Digital Finance Enables Green Innovation in New Energy Companies

-- Empirical Evidence From A-share Listed Companies in Shanghai and Shenzhen

Yang Yu

Inner Mongolia University Hohhot, China

15047047571@126.com

Abstract. Digital finance development has an important role in promoting economic transformation and has become a new engine leading the development of the real economy, while green innovation is an important goal of the current economic transformation to a green and sustainable one. Based on the panel data of Shanghai and Shenzhen A-share listed companies from 2008 to 2018, this paper finds that digital finance has a significant promoting effect on the green innovation of new energy enterprises through panel data fixed effects regression model. Furthermore, through sub-sample regression, it is found that the promotion effect of digital finance on new energy enterprises is heterogeneous, and the promotion effect is more significant for state-owned enterprises and enterprises with more decentralized power. The above findings of this paper have important implications for the current economic transformation in China.

Keywords: Digital finance; green innovation; listed companies.

1. Introduction

Digital finance refers to a new generation of financial services combining traditional finance and Internet technology, providing people with financial products and services such as digital payment, Internet insurance and consumer credit with its wide coverage, variety, convenience and low cost.

Innovation is the soul of a company's survival and development, and is an important driving force for economic growth and development. In addition, in response to the double carbon target proposed by General Secretary Xi Jinping in September 2020, China should reach the peak of carbon emission by 2030 and achieve carbon neutrality by 2060. Based on the above background, new energy enterprises, as key subjects in building a market-oriented green technology innovation system, should take into account environmental protection while carrying out innovation, and combine green and innovation organically. However, for new energy enterprises, the characteristics of high investment, high risk and long cycle of innovation cause serious information asymmetry in innovation financing, which makes new energy enterprises face serious financing difficulties when they carry out green innovation, resulting in a low level of green innovation investment of new energy enterprises. China's traditional finance has more prominent structural problems, coupled with the limitations of new energy enterprises themselves and other drawbacks, so that financing constraints often limit new energy enterprises to obtain sufficient funds and high-quality and perfect financial services. This shows that the traditional financial industry, mainly commercial banks, has a more serious financial mismatch problem in serving the innovative development of new energy enterprises, which restricts the incentive for new energy enterprises to carry out green innovation.

In recent years, China is accelerating the digital transformation and promoting the development of digital finance, which alleviates the problem of difficulty in financing new energy enterprises to carry out green innovation and solves the problem of financial capital, so as to find suitable investment opportunities and provide them with suitable investment solutions. Digital finance breaks the "Pareto Principle" of the traditional financial model, allowing new energy enterprises to receive sufficient financial support and high-quality and complete financial services in the financial market.

This paper presents an empirical analysis of the impact of digital finance on green innovation of new energy enterprises based on the Digital Financial Inclusion Index from 2011 to 2020 released by the Institute of Digital Finance of Peking University and the panel data of Shanghai and Shenzhen A-share listed companies from 2008 to 2018. Through the panel data fixed effects regression model, it is found that digital finance significantly promotes green innovation of new energy enterprises. In the further analysis, we found that, based on the ownership dimension, digital finance promotes green innovation in state-owned enterprises more than in non-state-owned enterprises; based on the power concentration dimension, digital finance promotes green innovation in enterprises with more decentralized power. In addition, this paper also constructs theoretical hypotheses and analyzes theoretically that digital finance has a facilitating effect on new energy enterprises to conduct green innovation.

The contributions of this paper are mainly reflected in the following aspects. Firstly, it enriches the research on digital economy and extends the consequences of the role of digital economy from the dimension of green innovation, which is a new economic consequence. Secondly, it is also a complement of the influencing factors of green innovation: digital finance can significantly promote the green innovation of firms. Thirdly, the heterogeneity in the conclusion of this paper is enlightening for the current policy orientation and the development of enterprises.

