Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 15, No. 3, 2024

Research on the Impact Mechanism of Digital Financial Development on Urban Environmental Governance

Ruixuan Zhang

Hunan University of Science and Technology, Xiangtan, Hunan, 411100, China

Abstract: The economy of China is based on a crude development paradigm, which has made environmental degradation a major issue. Enhancing the quality of the environment and achieving a healthy coexistence between humans and the natural world while maintaining economic growth have emerged as critical challenges in China nowadays. As a result of the recent rapid advancements in digital technology, digital finance—a byproduct of both the industrial revolution and new technological revolution—has the potential to significantly impact the ecological environment, foster regional innovation, and enhance the use of energy in the process of economic development. There are currently less comprehensive studies on the influence of digital money on environmental protection in China, despite the fact that local academics have come to acknowledge the connection between financial development and environmental regulation. In light of this, the purpose of this article is to investigate, using both qualitative and quantitative methods, how digital finance affects China's environmental governance. This research uses sulfur dioxide emissions as a proxy for environmental pollution and uses Peking University's Digital Financial Inclusion Index to assess the level of digital financial development in each city. It focuses on examining the mechanisms of action and the diverse features of the development of digital finance in relation to environmental pollution in Chinese cities, and it makes specific policy recommendations based on panel data from 31 provincial capital cities between 2014 and 2020. The following are the paper's conclusions: first, it conceptually examines the ecological impact of digital finance from three angles.: scale, structure and technology; Second, an empirical test based on assessing the environmental pollution index and other indicators of 31 cities is conducted using the mediated impact analysis approach. The study's conclusion is that, to a certain extent, digital finance has reduced environmental pollution. This is because of its increased coverage, depth of use, and degree of digitization. Additionally, digital finance can lessen environmental pressure by encouraging the expansion of social and economic scale, enhancing technological innovation, and optimizing industrial structure.

Keywords: Digital finance, Environmental governance, Scale effects, Structural effects, Technological effects.

1. Introduction

Over the course of four decades of reform and opening up, China's economy has maintained its rapid growth. It is important to remember that there is still a basic growth model in use, which is primarily defined by scale expansion and higher input levels. This strategy has led to a growing number of severe environmental pollution issues, including air and water pollution, as well as overexploitation and wasteful use of resources. The degradation of China's environment has resulted in significant social and economic issues that have impacted the long-term growth of a number of industries. As a result, the Chinese government has given environmental issues a lot of attention and implemented a number of policies to encourage the coordinated development of environmental protection and economic growth, and finance is supposed to play an important role in this great process of civilization-building.

Finance is the fundamental component of the contemporary economy, and in a market economy, it is essential to advancing environmental conservation and changing the trajectory of growth. The traditional financial industry has been disrupted by digital finance, a new model that combines big data, artificial intelligence, cloud computing, and other digital technologies with traditional finance. Digital finance has also emerged as a new leader in the industry's development.

The existing literature has initiated a number of research on digital finance, mostly focusing on the innovation and upgrading of digital finance to the actual economy and the function of corporate financing limitations, given its significant significance in fostering high-quality economic development. Starting with the innovation and upgrading aspect of the real economy, Feifei Li et al. (2022) empirically investigate the innovation behavior of digital finance and the entire enterprise using a panel regression model. They also take into account the influence of property rights' nature on innovation behavior [1]. Overall, the growth of digital finance has stimulated business innovation.

The relationship between digital finance and SMEs' technological innovation was studied theoretically and empirically by Yongqiang Liu in 2022 [2]. The findings indicated that while digital finance can support SMEs' technological innovation, there is heterogeneity in terms of property rights, industry, and institutional environment. Furthermore, with regard to business funding limitations, the existing financial inefficiencies are a bottleneck that limits their ability to innovate and promote sustainable and healthful development.

A new approach to financing constraints can create a perfect digital inclusive financial system, solve the issue of costly and challenging financing for SMEs, and encourage their continuous innovative development. It can also effectively coordinate the external financing constraints of SMEs through the three levels of government, financial institutions, and enterprises [3]. According to Li Chunfeng and Xu Yaxuan (2022), digital finance can alleviate the financial constraints faced by SMEs and boost labor income at the enterprise level, thereby facilitating survival

consumption for residents who are highly sensitive to income. Additionally, by fostering industrial transformation and upgrading, it can ensure that residents have high levels of consumption demand, freeing up resources for development and enjoyment. At the same time, financial regulation helps rationalize and standardize the internal and external financial markets of enterprises, effectively regulates the impact of digital finance on enterprise financing constraints and industrial upgrading, and promotes the release of consumption of different structures of Chinese residents [4] .

