

Research on the impact mechanism of digital financial inclusion on green consumption

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Abstract. The article empirically tests the effects and mechanisms of digital financial inclusion on green consumption by building an econometric model using panel data from 31 provinces in China from 2011 to 2023. The study finds that: (1) the conclusions of benchmark regression show that the rapid development of digital financial inclusion markedly elevates the level of green consumption, and this conclusion still holds after multiple robustness tests; (2) the conclusions of mechanism test show that digital financial inclusion can drive the growth of green consumption through the path of promoting the development of industrial structure to a higher level; (3) the analysis of regional heterogeneity reveals that, compared to other regions, the eastern provinces show more obvious effects in digital financial inclusion to promote green consumption. Given these results, the following suggestions are made: firstly, to strengthen the mechanism of synergistic development of digital financial inclusion and green consumption; secondly, to promote the optimization of the industrial structure; and thirdly, pay attention to and make efforts to address the issue of asymmetric regional progress of digital financial inclusion.

Keywords: Digital Financial Inclusion, Green Consumption, Advanced Industrial Structure, Mediation Effect.

1. Introduction

In recent years, global warming and resource depletion have escalated into pressing environmental challenges worldwide. Against this backdrop, the "dual carbon" goals have emerged as a critical policy framework, prompting a paradigm shift in economic development models. Digital financial inclusion, as an innovative financial development model [1], is fundamentally transforming production methods, lifestyles, and socioeconomic patterns. Its rapid advancement has not only revolutionized traditional business operations but has also created unprecedented opportunities for green consumption. More importantly, it can optimise the performance of resource deployment and improve the accuracy of environmental regulation through digital means, thus providing a new solution for promoting green development under China's 'dual-carbon' goal. In this context, exploring its driving mechanism and multi-dimensional impact on residents' green consumption behaviour not only helps to enrich the relevant theoretical system, but also provides empirical evidence for policy makers to optimize green financial instruments, which has important academic value and practical significance.

Current scholarship predominantly examines the macroeconomic effects of digital finance, while its micro-level impacts on consumer behavior—particularly regarding green consumption—remain underexplored. Existing research by Liu et al. (2023) and Hao et al. (2023) demonstrates that mobile payment platforms substantially lower the barriers to green consumption; their convenience has been shown to increase willingness to purchase energy-efficient appliances by 23% [2, 3]. Furthermore, in examining green industry development, Cao et al. (2021) [4] empirically verified that digital finance actively boosts clean energy technology innovation through green credit and bond financing mechanisms. Cost reduction constitutes another vital pathway through which digital financial inclusion drives green consumption. Empirical evidence indicates that digital payment systems significantly reduce transaction costs for green products by bypassing traditional financial intermediaries [5], while digital platforms' transparent supply chain management further minimizes resource waste [6]. Cross-national studies by Öztürk and Ullah [7] further reveal that in developing

economies, digital financial inclusion enhances green consumption by improving energy efficiency and strengthening local environmental regulations, with particularly pronounced effects in emerging markets. Nevertheless, the existing literature exhibits certain limitations, including insufficient attention to urban-rural digital infrastructure disparities and inadequate analysis of regional policy differentials across eastern, central, and western China.

Building upon this scholarly foundation, this paper develops a mathematical model to examine the correlation between digital financial inclusion and green consumption, proposing both direct and indirect effect hypotheses. This research makes three key contributions: First, employing balanced panel data from 31 Chinese provinces (2011-2023), we provide robust empirical evidence on digital finance's green consumption effects. Second, we pioneer an industrial structure upgrading perspective to unpack digital finance's intrinsic promotion mechanisms. Third, we conduct comprehensive heterogeneity analyses that account for regional development disparities, offering nuanced insights into policy implementation.

2. Theoretical mechanisms and research hypotheses

2.1. Impact of digital financial inclusion on green consumption

As the concept of sustainable development is widely practiced around the world, green consumption, as a new economic model, is gradually becoming an important way to alleviate environmental pressure, optimise resource allocation and achieve long-term balanced social development. Utilizing the cooperative innovation between financial and digital technologies, digital financial inclusion shows many unique advantages, which not only lays a theoretical foundation for the popularisation of green consumption behaviour, but also provides a feasible operational path for its practical promotion.

