Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 9, No. 1, 2023

Digital Inclusive Finance and Green and Low-carbon Agricultural Development

-- Take the Cities in The Yellow River Basin as An Example

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Abstract: Under the two-carbon target, the road of green development in China has reached a new height. This paper is based on the SBM-GML model of 2001-2019 the Yellow River basin nine provinces of agricultural green total factor productivity, combined with the number of Beijing university Digital Inclusive Financial index, from the perspective of time series, space to explore the Digital Inclusive Financial and the relationship between agricultural green low carbon development, for the Yellow River city Green High Quality Development.

Keywords: Digital Inclusive Finance, Yellow River basin, Agricultural Green Total Factor Productivity Green Total Factor Productivity (GTFP), Agricultural Green Development.

1. Introduction

The goal of "double carbon", which is to achieve the carbon peak by 2030 and carbon neutrality before 2060, has elevated the road of green development in China to a new height, and has now become one of the main key note of economic development. Therefore, the economic growth mode in the new era should pursue the "high-quality growth" with the total factor productivity as the measurement index. At the same time, with the development of digital technology, digital inclusive finance has become an active application direction, and its development may promote or inhibit the growth of total factor production rate. Therefore, based on the "double carbon" goal, this paper to the Yellow River basin in China as the research object, with agricultural green total factor productivity as the core index, the Digital Inclusive Financial and agricultural green total factor productivity relationship between the empirical research, to explore the evolution of space-time evolution effect, to realize the recommendations of agricultural economy "high quality growth". This project has important theoretical and practical significance for the improvement of industrial green efficiency, sustainable development and high-quality economic development in the Yellow River basin in China, and provides a reference for the efficient development of green economy in China.

2. Literature Review

Regarding the relevant research on digital inclusive finance, scholars mainly study it from two perspectives: first, the advantages and development prospects of digital inclusive finance. Wang Haijun [1] et al. (2014) proposed that the integration of electronic technology in financial services has improved the convenience of obtaining financial capital, and significantly reduced the cost of financial services. Hu Bin [2] (2016) proposed that the advantage of digital inclusive finance is to reduce the cost of financial information collection and supervision, and then play the function of financial risk diversification at low cost, better play the financial inclusive effect based on digital technology, and further improve the possibility of obtaining financial services. Huang Yiping [3] et al. (2018) proposed that based on electronic information technology and database, digital inclusive finance has incomparable advantages in traditional finance. Second, pay attention to the poverty reduction effect of digital inclusive finance in social and economic development and urban-rural gap. Chen Xiao [4] et al. (2018), Sun Jiguo [5] et al. (2020), Qian Peng [6] et al. (2019) respectively use the space spillover effect, threshold effect and space Dubin model to empirically analyze that digital inclusive finance more effectively promotes the narrowing of the gap between urban and rural areas, and also reduces the educational gap between urban and rural areas.

As for the relationship between financial development and green total factor productivity, it is mainly studied from two perspectives: first, the role path of financial development on total factor productivity. Li Jian [7] et al. (2014) pointed out that there are differences in total factor growth rates in different regions. The import of human capital and mechanical equipment can promote the growth of total factor productivity, while the level of financial development can not promote technological progress, and thus inhibit its growth. The second is to study the relationship between them from the influence effect. Yao Yaojun [8] (2010) found that the level of financial development can promote the development of total factor productivity in the long term, and the degree of economic freedom promotes the development of total factor productivity is short-term in time. Tian Jie [9] (2021) and others, combined with prefecture-level panel data, believe that digital inclusive finance can improve the distortion of factor allocation by improving the efficiency of the financial market, and then promote the improvement of green total factor productivity. Wang Yu [10] (2022), on the basis of measuring the urban green total factor productivity, studies the impetus of the industrial structure upgrading in the Yellow River Basin and the high-quality development of digital economy.

As for the impact of digital inclusive finance on green total factor productivity in agriculture, there are still few scholars who conduct correlation studies between the two, and most scholars still conduct empirical evidence and discussion based on the impact of finance on green total factor productivity. The green efficiency level is still less discussed. And only a few scholars have studied the Yellow River basin.

