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Study on Current Situation of Agricultural Green Development in Anhui Province

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Abstract

In this paper, 16 prefecture-level cities in Anhui Province located in the Yangtze River Delta region were selected to calculate the agricultural green total factor productivity and its decomposition of each city in Anhui Province from 2010 to 2019 by using the super-efficience-SBM Malmquist model, and the 16 cities were divided into three regions: Northern Anhui, central Anhui and southern Anhui. The current situation of agricultural green development at the provincial, regional and municipal levels in Anhui Province was comprehensively analyzed.

Keywords

Green Development of Agriculture; Green Total Factor Productivity; Agriculture of Anhui Province.

1. Introduction

At present, China's agriculture is he historical transition to high-quality development, among which green development is particularly critical. Green agricultural development is the embodiment of the five-sphere Integrated plan in agriculture for the new era. It is a necessary requirement for implementing the new development concept of "innovative, coordinated, green open and shared development" and advancing agricultural sup -side structural reform. It is also a prerequisite for implement the rural revitalization strategy. Is of great significance to ensuring national food security, resource security and ecological security. Anhui Province is located in he Yangtze River Delta region, and the agriculture of the Yangtze River Delta occupies an important position in the whole country. The green development of agriculture is an important conte of the economic green development of the Yangtze River Delta. However, as a major agricultural province in the Yangtze er Delta region, the rapid development of agriculture Anhui Province has also caused negative impacts on the environment. All along, Anhui Province has been carrying out rural reform to promote green agricultural development. At present, the existing research results show that the starting point of agricultural green development in Anhui Province is not high, and the development level tends to be average. In order to further analyze the differences and development changes of agricultural green development among specific regions in Anhui Province, this paper selected the data of 16 prefecture-level cities in Anhui Province from 2010 to 2019, referred to the existing agricultural green development index system, and used the ultra-efficience-SBM-Malmquist model to calculate agricultural green total factor productivity and its decomposition. To analyze the status quo of agricultural green development in Anhui Province.

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2. Measurement of Municipal Green Total Factor Productivity in Anhui Province

2.1. Measurement Method of Municipal Green Total Factor Productivity in Anhui Province

2.1.1. SBM Super-efficiency Model of Undesired Output

DEA method does not need to consider the functional relationship between input-output indicators a es not need to set presupposition, so it is widely used in the study of efficiency measurement. However, the traditional DEA model has some shortcomings, such as the f lure to fully consider the impact of undesired output on efficiency and the slackness of input-output variables. Tone (2003) proposed a non-radial and non-angular SBM model. Based on the SBM model with non-desired output defined by Tone and the "super-efficiency" model proposed by Andersen & Petersen, the SBM supe -efficiency model with non- desired output is constructed as follows:

$$\min \rho = \frac{1 + \frac{1}{m}\sum_{i=1}^{m} \bar{si} / x_{ik}}{1 - \frac{1}{q_1 + q_w}(\sum_{r=1}^{q_1} s_r^+ / y_{rk} + \sum_{t=2}^{q_2} s_t^{b-} / b_{rk})}$$

$$\text{S. t.} \quad \sum_{j=1, j\neq k}^{n} x_{ij}\lambda_j - s_i^- \leq x_{ik}$$

$$\sum_{j=1, j\neq k}^{n} y_{rj}\lambda_j - s_r^+ \geq y_{rk}$$

$$\sum_{j=1, j\neq k}^{n} b_{tj}\lambda_j - s_t^{b-} \leq b_{tk}$$

2.1.2. Malmquist-luenberger Index Model

Combining the Global production index proposed by Pastor&Lovell(2005) with the Malmquist index model obtained by Chung et al. by applying the directional distance function containing bad output to the Malmquist model, The GML index model was constructed to make up for the static efficiency result of SBM model, and the efficiency change of green total factor productivity and its decomposition from period T to period T +1 could be measured. Its expression is as follows:

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

$$Effch = \frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)}$$

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

$$Tfpch = Effch \times Tech = (Pech \times Sech) \times Tech$$

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2.2. Indicator Selection and Data Sources

Based on the existing literature and the content to be studied, this paper selects the ta of cities in Anhui Province from 2010 to 2019 to measure the green total factor productivity. With reference to the research of Wu Chuanqing et al. (2018), narrow sense agriculture (planting industry) was selected as the research object. Agricultural GTFP index includes input index, expected output index and non-expected output index.