2. Literature Review and Research Hypothesis

2.1 Literature Review

Scholars at home and abroad have already conducted certain research on enterprise innovation, and these research results are of great significance to increase the innovation ability of enterprises, improve the value of enterprises, and promote high-quality economic development. In terms of traditional finance and corporate innovation, Sun Zhilong studied the relationship between equity structure, industry-finance integration and innovation behavior of private enterprises, and found that the implementation of industry-finance integration by private enterprises and the internal market linked by financial institutions with equity have promoted the improvement of corporate innovation. Liu Hui conducted a quasi-natural experiment through PSM-DID model to study the impact of green credit policy on enterprise innovation performance. The results of the study showed that the implementation of the Green Credit Guidelines promoted the improvement of enterprise innovation performance, and with the implementation of the policy, its effect on enterprise innovation was more significant. In terms of modern finance and enterprise innovation, Xie Tingting explored the impact of digital finance on SMEs' technological innovation in the context of traditional financial structural mismatch, and found that the driving effect of digital finance on SMEs' technological innovation is more significant compared to traditional finance by correcting the traditional financial structural mismatch. Wang Zhixin et al. found that digital finance development is an important driving force to enhance enterprises' green technology innovation capability, and the promotion effect is more significant for enterprises located in central regions, developed regions and regions with high marketization level. Ran Fang et al. pointed out that digital finance has a positive effect on enterprise total factor productivity by promoting enterprise innovation inputs. By studying the relationship between government subsidies, digital inclusive finance and enterprise innovation, Chen Li et al. found that the development of digital inclusive finance has strengthened the role of the market as the "invisible hand" in the allocation of resource factors, and to some extent weakened the contribution of government subsidies to enterprise innovation. The relationship between the development of digital inclusive finance and government subsidies has been found to strengthen the role of the market as the "invisible hand" in resource allocation. In addition, some scholars have studied the role of financing constraints in enterprise innovation, including Zhou Qin et al., Zhou Zhenjiang et al., Zhai Huayun et al., and Lang Xiangxiang et al., who believe that financing constraints have a negative effect on enterprise innovation, and the development of digital finance can promote enterprise innovation by alleviating enterprise financing constraints.

2.2 Research Hypothesis

Digital finance is a new generation of financial services through the combination of Internet technology and traditional financial service industry. Unlike traditional financial services, traditional finance only focuses on the top 20% of users and chooses to ignore the 80% of people who are the majority. Digital finance, on the other hand, is the opposite of the traditional "Pareto Principle", grabbing this "long tail" of users and providing them with more quality services. New energy companies have become a significant beneficiary in the context of digital finance. Digital finance can monitor the innovation activities of investee companies based on data, supervise the behavior of managers and the operation of companies, and promote the R&D innovation of investee companies. Digital finance expands the breadth and depth of financial services, improves the efficiency of financial services, provides new energy enterprises with more opportunities for credit supply, effectively solves the problem of "difficult and expensive financing" for new energy enterprises, and gets rid of the dilemma of green innovation activities caused by the shortage of funds for new energy enterprises under the traditional financial model. The dilemma of termination of green innovation activities caused by the shortage of funds in the traditional financial model. On the one hand, digital finance can help new energy enterprises transform their core innovation technology knowledge and make them respond positively to the digital finance system, thus promoting green innovation in new energy enterprises. On the other hand, it can also help new energy enterprises learn financial knowledge, transform their original financial system, enhance their financing ability, and promote green innovation. Digital finance makes financial services more accurate, automated, intelligent and convenient through artificial intelligence, big data and other information technology means, which effectively provides strong financial guarantee for new energy enterprises' innovative R&D and greatly improves the possibility of green innovation of new energy enterprises. The green innovation activities of new energy enterprises are characterized by high risk, long cycle and irreversibility, which make the traditional financial market unable to serve this part of enterprises due to the limitation of cost and technology, etc. Digital finance has greatly improved this drawback, and it uses the advantages of technology and scenario to absorb this part of enterprises, greatly reducing the threshold of financial services, providing more accurate financing services for new energy enterprises, and promoting New energy enterprises carry out R&D innovation. Digital finance has become an important engine to lead new energy enterprises to carry out green innovation and development.

Based on the above analysis, the following hypothesis is proposed.

Hypothesis: Digital finance can promote green innovation in new energy enterprises.

3. Research Design and Research Data

3.1 Sample Selection and Data Sources

With reference to relevant literature, this paper adopts the Digital Financial Inclusion Index released by the Institute of Digital Finance of Peking University, and selects China's new energy listed enterprises from 2008 to 2018 as the research object, with data samples from the China Stock Market Accounting Research (CSMAR) database. Through the Digital Financial Inclusion Index published by the Institute of Digital Finance of Peking University, data on regional digital finance situation in 31 provinces, autonomous regions and municipalities directly under the Central Government (except Hong Kong, Macao and Taiwan) from 2011 to 2020 were collected, including regional digital finance index, regional digital finance coverage breadth, and regional digital finance usage depth. The year 2018 was selected as the last year of observation mainly due to the availability of the data sample. In this paper, the data are processed as follows: (1) enterprises with incomplete green innovation data were excluded; (2) listed ST and delisted enterprises are excluded; and (3) enterprises with missing financial data are excluded.

