



How does Digital Finance Promote Green Innovation in New Energy Firms? Evidence from Chinese Listed Companies

Jiangnan Zheng*

Wuhan University of Technology, Wuhan, 430070, China

*zjh15639927809@126.com

Abstract. Within the digital economy, digital finance provides innovative sources of financing corporate innovation. This paper examines how digital finance influences green innovation with panel data on the Chinese listed new energy companies during 2011-2022. According to the results obtained based on the two-way fixed effects model, it can be stated that digital finance has a strong positive effect on green innovation. The mechanism tests also demonstrate that digital finance can be used to support green innovation through reducing the financing constraint as well as facilitating the upgrading of industrial structure. The stability of the results is verified by robustness checks. This paper offers an empirical basis at the level of firms of how digital finance can play a role in furthering green technological innovation and green transition..

Keywords: Digital finance, Green innovation, New energy firms, Financing constraints, Resource allocation

1 Introduction

In the context of climate change and energy transition, green innovation has become a necessity to achieve sustainable development[1]. Being the major providers of low-carbon technologies, the new energy companies have an important part to play in lowering emissions and supporting clean energy, but their green innovation is usually limited to high R&D expenses, lengthy payback periods, technological risk, and restricted ability to obtain external finance[2]. Due to the high rate of development of digital technologies, digital finance has become one of the new sources of innovative practices within corporations[3]. Digital finance may reduce financing constraints and improve the innovation capability of firms by enhancing information processing, lowering transaction costs, and increasing the scope of financial services[4]. The connection between digital finance and innovation has been addressed in previous works, but there is little empirical research at the level of the individual company, especially regarding green innovation in new energy companies, and the mechanisms behind it are not yet fully explained[5]. This paper investigates how digital finance influences green innovation based on the panel data of listed new energy companies in

China between 2011 and 2022 using a two-way fixed effects model[6]. It also tests if financing constraints and industrial structure upgrading are transmission channels[7]. The research is useful in enhancing micro-level evidence of environmental impacts of digital finance, elucidating the mechanisms behind it and offering empirical information to developing countries that aim at green transition[8].

2 Theoretical Analysis and Hypotheses

Two ways that digital finance can be used to promote green innovation in new energy companies are as follows. It assists in the alleviation of the financing constraint on account of the development of information processing and increased access to funds, and it is also helpful in promoting the upgrading of the industrial structure with an emphasis on channeling capital into the high-technology and green industries. Both these actions result in more favorable environment to conduct green innovations by the companies[9].

3 Research Design

3.1 Model Specification

This paper uses a two-way fixed effects model based on a panel of Chinese listed new energy companies between 2011 and 2022 to explore the role of digital finance in green innovation. The base model examines the direct impact of digital finance whereas other models substitute the composite index with its sub-indices to determine if the findings are consistent across various aspects of digital finance[10].

$$Y_{it} = a_0 + a_1 * dif + a_3 * \sum control + U_i + T_t + \varepsilon_{it} \quad (1)$$

$$Y_{it} = a_0 + a_1 * dif_{cb} + a_3 * \sum control + U_i + T_t + \varepsilon_{it} \quad (2)$$

$$Y_{it} = a_0 + a_1 * dif_{ud} + a_3 * \sum control + U_i + T_t + \varepsilon_{it} \quad (3)$$

$$Y_{it} = a_0 + a_1 * dif_{dl} + a_3 * \sum control + U_i + T_t + \varepsilon_{it} \quad (4)$$

The models (5) and (6) are utilized to examine the mediation role of financing constraints between the impact of digital finance on green innovation. Initially, digital finance is regressed on the financing constraints, which are then incorporated into the green innovation model. When digital finance decreases financing constraints, financing constraints reduce the use of green innovation, and the coefficient of digital finance is reduced when the mediator is introduced, it confirms that it has a mediating effect.

$$KZ = a_0 + a_1 * dif + a_3 * \sum control + U_i + T_t + \varepsilon_{it} \quad (5)$$

$$Y_{it} = a_0 + a_1 * dif + a_2 * KZ + a_3 * \sum control + U_i + T_t + \varepsilon_{it} \quad (6)$$

Models (7) and (8) examine whether the upgrade of industrial structure has a mediating role between digital finance and green innovation. Initially, industrial upgrading is regressed on digital finance followed by including these two variables in the green innovation model. When digital finance contributes to industrial upgrading, this contributes to improved green innovation and the coefficient of digital finance falls as a result of the mediation, this indicates the existence of a mediating effect.