Firstly, through digital means mobile payment, online lending and so on, digital financial inclusion enables more consumers to conveniently access and use financial services, thus enhancing their purchasing power. Second, through big data and artificial intelligence technology, digital financial inclusion is able to more accurately identify and assess consumers' credit status, thus providing personalised financial support for green consumption [8]. For example, consumers can obtain green consumption loans or instalment services through digital platforms, which lowers the purchase threshold of green products and incentivises more consumers to choose environmentally friendly products [9]. In addition, digital financial inclusion platforms can identify user groups with green consumption preferences through data analysis and provide them with customised financial products and services, further promoting the popularity of green consumption. Finally, digital platforms can provide abundant information on green products and environmental knowledge, and digital financial inclusion also helps consumers make more environmentally friendly consumption decisions through information transparency and consumer education, thus increasing consumer awareness and acceptance of green consumption. Based on the above theoretical analysis, this paper proposes hypothesis H1.

H1: Digital financial inclusion has a direct contribution to the level of green consumption.

2.2. Intermediation mechanisms for the advanced industrial structure

Digital financial inclusion has a profound impact on broadening and enhancing the accessibility and effectiveness of funding channels, thereby securing a vital lifeline for small to medium enterprises (SMEs) and cutting-edge sectors seeking financial backing [10]. Widening the scope of financial services propels the modernization and advancement of conventional industries while also fueling the expansion of tech-savvy and service-oriented sectors. This, in turn, propels the industrial landscape towards an elevated echelon. The refinement and enhancement of the industrial makeup are most clearly seen in the ongoing ascendancy of tech-centric industries and the explosive growth of high-revenue sectors, all of which bolster the system's innovative prowess and technical capabilities.

The promotion effect of advanced industrial structure on green consumption is primarily manifests in these areas: firstly, advanced industrial structure is usually accompanied by higher environmental standards and technological innovation [11], which encourages enterprises to produce more environmentally friendly products. Secondly, with the development of high value-added industries, consumers' income level and environmental awareness generally increase, which makes them more inclined to choose green products. Finally, advancements in the industrial landscape, fueled by technological breakthroughs, lower the manufacturing expenses of eco-friendly goods, enhancing their market viability.

Specifically, digital financial inclusion effectively helps SMEs and emerging industries by enhancing financial service effectiveness and lowering the threshold of access, thereby driving industrial restructuring toward technology-driven and higher-value production. This transformation process significantly improves the overall technological level of the economy and enhances the environmentally friendly production capacity of enterprises. In this process, the improvement of residents' income level and the popularisation of the concept of sustainable development promote each other, effectively cultivating the green consumption market and promoting its continuous growth. Based on the above analysis, this paper proposes hypothesis H2.

H2: Digital financial inclusion indirectly promotes the development of green consumption by promoting the advanced industrial structure.

3. Research design

3.1. Data sources

Drawing on comprehensive panel data spanning China's 31 provincial-level regions (excluding Hong Kong, Macao, and Taiwan) between 2011 and 2023, this research employs advanced econometric modeling to examine how digital financial inclusion influences green consumption. The primary dataset leverages Peking University's Digital Finance Research Center's authoritative Digital Financial Inclusion Index, while supplementary indicators are sourced from reliable government publications including the China Statistical Yearbook and China Environmental Statistics Yearbook. To control for data outliers, all continuous variables were shrink-tailed at the 1% level and log-transformed to eliminate differences in magnitude, and missing values were handled by linear interpolation. Data analysis was done using Stata 16.0 and Excel.

3.2. Variable definitions

3.2.1. Explained variable

Drawing on the foundational work of Yao Zhanqi (2022) [12] and Shi Biao (2023) [13], this study establishes a multidimensional framework to assess green consumption development. The evaluation system encompasses five key dimensions: consumption level, green production, green life, consumption basis and green consumption environment. To mitigate potential biases from subjective weighting and redundant data across multiple indicators, the analysis employs the entropy weighting method. This methodology ensures a balanced and data-driven assessment of green consumption trends.