3.2 Variable Definition

The explained variable of this paper is green innovation of new energy enterprises (patent_num). The number of green patents granted in this paper is chosen to measure green innovation of new energy enterprises, which can accurately reflect the actual innovation ability of new energy enterprises.

The main explanatory variable in this paper is digital finance index (index_aggregate). This variable is derived from data published by the Institute of Digital Finance of Peking University, which records data on digital finance-related indicators in provincial areas on a yearly basis. Villani's (2017) study proved that the level of financial consulting and other service industries in a region has a radiating effect on new energy enterprises in the immediate administrative area. Therefore, it can be assumed that the level of digital finance within the same provincial area (including municipalities directly under the central government) has an equally potent impact on green innovation in new energy enterprises.

Control variables. There are many factors that affect the green innovation of new energy enterprises, and by drawing on the research of previous scholars, the following table control variables are selected in this paper. Nature of Property Rights (STATE), recorded as 1 for state-owned, otherwise recorded as 0; Debt-to-asset Ratio Enterprise Size (LEV), selected as the ratio of total liabilities/total assets to represent; Executive Stock Ownership Ratio (SR), selected as the ratio of executive shareholding to total shares to represent; Board Size (BOARD), represented by the number of board members; Tobin's Q Value (GROWTH); Gross Profit Margin (GP), selected as gross operating margin; Asset Structure (AS), the current asset ratio is selected as a measure; Firm Size (SIZE), the total assets are used as a measure; Net Profit Ratio of Total Assets (ROA), the percentage of net profit to average total assets is used as a measure; Power Concentration (BOTH), the power concentration is recorded as 1, otherwise it is 0.

3.3 Model Construction

$$patent\_num_{it} = constant + \beta 1 * index\_aggregate_{jt} + CV_{sit} + \mu_{it}$$

where patent_numit denotes the green innovation performance of new energy enterprise i in year t, measured by the number of green patents granted; index_aggregatejt denotes the digital financial index of province j in year t; constant denotes the constant term; CVsit refers to other control variables that affect the dependent variable, containing the Nature of Property Rights (STATE), Debt-to-asset Ratio Enterprise Size (LEV), Executive Stock Ownership Ratio (SR), Board Size (BOARD), Tobin's Q Value (GROWTH), Gross Profit Margin (GP), Asset Structure (AS), Firm Size (SIZE), Net Profit Ratio of Total Assets (ROA), and Power Concentration (BOTH). μit is a random error term. Where, the registered address of new energy enterprise i is located in province j.

4. IV. Empirical Results and Analysis

4.1 Regression Analysis

Table 1 Regression Analysis

patent_num	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
index_aggregate	.062	.008	8.16	0	.047	.077	***
LEV	-.749	.524	-1.43	.153	-1.776	.279	
SIZE	4.878	.131	37.23	0	4.621	5.135	***
ROA	-1.203	.743	-1.62	.105	-2.66	.253	
GP	.205	.598	0.34	.732	-.967	1.376	
AS	3.145	.807	3.90	0	1.564	4.726	***
GROWTH	.092	.018	5.13	0	.057	.127	***

BOARD	-1.978	.755	-2.62	.009	-3.458	-.498	***
BOTH	.72	.336	2.14	.032	.061	1.379	**
SR	.53	.558	0.95	.342	-.563	1.623	
STATE	.041	.355	0.12	.907	-.654	.736	
Constant	-105.357	3.296	-31.96	0	-111.818	-98.896	***
Year Fixed Effects					YES		
Industry Fixed Effects					YES		
Mean dependent var	3.179		SD dependent var		21.375		
R-squared	0.098		Number of obs		20911		
F-test	*58.166*		*Prob > F*		*0.000*		
Akaike crit. (AIC)	185331.919		Bayesian crit. (BIC)		185649.840		

*** *p<.01, ** p<.05, * p<.1*

As seen from Table 1, the model Green_patentit = constant + β1*Digitaljt+ CVsit+μit, in which β1 is 0.062 and the p-value is 0. So it indicates that the coefficient β1 of digital inclusive finance index on the number of green patents granted is significantly positive at the 1% level, implying that digital finance significantly promotes new energy enterprises' green innovation. This also indicates that the hypothesis 1 of this paper is valid, that is, digital finance can promote green innovation of new energy enterprises.

