Research on the Impact of Digital Finance on Enterprise Green Technology Innovation

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Abstract. With the increasingly severe problems of global climate change and resource shortage, green technology innovation has become a key factor for enterprises to achieve sustainable development. This paper aims to explore the impact mechanism of digital finance on enterprises' green technology innovation, in order to provide reference for relevant policy formulation and Aenterprise practice. This paper selects the panel data of China's A-share listed companies from 2015 to 2022 to examine the impact of digital finance on enterprises' green technology innovation. The results show that digital finance has a significant role in promoting enterprise green technology innovation, and this conclusion is still valid after the robustness test.

Keywords: Digital finance; Green technology innovation; Financing constraint.

1 Introduction

In the global economic landscape of the 21st century, the rise of digital finance is changing the face of financial services at an unprecedented speed and becoming an important force to promote economic transformation and upgrading. At the same time, the severe challenge of global climate change and the urgent need for sustainable development make green technology innovation the key to the competitiveness of enterprises and even countries.

Liu Mengfei and Jiang Wei (2021) found through empirical research that in the early stage of the development of fintech, the risk bearing capacity of banks can be improved, and in the later stage, the risk burden can be reduced by reducing the cost [1].Hui Xianbo (2021) believes that digital inclusive finance can effectively reduce the entry threshold of innovative entities and reduce the cost of production technology in enterprise reform, and promote enterprises to take the initiative to introduce green production processes[2]. The personal characteristics of senior executives also play a significant role in corporate green technology innovation (Doluca et al., 2021)[4]. Qiao Bin et al. (2021) pointed out that digital financial inclusion has shown remarkable results in promoting the progress of green technology in enterprises[3]. As a tool for macro-control, digital finance gives priority to supporting environmentally friendly enterprises

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and green production models, and accelerates the transformation of the green economy (Lv et al., 2021)[5].

2 Research Design

2.1 Source of Sample Data

This paper takes China's Shanghai and Shenzhen A-share listed companies from 2015 to 2022 as A sample. The logarithm of the total number of green invention patents and green practical patent applications of the enterprise in the current year plus 1 is used as the index to measure the green technology innovation of the enterprise, and the logarithm of the number of green patents granted is used as the index of robustness test. Green patent data (including the number of applications and grants) are screened and searched according to keywords. And from the National Intellectual Property Official website (CNIPA); Data related to digital finance are taken from Peking University Digital Financial Inclusion Index. Other data comes from the CSMAR and Wind databases. For the data of Shanghai and Shenzhen A-share listed companies, according to the location of the registration place of the enterprise, the digital inclusive financial index of each city is matched to obtain the panel data of 2015-2022.

2.2 Variable Selection

Explained Variables. Enterprise green Technology Innovation (GI). At present, the commonly used measurement methods mainly include the number of enterprise green patent authorization and the number of applications. Due to the time lag between patent application and approval, this paper draws on the study of Zhong Tingyong et al. (2022) to measure the level of green technology innovation of enterprises by the number of green patent applications.

Explanatory Variables. Digital Finance (Index_p). Most of the existing index systems to measure the level of digital inclusive finance lack systemicity and completeness. In order to overcome this problem, the Peking University Digital Inclusive Finance Index (Index_p) came into being. At present, this index has been widely accepted by scholars for the relevant research of digital financial inclusion. Therefore, this paper takes the municipal Peking University Digital financial Inclusion Index as a measure index.

Control Variables. This paper selects asset-liability ratio (Lev), equity concentration (Top1), return on assets (Roa), total asset turnover (Turn), enterprise Size (Size), enterprise Age (Age), Cash flow level (Cash), operating income Growth rate (Growth), management expense ratio (Mfee), and earnings per share (EPS)) as a control variable in this article.

2.3 Model Construction

In order to confirm the correctness of the research hypothesis proposed by the theoretical analysis, this paper constructs the following panel fixed effect model:

$$\mathrm{GI_{it}} = \alpha_0 + \alpha_1 Index\_p_{it} + B' Controls_{it} + \mu_t + \gamma_i + \varepsilon_{it} \quad (1)$$

Where, i represents enterprise individual, t represents time, GIit represents enterprise green technology innovation, Index_pit represents the development level of digital fin ance in the region where the enterprise is located, and Controlsit represents a series of control variables. it mainly includes asset-liability ratio, equity concentration, return o n assets, total asset turnover, enterprise scale, enterprise age, cash flow level, operatin g income growth rate, overhead ratio and earnings per share. μ_t is the fixed time effec t, γ_i is the fixed industry effect, ε_{it} is the random error term, and the robustness standa rd error is adopted by default.

3 Empirical Analysis

3.1 Benchmark Model Test

The regression results of digital finance promoting the development of enterprise green technology innovation are shown in Table 1. In the first column, only year and industry are controlled, and no control variables are used for regression. The results show that the regression coefficient of digital finance (Index_p) is significantly positive at the 1% level. After adding control variables, the coefficient of digital finance is still positive and significant at the level of 1%, which indicates that digital finance has a significant promoting effect on enterprises' green technology innovation.

