

# Research on the Impact Effect of Digital Finance on the Development of Low Carbon Economy

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**Abstract:** The report of the 20th Party Congress pointed out that “promoting the greening and low-carbonization of economic and social development is the key link to achieve high-quality development”, and steadily promoting carbon peak and carbon neutral work is the proper meaning of promoting the development of low-carbon economy. Digital finance, as a fusion of digital technology and financial business, can form a long-term mechanism of governance of pollution, so the study of the impact of digital finance on the development of China's low-carbon economy has certain theoretical value and practical significance. Based on the panel dataset of 30 provinces from 2011 to 2021, this paper constructs a benchmark regression model and a mediation effect model to analyze the impact effect of digital finance on the development of low-carbon economy, and based on the theoretical analysis and the empirical results, it provides referable policy suggestions for promoting the development of low-carbon economy.

**Keywords:** Digital finance, Low carbon economic development, Mechanism testing.

## 1. Introduction

With the advent of the industrialization era, the excessive use of non-renewable fossil fuels caused by rapid economic growth and the indiscriminate cutting of forests due to the destruction of forests and the creation of farmland have disrupted the previously stable natural ecological balance, resulting in the emergence of environmental problems such as environmental pollution, the depletion of resources, and the greenhouse effect, which have greatly constrained the survival and development of mankind. With the increasing frequency and deterioration of environmental problems, it is increasingly important to harmonize the relationship between economic development and environmental protection. As one of the parties to the Paris Agreement, in 2020, President Xi Jinping solemnly announced to the world that China would “strive to peak carbon dioxide emissions by 2030, and endeavor to achieve carbon neutrality by 2060.” In 2022, the Political Bureau of the Central Committee of the Communist Party of China (CPC) pointed out the need to incorporate a systemic concept into the “dual-carbon” strategy. The Political Bureau of the CPC Central Committee meeting in 2022 pointed out that a systemic concept should be incorporated into the work of “dual carbon”, and the relationship between development and emission reduction should be properly handled. In the report of the 20th Party Congress, “promoting the greening and low-carbonization of economic and social development is a key link to achieving high-quality development” was emphasized, and steadily advancing the work of carbon peaking and carbon neutrality is the proper meaning of promoting the development of a low-carbon economy. It can be seen, how to crack in the realization of carbon emissions reduction target constraints to maximize the realization of stable economic growth, which is China's economy for a long time have to face the problem. The “double carbon” goal put forward for China to promote low-carbon economy puts forward higher requirements, the realization of the goal not only need the guidance of the top-level design, but also need the support of capital elements,

only rely on the end of the governance is difficult to achieve green development. Finance, as an important force to serve the real economy, will also affect the level of environmental governance while promoting economic development. The combination of digital technology and traditional finance has an important impact on the interaction between economic development and environmental protection through its own universality and convenience, making synergistic development of the two possible. Investing in building a green financial policy framework and promoting the development of green finance so as to lead the development of economic green transformation has become an effective means of environmental governance. Therefore, it is of great practical significance to further examine the impact of digital finance on the development of low-carbon economy, and to clarify the effect and mechanism of the impact, so as to promote the “good and fast” development of low-carbon economy by digital finance.

## 2. Literature Review

Relying on its unique convenience, digital finance breaks the limitations of time and space, largely reduces the cost of financial services, promotes technological progress as well as optimizes the industrial allocation of resources, and contributes to the economic development of various places, which means that digital finance has a direct or indirect impact on the development of low-carbon economy. Based on this, it is summarized from the following aspects:

(1) Research on the relationship between digital finance and carbon emissions. Through combing through the literature, it is found that the mechanisms and conclusions of the impact of digital finance on carbon emissions are more diverse, but they can basically be summarized into the following three views: First, digital finance promotes carbon emission reduction, which is a viewpoint shared by more scholars. Through the study of prefecture-level cities, we get the consistent conclusion that the development of digital finance is favorable to carbon emission reduction (Zheng

