Research on the impact of digital inclusive finance on enterprise's green innovation --with government grants as a mediating variable

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Abstract. Based on carbon neutralization, enterprise's green innovation is increasingly becoming a significant support for high-quality economic development. This paper uses a two-way fixed-effects model to test the impact of digital inclusive finance on enterprise's green innovation. It shows that digital inclusive finance can effectively promote the quantity and quality of enterprise's green innovation. It also can indirectly promote enterprise's green innovation by improving the precision of government grants. The heterogeneity analysis shows that the promoting effect of digital inclusive finance on green innovation is more significant in the middle and western regions, which lack financial services. And it is more significant in the heavy polluting enterprises, where the pressure of environmental regulation is greater; while the mediating effect of government grants is more significant in non-heavily polluting enterprises. Therefore, the digital inclusive finance should develop continuously, from multiple and differentiated dimensions, so as to promote enterprises' green innovation.

Keywords: Digital inclusive finance, Enterprise's green innovation, Government grants.

1. Introduction

With the acceptance of the environmental protection concept of "harmony between human beings and nature" by most countries in the world, enterprise's green innovation has become a new issue to promote high-quality and sustainable development. However, since enterprise's green innovation is a process with high risk and long cycle, requiring high social and environmental responsibility awareness, it is difficult to effectively promote enterprise's green innovation by market regulation alone[1]. Government policies are needed to solve the problem of "market failure" caused by public goods externalities and information asymmetry. In addition, due to long-standing imbalance between traditional financial resources and financial supply, it is difficult to promote enterprises' green innovation. Along with the development of the financial and technological revolutions, the integration of digital technology and traditional industries has become a breakthrough in the transformation of the digital economy.

Digital inclusive finance has the advantages of "low cost, high efficiency, high quality and wide coverage", which is an important driving force for enterprise's green innovation. On the one hand, the development of digital inclusive finance has generated more financial products, broadened enterprise financing channels, and reduced the financing costs, through the market adjustment mechanism to alleviate the financing problem, which has a facilitating effect on enterprise's green innovation. On the other hand, digital inclusive finance enables enterprises to establish a close contact with the government through the digital platform, facilitating the government to obtain timely and accurate information about the credit level, financial status and business condition of enterprises, which could reduce the information asymmetry between the government and enterprises, thus ensures that government grants can be accurately invested in enterprises with green innovation needs. Could digital inclusive finance promote enterprise's green innovation by improving the accuracy of government grants? This paper matches the 2011-2017 Digital Inclusive Finance Index released by the Internet Finance Research Center of Peking University with the data of all listed enterprises in Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE) to explore the promoting effect of digital inclusive finance on enterprise's green innovation.

The main contributions of this paper are as follows. Firstly, combining enterprise's innovation and environmental responsibility with the trend of green development, measuring corporate innovation from the perspective of corporate social responsibility, so that to explore the impact of digital inclusive finance on enterprise's green innovation. Secondly, when exploring the impact of digital inclusive finance on enterprise's green innovation, government grants act as a macro-mediating variable enriches the existing empirical research literature and provides new views for the mechanism of digital inclusive finance on enterprise's green innovation.

2. Literature Review and Hypothesis Formulation

2.1 Literature review

As a new financing method (Tang Song et al., 2020 [3]), digital inclusive finance broadens the financing channels by providing diversified products and services, and improves the financing efficiency of enterprises by reducing information asymmetry (Liang Bang and Zhang Jianhua, 2019[4]; Wan Jiayu et al., 2020 [5]), reduce the innovation financing cost by speeding up the approval process and preventing credit risks, so as to alleviate the external financing constraints of innovation activities. By driving enterprises to deleverage and stabilize their financial status (Tang Song et al., 2020 [3]), digital finance is conducive to increasing the innovation output of enterprises.