Agricultural input indicators include: (1) Land input: expressed by the sown area of crops; (2) Labor input: the proportion of agricultural output value in the total output value of agriculture, forestry, animal husbandry and fishery is multiplied by the number of employed persons in the primary industry to obtain the labor input of planting industry; (3) Machinery input: the proportion of the total agricultural output value in the total output value of agriculture, forestry, animal husbandry and fishery is multiplied by the total power of agricultural machinery to obtain the total power of planting machinery; (4) Irrigation input: expressed by effective irrigation area;(5) Diesel oil input: expressed by the amount of agricultural diesel oil; (6) Fertilizer input: expressed by the amount of agricultural fertilizer application; (7) pesticide input: expressed by pesticide use;(8) agricultural film input: with the use of plastic film.

Expected output is expressed by agricultural gross output value. The non-expected output is represented by agricultural carbon emissions. According to Li Bo (2011), the main sources of agricultural carbon emissions are divided into six aspects: first, direct or indirect agricultural carbon emissions caused by the production and use of chemical fertilizers; Second, the carbon emissions caused by the production and use of pesticides; Third, the carbon emissions caused by the production and use of agricultural film; Fourth, the carbon emissions caused by the direct or indirect consumption of fossil fuels (mainly agricultural diesel) due to the use of agricultural machinery; The fifth is the carbon emissions caused by the soil organic carbon pool destroyed by agricultural plowing, and a large amount of organic carbon is lost to the air. Finally, it is the carbon release caused by the indirect consumption of fossil fuels by the use of electricity in the irrigation process. Agricultural carbon emissions were obtained by multiplying the number of the six major sources of carbon emissions b their respective emission factors.

The DATA in this paper are from Anhui Prov l Bureau of Statistics, National Bureau of Statistics, and sorted by EPS DATA.

2.3. Measurement Results and Analysis of Green Total Factor Productivity in Anhui Province

The measurement results based on the super-efficience-SBM-Malmquist model are shown in Figure 1. This paper analyzes the measurement results at the overall, municipal and regional levels of Anhui Province.

Firstly, the GTFP of Anhui Province was analyzed as a whole. From 2010 to 2019, except for 2016, the overall agricultural green total factor productivity of Anhui Province was greater than 1, indicating that agricultural green production in Anhui Province was efficient. Among them, the agricultural green total factor productivity of Huangshan City, a well-known tourism city in China, was the highest among all prefecture-level cities in several years, indicating that the development of green tourism agriculture played a positive role in the development of agricultural green in Huangshan city. From the perspective of northern Anhui, central Anhui and southern Anhui, the agricultural green total factor productivity of southern Anhui was significantly higher than that of northern Anhui and central Anhui, which was related to the fact that the overall economy of southern Anhui was more developed than that of the other two regions.

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Year	Hefei	Huaibei	Bozhou	Suzhou	Bengbu	Fuyang	Huainan	Chuzhou	Luan	Maanshan
2010	1.220	1.019	1.102	1.021	1.024	1.237	1.009	1.123	0.597	1.142
2011	1.165	0.629	1.107	1.024	1.025	1.237	1.006	1.126	0.630	1.029
2012	1.161	0.639	1.109	1.035	1.016	1.195	1.002	1.124	0.600	1.023
2013	1.166	0.712	1.113	1.031	1.024	1.216	0.629	1.132	0.548	1.013
2014	1.149	0.614	1.104	1.031	1.009	1.217	0.572	1.126	0.590	1.005
2015	1.168	0.735	1.092	1.035	1.012	1.184	0.406	1.118	0.699	1.003
2016	1.170	0.712	1.140	0.715	1.019	1.162	0.408	1.071	0.691	0.884
2017	1.179	1.056	1.106	0.679	1.022	1.151	0.437	1.070	0.780	1.009
2018	1.210	1.052	1.138	1.000	1.025	1.114	1.004	1.067	1.004	1.032
2019	1.283	1.098	1.185	1.003	1.019	1.126	0.466	0.617	1.001	1.033

Year	Wuhu	Xuancheng	Tongling	Chizhou	Anqing	Huangshan	Northern Anhui	Central Anhui	Southern Anhui	Anhui province
2010	1.093	1.108	2.674	1.184	1.098	1.231	1.066	0.974	1.324	1.130
2011	1.128	1.094	8.940	1.269	1.085	1.283	0.984	0.973	1.626	1.185
2012	1.130	1.059	8.808	1.293	1.099	1.265	0.981	0.963	1.613	1.177
2013	1.142	1.084	8.443	1.296	1.096	1.266	0.928	0.943	1.609	1.146
2014	1.212	1.130	8.484	1.300	1.073	1.261	0.888	0.951	1.636	1.136
2015	1.241	1.127	1.321	1.312	1.009	1.580	0.860	0.980	1.251	1.023
2016	1.217	1.165	1.364	1.232	0.765	1.469	0.809	0.902	1.207	0.966
2017	1.180	1.181	1.367	1.199	1.003	1.466	0.861	0.997	1.225	1.019
2018	1.205	1.156	1.353	1.237	1.003	1.524	1.054	1.068	1.242	1.125
2019	1.222	1.172	1.715	1.167	0.704	1.418	0.942	0.864	1.270	1.031

