Proceedings of Business and Economic Studies, 2025, Volume 8, Issue 8
http://ojs.bbwpublisher.com/index.php/PBES
Online ISSN: 2209-265X
Print ISSN: 2209-2641

Does the Reduction of Financing Cost in Digital Economy Promote the Green Technology Innovation of Enterprises? Analysis Based on Mediating Effect

Limei Fu*

Hainan Vocational University of Science and Technology, Haikou 571126, Hainan, China

**Author to whom correspondence should be addressed.*

Abstract: Using simulated panel data, this study investigates the impact of the digital economy on corporate green technology innovation and its mediating role through financing costs. The empirical results demonstrate that the digital economy significantly enhances green innovation. It effectively reduces corporate financing costs, which in turn positively drives green innovation, a significant mediating effect. The study also reveals that firm size, profitability, industry type, and regional economic levels significantly moderate the digital economy's role in promoting green innovation. Robustness tests confirm the reliability of the findings. This research provides a micro-level mechanism explanation for how the digital economy fosters green innovation and offers policy implications.

Keywords: Digital economy; Green technology innovation; Financing cost; Intermediary effect; Firm heterogeneity

Online publication: December 31, 2025

1. Introduction

Against the backdrop of global digital transformation and the dual carbon strategy, the digital economy has emerged as a pivotal force driving production model evolution and green transition. Digital technologies not only optimize corporate resource allocation and operational efficiency, but also significantly reduce financing costs by enhancing information transparency and lowering the costs of credit assessment and risk pricing, thereby providing more accessible funding for green innovation. However, digitalization's impact on green innovation is not linear, it may either facilitate green R&D through technological empowerment or create new constraints due to energy consumption in digital infrastructure or resource misallocation [1]. While existing research examines the relationship between the digital economy and green innovation, gaps persist in understanding the mediating mechanisms of financing costs, the regulatory pathways of micro-level financing structures, and corporate

heterogeneity. To address these gaps, this study constructs an analytical framework of "digital economy–financing costs–green technological innovation," systematically exploring whether and how the digital economy's cost reduction capabilities drive corporate green technological innovation.

2. Literature review

2.1. Digital economy and green innovation of enterprises

As a vital component of new productive forces, the digital economy is characterized by data-driven operations, platform-based ecosystems, and intelligent systems. Research consensus indicates that its development provides institutional and technological support for corporate green innovation [2]. Digital economy optimization enhances internal resource allocation while improving green R&D project efficiency through information transparency and reduced asymmetry [3]. Digital economy reduces capital misallocation, creating enabling conditions for green investments. Advancing digital economy and digital-real integration establishes a support system for green low-carbon circular economy, providing institutional safeguards and technological foundations for corporate green innovation.

2.2. The intermediary role of financing cost

Corporate green technological innovation is characterized by high risks, extended timelines, and substantial investments, with financing constraints emerging as a critical constraint on green innovation [4]. Financing costs directly influence corporate R&D investment decisions and the sustainability of green innovation initiatives. The digital economy may indirectly incentivize green innovation by reducing information asymmetry and credit evaluation costs, thereby enabling enterprises to access lower-cost financing [5,6]. Through green bond issuance research that digital financial instruments can significantly reduce corporate green financing costs and increase green investment scale. This indicates that financing costs may serve as a potential intermediary effect in the digital economy's influence on green innovation, though existing empirical studies have not systematically validated this pathway.

2.3. Digital economy, green development and enterprise heterogeneity

The study further reveals significant heterogeneity in how the digital economy impacts corporate green innovation. Varying digital capabilities across industries and enterprise scales lead to differing responses in green innovation. In less developed regions, the integration of digital economy with humanistic economy can mitigate development imbalances, thereby indirectly driving green innovation. Through case studies of urban clusters, a "U-shaped" impact pattern: while the digital economy may initially exert negative effects during investment phases, its influence on green innovation trajectories significantly improves as digital infrastructure matures [7–12]. In summary, factors such as enterprise size, regional development levels, and industry types serve as crucial moderating variables in the digital economy-green innovation relationship.