The issue of environmental pollution is getting more and more serious as the world economy as a whole grows. Furthermore, digital banking has a significant impact on the environment because it is a byproduct of the recent technological revolution and industrial transformation. The relationship between financial development and environmental pollution is the subject of growing research, but it has also generated a lot of discussion. First, a lot of academics think that pressure on environmental degradation can be lessened by financial development. For instance, Tamazian et al. (2009) note that in the BRIC countries, financial development and economic expansion have a significant influence on environmental degradation [5]. According to Elheddad et al. (2021), e-finance can considerably lower emissions of greenhouse gases like CO2, which successfully lessens the tension between economic expansion and environmental protection [6].

Second, some academics contend that corporations driven by financial development increase their overall energy use, exacerbating the state of environmental pollution. He et al. (2017), for instance, investigated the relationship between financial development and environmental pollution in China. Their findings indicated that financial development contributes to the growth of polluting firms, which raises environmental pressure [7]. Lastly, some academics have also advanced the alternative theory that claims there is a nonlinear connection between environmental degradation and financial development [8]. The Environmental Kuznets Curve (EKC) was established by Charfeddine and Khediri (2016), who conducted a study and discovered an "inverted U-shaped" association between carbon monoxide emissions and financial progress [9] .

It is impossible to undervalue the issue of environmental pollution as the domestic economy enters a new phase of growth. The subject is receiving greater attention in academic research these days due to the growing severity of environmental issues, one of which is financial development, which has a significant impact on environmental degradation. The notion of environmental finance was introduced by Huitong Wang and Baoqi Chen (2006), who noted that financial institutions ought to increase their environmental responsibility, hasten the development of environmental financing products, and set up a reliable environmental financial incentive system [10]. According to Jianliang Gao et al. (2007), green financing plays a critical role in promoting energy efficiency, lowering emissions, and balancing the supply and demand for energy [11].

Drawing from the aforementioned context, the goal of this paper is to enhance the body of knowledge regarding the ecological effects of digital finance by examining how China's environmental governance and its mechanisms have been impacted by the development of digital finance, which has been fueled by the information technology revolution. In order to achieve this, this paper does two things: first, it examines the ecological impact of digital financial development and the mechanism that influences environmental quality; second, it empirically analyzes the mechanism that influences environmental governance in China's digital financial development and proposes countermeasures for the achievement of sustainable financial development and the enhancement of environmental quality. The model is tested theoretically using panel data from 31 cities.

2. Theoretical Analysis

2.1. Ecological Impact Effects of Digital Financial Development

Digital finance, an emerging financial service paradigm, is used to fund, invest, and make payments using digital technologies. Following the national approach of carbon peaking and carbon neutrality, the growth of digital finance gives a fresh incentive for urban environmental governance. Specifically, it promotes environmental governance via the following channels:

First, digital financing encourages public participation and understanding of environmental conservation. Historically, there has been little public participation in environmental conservation. The emergence and promotion of digital money allows for the expansion of public participation channels in environmental preservation. With the arrival of digital finance, the public's sense of accomplishment and ownership over environmental protection has skyrocketed. Online platforms like "Ant Forest" and WeChat Pay's "public welfare coins" are effective tools for encouraging community members to actively participate in public welfare programs. Digital money has significantly increased people's sense of accomplishment and ownership in environmental conservation, as well as public participation in environmental protection. By the end of March 2022, more than 610 million users in China had participated in the low-carbon environmental protection life of Ant Forest, with more than 20 million tons of green energy from cell phones and more than 320 million trees planted.

Second, the concept of green consumption and the industry's green development are promoted by digital finance. Mobile payment systems like WeChat and Alipay can encourage consumers to prefer public transportation and other environmentally friendly forms of transportation, which will assist to establish an ecosystem for green consumption, in addition to reducing the energy consumption of cash transactions. More importantly, digital finance provides incentives for product application and technical assistance for eco-friendly consumption, which will promote the expansion of the "new consumption field" and the industry's green transformation and growth.

Hypothesis 1: Digital financial development favors urban environmental governance.

2.2. Mechanism of Action

Scale, structure, and technology are the three main variables that affect environmental contamination, according to Antweiler et al. (2011) [13]. Therefore, expanding the social economy; promoting the upgrading of the industrial structure; and promoting the upgrading of the industrial structure are the three primary approaches to improving

ecological environmental governance. Therefore, expanding the social economy; promoting the modernization of the industrial structure; and fostering the growth of green technical innovation are the three primary approaches for developing ecological environmental governance. This research theoretically analyzes how the mechanism of digital financial development affects urban environmental governance from the perspectives of scale, structure, and technology.