3.2.2. Core Explanatory Variable

This study employs the comprehensive digital financial inclusion metric, as presented in the Peking University Financial Research Centre's Digital Financial Inclusion Index Report.

3.2.3. Control Variables

Referring to existing studies on green consumption determinants, to ensure analytical validity this research employs the following control variables: Tax Burden Level (TL) will be the percentage of GRP that comes from tax revenue. Social Consumption Level (SCL) will be the proportion of GRP represented by total retail sales. Population Density (PopD) is simply the number of residents per

square kilometer at year's end. Loan Balance to GDP (LBDP) will be the ratio of all outstanding loans from financial institutions (both local and foreign currency) compared to the GRP. Lastly, the Sum of Deposits and Loans of Financial Institutions to GDP (TDLGDP), expressed as the ratio of the sum of the balances of loans in local and foreign currencies of financial institutions and the balance of deposits to the GRP.

3.2.4. Mediating variable

This paper adopts the ratio of the added value of the tertiary industry to that of the secondary industry as an indicator of the advanced industrial structure. Changes in the value of this indicator can effectively reflect the degree of industrial structure upgrading, specifically, when the ratio increases, it indicates that the industrial structure evolves to a more advanced stage.

3.3. Model construction

3.3.1. Benchmark regression model

This paper examines the impact of digital financial inclusion on green consumption by constructing a two-way fixed-effects model, and the fixed-effects regression is shown in equation (1).

$$Green_{it} = \alpha_0 + \alpha_1 Dfin_{it} + \alpha_2 \sum Controls_{it} + \mu_i + \varphi_t + \varepsilon_{it} \quad (1)$$

In equation (1), $Green_{it}$ represents the green consumption level of province i in year t as the dependent variable; $Dfin_{it}$ measures the development of digital financial inclusion in province i in year t as the core explanatory variable; $Controls_{it}$ is the set of control variables; α_0 is the intercept term, α_1 and α_2 indicate the regression coefficients for the core and control variables respectively; μ_i and φ_t denotes the individual and time fixed effects, respectively, reflecting the service consumption of rural residents in different provinces individual differences; ε_{it} stands for the random disturbance term.

3.3.2. Mediating Effect Model

To delve into how digital financial inclusion influences green consumption, this paper uses an advanced industrial structure as a go-between. We've built a mediation effect test model (show in Equations (2) and (3)) on top of a standard regression model, drawing inspiration from Wen Zhonglin et al. (2004) [14] on mediation effect analysis.

$$ISA_{it} = \beta_0 + \beta_1 Dfin_{it} + \beta_2 \sum Controls_{it} + \mu_i + \varphi_t + \varepsilon_{it} \quad (2)$$

$$Green_{it} = \theta_0 + \theta_1 Dfin_{it} + \theta_2 ISA_{it} + \theta_3 \sum Controls_{it} + \mu_i + \varphi_t + \varepsilon_{it} \quad (3)$$

In equations (2) and (3), ISA_{it} denote the mediating variables, and both β and θ denote the magnitude of the regression coefficients, and the other variables and symbols have the same connotations as those in equation (1).

4. Empirical Analysis

4.1. Descriptive Statistics

The results of descriptive statistics are shown in Table 1.

Table 1. Descriptive statistics table

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	mean	sd	min	max
Green	403	0.367	0.114	0.116	0.695
Dfin	403	253.5	110.7	16.22	498.3
TL	403	0.0825	0.0282	0.0355	0.188
SCL	403	0.390	0.0663	0.180	0.610
PopD	403	456.5	702.5	2.513	3,951
LBDP	403	1.556	0.472	0.669	2.998
TDLGDP	403	3.541	1.139	1.688	8.164
Number of id	31	31	31	31	31

4.2. Benchmark Regression

The results of the empirical analyses (Table 2) show that the development of digital financial inclusion has a significant contribution to the level of green consumption. In the baseline regression without considering control variables (column 1), the coefficient estimate of Dfin reaches 0.001 and passes the significance test at the 1% level. To further verify the robustness of this relationship, the study maintains the coefficient of Dfin at the 0.001 level of significance after introducing relevant control variables in the model (column 2). This result confirms that digital financial inclusion is still effective in enhancing the level of green consumption when controlling for other potential influencing factors, thus supporting the validity of hypothesis 1.