Table 1. Results of baseline regression

	(1)	(2)
Variables	EnvrPat	EnvrPat
Index_p	0.1165***	0.0800***
	(0.0219)	(0.0212)
Lev		0.1782***
		(0.0277)
Top1		0.0005
		(0.0003)
Turn		0.0324**
		(0.0134)
Size		0.1348***
		(0.0059)
Cash		0.0319
		(0.0771)
Growth		-0.0788***
		(0.0101)

Roe		0.2738***
		(0.0953)
Age		-0.0073***
		(0.0009)
Mfree		-0.1519**
		(0.0700)
EPS		0.0312***
		(0.0104)
_cons	0.4839***	-2.3105***
	(0.0790)	(0.1458)
N	24170	24170
r^2	0.1272	0.1814
year	Yes	Yes
Industry	Yes	Yes

Note: ***, ** and * represent significance levels of 1%, 5% and 10% respectively.

3.2 Robustness Test

Replacing a Model. Considering that the green technology innovation of the explained variable enterprise has the characteristics of zero accumulation, this paper changes the fixed effect model in the benchmark regression model to the Tobit model for regression, and tests the robustness of the benchmark regression results. The Tobit regression results are shown in Table 2 (1): The coefficient of the core explanatory variable Index_p is 0.2718, which is significant at the 1% level. It shows that after changing the model structure, the development of digital finance has a significant promoting effect on the enterprise green technology innovation, which tests the good robustness of the benchmark regression mentioned above.

Replace Explained Variables. As the explained variable used the number of green patent applications of enterprises in the previous article, here we refer to the practice of Zhong Ting-yong et al. (2022) and use the number of green patent grants of enterprises to replace it[6]. The regression results are shown in Table 2 (2). The coefficient of core explanatory variable Index_p is 0.2537 and significant at 1% level, which is consistent with the conclusions above.

Exclude Samples of Municipalities Directly under the Central Government. Due to the particularity of municipalities directly under the central government, compared with other provinces and cities, they have obvious advantages in terms of location, political economy and other aspects, so the development of digital inclusive finance and the development of innovative enterprises are generally better than other provinces and cities. In order to obtain the general law of digital financial development and enterprise green technology innovation, this paper excludes the samples of municipalities directly under the central government, and then conducts a regression test on the benchmark

model. Table 2 (3) reports the robustness test results excluding samples of municipalities directly under the central government. The coefficient of core explanatory variable Index_p is 0.1306, which is significant at 1% level. The above results indicate that the benchmark regression results are still valid and have good robustness.

Table 2. Regression results of robustness test

	(1)	(2)	(3)
main			
Index_p	0.2718***	0.2537***	0.1306***
	(0.0423)	(0.0252)	(0.0241)
_cons	-5.5922***	-9.4772***	-2.5392***
	(0.5644)	(0.1659)	(0.1637)
N	24170	2.4170	19549
r^2	—	0.4294	0.1841
Control	Yes	Yes	Yes
year	Yes	Yes	Yes
Industry	Yes	Yes	Yes

Note: ***, ** and * represent significance levels of 1%, 5% and 10% respectively.

4 Conclusion and Enlightenment

4.1 Conclusion

The main research conclusion of this paper is that digital finance has a significant role in promoting enterprise green technology innovation, and this conclusion is still valid after the robustness test.

4.2 Inspiration

First and foremost, strengthen policy orientation, improve the effectiveness of regulatory authorities in preventing and controlling financial risks, and accelerate the transformation of regulatory services to digital.Digital finance, as a cutting-edge technology innovation, has a significant impact on promoting corporate green technology innovation and driving high-quality economic development. Due to its emerging status and the uneven development between regions, the potential of digital finance is huge, with the benefits not fully realized. Therefore, the government needs to actively guide and support it by providing favorable policies to encourage traditional financial institutions to accelerate the application of digital technology. At the same time, as digital technology is widely applied, financial risks also tend to be amplified. Regulators need to take a two-pronged approach: first, improve the regulatory framework and increase the regulatory intensity of digital finance; The second is to flexibly adjust the management service model to effectively respond to the challenges brought by digital technology,

and ensure that the regulation keeps pace with The Times and integrates into the tide of the digital economy.

Second, listed companies should enhance the ability to identify risks, reasonably set risk tolerance limits, and optimize resource allocation by improving risk tolerance. At the same time, improve the internal governance structure, scientifically build the relevant internal control system, and proactively identify and prevent risks to ensure the steady operation of the company.

Third, the government should fully consider the heterogeneity of enterprises when formulating digital financial policies, such as the ownership nature of enterprises, the level of high-tech, etc. Digital finance can stimulate green technology innovation by non-state-owned enterprises more, which indicates that the inclusiveness of digital finance needs to be improved, and it is necessary to enhance the coverage of financial services and pay attention to the implicit lending discrimination in financing enterprises, promote the equal development of state-owned enterprises and non-state-owned enterprises, and the government should tailor policies for enterprises. The government should push the reform of state-owned enterprises to enable them to participate in market competition fairly and stimulate innovative vitality. The impact of digital finance on the green technology innovation capacity of enterprises is greater in high-tech enterprises, so more efforts should be made to promote green technology innovation in non-high-tech enterprises, and digital finance should be more widely applied to non-high-tech enterprises to strengthen support for them.

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