, the pure technical efficiency index of rural total factor productivity in the Central Plains is 0.959, which is only 0.041 behind the production frontier, reflecting that there is a lot of room for improvement in the management level. On the whole, the number of cities with effective pure technical efficiency is higher than that of scale efficiency. In 2013 and 2020, the number of cities with effective pure technical efficiency is 7, indicating that these cities are more advanced in terms of rural management and technology. A given input maximizes the output. The low scale efficiency is an important reason for the low comprehensive efficiency. Each city should adjust the investment scale of agricultural production factors to further improve its scale benefit. The pure technical efficiency of Zhengzhou in 2013 was only 0.877, which was far lower than the regional average level, but it has achieved pure technical efficiency in 2020, indicating that Zhengzhou has increased the level of rural technology in the past 8 years of rural development. put in. In 2020, the pure technical efficiency index of Luoyang, Suzhou and Suqian was lower than the regional average level, and there was a trend of decreasing pure technical efficiency. It is necessary to continuously accelerate technological innovation, improve agricultural production efficiency, and promote the transformation of local rural economic development.

3) The scale efficiency of rural total factor productivity in the Central Plains can reflect whether the allocation of regional agricultural factors has reached the optimal scale. It can be seen from Table 1 that the scale efficiency index has increased from 0.961 in 2013 to 0.997 in 2020, which is close to the scale efficiency. As of 2020, 70% of the Central Plains cities have achieved optimal scale efficiency. Among them, the cities with scale efficiency of 1 in two years are : Huaibei, Bozhou, Xuzhou, Huaian, accounting for 40% . The scale efficiency of Luoyang and Suqian is slightly lower than the regional average level, and it is necessary to further expand the input of agricultural production factors to maximize the scale efficiency as soon as possible. Areas with increasing scale efficiency, such as Luoyang and Suzhou, should reasonably increase the input of agricultural production factors, while areas with decreasing returns to scale, such as Suqian City, may have obvious efficiency due to insufficient and effective use of capital and other factors. For the problem of loss, special attention should be paid to improving the direction and number of elements used.

4.2. DEAP --Dynamic Analysis of Malmquist Index

Table 2. Malmquist index and its decomposition of rural total factor productivity in the Central Plains from 2013 to 2020

years	technical efficiency	skill improved	pure technical efficiency	scale efficiency	full factors production rate
2013-2014	0.994	1.004	0.994	0.999	0.997
2014-2015	1.002	1.004	0.993	1.010	1.007
2015-2016	0.978	1.076	0.981	0.998	1.053
2016-2017	1.037	0.980	1.004	1.033	1.016
2017-2018	1.003	1.026	1.005	0.998	1.029
2018-2019	1.002	1.032	1.001	1.001	1.035
2019-2020	0.996	1.090	0.995	1.001	1.086
average value	1.002	1.030	0.996	1.006	1.031

The dynamic analysis of Malmquist index can reflect the dynamic trend of agricultural total factor productivity in different cities and regions. Therefore, DEAP2.1 software is used to calculate and analyze the rural total factor productivity of 10 cities in the Central Plains from

2013 to 2020, and then investigate The dynamics and heterogeneity of total factor productivity. The calculation results are shown in Table 2.

Table 3. Malmquist index of rural total factor productivity and its decomposition in various cities

city	technical efficiency	skill improved	pure technical efficiency	scale efficiency	full factors production rate
Shangqiu	1.040	0.987	1.000	1.040	1.027
Zhengzhou City	1.028	1.073	1.019	1.009	1.102
Kaifeng	1.005	1.063	1.005	1.001	1.068
Luoyang City	0.989	1.039	0.981	1.008	1.027
Huaibei City	1.000	1.047	1.000	1.000	1.047
Suzhou City	0.973	0.993	0.974	1.000	0.966
Bozhou	1.000	1.002	1.000	1.000	1.002
Xuzhou	1.000	1.059	1.000	1.000	1.059
Huaian city	1.000	1.022	1.000	1.000	1.022
Suqian	0.984	1.015	0.984	1.000	0.999
average value	1.002	1.030	0.996	1.006	1.031

1) Analysis of overall efficiency changes: From 2013 to 2020, the average Malmquist index of rural total factor productivity in the Central Plains was 1.031, and the overall trend was on the rise. During the study period, except for 2013-2014, when the total factor productivity index was less than 1, all other years were greater than 1, indicating that the agricultural total factor productivity in the Central Plains was in a stage of steady increase. From the decomposition point of view, the technical efficiency increased by 0.2%, and the average technological progress increased by 3%, indicating that the management level of agricultural total factor productivity and technological progress played a major role in the improvement of comprehensive efficiency, followed by the driving efficiency of technical resources. It shows that in the process of agricultural development in the Central Plains, there is still a lot of room for rational allocation of technical resources, to improve the efficiency and effect of agricultural technology utilization, and to speed up technological innovation. In terms of years, for example, the technical efficiency index was 0.978 and the technological progress index was 1.076 in 2015-2016, indicating that the technological progress index made a major contribution to the improvement of agricultural total factor productivity in the Central Plains. Except for 2013-2014, 2015-2016, and 2019-2020, in other time periods, the technical efficiency index has a greater impact on changes in total factor productivity. In 2013-2020, although the average value of the scale efficiency index of agricultural productivity in the Central Plains was 1.006 and greater than 1, the scale efficiency index in 2013-2014, 2015-2016, and 2017-2018 were all less than 1, reflecting that scale efficiency inhibited the growth of technical efficiency. All cities need to focus on rationally adjusting the scale of technical resources and agricultural production factors, improving agricultural production efficiency, and ensuring food production safety in the Central Plains.