3. Development Status of Digital Inclusive Finance and Green Agriculture in the Yellow River Basin

3.1. Digital Inclusive Finance Index of the Yellow River Basin

Digital Inclusive Financial, is through the Internet technology, with the help of computer information processing, data communication, data analysis, cloud computing and a series of related technology in the field of financial application, promote the information sharing, effectively reduce the transaction cost and financial services threshold, expand the scope of financial services and coverage, through the digital financial sharing, convenient, safe, low cost, low threshold, using big data, cloud computing, artificial intelligence technology, build up risk control system based on data, so as to improve the financial risk control ability.

This paper refers to the digital financial inclusion index of Peking University and selects the digital financial inclusion index [11] of nine provinces in the Yellow River Basin.

Table 1. Digital Financial Inclusion Index of 9 provinces in the Yellow River Basin from 2011 to 2019

province	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Qinghai	18.33	61.47	118.01	145.93	195.15	200.38	240.20	263.12	282.65	298.23
Sichuan	40.16	100.13	153.04	173.82	215.48	225.41	267.80	294.30	317.11	334.82
Gansu	18.84	76.29	128.39	159.76	199.78	204.11	243.78	266.82	289.14	305.50
Ningxia	31.31	87.13	136.74	165.26	214.70	212.36	255.59	272.92	292.31	310.02
Nei Monggol	28.89	91.68	146.59	172.56	214.55	229.93	258.50	271.57	293.89	309.39
Shaanxi Province	40.96	98.24	148.37	178.73	216.12	229.37	266.85	295.95	322.89	342.04
Shanxi	33.41	92.98	144.22	167.66	206.30	224.81	259.95	283.65	308.73	325.73
Henan	28.40	83.68	142.08	166.65	205.34	223.12	266.92	295.76	322.12	340.81
Shandong	38.55	100.35	159.30	181.88	220.66	232.57	272.06	301.13	327.36	347.81

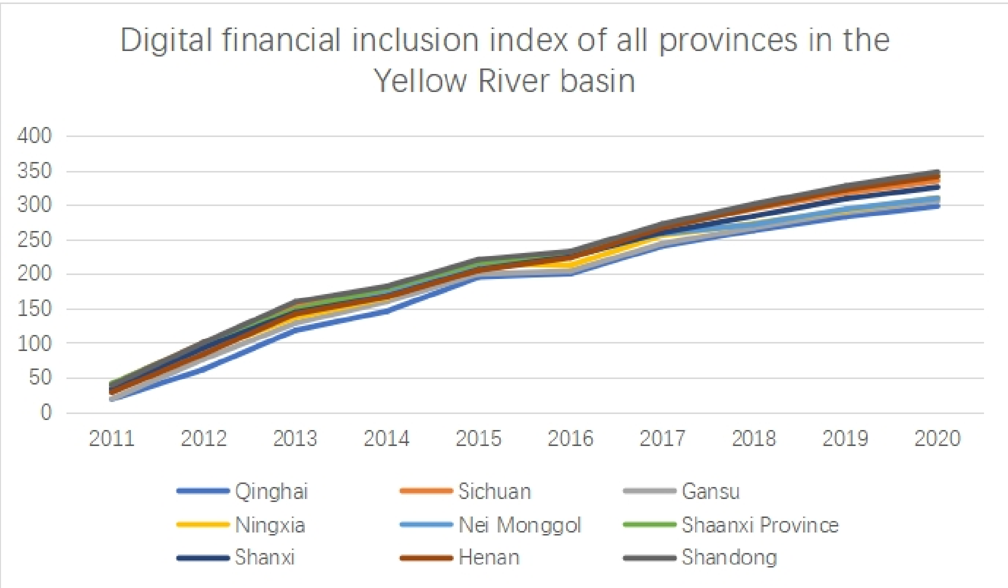

Figure 1. Digital financial inclusion index of all provinces in the Yellow River Basin

According to the easy knowledge from the line chart, the digital inclusive finance index in the Yellow River Basin showed a steady growth trend from 2011 to 2020.

3.2. Green total factor productivity of agriculture in the Yellow River Basin

Agricultural green total factor productivity is the production efficiency of reducing agricultural pollution emission while realizing the maximum agricultural output on the premise of given agricultural input elements, which is an objective reflection of the level of sustainable agricultural sustainable development.

This paper uses the provincial panel data of the agricultural input and output of 9 provinces in the Yellow River basin from 2001 to 2019 to establish the SBM-GML model to measure the agricultural GTFP in the Yellow River basin. The original data reference sources are China Agricultural Yearbook, China Rural Statistical Yearbook and provincial statistical yearbooks.