The mechanism of digital inclusive finance on enterprise innovation is mainly divided into two aspects: macro and micro, and existing research mainly focuses on the micro perspective. Government grants can significantly promote the enterprise's green innovations (Liu Yali et al., 2021 [6]). However, due to the lack of external supervision, government grants may not be implemented in green innovation projects, resulting in the crowding out of green innovation resources (Wang Qiuming et al., 2014) [7]. The development of digital inclusive finance alleviates the information asymmetry and helps enterprises to accurately invest financial resources in green innovation projects.

Digital inclusive finance can influence enterprise innovation through government regulation, but existing studies have different effects on the mediating effect of government grants. Li Dong (2020) [8] believes that the government's direct intervention and indirect intervention can form a synergy with digital finance, play a synergistic effect, and significantly enhance the innovation and promoting effect of digital finance on enterprises. Chen Li et al. (2022) [2] believe that government grants and digital finance have a substitution effect in the process of driving enterprise innovation.

Based on the existing papers of domestic and foreign scholars, there are few studies on the relationship between digital inclusive finance, government grants, and enterprise's green innovation. Therefore, the research in this paper enriches the research direction in this field and has certain innovative and practical significance.

2.2 Research hypothesis

(1) Digital Inclusive Finance and Enterprise's Green Innovation

The development of the traditional financial system is not perfect. Firstly, it is manifested in the regional nature of the financing environment. Then it is manifested in the imperfect credit record. Since the green innovation activities of enterprises add environmental protection value on the basis of economic interests, the double uncertainty of benefits and risks makes them face greater external financing constraints. Therefore, digital inclusive finance is particularly important for enterprise's green innovations. It can broaden the financing channels for enterprises' green innovation, ease the external financing constraints of enterprises, speed up the approval process, and reduce the financing cost of enterprises' green innovation. In addition, it effectively reduces the information asymmetry between the fund provider and the demander, and helps improve the efficiency of green innovation financing for enterprises. Based on this, this paper proposes the following assumptions:

H_1: Digital inclusive finance can effectively promote enterprise's green innovations.

(2) Digital Inclusive Finance, Government Grants and Enterprise's Green Innovation

Due to the asymmetry of information, some enterprises in order to get the government funding, to manipulate the enterprise information. And the lack of strict supervision can also lead to large amounts of government grants cannot implement to green innovation project, but for other projects. Therefore, digital inclusive finance can help improve the accuracy of government grants. Thereby encouraging the development and implementation of green innovation projects of enterprises. Based on the above analysis, the following assumptions are put forward:

H_2: Digital inclusive finance can improve the accuracy of government grants and indirectly promote enterprise's green innovations.

3. Research Design

3.1 Sample selection and data sources

This paper selects all listed companies in SHSE and SZSE from 2011 to 2017 as research samples. According to the usual practice in the literature, this paper excludes single data missing, PT, ST, listed companies that have been delisted and financial enterprises, and the two-sided 1% abbreviated treatment is carried out(winsor). In the end this paper retains a total of 9107 data from 1946 companies as research samples, and a panel data set from 2011 to 2017 was constructed. Among them, the green patent data and economic characteristic data of listed companies come from CSMAR, and the digital financial index comes from the "Peking University Digital Inclusive Finance Index".

3.2 Variable description

Table 1. Definitions of primary variables

variables	variable name	variable symbol	variable measure
Explained variable	Applications of enterprise's green innovation	$Patent_1$	Total number of green invention and utility patent applications
	Applications of green invention innovation	$Patent_2$	Green invention patent applications
Explanatory variables	Digital inclusive finance Index	$Index$	Peking University Digital inclusive finance Index (2011 -2018)
Mediating variable	Government grants	$Grant$	The natural logarithm of the annual subsidy to the enterprise
control variable	Operating age	Age	(current year - year of establishment of the company) +1
	Company size	$Scale$	The natural logarithm of the annual total assets of the sample enterprises
	Assets and liabilities	Lev	Annual total liabilities/total assets of sample companies
	Return on assets	ROA	Enterprise net profit/enterprise total assets ratio
	Proportion of independent directors	Ind	Number of Independent Directors/Number of Board of Directors
	Remuneration incentives	SI	The logarithm of the total annual salary of the directors and supervisors of the enterprise
	Number of executives	Num	Add 1 to the number of senior executives at the end of the year and take the logarithm
	Shareholding ratio of the largest shareholder	$TLPOS$	Shares held by the largest shareholder/total share capital
	Operating Cash Flow CFO	CFO	Cash flow from operating activities /total assets
	Audit opinions	Opi	The standard unqualified opinion issued by the audit unit is 0, otherwise it is 1
	property rights	$Nature$	State-owned 1, Non-State-owned 0
	Two jobs in one	$Dual$	Dummy variable, the combination of CEO and chairman takes 1, and the separation of the two takes 0