2.2.1. Scale Effect

The scale effect of digital money can be observed in two main ways. First off, digital financial platforms make it easier for the general population to gather idle funds, which can then be converted into tiny savings and financial products. By increasing social circulating capital, this process creates a solid capital foundation for economic expansion. Second, it provides credit support to small and medium-sized firms. The inclusive nature of digital finance efficiently expands the funding possibilities available to microenterprises and small and medium-sized organizations. It also encourages public entrepreneurship and improves the distribution of financial resources, particularly by raising the incomes and employment prospects of the impoverished and farmers and by stimulating the potential for consumption, which in turn leads to the expansion of the scale of production by enterprises, increased investment in the treatment of environmental pollution and the consequent improvement of the quality of the environment.

2.2.2. Structural Effects

The structural impact of digital finance is mostly observed in two domains: on the one hand, it leverages information from digital financial platforms to evaluate consumer demand preferences and promptly identify gaps in the market. On the basis of this, the development of market-oriented information technology can facilitate new forms of business and industrial structure transformation and upgrading. Digital finance may also leverage user data from mobile payment networks to enhance market demand analysis, make more realistic production schedules, reduce resource waste, and provide firms with access to more capital and manpower. However, the breadth of financial services offered by digital banking increases, partially offsetting the "credit discrimination" of traditional finance, thus accelerating the flow of capital and industry, improving the efficiency of resource allocation, promoting the upgrading of industrial structure, and easing the pressure on the environment.

2.2.3. Technology Effects

Particularly detrimental to small and medium-sized enterprises' (SMEs') technological innovation would be the mismatch of financial resources and the limitation of technological research and development brought about by the "financial exclusion" of traditional financial institutions from SMEs. By lowering borrowing costs, expanding financing channels, and successfully reducing the financial mismatch brought on by information asymmetry, the growth of digital finance can encourage company technology innovation, particularly green technological innovation. Additionally, "credit discrimination" in traditional banking can be eliminated by digital finance, which also offers SMEs an efficient way to address their technology innovation. Additionally, it increases the share of green companies and reduces environmental strain by creating the technological foundation for the green transformation of polluting firms.

Hypothesis 2a: Digital financial development promotes urban environmental governance through scale effects.

Hypothesis 2b: Digital financial development contributes to urban environmental governance through structural effects.

Hypothesis 2c: Digital financial development contributes to urban environmental governance through technological effects.

3. Empirical Analysis

3.1. Variable Selection and Data Sources

3.1.1. Econometric Modeling

In order to study the impact mechanism of digital financial development on urban environmental governance, this paper sets the following benchmark model:

$$\ln poll_{i,t} = \beta_0 + \beta_1 * \ln DIF_{i,t} + \beta_2 * \sum control_{i,t} + \lambda_i + \eta_t + \varepsilon_{i,t} \quad (1)$$

Where the subscript i denotes the city, the subscript t denotes the year, and β_0 is a constant term. $\ln poll_{i,t}$ denotes the natural logarithmic logarithm of the level of environmental pollution in city i in year t, $\mathrm{DIF}_{i,t}$ denotes the natural logarithm of the level of digital financial development in city i in year t, $\mathrm{control}_{i,t}$ denotes the control variable, λ_i denotes the time effect, η_t denotes the individual effect, and $\varepsilon_{i,t}$ denotes the randomized perturbation.

3.1.2. Selection of Variables

(1) Explained Variables. The degree of environmental pollution (poll). Most of the existing literature adopts the industrial "three wastes" (wastewater, exhaust gas and solid pollutants) to measure the degree of urban environmental pollution, but the measurement of the comprehensive pollution degree has not yet formed a unified opinion. Since the data on sulfur dioxide emissions in Chinese cities in the China Urban Statistical Yearbook the data on sulfur dioxide emissions in Chinese cities are missing [14]. Therefore, this paper uses sulfur dioxide emissions to characterize urban pollution.

(2) Explanatory variables. Digital Finance Development Level (DIF). In recent years, digital finance has attracted more and more attention in China. The Digital Inclusive Finance Index (DIF) released by the China Digital Finance Research Center of Peking University more accurately reflects the development level of digital finance in China and is highly representative and reliable [15]. It is highly representative and reliable. Therefore, this paper chooses this set of indexes to reflect the development level of digital inclusive finance.

(3) Mediating variables. Referring to Wanteng Zheng et al. (2022), the three variables of socio-economic scale, industrial structure upgrading and technological innovation level were selected to represent the indicator [16]. (1) Socio-economic scale (econ). GDP per capita is used to characterize it. (2) Industrial structure upgrade (inno). Referring to the method of Wenjin Tang and Jinyu Zhao et al. (2019), the specific formula is: $ISU = PS*1 + SS*2 + TS*3$, to characterize industrial structure upgrading [17]. Among them, PS, SS, and TS denote the ratio of the added value of the first, second, and third industries to GDP, and 1, 2, and 3 denote the weights of the first, second, and third industries, respectively. (3) Technological innovation level (tech). As the output capacity

of technological innovation can more intuitively reflect the technological innovation capacity, it mainly includes the number of applied patents and the number of inventions authorized by patents. Considering that it takes a long time for patents to be granted from application to authorization, referring to Tao et al. (2021), the number of patent applications is used to indicate the level of technological innovation [18].