$$third = a_0 + a_1 * dif + a_3 * \sum control + U_i + T_t + \varepsilon_{it} \quad (7)$$

$$Y_{it} = a_0 + a_1 * dif + a_2 * third + a_3 * \sum control + U_i + T_t + \varepsilon_{it} \quad (8)$$

In all models, the dependent variable Y_{it} denotes the level of green innovation of firm i in year t . The core explanatory variable dif represents the level of digital finance development. $difcb$, $difud$, and $difdl$ respectively represent the coverage breadth, usage depth, and digitalization level of digital finance. The control variables are denoted by $\sum control$. Firm fixed effects U_i and year fixed effects T_t are included to control for time-invariant firm characteristics and macroeconomic shocks, respectively. The error term is denoted by ε_{it} .

3.2 Variables Sample and Data Sources

The logarithm of green patents granted plus one measures green innovation and the Peking University Digital Inclusive Finance Index is a proxy of digital finance. Financing constraints and industrial structure upgrading are taken as mediator variables whereas firm size, ownership concentration, profitability, and inventory turnover are control variables. The sample is made up of Chinese listed new energy companies between 2011 and 2022, excluding financial and ST/*ST companies. The unbalanced panel dataset is created after winsorizing continuous variables and matching information with CNRDS, the digital finance index, and official statistics..

4 Empirical Results and Analysis

4.1 Baseline Regression Results

To test Hypothesis 1, this study employs a two-way fixed effects model to estimate the relationship between digital finance and green innovation in new energy firms. The baseline regression results are reported in Table 1.

Table 1. Baseline regression results

	(1)	(2)	(3)
	Insec	Insec	Insec
dif	0.206*** (0.013)	0.096*** (0.013)	0.264*** (0.037)
size		0.136*** (0.005)	0.173*** (0.004)
top1		-0.841*** (0.098)	0.050 (0.079)
roa		1.742*** (0.230)	0.921*** (0.195)
quick		3.446*** (0.751)	-3.834*** (0.618)
_cons	1.929*** (0.037)	-1.102*** (0.115)	-2.176*** (0.141)
N	16565.000	16565.000	16565.000
r2	0.016	0.074	0.453

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

As a result, digital finance is shown to have a highly positive impact on green innovation in new energy companies. The result also does not change when control variables at the firm level are included and the fixed effects of the firm and year are controlled, suggesting that the baseline result is strong. On the whole, the evidence is extremely supportive of Hypothesis 1, which is that digital finance is beneficial to corporate green innovation.

4.2 Mediation Effect Analysis: Financing Constraints and Industrial Structure Upgrading

4.2.1 The Mediating Role of Financing Constraints.

To examine Hypothesis 2, this study introduces financing constraints as a mediating variable and estimates the mediation models. The corresponding regression results are presented in Table 2.

Table 2. Mediation effect results

	(1)	(2)	(3)	(4)	(5)
	Insec	kz	Insec	third	Insec
dif	0.264*** (0.037)	-0.230*** (0.037)	0.173*** (0.034)	0.072*** (0.001)	-0.155*** (0.046)
kz			-0.395*** (0.009)		

	(1) lnsec	(2) kz	(3) lnsec	(4) third	(5) lnsec
third					5.817*** (0.422)
size	0.173*** (0.004)	-0.058*** (0.005)	0.150*** (0.004)	0.001*** (0.000)	0.168*** (0.004)
top1	0.050 (0.079)	-0.318*** (0.081)	-0.076 (0.073)	0.009*** (0.001)	-0.005 (0.079)
roa	0.921*** (0.195)	-6.752*** (0.273)	-1.747*** (0.184)	-0.018*** (0.003)	1.028*** (0.195)
quick	-3.834*** (0.618)	-18.889*** (0.798)	-11.299*** (0.689)	0.025*** (0.011)	-3.979*** (0.617)
_cons	-2.176*** (0.141)	3.800*** (0.197)	-0.674*** (0.140)	-0.038*** (0.002)	-1.955*** (0.142)
N	16565.000	16565.000	16565.000	16565.000	16565.000
r2	0.453	0.290	0.544	0.457	0.459

Standard errors in parentheses

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

The findings indicate that digital finance greatly decreases financing constraints, whereas financing constraints significantly hinder green innovation. With both variables present, the coefficient on digital finance is still positive and statistically significant but it is smaller, which means that financing constraints do act as mediators, albeit partially. It implies that digital finance does not only have a direct impact on the improvement of green innovation, but also an indirect influence on it, relieving the financing pressure on firms and helping them invest more in green R&D in the long run.