4.2 Further Analysis

Table 2 Regressions of SOE Subsamples

patent_num	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
index_aggregate	.121	.02	6.13	0	.082	.16	***
LEV	-6.63	1.777	-3.73	0	-10.114	-3.146	***
SIZE	8.06	.328	24.60	0	7.418	8.702	***
ROA	-7.655	3.54	-2.16	.031	-14.595	-.716	**
GP	-1.312	2.538	-0.52	.605	-6.287	3.664	
AS	5.592	2.03	2.76	.006	1.613	9.571	***
GROWTH	1.164	.195	5.97	0	.782	1.546	***
BOARD	-5.316	1.889	-2.81	.005	-9.019	-1.614	***
BOTH	.441	1.215	0.36	.717	-1.942	2.823	
SR	-4.846	12.743	-0.38	.704	-29.827	20.134	
o	0	.	.	.	.	.	
base A							
B	6.922	3.338	2.07	.038	.379	13.465	**
C1	-2.883	3.223	-0.89	.371	-9.202	3.436	
C2	-1.957	2.991	-0.65	.513	-7.82	3.907	
C3	-.303	2.92	-0.10	.917	-6.027	5.421	
C4	2.858	5.348	0.53	.593	-7.624	13.341	
D	-5.205	3.218	-1.62	.106	-11.514	1.104	
E	9.972	3.514	2.84	.005	3.083	16.861	***
F	-7.036	3.146	-2.24	.025	-13.203	-.87	**

G	-10.326	3.222	-3.20	.001	-16.642	-4.01	***
H	-2.35	5.194	-0.45	.651	-12.531	7.832	
I	-3.371	3.46	-0.97	.33	-10.154	3.412	
J	-11.811	4.806	-2.46	.014	-21.233	-2.389	**
K	-15.725	3.327	-4.73	0	-22.247	-9.203	***
L	-9.579	4.197	-2.28	.022	-17.805	-1.352	**
M	2.357	4.868	0.48	.628	-7.185	11.9	
N	4.587	4.171	1.10	.272	-3.59	12.763	
P	1.62	10.258	0.16	.875	-18.49	21.729	
Q	-5.285	18.192	-0.29	.771	-40.946	30.375	
R	-7.201	3.823	-1.88	.06	-14.694	.293	*
S	-.789	4.321	-0.18	.855	-9.26	7.682	
2011b	0	.	.	.	.	.	
2012	-5.79	1.687	-3.43	.001	-9.097	-2.483	***
2013	-11.751	2.219	-5.30	0	-16.101	-7.401	***
2014	-14.23	2.437	-5.84	0	-19.008	-9.451	***
2015	-19.642	2.929	-6.71	0	-25.383	-13.901	***
2016	-22.699	3.283	-6.91	0	-29.135	-16.264	***
2017	-26.233	3.809	-6.89	0	-33.701	-18.766	***
2018	-32.427	4.05	-8.01	0	-40.365	-24.488	***
Constant	-169.817	8.109	-20.94	0	-185.713	-153.921	***

Mean dependent var	5.202	SD dependent var	33.189
R-squared	0.129	Number of obs	7599
F-test	30.218	Prob > F	0.000
Akaike crit. (AIC)	73818.697	Bayesian crit. (BIC)	74082.256

*** *p<.01,* ** *p<.05,* * *p<.1*

Table 3 Regressions of Non-SOE Subsamples

patent_num	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
index_aggregate	.01	.004	2.48	.013	.002	.018	**
LEV	.692	.258	2.69	.007	.187	1.198	***
SIZE	2.169	.08	27.01	0	2.012	2.327	***
ROA	.744	.358	2.08	.038	.042	1.446	**
GP	.016	.282	0.06	.955	-.536	.568	
AS	1.021	.452	2.26	.024	.135	1.907	**
GROWTH	.026	.008	3.27	.001	.01	.042	***
BOARD	.285	.417	0.69	.493	-.531	1.102	
BOTH	.58	.162	3.58	0	.262	.898	***
SR	.01	.246	0.04	.969	-.473	.492	
o	0	.	.	.	.	.	
base A							