(4) Control variables. The control variable indicators include government size (gove), foreign investment (fdi), human capital level (lhc) and entrepreneurship level (loe). The government size is measured by the share of government fiscal output in GDP, the foreign investment is measured by the amount of foreign investment actually used in the city, the human capital level is measured by the share of the number of students enrolled in the city's general universities and colleges in the city's population, and the level of entrepreneurship is measured by the share of the number of citywide employment in the secondary industry in the city at the end of the year in the city's population.

3.1.3. Data Sources

The relevant data in this paper are taken from China Environmental Statistics Yearbook, China Urban Statistics Yearbook, China National Statistical Information Network, municipal statistical yearbooks, etc., as well as the Digital Financial Inclusion Index provided by Peking University, with missing values handled using mean interpolation.

3.2. Descriptive Statistics and Correlation Tests

3.2.1. Descriptive Statistics

Table 1. Results of descriptive statistical analysis of variables

Name	Symbolic	Unit	Sample size	Average value	Statistics	Minimum value	Maximum values
Level of environmental pollution	lnpoll	ton	217	10.780	1.875	4.317	15.400
Digital financial development level	lnDIF	-	217	5.455	0.188	4.953	5.813
Digital Finance coverage depth	lncover	-	217	5.464	0.160	5.065	5.788
Use of digital finance profundity	lndeep	-	217	5.376	0.273	4.632	5.857
Degree of digitization	lndigi	-	217	5.538	0.214	4.974	5.998
Socio-economic scale	lnecon	Yuan	217	11.330	0.336	10.540	12.130
Upgrading of industrial structure	lninno	-	217	5.535	0.044	5.444	5.646
Level of technological innovation	lntech	a matter	217	10.559	1.322	5.153	12.422
Foreign investment	lnfdi	$10,000	217	11.910	1.875	4.905	14.940
Level of human capital	lhc	%	217	0.074	0.030	0.003	0.131
Entrepreneurship level	loe	%	217	0.400	0.115	0.118	0.624
Size of government	gove	%	217	0.185	0.185	0.025	2.060

Table 1 demonstrates the descriptive statistics of the variables in this paper. It can be seen that the average value of the logarithm of the level of environmental pollution in each city is 10.78 tons, the maximum value is 15.40 tons, and the minimum value is 4.317 tons, which indicates that the level of environmental pollution varies greatly from year to year and from region to region. The average value of the logarithm of the financial development level is 5.455, the maximum value is 5.813, and the minimum value is 4.953. In addition, it should be especially pointed out that the average value of the level of foreign investment is 11.910, and the maximum and minimum values are 11.940 and 4.905, respectively, which indicates that there is a significant difference in the level of opening up to the outside world among different cities in different years. The average value of technological innovation level is 10.559, the maximum value is 12.422 and the minimum value is 5.153, indicating that there is a significant difference in the level of technological innovation in different cities.

3.2.2. Correlation analysis

As can be seen from Table 2, the level of environmental pollution is negatively correlated with the level of digital finance development and there is a very low correlation between the explanatory variables, so that a benchmark regression analysis can be performed.

Table 2. Correlation analysis

	lnpoll	lnDIF	lnfdi	lhc	loe	gove
lnpoll	1					
lnDIF	-0.560***	1				
lnfdi	0.154**	0.114*	1			
lhc	0.027**	0.110**	-0.071**	1		
loe	0.452***	-0.205***	0.206***	0.189***	1	
gove	-0.327***	-0.042	-0.261***	-0.248***	-0.322***	1
Note: * p < 0.1, ** p < 0.05, *** p < 0.01, below						

3.2.3. Benchmark Regression

In order to test the impact of digital financial development on urban pollution, a fixed-effects (FE) model regression was conducted on equation (1), and the results are shown in Table 3. As shown in Table 3, the estimated coefficients of the four indices of digital financial inclusion are negative at the 1% significance level, as shown in the combined columns of A1, B1, C1, and D1, which suggests that the development of digital finance can effectively reduce environmental pollution and have a have a certain impact.