Figure 1. Agricultural green total factor productivity in Anhui Province from 2010 to 2019

From the perspective of ML index, it can be found that the average value of ML index of Anhui province from 2010 to 2019 is 1.10117, that is, the annual growth rate of agricultural GTFP is 10.117%, the annual growth rate of technological progress is 11.244%, and the annual decline rate of technical efficiency is 1.013%. Technological progress is the main growth point ofgreen total factor productivity, which is the result of Anhui Province's positive response to national policies, implementation of innovation-driven strategy and promotion of high-quality agricultural development in recent years. (figure 2)

The analysis of prefecture-level cities showed that the agricultural green total factor productivity of all prefecture-level cities in Anhui Province, except Ma 'anshan City, showed an increasing trend from 2010 to 2019.The average annual growth rate of agricultural green total factor productivity in Hefei, Huaibei, Bozhou, Suzhou and other cities was relatively high, while the average annual growth rate of agricultural green total factor productivity in Ma 'anshan, Huainan, Tongling and other cities was relatively low.

By analyzing the three regions of northern Anhui, Central Anhui and southern Anhui, it can be found from Figure 1 that the green total factor productivity of the three regions is consistent with the change trend of Anhui Province, and the growth trend is mainly driven by technological progress. The growth rate of green total factor productivity in northern Anhui is higher than that in other regions. The average annual growth rate of technical progress is 12.989%, and the average annual decline rate of technical efficiency is 1.362%. The average annual growth of green total factor productivity in central Anhui and southern Anhui is 11.244% and 8.063%, respectively.

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City	ML	EC	TC
Hefei	1.13251	1.00563	1.12617
Huaibei	1.13304	1.00834	1.12366
Bozhou	1.13406	1.00815	1.12489
Suzhou	1.15208	0.99807	1.15430
Bengbu	1.13842	0.99947	1.13903
Fuyang	1.09698	0.98967	1.10843
Huainan	1.03660	0.91771	1.12956
Chuzhou	1.05805	0.93557	1.13091
Luan	1.18005	1.05902	1.11429
Maanshan	0.99977	0.98898	1.01091
Wuhu	1.12083	1.01240	1.10710
Xuancheng	1.11868	1.00625	1.11173
Tongling	1.05770	0.95184	1.11122
Chizhou	1.09036	0.99843	1.09207
Anqing	1.08307	0.95187	1.13783
Huangshan	1.10149	1.01587	1.08428
Northern Anhui	1.11450	0.98638	1.12989
Central Anhui	1.11244	0.98684	1.12727
Southern Anhui	1.08063	0.99539	1.08563
Anhui Province	1.10117	0.98987	1.11244

Figure 2. List of ML index and decomposition mean of agricultural green total factor productivity in Anhui Province

As can be seen from Figure 3, the average ML values of northern Anhui, Central Anhui and southern Anhui showed an upward trend from 2010 to 2019, and the green total factor productivity of agriculture in the three regions increased significantly from 2018 to 2019. The characteristics of growth rate distribution are as follows: from 2010 to 2019, the growth rate of northern and southern Anhui alternately changed from high to low year by year, and the regional difference of agricultural green total factor productivity between northern and southern Anhui was decreasing. Before 2015, the growth rate of agricultural green total factor productivity in central Anhui Province was relatively high, followed by that in northern Anhui Province, which was higher than that in Anhui Province. In some years, the ML value of agricultural green total factor productivity in southern Anhui Province was lower than 1, which meant that agricultural green total factor productivity declined.

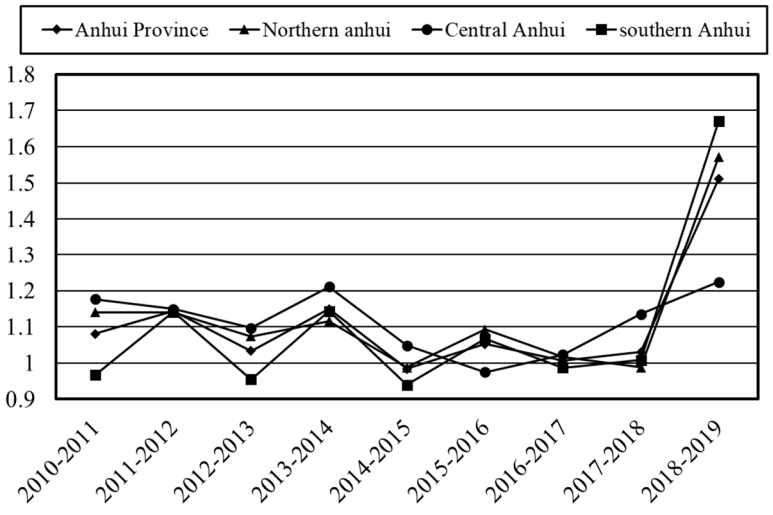

Figure 3. Mean values of ML index of agricultural green total factor productivity in northern Anhui, Central Anhui and southern Anhui from 2010 to 2019