The explained variables of this paper are the level of enterprise's green innovation ($Patent_1$, $Patent_2$); the total number of patent applications ($Patent_1$) and the number of green invention patent applications ($Patent_2$) are used to measure the quantity and quality of enterprise's green innovation, respectively. The explanatory variable in this paper is the provincial digital inclusive

finance development index ($Index$). The mediating variable in this paper is government grants ($Grant$). By referring to relevant literature, the control variables in this paper are operating age (Age), company size ($Scale$), asset-liability ratio (Lev), return on assets (ROA), proportion of independent directors (Ind), compensation incentives (SI), number of executives (Num), Shareholding ratio of a major shareholder ($TLPOS$), audit opinion (Opi), nature of property rights ($Nature$), two-in-one ($Nature$), operating cash flow (CFO) as 12 control variables .This paper also controls for year and industry fixed effects.

3.3 Model setting

3.3.1 Baseline regression model

This paper firstly verifies whether digital inclusive finance has a significant impact. Based on the Hausman test, this paper uses a fixed effect model to test the impact of digital inclusive finance on enterprise's green innovation, and establishes the following model:

$$Patent_{i,t} = a_0 + a_1 Index_{i,t} + \sum \varphi CV_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (1)$$

3.3.2 Mediating effect model

In order to test the hypothesis 2, digital inclusive finance can indirectly promote enterprise's green innovations by improving the accuracy of government grants. This paper draws on the mediating effect test method of Wen Zhonglin et al. (2004) [9](2) and model (3):

$$Grant_{i,t} = \beta_0 + \beta_1 \cdot Index_{i,t} + \sum \varphi CV_{i,t} + \sum Year + \sum Industry + \gamma \quad (2)$$

$$Patent_{i,t} = \alpha + \gamma_1 \cdot Index_{i,t} + \gamma_2 \cdot Grant_{i,t} + \sum \varphi CV_{i,t} + \sum Year + \sum Industry + \xi \quad (3)$$

Model (2) is used to examine the impact of digital inclusive finance on government grants , and model (3) is used to examine the impact of digital inclusive finance through government grants on enterprise's green innovation.

4. Empirical Analysis

4.1 Descriptive statistics and Correlation Analysis

Table 2. Quantitative variable descriptive statistical results

$Variables$	$Mean$	$Std.Dev.$	Min	Max	$Correlation\ coefficient$
$Patent_1$	225.615	558.217	0	4191	1
$Patent_2$	104.174	260.170	0	1908	0.951***
$Grant$	16.300	1.708	11.341	20.598	0.385***
$Index$	198.318	75.643	16.220	336.651	0.064***
Age	2.712	0.374	1.504	3.412	0.023**
$Scale$	8.365	1.314	6.211	12.622	0.469***
Lev	0.414	0.207	0.049	0.888	0.218***
ROA	0.044	0.047	-0.114	0.192	0.018*
Ind	0.276	0.037	0.200	0.375	0.061***
SI	6.602	0.305	5.871	7.428	0.312***
Num	1.235	0.088	1.041	1.491	0.227***
$TLPOS$	0.352	0.149	0.084	0.741	0.112***
CFO	0.043	0.065	-0.140	0.225	0.048***
Opi	0.018	0.135	0	1	0.024**
$Nature$	0.369	0.482	0	1	0.136***
$Dual$	0.293	0.455	0	1	0.022**

