

Influence of Digital Finance Development on Carbon Emission Intensity

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Abstract

After the dual-carbon goal was put forward, low-carbon development has become a hot spot at home and abroad. In the era of digital economy, digital finance, as a new financial service that combines cutting-edge technology with traditional financial services, can promote China's low-carbon development while promoting economic development? This is worthy of further study. This paper selects the development level of digital finance and carbon emission intensity as the research objects, Based on the panel data of 30 provinces in China from 2011 to 2019, the empirical study of random effect model shows that the development of digital finance in China has a restraining effect on carbon emission intensity. In the future, the Chinese government should accelerate the development of digital finance, make innovative integration with other industries, establish and improve the supervision system, and contribute financial strength to the realization of the dual-carbon goal.

Keywords

Digital Finance; Carbon Emission Intensity; Random Effect Model; China.

1. Introduction

Since the reform and opening up, China's economy has maintained high-speed development and achieved leap-forward growth, but the high-speed economic growth has led to a series of economic development problems, such as widening regional wage gap, unbalanced regional economic development, low utilization rate of resources, lack of independent innovation ability and so on. Among them, the extensive economic development model characterized by scale expansion and investment increase for a long time has led to serious environmental pollution. As the largest developing country and carbon emitter in the world, China pays special attention to environmental pollution while paying attention to economic development. In 2016, the Chinese government put forward the commitment of independent emission reduction in the Paris Agreement, and in September 2020, it clearly put forward the goals of "carbon peaking" in 2030 and "carbon neutrality" in 2060. The outline of the "14th Five-Year Plan" clearly defines the goal of double carbon, and carbon emission reduction and green and low-carbon development have risen to a new strategic height. China's eco-environmental protection has a long way to go.

In the era of rapid development of science and technology, Digital finance is a product of the combination of cutting-edge digital technologies such as cloud computing, big data and artificial intelligence with traditional financial industries. With its characteristics, it overcomes the shortcomings of traditional financial industry, such as high transaction cost, high threshold and insufficient resources, and plays an important role in promoting high-quality economic development, promoting the growth of residents' consumption, narrowing the income gap between urban and rural areas, and promoting the upgrading of industrial structure. Therefore,

the role of the financial industry in reducing carbon emissions should not be underestimated. To achieve the goal of "double carbon", it is necessary to effectively restrain the intensity of carbon emissions through effective financial means. Therefore, studying the relationship between the development of digital finance and carbon emission intensity is conducive to promoting the development of ecological economy, optimizing financial structure and building ecological civilization. It is of great significance for the financial system to better serve the ecological environment protection and promote the green development of society.

2. Literature Review

With the signing of Paris Agreement and the announcement of "double carbon" goal in China, more and more scholars at home and abroad pay attention to the relationship between financial development and carbon emissions, and have conducted empirical research. The research conclusions are mainly summarized into three categories. First, financial development has curbed carbon emissions. Artur(2009) and others first studied BRIC countries and thought that financial liberalization and opening up were important factors for carbon dioxide emission reduction [1]. Shahbaz et al.(2013) believes that financial development can help reduce energy consumption and reduce carbon dioxide emissions. Second, financial development promotes carbon emissions [2]. Zhang (2011) found that financial development promoted carbon dioxide emissions in China, and the impact of financial intermediaries on carbon emissions was much higher than other financial indicators [3]. Chen Biqiong(2013) and others believe that the development and expansion of financial scale has increased carbon emissions and improved carbon productivity by establishing a dynamic panel model. Third, the impact mechanism of financial development on carbon emissions is complex, and different regions and different financial levels will get different impact results [4]. Yan Chengliang (2016) et al. concluded that the impact of credit scale on carbon dioxide intensity is inverted U-shaped by constructing endogenous variable model, because the higher the level of financial development, the obvious mutual restriction between technical level and energy consumption [5]. He Yunxin(2020) and others analyzed the relationship between financial development and carbon emissions from the structural dimension [6]. It is considered that the development of traditional finance restrains carbon emission intensity, but there is an inverted U-shaped relationship between the development of new finance and carbon emission intensity.