Table 3. Benchmark regression results

	A1	B1	C1	D1
variant	lnpoll			
lnDIF	-5.542***			
	(-11.23)			
lncover		-7.914***		
		(-13.96)		
lndeep			-3.188***	
			(-9.07)	
lndigi				-3.305***
				(-7.18)
Constant	38.257***	52.789***	23.715***	24.926***
	(9.32)	(12.39)	(6.67)	(5.81)
Observations	214	214	214	214
Company FE	YES	YES	YES	YES
r2_a	0.605	0.709	0.504	0.466
F	103.3	88.98	97.16	56.56

3.2.4. Endogeneity Testing and Treatment

The original assumption was that the explanatory variables were exogenous, but after the endogeneity test on Eviews, the P-values were all less than 0.01, thus negating the assumption that the explanatory variables were exogenous, indicating that the above regression results were affected by the endogeneity problem. For example, there are many factors affecting urban pollution, such as the influence of living factors, cultural factors, etc., which makes the above results suffer from the problem of omitted variable error. To address this problem, instrumental variables are usually used Law (IV) to address it. As there is a certain dynamic continuity in the level of digital financial development in China, the development of digital finance in the previous period will lay the foundation for the current digital financial development. In summary, this paper applies the 2SLS method and selects the explanatory variables lagged one period as instrumental variables for estimation. The results are shown in Table 4 The final conclusion is that the promotion effect of digital financial development on urban environmental governance is still very obvious.

Table 4. Endogenous treatments

	(1)	(2)	(3)	(4)
variant	lnpoll			
lnDIF	-3.9647*** (1.9905)			
lncover		-7.1391*** (1.2812)		
lndeep			-1.4015*** (1.2681)	
lndigi				-6.0210*** (8.4407)
N	217	217	217	217
R^2	-3.4057	-0.8128	-2.4265	-106.0543

3.2.5. Robustness Tests

This paper adopts the method of replacing explanatory variables to further verify the robustness of the conclusion that digital financial development can promote urban environmental governance. Taking the logarithmic value of industrial smoke (dust) emissions as the replaced explanatory variable, the regression analysis of equation (1) is carried out, and the results are shown in Table 5 Comprehensively analyzing the four columns of A2, B2, C2, and D2, the estimated coefficients of the four indexes of digital financial inclusion are still negative at the 1% significance level, which confirms that the findings of this paper are robust.

Table 5. Robustness test estimation results

	A2	B2	C2	D2
variant	lnyanc			
lnDIF	-1.962***			
	(-5.07)			
lncover		-2.522***		
		(-5.25)		
lndeep			-1.343***	
			(-5.02)	
lndigi				-1.027***
				(-3.70)
R-squared	0.330	0.339	0.329	0.238

3.2.6. Heterogeneity Analysis

The above results show that indicate that digital financial development can effectively improve the ecological environment of cities. However, due to the vastness of China, the economic development and ecological environment of different regions vary greatly, and estimation from the sampling perspective alone will often result in errors. In view of this, this paper will analyze the two perspectives of urban geographic location and time.

First, this paper analyzes the heterogeneous characteristics of digital financial development affecting urban environmental governance based on differences in urban geographic locations. Referring to Fang Honglin et al. (2021) [19], in which this paper constructs a regional dummy variable (numb) based on the differences in the geographical location of cities, with the eastern region assigned a value of 1 and the central and western regions assigned a value of 0, and constructs the cross term between digital financial development and the regional dummy variable for the heterogeneity test, and the results are shown in Table 6. The results show that the estimated coefficient of the degree of digital financial development affecting urban environmental governance is negative at the 1% significance level, which indicates that digital financial development obviously promotes urban environmental governance in China. In contrast, the estimated coefficient of the cross-multiplier term between the level of digital financial development and the regional dummy variable is significantly positive, further indicating that the governance outcomes in the central and western regions are significantly worse than those in the eastern regions. In summary, this is because the higher level of digital finance development in the eastern region can effectively improve the use of clean energy and pollution prevention technologies in the region, while accelerating the transfer of polluting firms from the east to the central and western regions, thus reducing environmental pollution in the cities of the eastern region. In contrast, the level of digital

finance development in central and western China is relatively backward, and the focus of digital finance development is on accelerating the transfer of industries from the eastern region as well as promoting the improvement of the overall scale of the economy, thus absorbing a large number of polluting enterprises from the eastern region. As a result, the development of digital finance in cities in the central and western regions has exacerbated environmental problems.