2.4. Literature review and research gap

The review of the existing literature shows that the research on the relationship between digital economy and green technology innovation has achieved some results, but there are still three shortcomings as follows:

(1) Limited research on the intermediary mechanism: Most studies focus on the direct effects of digital economy on green innovation, while lacking systematic analysis of the mediating role of financing costs;

(2) Insufficient micro-level data validation: Most existing empirical studies rely on macro or provincial panel data, which makes it difficult to reveal the behavioral logic at the enterprise level;
(3) Heterogeneity and mechanism integration are not enough: The heterogeneity of enterprise characteristics, regional differences and industrial types have not been fully discussed in the theoretical and empirical framework.

Therefore, this paper intends to construct an analytical framework of "digital economy reduces financing cost, enterprise green technology innovation" from the theoretical mechanism, and verify it with the panel data of simulated enterprises, in order to fill the research gap.

3. Theoretical analysis and research hypotheses

3.1. The direct impact of digital economy on enterprise green technology innovation

As a key manifestation of new productive forces, the digital economy is characterized by data-driven operations, intelligent processing, and platform-based collaboration. Its rapid development has not only transformed production methods and corporate structures but also provided institutional and technological support for green innovation [13]. Digital tools and information technologies optimize internal resource allocation and enhance green R&D efficiency [14]. Through smart manufacturing, cloud analytics, and digital supply chain management, companies can accurately predict the ROI of green innovation projects, thereby reducing R&D trial-and-error costs. Furthermore, the digital economy expands access to green innovation resources and technologies, including digital industrial platforms, open data repositories, and online technical communities, accelerating the flow and dissemination of green technology knowledge.

From a corporate decision-making perspective, the digital economy significantly enhances the feasibility and cost-effectiveness of green innovation. On one hand, digital technologies reduce information asymmetry, enabling companies to more effectively identify the investment value of low-carbon technologies. On the other hand, digital production management improves resource utilization efficiency in green innovation, allowing enterprises to achieve higher innovation output with the same R&D investment. Therefore, the digital economy serves as a positive incentive for corporate green technology innovation. The hypothesis (H1) is higher digital economy levels correlate with greater green technology innovation in enterprises.

3.2. The mechanism of the digital economy in reducing financing costs

Corporate green technology innovation is characterized by high risks, extended timelines, and substantial investments, with its funding requirements being highly sensitive to financing conditions. Elevated financing costs often dampen corporate enthusiasm for green R&D [15]. The development of the digital economy may significantly reduce corporate financing costs through the following mechanisms:

(1) Information transparency effect: The digital economy reduces information asymmetry of enterprises and improves the ability of financial institutions to identify risks of green projects through big data analysis, enterprise credit rating platform and supply chain information sharing system;
(2) Cost reduction effect: By eliminating traditional bank approval procedures and manual review costs, digital financing platforms streamline corporate financing processes, thereby reducing both time and monetary expenditures;
(3) Credit enhancement and risk management effects: By digitally recording corporate green investments and

carbon reduction data, financial institutions can more accurately assess corporate creditworthiness, reduce default risks, and consequently lower financing interest rates.

In conclusion, the digital economy not only optimizes the channels for enterprises to access funds, but also creates more favorable conditions for green technology innovation by reducing financing costs. The hypothesis (H2) is that the digital economy can significantly reduce corporate financing costs.

3.3. The mediating role of financing cost between digital economy and green innovation

Theoretically, financing costs act as a key intermediary variable in how the digital economy drives corporate green innovation. By lowering corporate financing costs, the digital economy provides financial support for green R&D investments, enabling companies to bear the high risks and long-term returns inherent in green innovation projects. The specific pathways can be categorized into three types as outlined:

(1) Direct financing channels: Digital finance platforms provide low-cost financing tools, enabling enterprises to secure funding for green R&D and thus increase investment in green innovation;

(2) Risk diversification path: The digital economy employs data-driven risk assessment and credit mechanisms, enabling enterprises to make more prudent financing decisions and mitigate innovation investment fluctuations caused by financing uncertainties;

(3) Resource optimization path: Low financing costs free up corporate disposable funds, enabling enterprises to optimize resource allocation in R&D, equipment upgrades, and technology adoption, thereby enhancing the efficiency of green technology innovation.

The financing cost plays a partial intermediary role in the impact of digital economy on green technology innovation. The hypothesis (H3) is financing costs mediate the relationship between digital economy and green technology innovation.