4.2.2 The Mediating Role of Industrial Structure Upgrading.

The findings indicate that digital finance has a high potential to influence positively industrial structure upgrading and then industrial upgrading positively influences green innovation development in the new energy company. With both variables introduced, the digital finance coefficient is still positive and significant but reduces, which means that the upgrading of the industrial structure has a partial mediating role. It indicates that, besides the direct firm-level support of green innovation, digital finance contributes to green innovation by enhancing the general industrial environment.

4.3 Robustness Checks and Endogeneity Discussion

To assess the robustness of the baseline results, this study replaces the composite digital finance index with its three sub-indices—coverage breadth (difcb), usage depth (difud), and degree of digitalization (difdl). The corresponding regression results are reported in Table 3.

Table 3. Robustness test results

	(1)	(2)	(3)	(4)
	Insec	Insec	Insec	Insec
difcb	0.239*** (0.036)			
difud		0.180*** (0.025)		
difdl			0.108* (0.062)	
L.dif				0.256*** (0.038)
size	0.173*** (0.004)	0.173*** (0.004)	0.173*** (0.004)	0.189*** (0.004)
top1	0.044 (0.079)	0.062 (0.079)	0.080 (0.079)	0.057 (0.077)
roa	0.918*** (0.195)	0.917*** (0.195)	0.984*** (0.195)	0.927*** (0.192)
quick	-3.854*** (0.618)	-3.775*** (0.619)	-3.607*** (0.619)	-5.114*** (0.617)
_cons	-2.161*** (0.141)	-2.156*** (0.141)	-2.169*** (0.144)	-3.992*** (0.129)
N	16565.000	16565.000	16565.000	15184.000
r2	0.453	0.453	0.451	0.521

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The results of robustness demonstrate that the three sub-indicators of digital finance stay highly significant positively, which indicates that the baseline results are not based upon one indicator. Following the introduction of the one-period lag of digital finance, the coefficient remains significantly positive, and it implies that the promoting role of digital finance on green innovation is consistent, and relieves the worry regarding reverse causality. On the whole, the findings confirm that digital finance provides a stable support to green innovation within new energy businesses.

5 Conclusion and Implications

The findings indicate that digital finance plays a significant role in promoting green innovation among Chinese listed new energy companies, especially reducing the financing constraints and facilitating the development process. It implies that digital finance has the potential to enhance green innovation across both the firm and structural level. Companies could apply digital finance to increase funding channels and help them with long-term green R&D, whereas on the macro-level, it would be able to enhance the allocation of capital and help transform industries. Nonetheless, the re-

search suffers from its dependence on green patent counts, its consideration of two mechanisms only, and its use of data on Chinese companies.

Reference

1. Zhang, P., Wang, Y., Wang, R., & Wang, T. (2024). Digital finance and corporate innovation: Evidence from China. *Applied Economics*, 56(5), 615–638.
2. Chen, C., Fan, M., & Fan, Y. (2024). The role of digital inclusive finance in green innovation. *PLOS ONE*, 19(12), e0315598.
3. Ma, K. (2023). Digital inclusive finance and corporate green technology innovation. *Finance Research Letters*, 70, 106283.
4. Li, B. (2024). Digital finance, financing constraints, and green technological innovation: A spatial analysis. *Global Finance Journal*, 61, 100988.
5. Fan, W. (2022). Does digital finance induce improved financing for green technological innovation? *Journal of Environmental Planning and Management*.
6. Shen, Y., & Gu, H. (2023). Digital finance, financial constraint and enterprise innovation. *Finance*, 13(1), Article 60430.
7. Zhang, Q., & Mao, Z. (2025). Digital finance, financing constraints, and green innovation in Chinese firms: The roles of management power and CSR. *Sustainability*, 17(15), 7110.
8. Gu, H., & Gao, S. (2022). Digital finance development and corporate green innovation. *Statistical Research and Information Forum*, 37(11), 77–93. (in Chinese)
9. Liu, G., & Liu, J. (2022). Digital finance and green innovation: Theory and evidence from prefecture-level cities in China. *Wuhan Finance*, 2022(9), 50–60. (in Chinese)
10. Liu, J., & Zhang, L. (2022). Financing efficiency and corporate green innovation: Evidence from listed new energy firms. *Industrial Technology Economics*, 41(9), 35–42. (in Chinese)

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