B	-.246	.951	-0.26	.796	-2.109	1.618	
C1	-.116	.752	-0.15	.877	-1.591	1.358	
C2	.425	.715	0.59	.553	-.977	1.826	
C3	2.778	.707	3.93	0	1.392	4.163	***
C4	4.138	.862	4.80	0	2.449	5.828	***
D	2.306	1.008	2.29	.022	.33	4.282	**
E	1.547	.86	1.80	.072	-.138	3.232	*
F	-1.686	.793	-2.13	.034	-3.241	-.131	**
G	-.031	1.059	-0.03	.976	-2.107	2.045	
H	3.763	2.209	1.70	.088	-.566	8.092	*
I	.8	.747	1.07	.284	-.664	2.265	
J	-.712	1.174	-0.61	.544	-3.013	1.589	
K	-3.748	.83	-4.52	0	-5.375	-2.122	***
L	-1.138	.939	-1.21	.226	-2.98	.703	
M	2.165	.999	2.17	.03	.207	4.124	**
N	7.518	.958	7.85	0	5.64	9.395	***
O	4.428	8.843	0.50	.617	-12.907	21.762	
P	1.759	1.732	1.02	.31	-1.636	5.153	
Q	-.479	1.305	-0.37	.713	-3.036	2.078	
R	-.128	.982	-0.13	.897	-2.053	1.798	
S	.064	1.223	0.05	.958	-2.332	2.46	
2011b	0	.	.	.	.	.	
2012	-.316	.396	-0.80	.425	-1.092	.46	
2013	-.983	.502	-1.96	.05	-1.968	.002	*
2014	-.858	.543	-1.58	.114	-1.922	.206	
2015	-1.319	.64	-2.06	.039	-2.573	-.064	**
2016	-1.5	.71	-2.11	.035	-2.891	-.108	**
2017	-2.047	.819	-2.50	.013	-3.653	-.441	**
2018	-4.222	.875	-4.83	0	-5.937	-2.507	***
Constant	-48.555	2.011	-24.15	0	-52.497	-44.613	***

Mean dependent var	2.024	SD dependent var	9.235
R-squared	0.093	Number of obs	13312
F-test	35.633	Prob > F	0.000
Akaike crit. (AIC)	95747.263	Bayesian crit. (BIC)	96039.624

*** $p<.01$, ** $p<.05$, * $p<.1$

Based on the ownership dimension, as seen in Table 2 and Table 3, for state-owned enterprises (SOE), the coefficient $\beta1=0.121$ and the p-value is 0. This indicates that the coefficient $\beta1$ of digital financial inclusion index on the number of green patents granted by state-owned enterprises is still significantly positive at the 1% level, implying that digital finance significantly promotes green innovation of state-owned enterprises. For non-SOEs, the coefficient $\beta1=0.01$ and the p-value is 0.013,

indicating that the coefficient β1 of digital inclusive finance index on the number of green patents granted to non-SOEs is still significantly positive at the 10% level, implying that digital finance also significantly promotes green innovation in non-SOEs. Therefore, digital inclusive finance has a greater role in promoting green innovation by state-owned enterprises.