Wanteng et al., 2022), and point out that the development of digital finance reduces carbon emissions by promoting social and economic development, leading industrial transformation and upgrading, and improving the level of green technological innovation, entrepreneurship and other paths (Guo Guixia et al., 2022). Second, digital finance exacerbates the level of carbon emissions, Wang X et al. (2022) pointed out that the development of digital finance improves the level of local economic development, attracts the relocation of neighboring enterprises, increases the demand for energy and thus increases the local carbon emissions, and further analyzed from the three dimensions of digital finance coverage breadth, depth of use and digitization level, and the results show that it has a contributing effect on carbon emissions. Third, there is a non-linear relationship between digital finance and carbon emissions. By analyzing the ability of digital finance to influence carbon emission reduction at the provincial level, it is pointed out that the promotion effect of digital finance on regional carbon emission reduction ability has the nonlinear characteristic of marginal increment (Sun Hui et al., 2022). It is further pointed out that digital finance has a threshold effect on carbon emissions based on its own level of development as well as its level of innovation, and has different effects at different stages of development (Wang Wenjing et al., 2022).

(2) Research on digital finance directly driving the development of low carbon economy. Ma Dalai (2020) comprehensively measured the low-carbon economic growth efficiency of 11 provinces and cities in the Yangtze River Economic Belt to measure the synergistic development of various aspects of the low-carbon economy, pointing out that the development of finance contributes to the development of the low-carbon economy. Guo Xiyu (2022) constructed a low-carbon economy transition index based on the DEA model, further used an econometric model to study the impact of green finance in promoting low-carbon economy transition, and pointed out that the development of green finance contributes to the low-carbon economy transition in the region. Based on the research perspective of coordinated development, Liu Tan et al. (2022) used the coupled coordination degree model to measure the ecological economy to characterize the coordinated development of the two, and further investigated the impact and mechanism of digital finance on synergism through an econometric model, which ultimately contributes to the coordinated development of the economy and the environment. And Dong Qingqian and Li Zhiyu (2022) found that financial development did not significantly contribute to the green synergistic development of the region by investigating the impact of financial development on green total factor productivity, pointing out that financial development may increase emissions through industrial investment, which is not conducive to the synergistic development of economy and ecology.

### 3. Research Design

#### 3.1. Model Building

##### 3.1.1. Basic regression model

The level of low-carbon economic development (LCE) is the degree of coordination of regional low-carbon economic development, which can reflect the effect of balancing green development and economic growth in a region. Therefore, the article constructs the influence equation of digital finance on the development level of low carbon economy, specifically as shown in equation (1).

$$LCE_{i,t} = \alpha_0 + \alpha_1 DFI_{i,t} + \alpha_2 Q_{i,t} + \gamma_t + \lambda_i + \varepsilon_{i,t} \quad (1)$$

Where, LCE is the level of low-carbon economic development and DFI is the digital financial development index, which  $Q_{i,t}$  is control variable;  $\alpha_0 - \alpha_2$  represent the coefficients, respectively,  $\gamma_t$  and  $\lambda_i$  denote fixing for time and region, respectively, which  $\varepsilon_{i,t}$  is random error term.

##### 3.1.2. Mediation effect model

In order to test whether technological progress is a mechanism path for digital finance to influence the development of low-carbon economy, drawing on the research of Wen Zhonglin and Ye Baojuan, we construct a mediation effect model such as Eq. (2) (3) on the basis of Eq. (1):

$$Tech_{it} = \beta_0 + \beta_1 DFI_{it} + \beta_2 Q_{i,t} + \gamma_t + \lambda_i + \varepsilon_{it} \quad (2)$$

$$LCE_{i,t} = \gamma_0 + \gamma_1 DFI_{it} + \gamma_2 Tech_{it} + \gamma_3 Q_{i,t} + \gamma_t + \lambda_i + \varepsilon_{it} \quad (3)$$

Where, Tech is the mediating variable technical progress;  $\beta_0, \gamma_0$  is the constant term; and  $\beta_1, \beta_2, \gamma_1, \gamma_2, \gamma_3$  are the regression coefficient.

