

A Study on the Impact of FinTech on Corporate Green Innovation

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Abstract. Taking China 's A-share listed companies from 2011 to 2023 as research samples, this paper conducts empirical analysis based on the two-way fixed effect model. The results show that financial technology has a significant promoting effect on corporate green innovation activities. Further mechanism test shows that Fintech mainly exerts its influence through two paths : first, alleviating the financing constraints faced by enterprises and improving the financial availability of green R & D activities ; second, promote the digital transformation of enterprises and enhance their ability in green technology R & D and application. The moderating effect analysis reveals that the good ESG performance of enterprises can positively regulate the promotion effect of FinTech, that is, the higher the ESG rating, the stronger the enabling effect of FinTech on green innovation. The research conclusions of this paper provide an empirical basis and policy enlightenment for improving the sustainable financial support system and guiding enterprises to accelerate the green and low-carbon transformation.

Keywords: FinTech, Green Innovation, Financial constraints, Enterprise Digital Transformation

1. Introduction

Under the dual pressures of escalating global climate risks and natural resources approaching ecological thresholds, advancing green and low-carbon transformation has become an international consensus and shared responsibility. Although corporate green innovation is crucial, it has long been hindered by high costs, long development cycles, financing difficulties, and insufficient support from traditional financial systems. FinTech harnesses technologies like big data and AI, offers significant advantages in alleviating information asymmetry, reducing transaction costs, and optimizing resource allocation. Consequently, whether and how FinTech can promote corporate green innovation has become a critical issue.

The existing literature mainly focuses on green finance and environmental regulation, and the research on financial technology is relatively insufficient, especially the lack of in-depth theoretical analysis and empirical test of the transmission mechanism behind it.

China is facing the dual pressures of international responsibility under the "double carbon" strategy and domestic demand for high-quality development, and green innovation-driven

transformation is imperative. Based on the panel data of A-share listed companies from 2011 to 2023, this paper examines the mechanism of FinTech affecting corporate green innovation from three dimensions : alleviating financing constraints, promoting digital transformation and improving ESG performance, aiming to provide empirical support for improving the green financial system and improving the application effect of FinTech.

2. Theoretical analysis and research hypotheses

FinTech, deeply integrated with big data, artificial intelligence, and blockchain, can assess credit risk, reduce financing costs, strengthen the collection and disclosure of environmental information, improve the efficiency of green credit allocation, and provide strong support for green innovation.

Based on this, this paper puts forward the central argument of this paper, hypothesis 1: FinTech promotes green innovation of enterprises.

Green innovation depends on long-term continuous investment, but traditional financial institutions tighten credit due to the difficulty in assessing technical risks and information asymmetry, which aggravates financing constraints and dampens the innovation power of enterprises [1]. FinTech alleviates information asymmetry and risk premium by dynamically integrating multidimensional data, thereby optimizing capital structure and maturity matching, and providing stable financial support for green R & D investment and patent output.

In summary, we propose, Hypothesis 2: FinTech promotes green innovation among enterprises by reducing financing constraints.

FinTech can not only accurately allocate resources and reduce operating costs at the financial level, thus accumulating capital reserves for digital transformation [2], but also directly provide technical support due to its underlying architecture sharing origin with technologies such as artificial intelligence and blockchain. Digital transformation further improves production process and management efficiency, and actively promotes green innovation [3].

We further propose hypothesis 3: Fintech enhances the green innovation capability of enterprises by promoting digital transformation.

Through standardized environmental disclosure and sound internal governance, companies with strong ESG performance can more effectively integrate with financial technology platforms, reduce information asymmetry, achieve accurate credit evaluation and risk pricing, and accelerate the transformation of digital financial resources into green innovation. At the same time, distributed ledger technology helps to reduce the risk of 'greenwashing' and enhance the enabling effect of ESG compliance companies. On the contrary, weaker ESG performance weakens this effect.

Therefore, this paper further proposes Hypothesis 4: Enterprise ESG positively regulates the impact of financial technology on green innovation.