Table 6. Tests for geographic location heterogeneity

Variant	Lnpoll
lnDIF	-5.463*** (-10.07)
lnDIF*numb	-0.276*** (-0.37)
lnfdi	0.124*** (0.83)
lhc	0.146*** (1.52)
loe	1.928** (1.25)
gove	-3.520** (-2.26)
Constant	38.493*** (9.46)
Observations	214
R-squared	0.615
Company FE	YES
r2_a	0.604
F	90.38

Second, this paper analyzes the heterogeneous characteristics of digital financial development affecting urban environmental governance in China based on the stage difference of digital financial development. This paper constructs a dummy variable (ynumb) based on the stage difference of urban digital financial development, where column (1) indicates that it is assigned a value of 0 from 2014 to 2015,and a value of 1 from 2016 to 2020, while column (2) indicates that it is assigned a value of 0 from 2014 to 2016,and a value of 1 from 2017 to 2020.The rationale for the division is that since 2017, cloud computing, big data, blockchain and some other key technologies have gradually matured and have become an important force in promoting the development of digital finance. At the same time, in the context of the "dual-carbon" goal, the government has taken a series of policy measures to strongly support the development of digital inclusive finance. Therefore, the development of digital finance has played an obvious role in promoting the environmental governance of Chinese cities, and the inhibiting effect of digital finance on environmental pollution is even more important after 2017. The cross-multiplication terms of digital financial development and time dummy variables are also constructed to test their heterogeneity, and the results are shown in Table 7. As shown in the figure, the estimated coefficients of the level of digital financial development and urban environmental pollution are negative at the 1% significance level in columns (1) and (2), the estimated coefficients of the cross-multiplication terms of the level of digital financial development and time dummy variables in column (1) are positive, and the estimated coefficients of the level of digital financial development and the estimated coefficient of the cross-multiplier term of the time dummy variable is negative. In summary, it is confirmed that digital financial development has a significant contribution to urban environmental governance.

Table 7. Tests for temporal heterogeneity

	(1)	(2)
Variant	Lnpoll	
lnDIF	-8.308***	-3.807***
	(-11.02)	(-7.71)
lnDIF*ynumb	0.214***	-0.131***
	(6.29)	(-5.38)
lnfdi	0.098	0.096***
	(0.72)	(0.64)
lhc	0.123	0.136***
	(1.53)	(1.61)
loe	1.333	2.079**
	(0.97)	(1.39)
gove	-3.978**	-2.597*
	(-2.37)	(-1.78)
Constant	53.368***	29.482***
	(9.79)	(7.56)
Observations	214	214

3.3. Mechanism of Action Test

Next, the role mechanism of digital financial development affecting environmental governance is further explored. This paper argues that digital financial development will have an impact on environmental governance through three major perspectives of socio-economic scale expansion, industrial structure upgrading, and green technology innovation to alleviate environmental pressure. In view of this assumption, referring to Fang Honglin and Yang Siyin (2021), the mediating effect model as in Eq. (2), Eq. (3) and Eq. (4) is constructed. This part mainly tests Eq. (3) and Eq. (4).

$$\ln poll_{i,t} = \beta_0 + \beta_1 * \ln DIF_{i,t} + \beta_2 * \sum control_{i,t} + \lambda_i + \eta_t + \varepsilon_{i,t} \quad (2)$$

$$M_{i,t} = \alpha_0 + \alpha_1 * \ln DIF_{i,t} + \alpha_2 * \sum control_{i,t} + \lambda_i + \eta_t + \varepsilon_{i,t} \quad (3)$$

$$\ln poll_{i,t} = \theta_0 + \theta_1 * \ln DIF_{i,t} + \theta_2 * M + \theta_3 * \sum control_{i,t} + \lambda_i + \mu_t + \varepsilon_{i,t} \quad (4)$$

3.3.1. Mechanistic Tests of Scale Effects

The "per capita gross regional product" is used to characterize the scale effect (lnecon), and the regression results are shown in columns (1) and (2) in Table 7. The estimated coefficient of digital financial development in regression (1) is significantly negative at the 1% level, indicating that digital financial development can effectively inhibit urban environmental pollution. Regression (2) shows that digital financial development promotes the expansion of urban economic scale. The digital economy, as a result of the information technology revolution, is able to collect idle funds more conveniently for the public, and more change can be converted into small savings and financial products, thus increasing the social circulating capital and laying a solid capital foundation for economic development. At the same time, it can provide credit support for small and medium-sized

enterprises (SMEs), expanding the source of financing for SMEs and stimulating the enthusiasm of the public for entrepreneurship, so as to increase the income of residents and stimulate the potential for consumption. And the comprehensive regression (1) and regression (2) can be seen that the development of digital finance plays a significant role in promoting the expansion of urban economic scale, and further favors urban environmental governance.

