



Data-Intelligence Empowerment, Digital Inclusive Finance and Green Innovation of Private Enterprises

Research on the Mechanism of Credit Availability

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Abstract. Chinese enterprises are urgently implementing green innovation strategies, with digital financial inclusion providing the necessary funds. This study examines the impact of digital financial inclusion on corporate green innovation, using A-share listed private companies from 2013 to 2020. The results show that digital inclusive finance significantly promotes green innovation in private enterprises. Additionally, Digital inclusive finance overcomes traditional financial system limitations by increasing credit availability, contributing to green tech innovation. This research provides a theoretical foundation for promoting green transformation through private enterprise innovation, ultimately contributing to the achievement of the “dual carbon” goal.

Keywords: Digital inclusive finance · Green innovation · Availability of credit

1 Introduction

Green innovation is a critical activity for promoting environmental sustainability in the context of the “dual carbon” goal and has garnered significant attention from scholars [1]. Factors influencing green innovation in companies primarily focus on environmental impact and resource supply [2]. Traditional finance faces challenges of asymmetric information, elevated thresholds, and low service efficiency, resulting in poor inclusiveness and difficulty in alleviating financing difficulties for green innovation. Credit availability constraints hinder green innovation development [3]. However, digital inclusive finance combines digital internet technology with traditional financial services to provide low-cost financial services and promote financial universality and accessibility for underdeveloped areas and low-income people.

Digital financial inclusion has the potential to promote R&D investment, stimulate green innovation, and facilitate high-quality economic development by increasing financing opportunities [4]. Digital inclusive finance has been able to incorporate long tail groups, namely “large, tiny and scattered” investors, into the market, thereby augmenting financial resources [5]. Furthermore, digital inclusive finance offers intelligent investment options, supply chain finance, and third-party payment, thereby expanding

financing channels and facilitating green innovation funding opportunities. Meanwhile, digital finance's information matching function has the potential to mitigate information asymmetry, ultimately enhancing resource allocation efficiency [6].

Scholars have made significant achievements in their research on digital inclusive finance, credit availability, and green innovation [7]. However, when considering digital finance, credit availability, and green technology innovation within the same research framework, several shortcomings in existing research become apparent. This study aims to explore the impact of digital inclusive finance and green innovation by analyzing public and private companies as study samples. This research develops a comprehensive framework for analyzing the relationship between digital finance, credit availability, and green technology innovation, enhancing empirical research on the interplay between digital finance and green innovation. It provides a valuable tool for assessing the impact of digital finance on promoting green technology innovation and advancing our understanding of its role in sustainable development.

2 Theoretical Analysis and Research Hypothesis

As a crucial driver of high-quality national development, digital inclusive finance offers new opportunities and momentum for economic growth. At the macro level, digital inclusive finance can stimulate consumer consumption, promote mass entrepreneurship, accelerate inclusive growth, reduce the urban-rural income gap, and drive commercial bank innovation. At the micro level, digital inclusive finance is conducive to assess enterprise risks accurately using digital technology. Furthermore, some scholars have highlighted the significant impact of digital financial inclusion on enterprise innovation, demonstrating that it can improve R&D investment, promote excess capacity accumulation, and upgrade human capital, all of which contribute to enhanced innovation capacity. This not only provides a favorable external financial environment for the development of green innovation in enterprises but also improves credit availability, thereby promoting green innovation. Based on this research, we propose the following hypotheses: Hypothesis 1. The development of digital inclusive finance has been shown to have a positive impact on promoting green innovation.

Digital inclusive finance has an immediate effect of promoting the development and growth of small and medium-sized financial institutions, thereby narrowing the gap between the demand for financial services and their supply. Digital inclusive finance expands the coverage, depth of use, and degree of digitalization of finance, it broadens the financing channels available to enterprises [8]. This reduces inefficient investment and further enhances the innovation input and output of enterprises, alleviate financing difficulties for enterprises and improve credit availability. According to Porter's hypothesis, innovation can help offset the costs of meeting environmental regulations and drive further innovation. However, private enterprises often encounter obstacles in obtaining public resources, which can undermine their motivation for engaging in green innovation. Typically, financial resources are directed towards projects with quick returns and short cycles, while green innovation development entails longer cycles, higher costs, and uncertain benefits. As a result, green innovation is vulnerable to the adverse effects of misallocated financial resources, which can limit credit availability and impede green

innovation. However, the emergence of digital inclusive finance has effectively addressed the mismatch in the traditional financial system. It provides easier access to financial resources for private enterprises, thereby reducing the significance of financing constraints. Based on the above research, this paper proposes the following hypotheses: **Hypothesis 2.** Credit availability plays an intermediary role between digital financial inclusion and corporate green innovation.

3 Research Design

3.1 Data Sources

The data are from the China Stock Market & Accounting Research Database, the digital inclusive finance development data are from the Peking University Digital Finance Inclusive Finance Index, and the green innovation data are from the Research Data Service Platform. The selected samples are further screened in the following order: Financial enterprises are excluded; Remove ST,*ST and delisted companies; Retain the companies with no missing of vital data for five consecutive years or more.