Digital finance, as a new financial service combining Internet technology with traditional financial industry, has developed rapidly in recent years. With its characteristics, digital finance plays an important role in promoting high-quality economic development, promoting residents' consumption growth, narrowing the income gap between urban and rural areas, and promoting the upgrading of industrial structure. In recent years, a few scholars have paid attention to the relationship between digital finance and environment and started research. Similar to the impact of finance on carbon emissions, it can be summarized into three categories. First, the development of digital finance has curbed carbon emissions. Deng Rongrong(2021) and others concluded that the development level of digital finance can significantly reduce carbon emission intensity, improve carbon emission efficiency and improve carbon emission performance by using intermediary effect model [7]. Zhu Dongbo(2022) and others believe that the development of digital finance helps to reduce pollution emissions, and this emission reduction effect is mainly realized by improving the coverage and use depth of digital finance. Second, the development of digital finance promotes carbon emissions [8]. Zaidiet al.(2021) and others concluded through empirical analysis that the development of Inclusive Financing will aggravate carbon emissions. Third, the development of digital finance has a complex impact on carbon emissions [9]. Zhao Xu (2021) and others believe that digital finance can reduce pollution through entrepreneurial effect, innovation effect and industrial upgrading effect, but

after reaching a high level of digital finance, digital finance has an inhibitory effect on environmental pollution [10].

To sum up, the relationship between finance and environment has always been concerned by scholars. However, the existing research focuses on the relationship between traditional financial industry and environment. Scholars have studied the impact of financial development level on carbon emissions from various aspects and dimensions. There are mainly three kinds of theories: "improving environment theory", "deteriorating environment theory" and "nonlinear correlation theory". With the development of digital economy, digital finance has become a new financial service by virtue of its characteristics of combining Internet, cloud computing and other technologies with traditional financial industries. It also attracted some scholars to study the relationship between it and the environment. Similar to the traditional theory of the impact of financial industry on the environment, it is mainly divided into three theories: digital finance inhibits carbon emissions, digital finance promotes carbon emissions, and digital finance development has a complex impact on carbon emissions, which mainly has an "inverted U" relationship.

However, the existing research on the impact of digital finance development on carbon emissions is single and mostly concentrated on the overall level. The existing literature mainly qualitatively analyzes the impact of digital finance on the environment, lacking systematic theoretical analysis and empirical research. Based on this, this paper makes an empirical study on the relationship between digital finance development and carbon emission intensity based on the panel data of 30 provinces in China from 2011 to 2019 (excluding Hong Kong, Macao and Taiwan).

3. Theoretical Analysis

Digital finance is a new form of financial services, which retains the advantages of traditional finance and combines with big data, cloud computing, Internet and other technologies, and is rapidly spreading and developing to other fields besides the financial industry. With its wide coverage, deep use and high digitalization, digital finance has contributed to green economic development and carbon emission reduction from the financial level. Digital finance mainly inhibits the increase of carbon emission intensity from the following aspects:

First, digital finance expands public participation in carbon emission reduction. The inclusiveness and high coverage of digital finance have increased the number of the public participating in energy conservation and emission reduction. For example, in Alipay's "Ant Forest", users score points for personal carbon accounts through green travel and low-carbon life, and finally realize afforestation in real society by harvesting virtual energy, and finally promote social green development from energy conservation and emission reduction in personal life. Effectively improve the enthusiasm and sustainability of public participation in environmental protection, and improve the public's awareness of environmental protection and social responsibility for energy conservation and emission reduction.

Secondly, digital finance promotes the ability of society and enterprises to innovate and start businesses. Financial institutions use cutting-edge digital science and technology such as big data and cloud computing to optimize capital allocation, provide effective financial support for small and micro enterprises, starting potential enterprises and green development enterprises, lower the threshold and cost of financial services, and promote economic growth. Digital finance completes users' credit rating through data collection, optimizes resource allocation, promotes the enthusiasm of the public for innovation and entrepreneurship, and provides financial support and guarantee. Therefore, it can indirectly reduce the labor cost of enterprises, promote technological innovation, finally green reform of production methods and reduce carbon emissions.