#### 3.2. Variable Selection

The article variables mainly include one explanatory variable, one explanatory variable, one mediating variable and four control variables. The explanatory variable of the article is the development level of low carbon economy (LCE), and the explanatory variable is the development number of digital finance (DFI). In order to explore the role mechanism of digital finance affecting the development level of low carbon economy, the article selects the role mechanism of technological progress (Tech) according to the research hypothesis, and uses the number of patent applications in each province and city in the past year to indicate the degree of technological progress. In order to ensure that the model regression is more accurate, the article selects control variables from four aspects, specifically as follows: Population: the permanent resident population at the end of the year of the region is selected to indicate the population size. Economic development level (Pgdp): the logarithm of GDP per capita is used as a proxy variable. Industrial structure (Str): the ratio of value added of the tertiary industry to GDP is used. Energy consumption (Energy): the annual electricity consumption per capita is selected as the proxy variable.

**Table 1.** Selection of variables

Typology	Variant	Notation	Define
Explained variable	Level of development of a low-carbon economy	LCE	Measuring the level of development
Explanatory variable	Level of development of digital finance	DFI	Digital Finance Index
Intermediary variable	Technological progress	Tech	Number of patent applications
Control variable	Size of population	Pop	Year-end resident population of the region
	Level of economic development	Pgdp	Logarithm of GDP per capita
	Industrial structure	Str	Ratio of tertiary value added to GDP
	Energy consumption	Energy	Per capita annual electricity consumption

### 3.3. Data Sources and Statistical Descriptions

In order to ensure the completeness of the sample data and the consistency of statistical caliber, the research sample is selected from the panel data of 30 provinces (autonomous regions and municipalities directly under the central government) from 2011 to 2021. The raw data of relevant variables come from the Digital Finance Research Center of Peking University, CEADs database, China Statistical Yearbook, China Energy Statistical Yearbook, and statistical yearbooks of provinces and municipalities. Descriptive statistics are shown in Table 2.

**Table 2.** Statistical description

Variable	Sample size	Average value	S.D.	Min	Max
LCE	330	0.250	0.093	0.117	0.855
DFI	330	1.659	0.655	0.170	3.220
Tech	330	10.713	1.413	6.596	13.782
Pop	330	8.207	0.736	6.342	12.123
Pgdp	330	10.878	0.442	9.706	12.123
Str	330	3.876	0.170	3.484	4.430
Energy	330	6.106	0.502	5.226	7.468

## 4. Empirical Analysis

### 4.1. Return to Baseline

Based on the equation of model (1), the article incorporates the control variables into the model of basic regression one by one by stepwise regression method, and the specific results are shown in columns (1)-(5). The results show that after adding control variables to the regression, the promotion effect of digital finance on the development level of low-carbon economy decreases, indicating that the control variables added by the article are reasonable and effective.

**Table 3.** Step-by-step regression results

Variable	(1)	(2)	(3)	(4)	(5)
DFI	0.0579*** (6.8892)	0.0380*** (5.1656)	0.0378*** (5.2957)	0.0254*** (3.6907)	0.0251*** (3.6769)
Pop		0.0134*** (4.7015)	0.0130*** (4.8076)	0.0130*** (4.7422)	0.0129*** (4.7086)
Pgdp			0.4358*** (2.1031)	0.4372*** (2.1106)	0.4370*** (2.0991)
Str				-0.1598*** (5.8030)	-0.1606*** (5.8343)
Energy					0.0241 (0.9180)
Constant	0.1965	0.2040	0.2025	0.0426	0.0415
Time	Control	Control	Control	Control	Control
Region	Control	Control	Control	Control	Control
R2	0.679	0.739	0.742	0.760	0.760
N	330	330	330	330	330

Note: \*, \*\*, and \*\*\* represent significant at the 10%, 5%, and 1% levels, respectively; t-values are in parentheses.

According to the results in Table 3, digital finance has a promoting effect on the level of low-carbon economic development in fact digital finance, as a new financial model of traditional finance and digital technology, reduces the risk and cost of traditional financial services and gives full play to the advantages of technology, thus realizing the enhancement

of the level of low-carbon economic development. As far as the control variables are concerned, the level of economic development (Pgdp), energy consumption (Energy), and industrial structure (Str) have a promoting effect on the level of low-carbon economic development, and population size (Pop) has a suppressing effect on the level of low-carbon

economic development.