Table 4 Sub-sample Regressions of Power-Concentrated Enterprises

patent_num	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
index_aggregate	.023	.01	2.40	.017	.004	.043	**
LEV	.806	.681	1.18	.237	-.53	2.142	
SIZE	4.675	.196	23.84	0	4.29	5.059	***
ROA	-.201	1.265	-0.16	.874	-2.68	2.278	
GP	.21	.486	0.43	.665	-.743	1.164	
AS	4.641	1.063	4.37	0	2.557	6.724	***
GROWTH	.264	.058	4.51	0	.149	.378	***
BOARD	-1.555	.953	-1.63	.103	-3.424	.313	
o	0	.	.	.	.	.	
SR	.17	.474	0.36	.72	-.759	1.099	
STATE	-.263	.591	-0.45	.656	-1.421	.895	
base A							
B	2.673	2.202	1.21	.225	-1.643	6.99	
C1	-.35	1.705	-0.21	.837	-3.692	2.992	
C2	.117	1.618	0.07	.942	-3.053	3.288	
C3	3.391	1.601	2.12	.034	.253	6.528	**
C4	4.243	1.989	2.13	.033	.344	8.141	**
D	-.737	2.23	-0.33	.741	-5.108	3.634	
E	1.981	2.025	0.98	.328	-1.988	5.951	
F	-1.95	1.786	-1.09	.275	-5.451	1.55	
G	-2.689	2.202	-1.22	.222	-7.006	1.629	
H	4.562	3.384	1.35	.178	-2.073	11.197	
I	.806	1.689	0.48	.633	-2.506	4.118	
J	-.435	2.829	-0.15	.878	-5.98	5.111	
K	-10.816	2.011	-5.38	0	-14.758	-6.873	***
L	-3.366	2.044	-1.65	.1	-7.373	.641	*
M	2.111	2.226	0.95	.343	-2.253	6.474	
N	4.442	2.35	1.89	.059	-.165	9.05	*
O	7.14	13.255	0.54	.59	-18.845	33.125	
Q	-.74	3.292	-0.22	.822	-7.192	5.713	
R	-.34	2.252	-0.15	.88	-4.755	4.075	
S	-.516	2.496	-0.21	.836	-5.409	4.377	
2011b	0	.	.	.	.	.	
2012	-.805	.909	-0.89	.375	-2.587	.976	
2013	-2.175	1.174	-1.85	.064	-4.477	.126	*
2014	-2.826	1.278	-2.21	.027	-5.332	-.321	**

2015	-3.814	1.518	-2.51	.012	-6.79	-.839	**
2016	-4.904	1.679	-2.92	.004	-8.196	-1.613	***
2017	-5.296	1.935	-2.74	.006	-9.089	-1.503	***
2018	-7.985	2.07	-3.86	0	-12.043	-3.928	***
Constant	-101.55	4.79	-21.20	0	-110.94	-92.159	***

Mean dependent var	2.450	SD dependent var	14.046
R-squared	0.130	Number of obs	5735
F-test	23.026	Prob > F	0.000
Akaike crit. (AIC)	45858.813	Bayesian crit. (BIC)	46111.678

*** *p<.01, ** p<.05, * p<.1*

Table 5 Sub-sample Regressions of Power-Decentralized Enterprises

patent_num	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
index_aggregate	.074	.01	7.61	0	.055	.093	***
LEV	-1.423	.683	-2.08	.037	-2.762	-.084	**
SIZE	4.986	.164	30.34	0	4.664	5.308	***
ROA	-2.023	.945	-2.14	.032	-3.875	-.17	**
GP	.256	1.129	0.23	.82	-1.956	2.469	
AS	2.883	1.032	2.79	.005	.86	4.906	***
GROWTH	.084	.02	4.17	0	.045	.124	***
BOARD	-2.203	.974	-2.26	.024	-4.112	-.295	**
o	0	.	.	.	.	.	
SR	.885	.97	0.91	.361	-1.015	2.786	
STATE	.203	.44	0.46	.644	-.659	1.066	
base A							
B	7.772	1.878	4.14	0	4.091	11.453	***
C1	-1.008	1.709	-0.59	.555	-4.358	2.342	
C2	-.323	1.607	-0.20	.841	-3.472	2.827	
C3	1.836	1.577	1.16	.244	-1.256	4.928	
C4	3.85	2.137	1.80	.072	-.338	8.039	*
D	-2.45	1.814	-1.35	.177	-6.006	1.107	
E	7.961	1.887	4.22	0	4.262	11.659	***
F	-4.879	1.732	-2.82	.005	-8.274	-1.485	***
G	-6.511	1.835	-3.55	0	-10.107	-2.914	***
H	-2.233	3.522	-0.63	.526	-9.136	4.671	
I	-.149	1.729	-0.09	.931	-3.538	3.24	
J	-5.101	2.574	-1.98	.048	-10.146	-.055	**
K	-9.571	1.798	-5.32	0	-13.096	-6.047	***
L	-4.254	2.232	-1.91	.057	-8.629	.121	*
M	3.673	2.428	1.51	.13	-1.087	8.432	