Finally, digital finance optimizes and upgrades the industrial structure. The transformation and upgrading of industrial structure is the only way for China's development, and it is also the focus of the government work report in 2022. Digital finance can promote the optimization and upgrading of industrial structure, promote the rationalization of industrial structure, reduce the proportion of high energy-consuming industries and increase the proportion of low energy-consuming service industries. At the same time, resources and production factors are transferred from high energy-consuming sectors to low energy-consuming and green-friendly sectors. The optimization and upgrading of industrial structure improves the efficiency of resource allocation, thus promoting green economic development and reducing carbon emissions.

Based on the above basic analysis, this paper puts forward the assumption that the development of digital finance can inhibit the increase of carbon emission intensity.

4. Research Methods and Data Sources

4.1. Variable Selection

(1) Explained variable: Carbon Emission Intensity (Y), the data comes from China Emission Account and Datasets (CEADS), which covers China's multi-scale carbon accounting inventory.

(2) Core explanatory variable: Digital Finance (DFI), which uses China Inclusive Financing Index compiled by Digital Finance Center of Peking University, which includes three aspects: coverage breadth, use depth and digitalization degree, and comprehensively measures the development degree of digital finance at provincial, prefecture and county levels in China.

(3) Control variables: ① Economic Development Level (ECO), expressed by per capita GDP. ② Environmental Regulation (ER) is expressed by urban green coverage rate. ③ Urbanization rate (UR) is expressed by the proportion of urban population to the total population. ④ the Level of Foreign Trade (FDI) is expressed by the ratio of foreign direct investment to GDP.

4.2. Data Sources

Considering the availability and continuity of data, this paper selects 30 provinces in China from 2011 to 2019 as empirical research samples. Carbon emission data comes from China Emission Account and Datasets, and data financial index comes from Digital Finance Research Center of Peking University. Other data are from China Statistical Yearbook and China Urban Statistical Yearbook.

4.3. Basic Model

In order to verify the impact of the development of digital finance on carbon emission intensity, a linear regression model is set up based on the research of Qian Haizhanget al. (2020)[11]:

$$Y_{it} = \beta_0 + \beta_1 DfI_{it} + \beta_2 C_{it} + \mu_{it}$$

Where: i denotes the city; t denotes the year; Y represents carbon emission intensity; DfI represents the digital financial index; C denotes a series of control variables; μ denotes the random perturbation term; β_0 represents a constant term; β_1 and β_2 represent the coefficients to be estimated.

5. Empirical Analysis

5.1. Descriptive Statistics

The descriptive statistical results of the main variables in this paper are shown in the following table. As far as digital finance index is concerned, the mean value of variables is close to the

median, which indicates that the sample data is normally distributed with a standard deviation of 91.57, indicating that the development level of digital finance varies greatly among different provinces.

Table 1. Descriptive Statistics of Variables

Variable	Sample Size	Mean	S.D.	Min	Max
Carbon Emission Intensity (Y)	270	2.337	2.298	0.199	12.83
Digital Finance(DFI)	270	203.4	91.57	18.33	410.3
Economic Development Level (ECO)	270	54,717	26,320	16,413	164,222
Environmental Regulation(ER)	270	39.37	3.576	27.85	49.13
Urbanization rate(UR)	270	58.27	12.52	19.04	89.6
Level of Foreign Trade(FDI)	270	1.828	4.643	0.123	45.43

5.2. Correlation Analysis

To avoid multicollinearity in the inspection process, In this paper, the correlation coefficient method is used to test the correlation between the development level of digital finance and control variables. The test results are shown in Table 2, and the correlation coefficient is less than 0.7, which indicates that there is no multicollinearity between the core explanatory variable digital finance and the control variables such as economic development level, scientific and technological development level, environmental restriction and infrastructure level.

Table 2. Variable Correlation Detection

	Y	DFI	ECO	ER	UR	FDI
Y	1					
DFI	-0.244	1				
ECO	-0.311	0.553	1			
ER	-0.234	0.332	0.387	1		
UR	-0.224	0.465	0.889	0.343	1	
FDI	-0.0950	0.169	0.470	0.173	0.489	1

5.3. Baseline Regression

After Hausmann test, the benchmark regression test was carried out by using random effect model, and the results were shown in the following Table 3.