The number of valid samples in this experiment was 9106. The volatility of $Patent_1$, $Patent_2$, $Index$ and $Grant$ is large, indicating that there is a big gap in the degree of digital inclusive finance index and enterprise's green innovation among enterprises and government grants among provinces. According to the Person correlation test of variables, the digital inclusive finance index is positively correlated with the enterprise green innovation level at the significance level of 1%. H_1 is preliminarily verified, that is, digital inclusive finance can promote enterprise's green innovation.

There is a significant positive correlation between government grants and enterprise's green innovation level, which preliminarily verifies H_2, that is, digital inclusive finance can promote the accuracy of government grants, and then indirectly promote enterprise's green innovation.

4.2 Regression analysis

4.2.1 The impact of digital inclusive finance on enterprise's green innovation

Table 3. Digital inclusive finance and enterprise's green innovation - Analysis of the mediating effect of government grants

	Number of Green Innovations			Quality of Green Innovations		
Variables	(1)	(2)	(3)	(1)	(2)	(3)
	$Patent_1$	*Grant*	$Patent_1$	$Patent_2$	*Grant*	$Patent_2$
Grant			41.065***			22.902***
			(10.551)			(12.433)
Index	0.782***	0.001**	0.732***	0.439***	0.001**	0.411***
	(3.644)	(2.110)	(3.430)	(4.309)	(2.110)	(4.068)
Age	-75.429***	-0.102***	-71.236***	-24.067***	-0.102***	-21.729***
	(-5.298)	(-2.653)	(-5.032)	(-3.563)	(-2.653)	(-3.243)
Scale	233.729***	0.800***	200.896***	105.019***	0.800***	86.708***
	(39.005)	(49.361)	(29.898)	(36.941)	(49.361)	(27.264)
Lev	-108.631***	0.296***	-120.798***	-54.699***	0.296***	-61.484***
	(-3.279)	(3.309)	(-3.667)	(-3.480)	(3.309)	(-3.943)
ROA	97.694	2.267***	4.579	60.801	2.267***	8.871
	(0.753)	(6.463)	(0.035)	(0.987)	(6.463)	(0.145)
Ind	535.601***	0.418	518.449***	264.906***	0.418	255.340***
	(4.092)	(1.181)	(3.985)	(4.266)	(1.181)	(4.147)
SI	118.772***	0.275***	107.478***	61.551***	0.275***	55.252***
	(5.460)	(4.678)	(4.966)	(5.965)	(4.678)	(5.393)
Num	95.710	0.757***	64.640	81.654**	0.757***	64.326*
	(1.313)	(3.841)	(0.892)	(2.362)	(3.841)	(1.875)
TLPOS	9.203	-0.148	15.266	-13.872	-0.148	-10.491
	(0.265)	(-1.575)	(0.443)	(-0.843)	(-1.575)	(-0.643)
CFO	220.572***	0.783***	188.432**	100.259**	0.783***	82.335**
	(2.586)	(3.395)	(2.222)	(2.478)	(3.395)	(2.051)
Opi	-62.734*	-0.150	-56.591	-25.531	-0.150	-22.105
	(-1.727)	(-1.523)	(-1.567)	(-1.481)	(-1.523)	(-1.293)
Nature	-7.495	0.014	8.075	2.912	0.014	-2.588
	(-0.623)	(0.435)	(0.676)	(0.510)	(0.435)	(-0.458)
Dual	-51.627***	-0.023	50.692***	-25.624***	-0.023	25.103***
	(-4.699)	(-0.767)	(4.642)	(-4.916)	(-0.767)	(4.857)
Constant	-2,687.795***	6.790***	-3,025.375***	-1,366.381***	6.790***	-1,544.387***
	(-7.865)	(7.350)	(-8.858)	(-8.427)	(7.350)	(-9.554)
Year		Controlled			Controlled	
Industry						
Obs.	9,016	9,016	9,016	9,016	9,016	9,016
F	61.24	104.91	62.54	55.24	104.91	57.28
R^2	0.382	0.514	0.389	0.358	0.514	0.369
R^2_a	0.376	0.509	0.383	0.351	0.509	0.362

Note: The superscripts *, **, *** indicate the significance level of 10%, 5% and 1% respectively (the same below).