N	5.68	2.146	2.65	.008	1.474	9.886	***
P	1.785	3.837	0.47	.642	-5.735	9.306	
Q	-1.532	3.658	-0.42	.675	-8.702	5.638	
R	-3.603	2.114	-1.70	.088	-7.747	.542	*
S	-.261	2.556	-0.10	.919	-5.27	4.749	
2011b	0	.	.	.	.	.	
2012	-3.464	.892	-3.88	0	-5.213	-1.714	***
2013	-7.17	1.143	-6.27	0	-9.411	-4.93	***
2014	-8.125	1.243	-6.53	0	-10.562	-5.688	***
2015	-11.271	1.479	-7.62	0	-14.17	-8.372	***
2016	-13.138	1.648	-7.97	0	-16.368	-9.907	***
2017	-15.678	1.907	-8.22	0	-19.416	-11.94	***
2018	-19.867	2.029	-9.79	0	-23.844	-15.89	***
Constant	-107.295	4.15	-25.86	0	-115.428	-99.161	***

Mean dependent var	3.454	SD dependent var	23.552
R-squared	0.096	Number of obs	15176
F-test	43.334	Prob > F	0.000
Akaike crit. (AIC)	137503.687	Bayesian crit. (BIC)	137793.531

*** *p<.01,* ** *p<.05,* * *p<.1*

Analyzing from the power concentration dimension, it can be seen from Table 4 and Table 5 that digital inclusive finance has a stronger promotion effect on enterprises to conduct green innovation for enterprises with more decentralized power.

5. Conclusion

Based on the strong development of digital inclusive finance and the background that China is accelerating the construction of a strong science and technology country and the green transformation of economic and social development, this paper finds that digital finance has a significant promotion effect on new energy enterprises to carry out green innovation through the benchmark regression analysis. And by means of sub-sample regression, it is found that: the promotion effect of digital finance on both state-owned enterprises and non-state-owned enterprises to carry out green innovation is significant, and the promotion effect is greater for state-owned enterprises; the promotion effect of digital finance on enterprises with more decentralized power to carry out green innovation is greater than that of enterprises with more centralized power. It can be seen that digital finance has an important role in China's new energy enterprises to carry out green innovation, and plays an important role in the green transformation of China's economic and social development.

References

[1] Wang, Z.X. Zhu, W.Q. Han, C.B. Does Digital Finance Affect Corporate Green Technological Innovation——Empirical Evidence from Chinese Listed Companies[J]. Forum on Science and Technology in China, 2022(03):52-61. DOI:10.13580/j.cnki.fstc.2022.03.006.

[2] Yao, L.Y. Yang, X.L. Can digital finance boost SME innovation by easing financing constraints?: Evidence from Chinese GEM-listed companies.[J]. PloS one, 2022, 17(3).

[3] Han, H.Y. Gu, X.M. Linkage Between Inclusive Digital Finance and High-Tech Enterprise Innovation Performance: Role of Debt and Equity Financing [J]. Frontiers in Psychology, 2021,12.

[4] Luo, Y. Peng, Y.C. Zeng, L.Y. Digital financial capability and entrepreneurial performance[J]. International Review of Economics and Finance, 2021, 76.

[5] Zhao, X.G. Zhong, S.H. Guo, X.X. Digital inclusive finance development, financial mismatch mitigation and enterprise innovations[J]. Science Research Management, 2021, 42(04):158-169. DOI:10.19571/j.cnki.1000-2995.2021.04.017.

[6] Xie, X.Y. Zhu, X.Y. Digital Finance and SME's Technological Innovation——Evidence from NEEQ Companies[J]. Studies of International Finance, 2021(01):87-96. DOI:10.16475/j.cnki.1006-1029.2021.01.009.

[7] Sun, J.G. Hu, J.Y. Yang, L. Can Inclusive Finance Promote Enterprise Innovation? Empirical Test Based on Differences-in-Differences Model[J]. Research On Financial and Economic Issues, 2020(10):47-54. DOI:10.19654/j.cnki.cjwtyj.2020.10.006.

[8] Yu, P. Dou, J.X. Digital Inclusive Finance, Enterprise Heterogeneity and Innovation of SMEs[J]. Contemporary Economic Management, 2020, 42(12):79-87. DOI:10.13253/j.cnki.ddjjgl.2020.12.011.

[9] Nie, X.H.Research on the Path and Heterogeneity of Digital Finance Boosting Technical Innovation of Small and Medium-sized Enterprises[J]. West Forum, 2020,30(04):37-49.

[10] Liang, B. Zhang, J.H.Can the Development of Digital Inclusive Finance Stimulate Innovation?——Evidence from Chinese Cities and SMEs[J]. Modern Economic Science, 2019, 41(05):74-86.