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It can be seen from Figure 4 that the overall trend of the change of the mean TC value in northern Anhui, Central Anhui and southern Anhui from 2010 to 2018 was relatively stable, and the difference in the growth rate among regions was decreasing continuously. However, in 2019, the mean TC of the three regions and the whole province increased significantly compared with previous years, and the difference in the growth rate among regions was still decreasing. The mean value of TC in most years was greater than 1, and the mean value of TC in northern Anhui was higher than that in southern Anhui and central Anhui in most years. This indicates that the growth of agricultural green TFP in northern Anhui, central Anhui and southern Anhui is mainly driven by technological progress. Before 2017, the driving force of technological progress on agricultural green total factor productivity growth was relatively stable, maintaining a growth rate of about 10%. Since the beginning of 2017, the growth rate of technological progress has begun to decline, and there has even been a technological recession. After 2018, the growth rate of technological progress began to rise sharply.

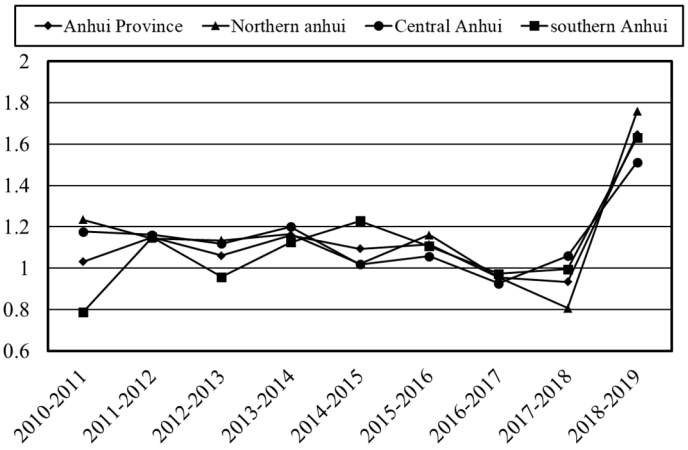

Figure 4. Average value of TC index of agricultural green total factor productivity in northern Anhui, Central Anhui and southern Anhui from 2010 to 2019

It can be found from Figure 5 that the overall trend of changes in the average value of EC in northern Anhui, Central Anhui and southern Anhui from 2010 to 2019 was relatively stable, but the average value of EC was lower than the average value of TC, which again confirmed that technological progress was the core growth factor.

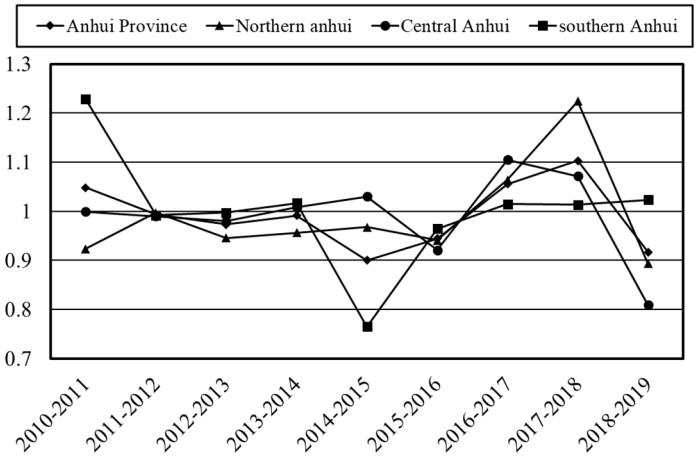

Figure 5. Average EC index of agricultural green total factor productivity in northern Anhui, Central Anhui and southern Anhui from 2010 to 2019

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3. Conclusion

In this paper, the ultra-efficience-SBM-malmquist model was used to measure and analyze the agricultural green total factor productivity of 16 prefecture-level cities in Anhui province located in the Yangtze river delta region. The results showed that :(1) agricultural green total factor productivity of Anhui province showed continuous growth from 2010 to 2019 and was driven by technological progress; (2) Agricultural green total factor productivity of all prefecture-level cities in Anhui Province showed an upward trend from 2010 to 2019, and there were some differences in the growth rate among cities. (3) characters of green, in Anhui, the three areas in the south of Anhui agriculture total factor productivity and the province show the same trend, technology progress is the core growth, growth in the regional distribution characteristics is northern Anhui and southern Anhui region growth year after year held high change alternately, northern Anhui and southern Anhui region agricultural green total factor productivity differences between regions in the shrinking.

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