Table 2. Measurement index system of agricultural green total factor productivity in the Yellow River Basin

Indicator type	name	meaning	unit
Investment index	land	Repressed by the total sown area of the crops	hectare
	Fertilizer applied (discounted volume)	The actual amount of chemical fertilizer used in agricultural production represents the chemical fertilizer input, including phosphate fertilizer, compound fertilizer, nitrogen fertilizer and potassium fertilizer	Ten thousand tons
	agricultural machinery	farm machinery production	Ten thousand kilowatt-hours
	labour force	Employment in the primary industry	thousands of people
	Agricultural irrigation area	effective irrigation area	hectare
	Agricultural film coverage area	Is presented as the actual usage per year	Ten thousand tons
	Pesticide application	Is presented as the actual usage per year	Ten thousand tons
Expect output	Total output value of agriculture, forestry, animal husbandry and fishery		100 million
Undesired output	Agricultural carbon emissions		Ten thousand tons

The input index mainly covers seven aspects: land, chemical fertilizer application amount (discount amount), agricultural machinery, labor force, agricultural irrigation area, agricultural film coverage area and pesticide application amount. The input of labor force is represented by the employment of primary industry (ten thousand people); the sown area of crops (hm 2); the total power of agricultural machinery (10,000 kW) to represent the agricultural machinery input; the amount of fertilizer used in agricultural production to represent the fertilizer input, including phosphate fertilizer, compound fertilizer, nitrogen fertilizer and potash fertilizer (10,000 t); the effective irrigation area (hm 2); the pesticide and agricultural film are represented by the annual usage (10,000 t).

The output index covers two levels, namely, the expected output and the undesired output. The expected output is represented by the total output value of agriculture, forestry, animal husbandry and fishery in the Yellow River basin (RMB 100 million yuan); the undesirable output is expressed by agricultural carbon emission. In this paper, agricultural carbon emissions will draw on the research of Li Bo et al., and multiply the use of agricultural plastic film, effective irrigation area, agricultural fertilizer application, crop sown area and pesticide use with the corresponding carbon emission coefficient to obtain the total agricultural emissions. Specific reference coefficient is shown in the table below.

Table 3. Agricultural carbon emission sources, coefficients and references

Carbon emission sources	Emission system / (kg · kg-1)
chemical fertilizer	0.8956
pesticide	4.9341
irrigate	266.48
agricultural film	5.18
diesel oil	0.5927
turn over	312.6

At present, many scholars have used SBM method to measure the green total factor productivity of inter-provincial agriculture, which has been effectively verified in long-term calculation. This paper refers to the calculation method in related studies of Li Bo [12] et al., and cites some data.

4. Agricultural Green Total Factor Productivity Calculation and Spatial and Temporal Evolution Effect Analysis in the Yellow River Basin

4.1. Time-series analysis

The calculation results of agricultural green total factor productivity in the Yellow River Basin are as follows, in which GML indicates the agricultural green total factor productivity in a certain period; GML is greater than 1, indicating that the undesired output decreases, the expected output increases and agricultural G TFP increases; otherwise, agricultural G TFP decreases. The GML is further decomposed into technical efficiency change (EC) and technical progress change (TC).

As can be seen from the table, from 2001 to 2019, the average growth rate of agricultural G TFP in the Yellow River Basin was close to 5%, the average growth rate of the technical progress index increased by 8.5%, and the average growth rate of the technical efficiency index decreased by 3%, showing negative growth. It can be analyzed that technological progress is the key to promote the high-quality development of agriculture in the Yellow River basin, and technological progress has a significant role in promoting the level of agricultural output, but the problems of agricultural management system, efficiency and optimal allocation of resources result in the low level of agricultural technical efficiency.

Table 4. Annual growth rate of green total factor productivity in the Yellow River Basin from 2001 to 2019

a particular year	EC	TC	GML
2000—2001	1.012	1.016	1.028
2001—2002	1.015	1.117	1.134
2002—2003	1.013	0.987	0.999
2003—2004	1.015	1.146	1.163
2004—2005	0.970	1.054	1.022
2005—2006	0.987	1.037	1.023
2006—2007	1.004	1.218	1.222
2007—2008	1.005	1.113	1.118
2008—2009	1.011	0.896	0.904
2009—2010	0.960	1.166	1.119
2010—2011	0.956	1.200	1.147
2011—2012	0.960	1.062	1.019
2012—2013	0.976	1.066	1.040
2013—2014	0.957	1.061	1.015
2014—2015	0.952	1.012	0.963
2015—2016	0.923	1.074	0.991
2016—2017	0.908	1.145	1.039
2017—2018	0.931	1.027	0.956
2018—2019	0.885	1.222	1.081
mean	0.970	1.085	1.051

Note: The table shows the geometric mean of each year of the 9 provinces (autonomous regions) in the Yellow River Basin.