This paper first uses model (1) to test the relationship between digital inclusive finance and enterprise's green innovation level, and the regression results are shown in Table 3 (1). According to the regression results, at the level of 1%, digital inclusive finance index is significantly positively correlated with the quantity and quality of enterprise's green innovations, indicating that the improvement of digital inclusive finance level can significantly promote the improvement of enterprise's green innovation. Therefore, H_1 is established.

4.2.2 Analysis of mediating effect of the digital inclusive finance on enterprise's green innovation

In order to verifyH_2, that is, digital inclusive finance has a positive effect on both the quality and quantity of enterprises' green innovation, and will promote enterprises' green innovation level through positive promotion of government grants, regression is conducted for models (2) and (3).

According to Model (2), it can be known that the influence on is positively significant at 5% level. It shows that the digital inclusive finance Development Index has a promoting effect on government grants. According to Model (3), it can be seen that the quantity ($Patent_1$) and quality ($Patent_2$) of enterprises' green innovation are positively correlated at the significance level of 1%, indicating that government grants have a promoting effect on enterprises' green innovation. Based on the above data analysis results, the following conclusions can be drawn:

After Sobel test, the mediating effect is significant. As shown in Table 3, the quantity ($Patent_1$) and quality ($Patent_2$) coefficients of enterprise's green innovations are reduced after the addition of government grants ($Grant$), which indicates that government grants ($Grant$) plays a part of the mediating effect. So, the hypothesis is valid.

4.2.3 Heterogeneity Analysis

(1) Region Heterogeneity

Table 4. Regional Heterogeneity Test

	Eastern Regions		Middle and Western Regions					
Variables	(1)	(1)	(1)	(2)	(3)	(1)	(2)	(3)
	$Patent_1$	$Patent_2$	$Patent_1$	$Grant$	$Patent_1$	$Patent_2$	$Grant$	$Patent_2$
Grant					24.072***			13.220***
					-6.275			-6.503
Index	-0.306	0.0115	1.864***	0.006**	1.728***	0.728**	0.006**	0.6535**
	(-0.810)	-0.065	-3.44	-1.991	-3.212	-2.534	-1.991	-2.292
CVs	*Controlled*				*Controlled*			
Year	*Controlled*				*Controlled*			
Industry								
Obs.	6489	6,489	2,527	2,527	2,527	2,527	2,527	2,527
F	52.33	47.71	21.84	33.10	22.41	17.02	33.10	17.64
R^2	0.419	0.396	0.397	0.500	0.407	0.339	0.500	0.351
R^2_a	0.411	0.388	0.379	0.485	0.389	0.319	0.485	0.331

There are differences in social and economic development level and system environment between the eastern and western regions of China. For middle and western regions, digital inclusive finance can more significantly improve the accuracy of government grants by solving the problem of information asymmetry, so as to solve the financing difficulties of enterprises and facilitate enterprises to have enough funds to invest in green innovation projects. By protecting the green innovative products, enterprise's innovation enthusiasm can be improved so as to promote the development of green innovation. In this paper, the regions where the sample enterprises are located are divided into the eastern region and the middle and western regions for regression according to their registration places, and the results are shown in Table 4.

It can be seen from Table 4 that the promotion effect of digital inclusive finance on enterprise's green innovation through government grants is not significant in the eastern region. However, in the middle and western regions, index had a positive effect on $patent_1$ at the level of 1%, and government grants had a mediating effect of 16.63%. Besides, index had a positive effect on $patent_2$ at the level of 5%, there was a significant positive mediating effect of government grants of 10.89%. That is, digital inclusive finance promotes enterprise's green innovation through government grants, and the innovation promoting effect is more significant in the middle and western regions.