2) Comparison of efficiency changes in different provinces: from Table 3: From 2013 to 2020, except for Suzhou and Suqian, the agricultural total factor productivity index was lower than 1, and the agricultural total factor productivity index of the other 8 cities was greater than 1, indicating that the agricultural production efficiency of most cities in the Central Plains is continuously improving and the development trend is good. In terms of growth drivers, the technological progress index of Shangqiu City has decreased, and the improvement of

agricultural total factor productivity is mainly due to the improvement of technical efficiency. The improvement of agricultural total factor productivity of Luoyang and Suqian is mainly due to technological progress, while Zhengzhou and Kaifeng The technological efficiency changes and technological changes in the six cities of Huaibei, Huaibei, Bozhou, Xuzhou and Huaian are synchronized, that is, the factors of technological efficiency and technological progress play a synergistic role in promoting.

5. Construction of the Regression Analysis Model of Agricultural Total Factor Productivity in the Central Plains

5.1. Variable Selection

In the selection of independent variables, this paper mainly selects the following three indicators:

1) The level of economic development. To estimate the level of development of a region, the primary indicator of concern is the level of economic development in that region, that is, the gross regional product. The growth of the regional GDP means that the production efficiency of the region is higher, and the agricultural production in the Central Plains has a greater impact on the GDP. Therefore, it is believed that the level of economic development is promoting the improvement of agricultural total factor productivity. This paper selects the GDP of 10 cities in the Central Plains to measure the economic development level of the region.

2) Government financial expenditure. Increasing the government's financial expenditure on agriculture will reduce the burden on farmers and increase the enthusiasm for agricultural production, thereby promoting the improvement of agricultural production efficiency. This paper selects the government 's fiscal expenditure in various regions from 2013 to 2020 as a measure, and expects that government fiscal expenditure will have a positive impact on agricultural production efficiency.

3) Human capital level. The level of human capital is one of the factors affecting the total factor productivity of agriculture. The improvement of human capital stock will increase the number of agricultural personnel and the level of science and technology. Therefore, it is expected that the level of human capital will have a positive impact on total factor productivity. This paper selects the number of employees in the primary industry as a measure of human capital level.

In the selection of dependent variables, this paper selects the grain output of 10 cities in the Central Plains region as a measure.

The specific variables and symbols are shown in Table 4.

Table 4. Variables and symbols

variable	name	unit	symbol
Explained variable	food production	tons	<i>FY</i>
Explanatory variables	GDP of the primary industry in the region	billion	GDP
	government spending	million	FE
	Number of employees in the primary industry in the region	10,000 people	NE

5.2. Data Sources

Select the panel data of 10 cities in the Central Plains from 2013 to 2020 . The data of independent variables and dependent variables are obtained from the statistical yearbooks of each year and province. And through the software Eviews9.0 to achieve the analysis results.

5.3. Model Construction

In this paper, the following regression model is set for analysis:

$$\ln FY_{it} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln FE_{it} + \alpha_3 \ln NE_{it} + \varepsilon_{it}$$

Both sides of the equation are adjusted logarithmically to improve the significance of the influence of the explanatory variables on the explained variables, while reducing the multicollinearity and autocorrelation of the model. in, FY, GDP, FE, NE The meaning is consistent with Table 4, $\alpha_1 - \alpha_3$ is the parameter, i represent different regions, t represent different years, α_0 is a constant term, ε is the random disturbance term.

Before performing panel data regression, we must first determine the type of model, and conduct Hausman test on the selection of fixed-effect model and random-effect model. The result is that the Hausman test rejects the null hypothesis at the 5% significance level, so a fixed-effect model is established.

Next, a unit root test is performed to test the stability of the model. This paper uses the LLC test method to test the obtained fixed-effects model, and the results show that the null hypothesis is rejected at the 5% significance level. Therefore, the established model is stationary and does not appear pseudo-regression.