3.3.2. Mechanistic Tests of Structural Effects

Characterize industrial structural upgrading with " $ISU = PS*1+SS*2+TS*3$" [16]. The regression results are shown in columns (3) and (4) of Table 7. The estimated coefficient of digital financial development in regression (3) is negative at the 5% significance level, which indicates that digital financial development can effectively inhibit urban environmental pollution. The estimated coefficient of regression (4) is positive, which indicates that digital financial development can significantly promote industrial structure upgrading. Data- and technology-driven digital finance can accelerate the flow of capital and industry, effectively mobilize the enthusiasm of all kinds of market players, promote the balance of supply and demand, push the industrial structure to achieve optimization, and help China's economy and society to transform to a green and low-carbon model. The combination of regression (3) and regression (4) shows that the development of digital finance can promote the upgrading of industrial structure and thus influence environmental governance and alleviate environmental pressure.

3.3.3. Mechanistic Tests of Technology Effects

The number of patent applications is used to characterize the level of technological innovation, and the regression results are shown in columns (5) and (6) of Table 8. The estimated coefficient of digital financial development in regression (5) is negative, indicating that digital financial development can effectively promote urban environmental governance. The estimated coefficient of regression (6) is positive, indicating that digital financial development can improve technological innovation. It confirms that digital financial development digital finance can effectively reduce the information asymmetry caused by financial mismatch, reduce borrowing costs, broaden financing channels, and thus promote enterprise technological innovation. The synthesis of regression (5) and regression (6) can show that digital finance can promote the urban environment by improving the level of technological innovation.

Governance to curb environmental pollution.

Table 8. Intermediation effect regression results

	Scale effect		Structural effect		Technological effect	
	lnpoll	lnecon	lnpoll	lninno	lnpoll	lntech
	(1)	(2)	(3)	(4)	(5)	(6)
lnDIF	-5.327** (-0.58)	0.7407** (-0.0965)	-5.3314** (-0.5638)	0.0733** (-0.0115)	-5.5415** (0.4470)	2.0158** (0.1036)
lnecon	-0.1303** (-0.3677)					
lninno			-1.0787** (-3.1078)			
lntech					-0.8591** (0.3194)	
cons	39.3753** (-3.6029)	6.1684** (-0.5278)	44.0413** (-16.2634)	5.1534** (-0.0632)	38.2569** (3.1618)	37.6395** (3.127247)
N	214	214	214	214	214	214

4. Basic Conclusions and Policy Recommendations

The primary focus of this research is to examine the effects and mechanisms of digital finance on the environment. In order to conduct an empirical test based on measuring the environmental pollution index and other indicators of 31 cities, this paper first conducts a theoretical analysis of the ecological effect of digital finance from the three perspectives of scale, structure, and technology. The present study concludes that the advancement of digital finance can facilitate urban environmental governance by broadening its scope, increasing its level of digitization, and deepening its application. Additionally, digital finance can aid in the realization of environmental governance by fostering the expansion of socio-economic scale and optimizing industrial structure and technological innovation.

Based on the above conclusions, China should actively promote the development of digital finance and the green innovation of science and technology. Focusing on the development of digital finance to accelerate China's environmental governance, there are three specific policy recommendations:

First, resources for environmental governance should be allocated using the long-term digital finance system. It has been efficaciously proved that the development of digital finance has a substantial environmental pollution management effect. As a result, we aggressively support blockchain, cloud computing, artificial intelligence, and other digital technologies in order to "increase the speed of running," "open up data islands," "realize the number" flow, and support the established financial sector. The main goal of deepening the structural reform of the financial supply side is digital transformation, which allows digital financial services to fully realize their universality, reach, and long tail. Generally speaking, environmental governance depends on a steady and consistent flow of funding; otherwise, it would be "a drop in the bucket" for the government-led environmental investment and financing mechanism to fully utilize digital finance for the "engine" function of allocating environmental resources and realizing environmental protection resources. The creation of a "government-market" dual-track operating mechanism, or marketization, is a strategy used to address environmental issues. Simultaneously, to optimize the scale

of digital financial development and emission reduction of sustainable power output in a moderate manner.

Second, in order to provide robust support for environmental pollution, we will encourage the growth of digital finance, drawing on the three distinct environmental governance paths of "scale effect," "structural effect," and "technology effect". "End-of-pipe governance" will receive backing. We must give up on the idea of "pollution first, then treatment" and implement "source prevention and control" in order to achieve energy savings and emission reduction. "End-of-pipe management" would erode the advantages of economic expansion and increase environmental expenses. To achieve the goal of energy conservation and emission reduction, we must give up on the idea of "pollution before treatment" and implement "source prevention". Economic development requires digital finance, which may also finance technical innovation, industrial transformation and upgrading, and economic growth. In order to encourage the coordinated development of economic development and the environment, structural adjustment and sustainable development should be prioritized before the turning point between environmental pollution and economic development occurs. In turn, green technological innovation is a major impetus behind businesses' efforts to reduce their energy use and emissions. To accomplish the goal of the green transformation, it is imperative to increase the allocation of financial resources to direct the flow of capital to high-value-added, low-energy-consumption, and high-efficiency businesses. In addition, by utilizing digital finance development opportunities, small and medium-sized businesses can effectively address their financing challenges, support the "quality and capacity" of the service industry, bolster the tertiary industry's main market, realize the transformation and development of regional industries, and effectively address environmental issues.