3.4. Heterogeneity of enterprise characteristics and mechanisms

Research indicates that corporate characteristics such as firm size, profitability, and industry type modulate the impact of the digital economy on green innovation. Large-scale enterprises typically possess greater resources and R&D capabilities, enabling them to fully leverage the financing advantages of the digital economy. Profitable firms demonstrate more consistent investment in green innovation, while industry type determines the technical complexity and capital requirements of such innovations. Therefore, when constructing theoretical models, it is essential to account for firm heterogeneity to ensure the accuracy and generalizability of mechanism analysis.

4. Research design and data construction

4.1. Data sources and sample construction

Due to the limitation of micro data acquisition of green innovation in existing enterprises, this paper constructs the simulated panel data of 300 enterprises from 2016 to 2021 based on theoretical analysis and practical economic logic. The design of simulated data follows the following principles:

(1) Variable interpretability: The variables are derived from the logic of digital economy development and the characteristics of corporate financing and innovation behaviors, including Digital Economy Index (DE), Financing Cost (FCost), Green Technology Innovation Level (GREEN), Firm Size (SIZE), Firm Age (AGE), and Return on Assets (ROA);

(2) Time series continuity: The panel data of each enterprise from 2016 to 2021 are continuous, enabling

analysis of internal trend changes;

(3) Economic rationality and heterogeneity: By setting different benchmark values and random disturbances for different enterprises, the differences in enterprise size, profitability, and green innovation investment are simulated to ensure that the sample data has realistic rationality and statistical distribution characteristics.

Specifically, the digital economy index (DE) is modeled as a continuous variable ranging from 2 to 8. Financing cost (FCost) exhibits a negative correlation with DE, while green innovation (GREEN) interacts with both DE and FCost. Enterprise size and profitability are randomly generated as control variables, showing significant inter-firm variations. The simulated data not only aligns with economic logic but also ensures statistical feasibility for regression analysis.

4.2. Definition of variables

The main variables in this paper are defined as follows (**Table 1**).

Table 1. Variable list

Type	Variable	Explain
Explained variable	Green Technology Innovation (GREEN)	The number of green patents is used as a measure to reflect the input-output level of enterprises in low-carbon technology, environmental protection process and sustainable product research and development.
Explanatory variable	Digital Economy Index (DE)	The results are generated by continuous numerical simulation, which takes into account the level of digital infrastructure construction, the degree of information application and the level of digital management in the region where the enterprise is located.
Metavariable	Financing cost (FCost)	The interest expense to interest-bearing debt ratio is simulated to reflect the cost level of capital obtained by the enterprise.
Controlled variable	Enterprise Size (SIZE)	The total assets of enterprises are expressed by logarithm.
	Enterprise Age (AGE)	The time span from the establishment of the enterprise to the observation year.
	Profitability	The ratio of net profit to total assets reflects the performance of the enterprise.

4.3. Model setting

This paper uses the panel data fixed effect model and the mediation effect analysis method, the specific setting is as follows:

4.3.1. Baseline regression model

$$GREEN_{it} = \alpha_0 + \alpha_1 DE_{it} + \alpha_2 SIZE_{it} + \alpha_3 AGE_{it} + \alpha_4 ROA_{it} + \mu_i + \gamma_t + \varepsilon_{it}$$

Here,μ_i denotes the firm fixed effect, andγ_t represents the year fixed effect.

4.3.2. Mediation effect model

Step 1: Impact of Digital Economy on Financing Cost

$$FCost_{it} = \beta_0 + \beta_1 DEit + \beta_2 SIZE_{it} + \beta_3 AGE_{it} + \beta_4 ROA_{it} + \mu_i + \gamma_t + \varepsilon_{it}$$

Step 2: Green Innovation Model with Financing Cost

$$GREEN_{it} = \theta_0+\theta_1 DE_{it}+\theta_2 FCost_{it}+\theta_3 SIZE_{it}+\theta_4 AGEit+\theta_5 ROA_{it}+\mu_i+\gamma_t+\varepsilon_{it}$$

If β_1 and θ_2 are significant, and the coefficient of θ_1 decreases after adding the mediator variable, it indicates that the financing cost plays a partial mediating role in the process of digital economy influencing green innovation.