Table 5. Unit root test results

Method	Series	Statistic	Prob
Levin, Lin & Chu t*	GDP	-6.54241	0.0000
	FE	-9.43841	0.0000
	NE	-3.12660	0.0009

5.4. Analysis of Results

Table 6. Panel data regression results

variable	Individual Fixed Effects Model	Double fixed effects model
The level of economic development	0.2785 *** (0.0000)	0.1650 ** (0.0267)
government spending	0.0288 * (0.0989)	0.0107 (0.5575)
Human capital level	0.0178 (0.6432)	0.0296 (0.5400)
Constant term	1.6594 *** (0.0000)	2.0098 *** (0.0000)
$\overline{R^2}$	0.9939	0.9947
F value	1068.304 *** (0.0000)	782.1078 *** (0.0000)

The regression results of the influencing factors are shown in Table 6. The F test showed that the regression equation as a whole was significant, and the regression results had good goodness of fit. At the same time, in order to test whether there is a time effect in the model, this paper establishes a dual fixed model of individual and time. From the results of the two models, the results of the double fixed effect model and the individual fixed effect model are basically consistent. Therefore, this paper believes that there is no time effect in the set model results. The specific regression equation is as follows:

$$\ln FY_{it} = 1.6594 + 0.2785 \ln GDP_{it} + 0.0288 \ln FE_{it} + 0.0178 \ln NE_{it}$$

According to the regression analysis results in Table 6, the level of economic development has a significant promoting effect on agricultural total factor productivity. The high level of economic development in the region means that the output and consumption of various

industries in the region are relatively high, and the region has more resources, attracting high-quality talents and advanced production technology, providing sufficient capital for expanding agricultural production, thereby enabling agricultural production. Productivity is improved.

The impact of government fiscal expenditure on agricultural total factor productivity is significant at the level of 10%. Government fiscal expenditure can give certain subsidies to agricultural production and farmers' lives. However, due to individual and regional differences, the subsidy policy cannot meet the fundamental needs of farmers, so that the effect of stimulating the enthusiasm of agricultural production cannot be achieved. Therefore, the effect of government fiscal expenditure on agricultural productivity is not large, and the influence coefficient is only 0.0288.

The influence coefficient of human capital level on agricultural total factor productivity is positive but not significant, probably because modern agricultural production mostly relies on mechanical equipment and high-tech support, and only the increase of personnel cannot have a significant impact on agricultural productivity.

6. Conclusions and Recommendations

Based on the DEA model calculation, it can be seen that the comprehensive efficiency of agricultural total factor production in the Central Plains in 2013 and 2020 did not reach the DEA effective. and room for improvement in scale efficiency. Combined with the quantitative analysis results of statistical regression, the government should increase the investment in agricultural science and technology in various cities and strive to promote the progress of agricultural technology; and design a reasonable incentive system to expand the input of agricultural production factors to achieve the best scale; secondly, improve agricultural technology Promote the system to improve the transformation rate of agricultural scientific and technological achievements; at the same time, vigorously popularize scientific and cultural knowledge to improve the level of farmers' scientific and technological culture.

Based on the dynamic analysis of Malmquist index, it can be seen that in agricultural production, technological progress is the main reason for the change of agricultural TFP, compared with that, the contribution of technical efficiency is not very obvious. From 2013 to 2020, the average value of the agricultural total factor productivity index in the Central Plains is 1.031, indicating that its agricultural total factor productivity is generally on the rise. Changes in technical efficiency of agricultural production play a major role in the improvement of overall efficiency, followed by the driving role of technological progress. From the perspective of spatial distribution, the changes in the supply efficiency of rural infrastructure in different regions are quite different, and fluctuate changes at different times. All regions should take targeted and effective measures according to the constraints to greatly improve the efficiency of agricultural production, ensure the stability of grain production in the Central Plains, and promote the development of the local economy, thereby increasing the income and living standards of farmers, and achieving the grand goals of rural revitalization and poverty alleviation. Just around the corner.

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References

- [1] Zhang Heng, Guo Xiangyu. The development of agricultural productive services and the improvement of agricultural total factor productivity: regional differences and spatial effects [J]. Agricultural Technology and Economics, 2021, (05): 93-107.
- [2] Long Shaobo, Zhang Mengxue . Recalculation and Influencing Factors of China's Agricultural Total Factor Productivity : From Tradition to High-quality Development [J]. Research on Financial Issues, 2021 (08):40-51.
- [3] Guan Lijie, Zhao Wei . Evaluation of Rural Infrastructure Supply Efficiency Based on DEA-Malmquist [J]. Statistics and Decision Making . 2020, 36(04).
- [4] Fang Fuqian, Zhang Yanli. Changes of China's Agricultural Total Factor Productivity and Its Influencing Factors Analysis --Based on the Malmquist Index Method from 1991 to 2008 [J]. Economic Theory and Economic Management, 2010, (09): 5-12.
- [5] Zhang Yunhua . Analysis of China's Agricultural Production Efficiency [J]. Statistics and Decision, 2007, (04): 62-64.
- [6] Liu Zhanwei. The dynamic evolution of China's agricultural total factor productivity and its influencing factors [J]. China Agricultural Resources and Zoning, 2018, 39(12): 104-111.
- [7] Shi Changliang, Zhu Junfeng, Jie Changliang. Regional Differences and Convergence Analysis of Agricultural Total Factor Productivity Growth in China : Based on Fixed Effects SFA Model and Panel Unit Root Method [J]. Economic Problems Exploration, 2016, (04): 134-141.