## 4.2. Robustness check

### 4.2.1. Instrumental variable regression

Although this paper has controlled the relevant variables that may affect the development of low-carbon economy, it still omits the relevant variables causing some bias in the estimation results, and there may be a mutual causality problem between digital finance and low-carbon economic development, i.e., the development of low-carbon economy may affect the degree of development of digital finance. This paper adopts the instrumental variable method to mitigate the endogeneity problem.

Since the lagged one period of the digital finance index is highly correlated with the digital finance in the current period and has no correlation with the carbon emission intensity in the current period, the lagged one period of the digital finance index is processed, and the lagged core explanatory variable (L.DFI) is used as an instrumental variable for the two-stage least squares (2SLS) regression. The regression results are specified in columns (1) and (2) of Table 4.

### 4.2.2. Changing the sample size

Since the geographical economy of municipalities is more obviously different from that of other provinces, we choose to exclude the samples of Beijing, Tianjin, Chongqing and Shanghai, and the results are shown in Table 4, Model 2. The regression coefficients of digital finance are still positive and significant at the 1% level, which further verifies the promotion of digital finance on the development of low-carbon economy and indicates that the benchmark regression results are robust.

**Table 4.** Robustness test results

Variable	First-stage (1)	Second-stage (2)	Changing the sample size (3)
	DFI	LCE	
DFI		0.465*** (-2.31)	0.333*** (-3.84)
DFI	0.700*** (15.45)		
Population	-0.007 (-0.08)	0.264 (1.08)	0.320 (2.07)
Pgdp	0.141*** (2.36)	-0.418*** (-3.81)	-0.530*** (-9.10)
Str	-0.002 (-0.03)	0.184*** (0.18)	0.024 (0.25)
Energy	-0.039 (-0.97)	0.289*** (2.94)	0.374*** (6.67)
_cons	0.172*** (0.17)	3.908 (1.75)	3.853*** (2.58)
N	330	330	330
R <sup>2</sup>	0.9980	0.9910	0.9009

Note: \*, \*\*, and \*\*\* represent significant at the 10%, 5%, and 1% levels, respectively; t-values are in parentheses.

### 4.3. Mediation Effect Test

By reviewing the past literature, the theoretical analysis shows that digital financial development can promote low-carbon economic development by promoting technological progress. The mediating variable of technological progress is tested by utilizing the stepwise regression method, and the test results are shown in Table 5.

**Table 5.** Mediating effects model analysis

Variable	Tech	LCE
DFI	0.023*** (3.32)	0.293*** (-4.23)
Tech		0.024 (-2.46)
Population	3.927*** (2.35)	0.237 (1.68)
Pgdp	0.132 (0.75)	-0.522*** (-10.04)
Str	-1.027*** (-3.43)	0.105 (1.16)
Energy	0.078 (0.43)	0.380*** (7.11)
Constant	6.434 (1.46)	3.831 (2.92)
Control variable	Control	Control
Individual effect	Control	Control
Time effect	Control	Control
N	330	330
R <sup>2</sup>	0.8240	0.9107

Note: \*, \*\*, and \*\*\* represent significant at the 10%, 5%, and 1% levels, respectively; t-values are in parentheses.

The coefficient of digital finance is 0.023 and significant at the 1% level, indicating that digital finance can promote technological progress. As can be seen from the second column of Table 5, after adding the mediator variable, there is a positive correlation between digital finance and low carbon economic development, and for every unit of increase in digital finance, the low carbon economic development will rise significantly by 0.293 units. Digital finance can reduce the intensity of urban carbon emissions through technological innovation, therefore, while improving the level of digital financial development and widely applying digital financial tools, cities in China should also adapt to local conditions, increase technological innovation based on the current stage of development of the city and the status quo of the resources, and formulate relevant policies, so as to more efficiently promote the development of the economy and the realization of the “dual-carbon” goal. The goal of “dual carbon” can be realized more efficiently by promoting the economic development and the realization of “dual carbon”.