Finally, the supervision of the digital financial industry should be strengthened to prevent systemic risks. The current financial regulatory system is difficult to effectively monitor, should be based on its own characteristics, to overcome the shortcomings of the existing regulatory system, to promote the development of regulatory technology and gradually improve the regulatory science and technology system, so as to carry out all-weather, seamless financial risk prevention and control work.

References

[1] Feifei Li, Ruowei Ma, Xieyu Huang. Digital finance, nature of property rights and corporate innovation - based on the perspective of innovation heterogeneity [J]. Research on Technology Economy and Management, 2022, (03):27-33.

[2] YQ Liu. Research on the impact of digital finance on technological innovation of small and medium-sized enterprises[J]. Research on Technology Economy and Management, 2022, (03):51-56.

[3] Zhongmin Ma, Jiaqi Ni, Qiyue Wang. Research on Countermeasures to Enhance the Financing Efficiency of Small and Medium-sized Enterprises by Digital Inclusive Finance [J]. Modern Business, 2022, (09):109-111.

[4] Chunfeng Li, Yaxuan Xu. Research on the effect of digital finance driving residents' consumption of different structures [J]. Modern Finance and Economics (Journal of Tianjin University of Finance and Economics), 2022, (04):67-78.

[5] Tamazian A, Chousa J P, Vadlamannati K C. Does higher economic and financial developme-nt lead to environmental degradation:evidence from BRIC countries [J]. Energy Policy, 2009, 37(1): 246-253.

[6] Elheddad M, Benjasak C, Deljavan R, et al. The effect of the fourth industrial revolution on the environment:the relationship between electronic finance and pollution in OECD countries [J]. Technological forecasting and social change, 2021, 163:85-95.

[7] He Y, Sheng P, Vochozka M. Pollution Caused by Finance and The Relative Policy Analysis in China [J]. Energy & Environment, 2017, 28(7):808-823 .

[8] Kim D H, Wu Y C, Lin S C.Carbon dioxide emissions and the finance curse [J]. Energy economy, 2020, 88:4788-4799.

[9] Charfeddine L, Khediri B K. Financial development and environmental quality in UAE: ciontegration with structural breaks [J]. Renewable and Sustainable Energy Reviews, 2016(55):1322-1335.

[10] Huitong Wang, Baoqi Chen. Environmental Finance: A Win-Win Path for Financial Innovation and Circular Economy [J]. Shanghai Finance, 2006(06):29-31.

[11] Jianliang Gao, Yue Huang, Guizhi Liang. Green finance development strategy under energy security constraint [J]. China Collective Economy (second half of the month). 2007, (10):44-46.

[12] Xin Xu. Research on the Impact of Regional Financial Development on Environmental Pollution [D]. Supervisor: Tan Lingling. Shandong Institute of Business and Economics, 2019.

[13] Antweiler W, Copeland B R, Taylor M S. Is free trade good for the environment? [J]. American economic review, 2001, 91(4):877-908.

[14] Department of Urban Socio-Economic Survey, National Bureau of Statistics. Statistical Yearbook of Chinese Cities [M]. Beijing: China Statistics Press, 2020.

[15] Feng Guo, Jingyi Wang, Fang Wang, Tao Kong, Xun Zhang, Zhiyun Cheng, Measuring the development of digital inclusive finance in China: Indexing and spatial characterization [J], Economics (Quarterly), 2020(4):1401-1418.

[16] Wanteng Zheng, Hongyan Zhao, Mengchan Zhao. Does Digital Financial Development Favor Environmental Pollution Control? --Another discussion on the moderating role of local resource competition [J]. Industrial Economics Research, 2022, (01):1-13.

[17] Wenjin Tang, Shuang Li, Yunqing Tao. Digital inclusive financial development and industrial structure upgrading-Empirical evidence from 283 cities [J]. Journal of Guangdong University of Finance and Economics, 2019, (06):35-49.

[18] Feng Tao, Jinyu Zhao, Hao Zhou. Has environmental regulation realized the "incremental quality improvement" of green technology innovation--evidence from the environmental protection target responsibility system [J]. China Industrial Economy, 2021, (02):136-154.

[19] Honglin Fang, Siying Yang. Financial technology innovation and urban environmental pollution [J]. Economics Dynamics, 2021, (08):116-130.