Four variables, digital finance, economic development level, environmental regulation, urbanization and foreign trade level, significantly affect carbon emission intensity. The specific situation is analyzed as follows:

The digital finance index can inhibit the carbon emission intensity at the significance level of 5%, that is, when the development level of digital finance increases by 1 percentage point, the carbon emission point intensity can be reduced by 0.044 percentage points.

The coefficient of economic development level is -0.877, which indicates that the growth of economic development level makes the carbon emission intensity decrease. On the premise that other conditions remain unchanged, the economic development level of each province will increase by 1 percentage point, and the carbon emission intensity of the province will decrease by 0.877 percentage points. And at the level of 1%, it has a significant impact on carbon emission efficiency.

Table 3. Regression results of random effect model

Variables	Explained variable: LnY
LnDFI	-0.044**
	(-2.07)
LnECO	-0.877***
	(-11.98)
LnER	-0.530**
	(-2.12)
LnUR	0.011
	(0.09)
LnFDI	-0.064**
	(-2.07)
Constant	12.080***
	(12.20)
Observations	270
Number of id	30
F test	0

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The coefficient of environmental regulation is -0.53, and it can inhibit the carbon emission intensity at the significance level of 5%, that is, when the environmental regulation level is increased by 1 percentage point, the carbon emission intensity can be reduced by 0.53 percentage points.

The urbanization coefficient is 0.011, which means that the urbanization rate promotes the carbon emission intensity. Whenever the urbanization rate increases by 1 percentage point, the carbon emission intensity in this region will increase by 0.011 percentage points. But its significance is not strong.

The coefficient of foreign trade level is -0.064, which shows its efficiency of restraining local carbon emissions. On the premise that other conditions remain unchanged, every 1 percentage point increase in foreign trade level will reduce the carbon emission intensity of the region by 0.064 percentage points. And at the level of 1%, it has a significant impact on carbon emission efficiency.

6. Conclusion and Suggestions

Based on the panel data of 30 provinces in China from 2011 to 2019, this paper constructs a random effect model, and empirically verifies that the development of digital finance is conducive to reducing carbon emission intensity. Digital finance is an environment-friendly emerging financial service, It can improve the public's participation and enthusiasm in environmental protection, cultivate residents' sense of ownership, improve the level of social innovation and entrepreneurship, and then promote green production, optimize industrial structure, promote industrial structure upgrading, and transfer resources and production factors from high energy-consuming departments to low energy-consuming and environment-friendly departments. Thereby improving carbon emission efficiency and reducing carbon emission intensity.

After in-depth study on the impact of digital finance development on carbon emission intensity, this paper draws the following policy enlightenment.

First of all, continue to promote the development of digital finance, so that digital finance will continue to play its role in green economic development. In the process of further development, we should pay attention to the balanced development among regions, help the backward areas of digital finance, refine and summarize the development experience and enlightenment of the leading areas of digital finance development, and strengthen the coordination and overall development among regions.

Secondly, improve the supervision mechanism of digital finance industry to prevent systemic risks. With the development of Internet and the progress of science and technology, market supervision has become a major technical problem. How to establish and improve the industry supervision mechanism, build a scientific and safe supervision system by using the advantages of digitalization, protect the property safety of small and micro enterprises and the general public, and escort the development of digital finance deserves further study.

Finally, adapt to local conditions and innovate to promote green economic development. While promoting enterprise innovation, digital finance should also enhance its own innovation ability, continuously provide innovative and high-quality financial service products for the society, and promote green economic growth. All regions should adapt to local conditions and combine local characteristics and advantages, such as innovatively integrating digital finance with other industries and businesses, so as to help achieve the goal of carbon neutrality and carbon peaking.

Acknowledgments

This work is funded by 2022 Anhui University of Finance and Economics undergraduate scientific research innovation fund project, "*The impact and mechanism of the development of digital finance in the Yangtze River Economic Belt on carbon emission efficiency*" (No.: XSKY 22087).

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