3.2 Variable Description

Explained variable: Green Innovation(GP). This paper chooses the number of green patent applications as the main index to measure green innovation [9].

Core explanatory variable: Digital Financial Inclusion (Index). Peking University's Internet Finance Research Center and Ant Financial have collaborated to compile the Digital Finance Inclusion Finance Index, the city-level digital financial inclusion index is utilized as the explanatory variable [10].

Mediating variable: Credit availability (Credit). The natural logarithm of long-term loans of enterprises is adopted as the intermediate variable.

Control variables: asset-liability ratio (Lev), return on assets (Roa), proportion of fixed assets (Fixed), enterprise growth, Dual (Dual), proportion of independent directors (Indep), number of directors (Board), age of establishment, and TobinQ value.

3.3 Methods

In model (1), GP represents the green innovation of private enterprises, Index represents Digital Inclusive Finance. α_0 represents the constant term. All regression models control for industry and time effects.

$$GP_{it} = \alpha_0 + \alpha_1 Index_{jt} + \alpha_2 Controls_{it} + \lambda_{it} + \theta_{it} + \varepsilon_{it} \quad (1)$$

In order to further explore the “transition bridge” between the development of digital finance and green innovation, and further establishes models (2) and (3).

$$Credit_{it} = \beta_0 + \beta_1 Index_{jt} + \beta_2 Controls_{it} + \lambda_{it} + \theta_{it} + \varepsilon_{it} \quad (2)$$

$$GP_{it} = \gamma_0 + \gamma_1 Index_{jt} + \gamma_2 Credit_{it} + \gamma_3 Controls_{it} + \lambda_{it} + \theta_{it} + \varepsilon_{it} \quad (3)$$

4 Analysis of Empirical Results

In Table 1, the result in column 1 indicates that digital financial inclusion index has a significant and positive impact of the on corporate green innovation at the 1% level. This finding supports hypothesis 1. Moving to Table 1 columns 2 through 4, the breadth of coverage, depth of use, and degree of digitization of the digital finance index all exhibit significant positive effects on green technology innovation.

Table 1. Analysis of baseline regression results

Variable	GP (1)	GP (2)	GP (3)	GP (4)
Index	0.024*** (2.85)			
Coverth		0.026*** (3.43)		
Useth			0.016* (1.69)	
Digilevel				0.013* (1.78)
Controls	YES	YES	YES	YES
Constant	-43.188*** (-5.49)	-43.458*** (-5.55)	-41.525*** (-5.25)	-41.176*** (-5.25)
Ind. & Year	YES	YES	YES	YES
N	6207	6207	6207	6207
Adj-R ²	0.0325	0.033	0.0316	0.0317

Table 2. Regression results of mechanism test

Variable	GP (1)	GP (2)	Credit (3)
Index	0.024*** (2.85)	0.023*** (2.71)	0.008*** (2.73)
Credit		0.154*** (4.08)	
Controls	YES	YES	YES
Constant	-43.188*** (-5.49)	-41.618*** (-5.29)	-10.208*** (-3.85)
Ind. & Year	YES	YES	YES
N	6207	6207	6207
Adj-R ²	0.0325	0.0349	0.183

Columns 1, 2, and 3 of Table 2 all pass the 1% level test, confirming that credit availability serves as an intermediary between digital inclusive finance and corporate green innovation, validating H2. The first column shows that digital inclusive finance has a significant positive effect on the availability of corporate credit. Secondly, the third column demonstrates that the coefficient of digital finance passes the test and is positive, indicating that digital inclusive finance significantly enhances the availability of credit for enterprises. All coefficients in column2 are significantly positive, it can be concluded that credit availability has an intermediary effect.

5 Conclusions and Recommendations

This study reveal the following: Firstly, digital inclusive finance fosters green innovation in private enterprises. Secondly, the primary way digital inclusive finance promotes green innovation is by enhancing credit access for private enterprises. This study contributes to the existing literature by examining the influence of digital inclusive finance on green innovation in enterprises, providing a fresh perspective on its determinants. However, this paper ignores an analysis of the impact of the COVID-19 pandemic on private sector, and future research should address this gap.

Promoting the development of digital financial inclusion and its various dimensions is crucial. Apart from expanding coverage and depth of use, emphasis should be placed on enhancing the information development of financial infrastructure. This involves expediting the construction of digital financial infrastructure, including networked communication environments and settlement payment systems, to enhance the industrial green innovation system and improve ecological welfare levels. Enhancing the financing support system for green innovation in enterprises. Enterprises often face challenges in securing stable and sustained financial support for green innovation, especially due to limited access to credit for private companies. The government should strengthen financing mechanisms to support green innovation in private enterprises, moreover, the financing support mechanism can be improved through the provision of green credit, tax incentives, and timely government subsidies to meet the financial requirements of private enterprises for green innovation.

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