(2) Industry Heterogeneity

Heavily polluting enterprise and non-heavily polluting enterprise in China have differences in green innovation activity. In this paper, with reference to the 2010 national environmental protection department issued the list of classified management of the environmental protection verification of listed companies industry segment of 16 heavily polluting enterprise, compared to the China Securities Regulatory Commission in 2012 revision of the classified indicators of listed companies, based on enterprise industry types will sample the heavy pollution of enterprises and non-heavily polluting enterprises, respectively through regression analysis. The results are listed in Table 5.

As can be seen from Table 5, digital inclusive finance plays a stronger role in promoting enterprise's green innovation in heavily polluting industries. However, sobel test found that the mediating effect of government grants was not significant in heavily polluting industries. For non-heavily polluting industries, index has a positive effect on $patent_1$ at the level of 10%, and government grants have a complete mediating effect. Also, it positively influences $patent_2$ at the 5% level, with mediating effect of government grants of 18.21%. In other words, digital inclusive finance in promoting enterprise's green innovation is more significant in non-heavily polluting enterprises by improving the accuracy of government grants. For non- heavily polluting enterprise, the pressure of heavily polluting enterprise green innovation and power are weak, generally will not put money directly into green innovation activities, so only when digital inclusive finance improves the accuracy of government grants can it highlight a strong promoting effect on green innovation of non-heavily polluting enterprises.

Table 5. Industry Heterogeneity Test

	Heavily polluting enterprises						Non-heavily polluting enterprises					
Variables	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
	$Patent_1$	*Grant*	$Patent_1$	$Patent_2$	*Grant*	$Patent_2$	$Patent_1$	*Grant*	$Patent_1$	$Patent_2$	*Grant*	$Patent_2$
Grant			9.930***			5.804***			63.906***			33.498***
			(3.432)			(4.863)			(10.577)			(11.395)
Index	1.081***	0.000	1.077***	0.465***	0.000	0.463***	0.610*	0.002**	0.503	0.368**	0.002**	0.312*
	(6.978)	(0.409)	(6.965)	(7.266)	(0.409)	(7.258)	(1.808)	(2.390)	(1.504)	(2.238)	(2.390)	(1.917)
CVs	*Controlled*						*Controlled*					
Year	*Controlled*						*Controlled*					
Industry												
Obs.	2,653	2,653	2,653	2,653	2,653	2,653	6,363	6,363	6,363	6,363	6,363	6,363
F	31.05	83.49	30.63	31.78	83.49	31.81	59.28	90.62	61.01	51.86	90.62	53.94
R^2	0.2874	0.520	0.291	0.292	0.520	0.299	0.411	0.516	0.421	0.379	0.516	0.392
R^2_a	0.2781	0.514	0.281	0.283	0.514	0.289	0.404	0.510	0.414	0.372	0.510	0.384

5. Robustness tests

This paper uses both lagged variables and replacement of explanatory variables for further robustness tests.

5.1 Lagged variables

It takes some time for digital inclusive finance to affect the enterprise's green innovations, and there is also a certain lag from the input to output of green innovation carried out by enterprises. In order to alleviate the endogeneity problem caused by the reverse causality, which is that the higher the level of green innovation of listed companies is, the higher the degree of digital inclusive finance development is, this paper further lag the explanatory variable, i.e. the digital inclusive finance index by one period, both the explanatory variables and control variables are adopted from listed companies in the future year. On this basis, the impact of the quantity and quality of green innovation is further examined, as well as whether the mediating effect of government grants has changed.

The regression results in Table 6 show that the coefficient of digital inclusive finance in the lagged period is significantly positive at 1% for both the quantity and quality of enterprise's green innovation, which means that digital inclusive finance can significantly promote enterprise's green innovation; the results of the mediating effect test show that there is still a significant mediating effect of government grants, and digital inclusive finance can promote enterprise's green innovation by increasing government grants, which is consistent with the above findings.