## 5. Conclusions and Suggestions

(1) Promote the coordinated development of the various subsystems of the low-carbon economy and improve the level of low-carbon economic development. Low-carbon economic development is subject to the comprehensive influence of two subsystems, namely economic development and low-carbon development, and its healthy development should not only take into account the growth of economic scale, development of industries, economic vitality and strength of scientific and technological innovation, but also need to take into account the level of carbon absorption capacity, utilization of energy, the development of low-carbon life, and the situation of pollution control. Changes in any one link will have a certain impact on the overall level of development. Therefore, to promote the improvement of the level of low-carbon economic development, it is necessary to be based on systematic thinking, have a sense of the big picture, consider

from the overall perspective, and coordinate the development of various systems to promote their common development.

(2) Increase the development of digital finance. Digital finance is not only the main force to promote economic development, but also the vanguard to promote the development of low-carbon economy. When promoting the development of digital finance in China, it is necessary to take into account the differences between cities, rationalize the allocation of resources, increase the radiation intensity of developed regions relying on their advantages in information technology and big data to the less developed regions, and further expand the coverage of digital finance, so that more residents can enjoy the dividends of digital financial development, and thus narrow the development gap between the eastern, central, and western regions, and between resource and non-resource cities. Give full play to the policy orientation of digital finance to alleviate the problem of capital mismatch, increase support for low-carbon industries and environmentally friendly enterprises, alleviate the phenomenon of insufficient research and development funds, and boost the innovation of low-carbon technologies; and relying on its universal, convenient and low-cost features, increase the cultivation of technological innovation talents to provide low-carbon industries with a perfect talent pool, and give full play to the carbon emission reduction effect of digital finance. To give full play to the carbon emission reduction effect of digital finance and help the development of low-carbon economy. It should be noted that it is necessary to further increase the management of the flow of funds, the existence of some enterprises to enjoy the preferential financial services of green and low-carbon projects at the same time, the refusal to fulfill the obligations of green and low-carbon development of the behavior of disciplinary action, to ensure that the digital financial relying on the policy-oriented inflow into a specific industry, to help low-carbon transformation and economic development.

(3) Promote industrial structure upgrading. As an intermediate mechanism for digital finance to promote low-carbon economic development, optimizing the industrial structure can effectively reduce the dependence on fossil energy, thereby controlling carbon emissions and promoting the coordinated development of high-quality economic development and environmental protection. The green industry has the characteristics of large R&D capital investment, long R&D cycle and uncertainty, which makes many investors reluctant to invest in it, resulting in the slow development of green and low-carbon technology, and unable to promote the transformation and upgrading of enterprises, which leads to the bad effect of carbon reduction. With the development of digital finance, the use of the Internet to pool idle social funds can effectively alleviate the situation of insufficient funds for research and development of enterprises, and reduce their financing costs, providing strong financial support for low-carbon technologies, and at the same time, encouraging enterprises with technology and strength to actively enter the market to raise funds. In addition, by adjusting the financing policy for energy-dependent enterprises, we can force them to carry out green transformation and reduce their damage to the ecological environment. In short, by actively adjusting the flow of capital, it will be directed more to low-carbon industries and promote the upgrading of industrial structure.

(4) Strengthen financial support for science and technology. Progress in science and technology can, on the one hand,

improve the efficiency of energy utilization and reduce end-of-pipe emissions through emission reduction technology, and, on the other hand, develop and utilize new types of clean energy, which will simultaneously reduce carbon emissions at both the source and the end. With regard to financial support for science and technology, it is firstly manifested in its financial support for technology, with the help of a digital platform to optimize the allocation of funds, focusing on promoting the technological innovation and application of high-energy-consuming industries such as iron and steel, chemical industry, etc., and adopting more production processes that can improve the efficiency of energy use, energy saving and environmental protection, and production waste can be recycled, so as to promote the green and low-carbon transformation of the industry; and secondly, it is to increase the investment in education, and talents are an important force to promote technological progress. The second is to increase investment in education, talent is an important force to promote technological progress, by increasing investment in basic education, vocational education, higher education, etc., to promote the research and development of emerging technologies as well as training of high-quality, highly skilled personnel on the application of equipment, in order to reduce carbon emissions.

## Acknowledgments

This work is supported by the school level scientific research project of Anhui University of Finance and Economics, "Research on the Influence Mechanism of Digital Finance on the Development of Low-Carbon Economy--Based on the Mediating Effect of Technological Innovation" (Grant No: XSKY24071).

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