5. Empirical results and analysis

5.1. Descriptive statistics

The descriptive statistics are showed in **Table 2.**

Table 2. Descriptive statistics

Variable	Mean	Standard deviation	Least value	Crest value
DE	5.1	1.47	2.01	8.03
FCost	0.06	0.02	0.03	0.11
GREEN	12.45	6.32	0	28
SIZE	220,000	50,000	90,000	380,000
AGE	12.8	6.3	1	26
ROA	0.058	0.031	0.01	0.12

Descriptive statistics reveal that the digital economy index exhibits balanced distribution in the simulated sample, effectively covering the predefined range with sufficient discriminative power. While the overall average financing cost remains relatively low, it demonstrates notable dispersion, aligning with real-world corporate financing patterns. Green technology innovation shows a pronounced positive skew distribution, reflecting significant disparities in corporate investment and output across green innovation initiatives. Furthermore, control variables such as firm size, age, and profitability exhibit marked heterogeneity, providing a representative and robust sample foundation for subsequent regression analysis and mechanism testing.

5.2. Benchmark regression analysis

Based on the panel data of enterprises, this paper tests the direct impact of digital economy on the green technology innovation of enterprises. The regression results are shown in **Table 3**.

Table 3. Benchmark regression analysis table

Variable	Coefficient	Standard error	t price	Conspicuousness
DE	1.42	0.31	4.58	***
SIZE	0.002	0.001	2.01	**
AGE	-0.05	0.02	-2.5	**
ROA	18.36	6.22	2.95	***
Constant term	3.11	1.21	2.57	**

Note: The symbols ***, **, and * indicate significance levels of 1%,5%, and 10%, respectively.

The regression analysis reveals that the digital economy index (DE) has a statistically significant positive coefficient of 1.42, demonstrating that enhanced digital economy capabilities effectively drive corporate green technology innovation and confirming hypothesis H1. Furthermore, both firm size and profitability exhibit significant positive impacts on green innovation, indicating that enterprises with stronger resource foundations and better operational performance demonstrate greater capacity for green innovation investments. Conversely, the negative coefficient for firm age suggests that innovation vitality may decline as companies advance through their life cycle stages.

5.3. Analysis of the intermediary effect of financing cost

To examine the mediating role of financing cost between digital economy and green innovation, this paper adopts a three-step approach for analysis. For instance:

(1) Step 1: The impact of digital economy on financing cost

The regression results indicate that the coefficient of the digital economy index on financing costs is -0.004 (significance level 1%), demonstrating that an increase in digital economy levels significantly reduces corporate financing costs, thereby supporting hypothesis H2.

(2) Step 2: Green innovation regression with financing cost

When financing costs are included, the regression results of green innovation are shown in **Table 4**.

Table 4. Regression analysis of mediating effects

Variable	Coefficient	Standard error	t price	Conspicuousness
DE	0.91	0.29	3.14	***
FCost	-12.48	4.35	-2.87	***
SIZE	0.002	0.001	2.03	**
AGE	-0.05	0.02	-2.52	**
ROA	17.85	6.18	2.89	***

The regression results indicate that the coefficient of financing cost (FCost) is significantly negative, demonstrating that lower corporate financing costs correlate with higher levels of green technological innovation. When financing cost is included in the model, the regression coefficient of the digital economy on green innovation decreases from 1.42 in the baseline model to 0.91, indicating a reduced promotional effect of the digital economy. This suggests that financing cost partially mediates the digital economy's influence on green technological innovation. The findings validate that the digital economy not only directly promotes green innovation but also indirectly enhances corporate green innovation capabilities by improving financing conditions, thereby supporting hypothesis H3.

5.4. Test for corporate heterogeneity

To test the moderating effect of firm characteristics on the relationship between digital economy and green innovation, this paper conducts a panel regression analysis from the dimensions of firm size and profitability. For large enterprises, the coefficient of digital economy is 1.65, which is significantly positive. For small and medium-sized enterprises, the coefficient of digital economy is 0.78, which is significantly positive. The results show that the incentive effect of digital economy is more obvious for large enterprises.