Table 6. Robustness tests of explanatory variables with one lagged period

	Number of Green Innovations			Quality of Green Innovations		
Variables	(1)	(2)	(3)	(1)	(2)	(3)
	$Patent_1$	*Grant*	$Patent_1$	$Patent_2$	*Grant*	$Patent_2$
Grant			40.995***			23.239***
			(9.746)			(11.532)
Index	0.809***	0.001*	0.763***	0.442***	0.001*	0.416***
	(3.415)	(1.787)	(3.239)	(3.888)	(1.787)	(3.687)
CVs		*Controlled*			*Controlled*	
Year		*Controlled*			*Controlled*	
Industry						
Obs	7,961	7,961	7,961	7,961	7,961	7,961
F	53.35	93.18	54.45	48.22	93.18	49.96
R^2	0.376	0.513	0.384	0.353	0.513	0.364
R^2_a	0.369	0.508	0.377	0.346	0.508	0.356

5.2 Replacing the explained variables

In order to increase the reliability of the conclusion, also considering that the number of green patent applications reflects more the enterprises' willingness to green innovation, and the number of grants which are authorized can further reflect the actual green innovation ability on the basis of the enterprises' willingness to green innovation, this paper replaces the explanatory variables with the total number of green patents granted (Aut_1) and the number of green invention patents granted (Aut_2) as the indicator of enterprises' green innovation for robustness testing.

The results are shown in Table 7. Under the year and industry fixed effects models, the effect of regional digital inclusive finance index on enterprises' green innovation still shows positive significance, indicating that digital inclusive finance can significantly promote enterprises' green innovation; considering the mediating effect of government grants, the result test shows that the mediating effect of government grants is significant, indicating that the Digital Inclusion Finance Index can contribute to both the quantity and quality of enterprise's green innovations by increasing government grants. This is consistent with the baseline regression, and the model and conclusions of the empirical analysis are robust.

Table 7. Robustness tests of replaced explained variables

	Number of Green Innovations			Quality of Green Innovations		
Variables	(1)	(2)	(3)	(1)	(2)	(3)
	Aut_1	*Grant*	Aut_1	Aut_2	*Grant*	Aut_2
Grant			25.875***			7.914***
			(10.620)			(12.052)
Index	0.529***	0.001**	0.495***	0.230***	0.001**	0.219***
	(3.769)	(2.209)	(3.543)	(6.057)	(2.209)	(5.822)
CVs		*Controlled*			*Controlled*	
Year		*Controlled*			*Controlled*	
Industry						
Obs.	9,016	9,016	9,016	9,016	9,016	9,016
F	63.08	102.03	64.41	52.35	102.03	54.20
R^2	0.389	0.507	0.396	0.345	0.507	0.356
R^2_a	0.383	0.502	0.390	0.339	0.502	0.349

6. Conclusions

This paper empirically examines the mechanism of the effect of digital inclusive finance on enterprise's green innovation using all listed enterprises in SHSE and SZSE as samples. The results show that digital inclusive finance can significantly improve the level of enterprise's green innovation and can promote enterprise's green innovation by improving the precision of government grants. Further research shows that the promoting effect of digital inclusive finance on enterprise's green innovation is more significant for heavily polluting enterprises and in middle and western regions.

This paper has certain limitations. First, digital inclusive finance is a long-term development process, so its realization effect varies from stage to stage. This paper only considers the control time factor, but does not analyze heterogeneity by stage. Second, enterprise's green innovation is an individual behavior of micro enterprises, which is a reflection of corporate social responsibility. This paper only considers the mediating role of government grants in digital inclusive finance on enterprise's green innovation, without considering the mediating role of the corporate governance structure. In future research, the results will be improved by considering the development stages and influencing factors of digital inclusive finance.

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