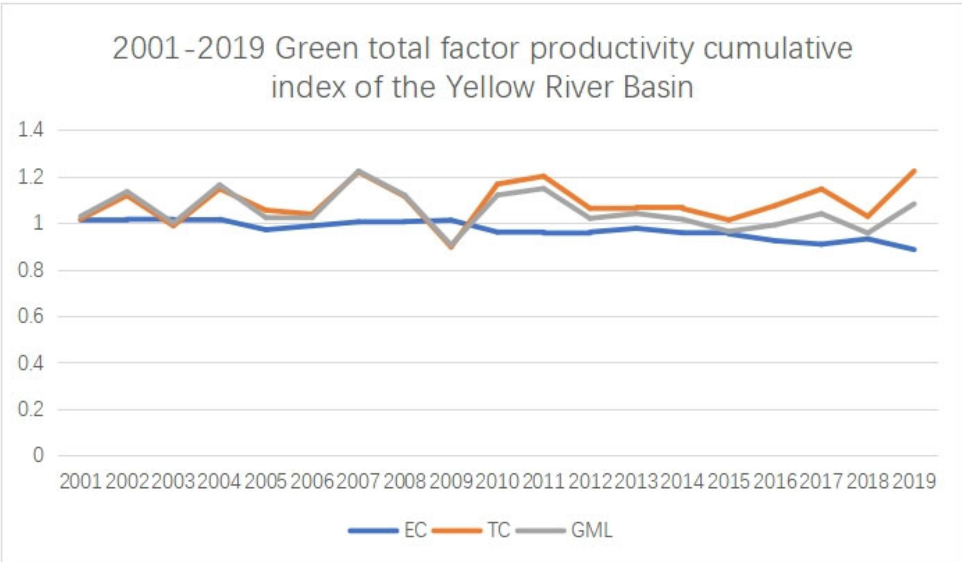

Figure 2. The cumulative index of green total factor productivity in the Yellow River Basin from 2001 to 2019

According to the change of time series, from 2001 to 2009, and was less than 1 in 2003 and 2009, indicating the degradation of technological progress during the sample cycle. From 2001 to 2002, the growth rate of agricultural G TFP was 13.4%, with technological progress and technological efficiency greater than 1; from 2004 to 2008, agricultural G TFP was greater than 1, with high annual growth rate of 10.9%; in 2010 to 2019.

4.2. Spatial difference analysis

Table 5. Annual growth rate and decomposition of agricultural green total factor productivity in provinces and regions in the Yellow River Basin

area	EC	TC	GML
Nei Monggol	0.919	1.094	1.005
Qinghai	1.000	1.056	1.056
Sichuan	1.000	1.077	1.077
Gansu	0.929	1.099	1.020
Ningxia	0.972	1.076	1.045
Shaanxi Province	0.943	1.101	1.038
Shanxi	0.973	1.082	1.052
Henan	0.972	1.064	1.034
Shandong	0.975	1.076	1.049
Upstream area	0.964	1.080	1.041
Middle and lower reaches	0.965	1.081	1.043