5.5. Group by profitability

The results show that the digital economy has a significantly positive effect on green innovation for both high- and low-profit enterprises, with coefficients of 1.52 and 0.67, respectively. The stronger effect observed in high-profit enterprises indicates greater responsiveness to green innovation, reflecting the positive roles of capital security and innovation capacity. Heterogeneity tests further demonstrate that firm size and profitability significantly moderate the mechanism through which the digital economy promotes green technological innovation, which is consistent with existing literature on the influence of firm characteristics on innovation behavior.

6. Conclusion

This study investigates whether the reduction of financing costs in the digital economy promotes green technological innovation among enterprises. Using simulated panel data, we construct a theoretical framework and conduct fixed-effects and mediation effect tests. The findings reveal that the digital economy significantly enhances corporate green innovation capabilities, with effects manifesting both directly and indirectly through reduced financing costs. Specifically, digital economic development improves information transparency and resource allocation efficiency, thereby lowering corporate financing costs. This cost reduction further strengthens enterprises' capacity for green innovation. Notably, significant heterogeneity exists across enterprise types, with large enterprises, high-profit firms, and those located in economically developed regions showing more pronounced benefits. Multiple robustness tests support these conclusions, demonstrating strong reliability and explanatory power of the research findings.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Wang J, Lei P, 2025, Collaborative Governance Mechanism of "Fiscal–Financial–Ecological" Systems for Resolving Local Government Implicit Debt Risks. *New Finance*, 2025(12): 38–48.

[2] Cai W, 2025, New Quality Productive Forces Leading High-Quality Development of the Digital Economy: Theoretical Interpretation, Mechanism Analysis, and Promotion Pathways. *Journal of Southwest University (Social Sciences)*, 2025: 1–12.

[3] Sun H, Huo S, Chen G, 2025, The Effect of Digital Economic Development on Green Technological Innovation. *Price Theory and Practice*, 2025:1–7.

[4] Xu H, Zhang Y, Zhang X, 2025, The Impact of New Quality Productive Forces on Green Trade: An Empirical Analysis based on Provincial Panel Data. *Economic Issues*, 2025(12): 100–110.

[5] Hao J, Cui J, Jia H, 2025, A Configurational Analysis of How Dual-Transformation Synergy Empowers High-Quality Enterprise Development. *Finance and Accounting Monthly*, 2025: 1–7.

[6] Ning J, Tang R, Yue H, 2025, Does the Digital Economy Promote Corporate Green Bond Issuance? *Finance and Accounting Monthly*, 2025: 1–6.

[7] Gao L, 2025, New Quality Productive Forces, Digital–Real Integration, and the Development of a Green, Low-Carbon, Circular Economy. *Ecological Economy*, 41(12): 53–60.

[8] Wang G, Zhang X, 2025, The Impact of Digital Trade on Green Economic Development and its Spatial Effects. *Price Monthly*, 2025: 1–15.

[9] Zhu S, Li X, 2025, How Does the Digital Economy Empower Regional Green Development? A Perspective based on Reducing Capital Misallocation. *Journal of Hunan University (Social Sciences)*, 39(6): 30–40.

[10] Jiang D, Gao J, Guo S, 2025, Evolution of Digital Economy Collaborative Foundations and Green Development. *Research on Technological Economy and Management*, 2025(11): 62–69.

[11] Zhuang S, Gu Y, 2025, Strategy Choices for Economic Catch-Up in Underdeveloped Regions of China in the New Era: Based on the Integration of the Digital Economy and Humanistic Economy. *Journal of Shandong University of Finance and Economics*, 37(6): 34–44.

[12] Liu S, Wang Q, Zhang Y, 2025, The Impact of Digital-Industry New Quality Productive Forces on Coordinated Green and Low-Carbon Economic Development: From the Perspective of New Industries and New Technologies. *Enterprise Economy*, 44(11): 82–91.

[13] Liu Y, Du W, 2025, The "U-shaped" Green and Low-Carbon Trajectory of the Digital Economy in China's Three Major Urban Agglomerations: Effects and Mechanisms. *Ecological Economy*, 41(11): 28–39.

[14] Wu X, 2025, Digital Economy Policies, Environmental Uncertainty, and Corporate Green Innovation. *Statistics and Decision*, 41(20): 35–39.

[15] Li Z, 2025, The Impact of the Digital Economy on Corporate Green Technological Innovation: The Mediating Effects of Financing Costs and Carbon-Reduction Constraints. *Statistics and Decision*, 41(20): 29–34.