3. Research design

3.1. Sample selection and data sources

This study focuses on Chinese A-share listed companies from 2011 to 2023. The data used were primarily sourced from the China Research Data Service Platform (CNRDS), Wind database, Guotai'an database, the "China City Statistical Yearbook," and annual financial reports of relevant companies. Drawing on existing literature, the following data processing steps were applied: excluding financial sector listed companies, as well as ST, ST*, and firms with missing data samples.

3.2. Definition of variables

3.2.1. Dependent variable

Following the approach of Qi Shaozhou et al. [4], the number of green innovation is represented by the sum of applications for green invention patents and green utility model patents. The natural logarithm of this sum plus one is used as the measure of corporate green innovation (GI).

3.2.2. Explanatory variables

Following the approach of Li Chuntao et al. [5], we constructed a city-level FinTech development index by conducting an advanced search on Baidu News using 48 keywords related to "FinTech."

3.2.3. Mediating variables

This study adopts the method of Kaplan & Zingales [6] and Ren Xiaoyi [7] to construct the KZ index, using its magnitude to reflect the degree of financing constraints faced by firms. A higher index value indicates a greater level of financing constraints.

Following the method of Wu Fei et al. [8], this paper constructed a keyword dictionary based on terms related to digital transformation, such as artificial intelligence and big data, and used Python text mining techniques to analyze the frequency of keywords like financial technology in annual reports of listed companies.

3.2.4. Moderating variables

To quantify corporate ESG performance, this paper adopts the rating score provided by Huazheng. Compared with other ESG evaluation systems, Huazheng's ESG rating has advantages such as faster updates and broader coverage, and it better suits the current actual development conditions of Chinese listed companies.

3.2.5. Control variables

Corporate green innovation levels are influenced by numerous factors. Drawing on previous research, we select the following variables: corporate age (Age), corporate size (Size), price-to-book ratio (PB), current ratio (Liquid), proportion of tangible assets (Tangible), total asset growth rate (AssetGrowth), board size (Board), financial leverage (FL), and the shareholding ratio of the top 10 shareholders (Top10).

3.3. Model construction

To test hypothesis 1, this paper conducts an empirical analysis by constructing the following model:

$$GI_{i,t} = \beta_0 + \beta_1 \text{Fintech}_{i,t} + \sum \beta_n \text{Controls}_{i,t} + \varphi_i + \mu_t + \gamma_j + \varepsilon_{i,t} \quad (1)$$

where $GI_{i,t}$ represents the green innovation level of firm i in year t ; $\text{FinTech}_{i,t}$ denotes the level of financial technology development for firm i in city-level year t ; Controls represent a set of control variables; φ_i is the individual fixed effect; μ_t is the time fixed effect; γ_j is the industry fixed effect; subscript i indicates firms, subscript t indicates time, and subscript j indicates industries; $\varepsilon_{i,t}$ denotes the random disturbance.

Based on the above study, construct the following model to test hypotheses H2, H3, and H4:

$$M_{it} = \beta_0 + \beta_1 \text{Fintech}_{i,t} + \beta_n \sum \text{Control}_{i,t} + \lambda_t + \mu_i + \varepsilon_{i,t} \quad (2)$$

Among them, the explained variable $M_{i,t}$ is a mechanism variable, including financing constraints (KZ) and enterprise digital transformation (DT), with other symbols having the same meanings as described earlier.

Based on the two-way fixed effects model, to further investigate the mechanism through which financial technology influences corporate digital transformation, This paper introduces an interaction term between financial technology and ESG performance, establishing a moderation effect model:

$$GI_{i,t} = \beta_0 + \beta_1 \text{Fintech}_{i,t} + \beta_2 \text{ESG}_{i,t} + \beta_3 \text{ESG}_{i,t} \times \text{Fintech}_{i,t} + \sum \beta_n \text{Control}_{i,t} + \gamma_i + \varepsilon_{i,t} \quad (3)$$

4. Empirical analysis

4.1. Benchmark regression analysis

Table 1 gives the regression estimation results of the core explanatory variable Final on the enterprise green innovation level (Ln Green). Column (1) reports that the coefficient of FT is 0.218, which is significant at the 1% level without control. Column (2) adds all the controls. The coefficient on FT is 0.129, which is still significant at the 1% level. Therefore, hypothesis 1 is supported.