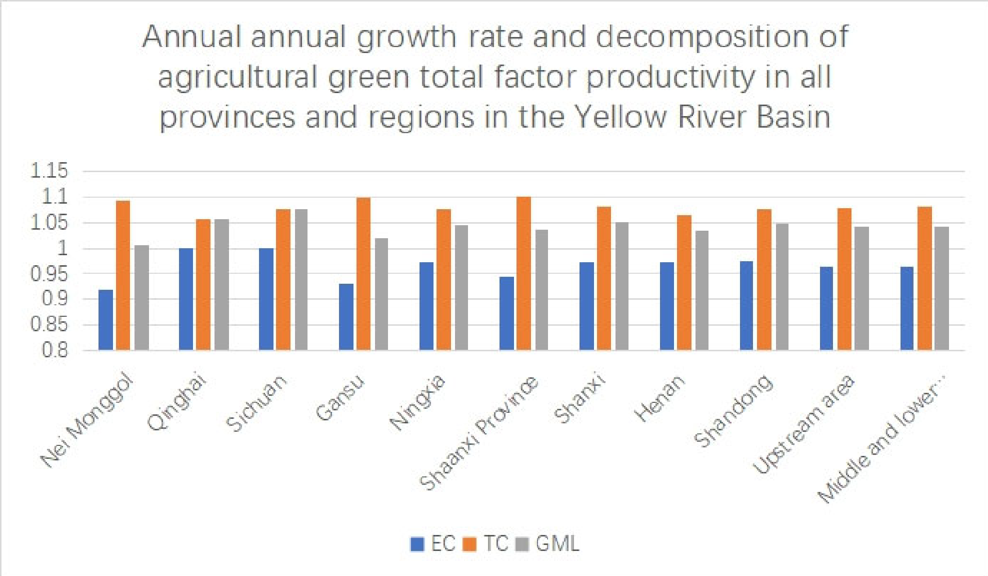

Figure 3. Average annual growth rate and decomposition of agricultural green total factor productivity in all provinces and regions in the Yellow River Basin

From the perspective of spatial difference, there is a small gap between the upper reaches and the middle and lower reaches of the Yellow River Basin from 2001 to 2019. From 2001 to 2019, the agricultural G TFP in the upper and lower reaches increased by 4.1% and 4.3% respectively, with the average annual growth rate of technological progress index of 8% and 8.1%, indicating the simultaneous deterioration of technical efficiency.

From the perspective of various regions, the average annual growth rate of agricultural GTFP in Sichuan province is 7.7%, ranking the first among the 9 provinces. The growth rate is mainly technological progress, with little impact on technological efficiency. It can be seen that the growth model of this region is moving towards intensive growth. Qinghai, Shanxi, Shandong, Ningxia, Shaanxi, Henan, Gansu and Inner Mongolia followed, with Qinghai ranking ahead of other provinces with an annual growth rate of 5.6 percent.

5. Conclusion and Policy Recommendations

5.1. Improve the development environment of digital inclusive finance in the Yellow River Basin

Digital inclusive finance has improved the efficiency of green technology, promoted the progress of green technology, and improved the agricultural green total factor productivity, but digital inclusive finance has a negative spatial spillover effect on agricultural green total factor productivity [13]. The coverage breadth and digitalization degree of digital finance can promote the increase of green total factor productivity of agriculture. Therefore, we should improve the construction of rural digital infrastructure and develop digital inclusive finance. Pay attention to urban and rural development as a whole, to speed up the "digital rural construction", promote the network communication infrastructure construction in rural areas, narrow the digital divide between urban and rural areas, improve the remote rural areas computer, smartphone mobile terminal penetration, improve the rural Internet penetration and ensure broadband network speed, moderate reduce broadband and traffic costs, improve the availability of Digital Inclusive Financial services, for the development of Digital Inclusive Financial provide better hardware and software conditions.

5.2. We will improve the environmental protection links in agricultural production

Relevant government departments should improve the legal provisions related to agricultural production and development in the Yellow River basin. The direction of agricultural development in the Yellow River basin should be further optimized, so that the development can conform to the natural environment, take the road of green agricultural development, reduce unnecessary environmental pollution, and optimize the treatment mechanism of agricultural waste development. Develop green agriculture as much as possible to reduce the emission of pollutants.

5.3. Optimize the allocation of financial resources and promote the improvement of agricultural technology efficiency and the progress of agricultural technology

Considering the difference of the green agricultural development in the Yellow River basin and other regions, the regional allocation of financial resources should be optimized, and the efficiency of the use of financial resources in the Yellow River basin should be improved. Actively use digital technology to guide the flow of financial resources to agricultural technology innovation activities, promote technological progress and technological promotion, and reverse the situation of technological regression. While maintaining technological progress, we should actively improve agricultural irrigation equipment, popularize agricultural machinery and equipment, improve the level of agricultural water conservancy, mechanization and informatization, and enhance the level of technical efficiency.

Acknowledgment

This work is supported by the Undergraduate Scientific Research and Innovation Foundation Project of Anhui

University of Finance and Economics (XSKY23081), and the research results are owned by Anhui University of Finance and Economics.

Project Name: Analysis of the spatial and temporal evolution effect of digital inclusive finance and agricultural green total factor productivity —— Take the cities in the Yellow River basin as an example. Project Number: XSKY23081.

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