Table 2. Regression analysis table

VARIABLES	(1)	(2)	(3)
Dfin	0.001***	0.001***	0.001***
	(8.48)	(3.50)	(3.11)
Controls	NO	YES	YES
Constant	0.205***	-0.027	-0.095
	(33.16)	(-0.43)	(-1.60)
Observations	403	403	403
Number of id	31	31	31
R-squared	0.952	0.968	0.966
Company FE	YES	YES	YES
Year FE	YES	YES	YES
F test	0	0	0
r2_a	0.950	0.967	0.964
F	421.7	457.8	431.7

Note: *, **, *** denote significant at 0.1, 0.05, 0.01 levels respectively, with t-statistics in parentheses, same for the table below.

4.3. Robustness test

4.3.1. Lagged one-period explanatory variables

To delve deeper into the reliability of the regression outcomes from the preceding section, the paper investigates the lasting influence of digital financial inclusion on green consumption by incorporating a time-lag variable. This is showcased in Table 2's third column. The regression results reveal that the impact of the lagged one-period digital financial inclusion development level (Dfin) on green consumption (Green) is consistent with the previous findings in terms of the coefficient estimates and statistical significance, which indicates that the impact of this variable is persistent in the time dimension. Concurrently, control variable regression coefficients (e.g., PopD, SCL) maintain sign and significance; substantial alteration is absent. This empirical finding further strengthens the

reliability of the research findings and confirms the robustness characteristics of the benchmark regression model.

4.3.2. Endogeneity Test

To mitigate potential endogeneity issues, including omitted variables and bidirectional causality, this paper employs the instrumental variable method for robustness testing. To assess the relationship between variables, we employed a two-stage least squares approach, using one-period lagged explanatory variables as instruments. As shown in Table 3, the first-stage regression yielded statistically significant coefficients for the instrumental variables at the 1% level. The Kleibergen-Paap rk Wald F-statistic, standing at 7900.05, comfortably surpasses the Stock-Yogo weak identification threshold at the 10% level, effectively ruling out concerns about weak instruments. Additionally, the Kleibergen-Paap rk LM test confirmed a robust association between the instruments and the endogenous variables. In the second-stage regression, the coefficient for the key explanatory variable Dfin was estimated at 0.001, with significance at the 1% level. This finding not only aligns with but also reinforces the credibility of the baseline regression results.

Table 3. Endogeneity analysis

	(1)	(2)
	first stage	second stage
VARIABLES	Dfin	Green
L.Dfin	0.854***	
	(88.882)	
Dfin		0.001***
		(26.005)
Controls	YES	YES
Observations	372	372
R-squared	31	0.946
Number of id	-163.9***	31
Kleibergen-Paap rk LM statistic	Chi-sq(1)=90.34	P-val=0.000
Cragg-Donald Wald F statistic		5596.82
Kleibergen-Paap Wald rk F statistic		7900.05

4.4. Mediation Effect Test

This study examines how advanced industrial structure (ISA) mediates the impact of digital financial inclusion on green consumption. The findings, presented in Table 4, reveal several key insights. Column (1) demonstrates that digital financial inclusion has a statistically significant positive effect (coefficient = 0.001, $p < 0.10$) on ISA, suggesting it contributes to industrial structure optimization. Furthermore, Column (2) indicates that even after accounting for this mediating effect, digital financial inclusion retains a significant positive influence on green consumption (coefficient = 0.001, $p < 0.01$). In order to enhance the reliability of the research findings, this paper further adopts Bootstrap method for robustness test. As shown in Table 4, the confidence intervals of both the direct and indirect effects of digital financial inclusion on green consumption do not contain zero values at the 95% confidence level, which confirms that industrial structure upgrading has a stable mediating role in the process of digital financial inclusion affecting green consumption.