Table 1. Benchmark regression results

	(1)	(2)
	GI	GI
FinTech	0.218*** (0.006)	0.129*** (0.009)
_cons	-0.162*** (0.030)	-9.708*** (0.539)
Controls	NO	YES
Time fixed effects	YES	YES
Individual fixed effects	YES	YES
N	34296	34296
R2	0.178	0.233

4.2. Mediation analysis

In order to explore the mechanism of FinTech affecting corporate green innovation, this study uses Model 2 to test the mediating effect based on benchmark regression. The results are shown in Table 2.

In Column (2) of Table 2, the regression coefficient of FinTech to financing constraints (KZ) is -0.150, which is significant at the level of 1%, indicating that FinTech alleviates corporate financing

constraints. The mechanism behind it is that FinTech enhances information transparency and trust, improves credit allocation efficiency, improves financial conditions, and provides financial support for green innovation. Hypothesis 2 is supported.

In Column (3) of Table 2, the coefficient of financial technology digital transformation DT is 0.185. On the one hand, FinTech provides financial support for equipment procurement, software deployment, and talent acquisition, and alleviates the financial pressure during the transition period. On the other hand, its technical architecture has commonality with the basic logic of digital technology, which reduces the adaptation cost of enterprises using similar technologies such as cloud computing and big data. Digital transformation improves operational efficiency, reconstructs R & D system, accumulates data and algorithm foundation, and drives green innovation. Hypothesis 3 is supported.

Table 2. Mediation effect test

	(1) GI	(2) KZ	(3) DT
FinTech	0.129*** (0.009)	-0.150*** (0.016)	0.185*** (0.009)
_cons	-9.708*** (0.539)	1.601* (0.943)	-4.963*** (0.498)
Controls	YES	YES	YES
Time fixed effects	YES	YES	YES
Individual fixed effects	YES	YES	YES
N	34296	33841	34054
R2	0.233	0.195	0.291

4.3. Moderation effect analysis

This study constructs the interaction term between FinTech and enterprise ESG performance (FinTech $\times$ ESG). Column (2) of Table 3 reports that the coefficient of the interaction term is 0.022, which is significant at the 1 % level. Therefore, better ESG performance magnifies the impact of financial technology on green innovation. Hypothesis 4 is supported. The reason is that enterprises with stronger ESG performance usually have more transparent information disclosure and better internal governance, so that they can more effectively connect with FinTech platforms and reduce information asymmetry, thus amplifying the incentive effect of FinTech on green R & D.

Table 3. Moderation effect analysis

	(1) GI	(2) GI
FinTech	0.129*** (0.009)	0.040** (0.020)
ESG	0.041*** (0.008)	-0.073*** (0.025)
FinTech*ESG		0.022*** (0.005)

Table 3. (continued)

_cons	-9.718*** (0.538)	-9.134*** (0.568)
Control	YES	YES
Time fixed effects	YES	YES
Individual fixed effects	YES	YES
N	34296	34296
adj. R2	0.234	0.236

5. Conclusion

Based on China's A-share data from 2011 to 2023, FinTech has significantly promoted corporate green innovation, and this effect is transmitted by alleviating financing constraints and driving digital transformation, and ESG performance positively regulates this process.

Deepen the application of financial technology and accurately support green innovation. Encourage financial institutions to use big data and blockchain to develop green credit and supply chain products and reduce the financing threshold of green projects; establish a connection platform, share environmental and carbon emission data in real time, and improve the efficiency of green capital allocation..

Multiple measures should be taken to alleviate financing constraints and ensure smooth transmission. Promote the intelligent risk control of dynamic credit evaluation and reduce the dependence on traditional collateral; establish a special green innovation guarantee fund to cooperate with the financial technology platform to provide long-term and low-cost financial support for green R & D.

Enterprises should accelerate the digital transformation and transform the advantages of FinTech into the driving factors of R & D efficiency improvement. The government needs to encourage digital investment through tax cuts and subsidies, support the development of green R & D management systems, and promote dual transformation among enterprises.

Regulators should improve ESG disclosure and evaluation systems, standardize reporting and governance, provide credit incentives to outstanding companies to create a virtuous cycle; at the same time, leverage blockchain technology to track funds and prevent greenwashing, ensuring that financial technology supports green innovation.

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