Table 4. Outcome tests for mediating effects

	(1)	(2)
VARIABLES	ISA	Green
Dfin	0.001*	0.001***
	(1.90)	(3.55)
ISA		0.146**
		(2.50)
Controls	YES	YES
Constant	2.341***	-0.370**
	(35.08)	(-2.44)
Observations	403	403
Number of id	31	31
R-squared	0.805	0.971
Company FE	YES	YES
Year FE	YES	YES
F test	0	0
r2_a	0.796	0.969
F	35.31	445.9
bootstrap test:		
Direct effect confidence interval: [0.0000873-0.0001752]		
Indirect effect confidence interval: [0.0006231-0.0007971]		

Note: Bootstrap tests report 95 per cent confidence intervals.

4.5. Heterogeneity Analysis

For the sake of examining regional variations, this study carved up the empirical sample into four major economic areas—the East, Central, West, and Northeast—as defined by the National Bureau of Statistics of China. Table 5's regression analysis reveals that the effect of digital financial inclusion on green consumption isn't uniform across the board: in the central and western regions, the impact effect fails the significance test; in the eastern region, the financial model significantly enhances the level of green consumption of the residents; while in the northeastern region, it shows a significant negative impact effect.

Table 5. Empirical results on regional heterogeneity

	(1)	(2)	(3)	(4)
VARIABLES	Eastern Region	Western Region	Central Region	Northeastern Region
Dfin	0.001*	0.001	0.000	-0.001***
	(2.24)	(1.67)	(0.60)	(-16.91)
Controls	YES	YES	YES	YES
Constant	-0.232	0.125	-0.021	-0.266
	(-1.37)	(1.67)	(-0.10)	(-1.01)
Observations	130	156	78	39
Number of id	10	12	6	3
Adjusted R-squared	0.975	0.964	0.985	0.984

5. Conclusions and Suggestions

5.1. Research Conclusions

The study reveals three key insights: First, digital financial inclusion significantly enhances green consumption levels, a finding that holds even after controlling for endogeneity using instrumental variables. Second, mediation analysis indicates this positive effect stems from advancing industrial structure toward more sophisticated sectors. Third, regional heterogeneity tests reveal clear geographical variations: the eastern region exhibits a significant promotion effect, while the central

and western regions show insignificant effects, and a certain inhibition effect in the northeastern region.

5.2. Related Suggestions

Firstly, to strengthen the institutional framework for coordinated growth between digital financial inclusion and green consumption, given the significant role of digital financial inclusion in promoting green consumption, local governments should incorporate it into their regional economic development strategies, formulate special supportive policies, and clarify development goals and implementation paths. Concurrently, it should fortify the regulatory evaluation of the amalgamation of digital technology with the green sector to guarantee policy enforcement.

Secondly, optimising industrial structure to help upgrade green consumption. The administration can drive meaningful collaboration between digital innovation and sustainable industry by implementing strategic policies like tax incentives and funding support. These measures would accelerate the digitization and automation of supply chains, ultimately elevating the overall industrial framework. Furthermore, establishing a real-time tracking system would enable more accurate evaluation of how digital financial inclusion influences green consumption patterns through industrial upgrades, allowing for timely policy refinements. By leveraging these approaches, policymakers can not only bridge the gap between technology and green industry but also fine-tune their strategies based on measurable outcomes. This proactive stance ensures that economic growth aligns with environmental sustainability while keeping pace with technological advancements.

Thirdly, targeted methods are needed to counter the challenge of regional development disparities. Relying on its advantages in digital infrastructure and financial resources, the eastern region can take the lead in launching pilot green consumer finance innovations, such as building a carbon point trading platform and promoting low-carbon consumer credit, so as to play a demonstrative and leading role. The northeastern region needs to strengthen the integration of digital financial resources, promote digital transformation and popularisation of green consumption concepts in traditional industrial zones, and promote green transformation through targeted credit support. In the central and western regions, efforts should be made to enhance the coverage of digital financial inclusion, strengthen the promotion of mobile payment and the construction of network infrastructure, so as to fully unleash their potential for promoting green consumption.

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