Digital Finance, Executive Background and Enterprise Green Innovation

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Abstract: Digital finance is a combination of digital information technology and finance. Compared with traditional finance, its development can be more efficient to achieve the improvement of the enterprise. Data from Shanghai and Shenzhen A-share listed companies for the period 2011-2020 in China, and matching with 31 provincial data. Regression models were used to analyze the function of digital finance on corporate green innovation and the impact of the senior managers' background on its mechanisms. Reached the following conclusion: first, digital finance clearly promotes green innovation in companies. Second, according to the upper echelon theory, the executive background in corporate has a regulatory effect. The higher the rate of managers within companies with background abroad or high-level education, the more digital finance promotes green renovation. Then, based on the results of the study, suggestions were put forward.

Keywords: digital finance, overseas background, education background, green innovation

1. Introduction

In order to control the global warming, the Paris Agreement in 2015 proposed " Carbon Neutral" and proposed countries to achieve " Net Zero Emission" at the macro level. China is the largest energy consumer and carbon emissions countries. In September 2020, China proposed the Carbon Neutra target at the 75th UN General Assembly. It is the Important topic facing various industries, green innovation and green development will be the main development direction of enterprises and economy in the future.

Finance can supply reasonable and effective capital which helps to operate various activities of the enterprise [1]. Compared with traditional financial services, digital finance can play the advantages of technology empowering finance to relieve corporate financing constraints [2], reduce the asymmetric information between the borrower and the lender, so that more borrowers can obtain credit opportunities with better conditions [3]. And fundamentally reduced the dependence of enterprises to bank credit [4], and there is a positive effect on regional capital allocation. Under the current environment, the market environment has gradually stricter on the green requirements, and the green awareness in corporates has gradually improved [5]. In order to achieve green development, enterprises gradually optimized production methods, and flexibly used green resources and green technology to support the green transformation [6]. Green innovation in enterprises is an unavoidable link in the sustainable development of the enterprise, and it is also a prerequisite for regional green innovation [7].

In the research, it has always focused on the role of digital finance functions on green innovation and the promotion of development at the macro level. Enterprises' green innovation not only requires external stimuli, but also requires the driver of green innovation in the enterprise. Among them, the performance of entrepreneurs such as entrepreneurs such as entrepreneurs and other senior managers cannot be ignored.

Enterprise executives are the main person in charge of controlling the future development direction of the enterprise. It is the internal factor that are most likely to affect the development of the enterprise. The development of an enterprise will change subtly under the control of different types of executive teams. In order to achieve the goal of social " Carbon Neutral", corporate executive members will be the helmsman of the enterprise become "green". Managers' overseas experience can promote the green innovation through the mechanism of risk preferences, self-confidence, and strengthening environmental attention of managers [8]. At this stage, it mainly comes from developed countries, and the social responsibility theory of Western countries starts earlier than China for nearly 70 years. Therefore, whether it is their study experience or work experience, influenced by Western countries, their green environmental awareness will be stronger [9]. At the same time, returnee talents will be more sensitive to international cutting-edge technology and green innovation knowledge. They can converge from international green standards and help enterprises establish a broader business network. Meanwhile, it shows that the higher the level of executive education, the higher the level of enterprise risk taking, and more capable to make some high-risk but rewarding decisions. In addition, the education level of executives will be associated with the performance of CSR, including the degree of education and professional backgrounds, etc.

2.   Research Framework and Hypothesis

2.1.   Digital Finance and Enterprise Green Innovation

In addition to the advantages of financing functions, the digital currency which is completely electronic with investment value and payment functions is another innovation of digital finance [10]. Based on big data technology, digital finance improves credit evaluation, which is conducive to the diversification and facilitation of enterprise investment to develop the level of innovation [11]. It is precisely because of the electronic characteristics of digital finance that although some risks have been reduced, it has also brought new risks that the regulatory system must follow the growth of digital finance [12]. All in all, digital finance can provide corporate green innovation with more stable capital flow, more optimized capital allocation, and reduce the asymmetry of information, which largely reduces the funding restrictions of green innovation [13]. In terms of coverage, digital finance strengthens the connection between financial subjects, alleviate information asymmetry in the financial market, broaden the financial border, and improve the ability to allocate financial market resource allocation. Digital finance with information technology blessings can enhance market information transparency, reduce non-performing credit, and suppress corporate zombification [14], which helps enterprises to develop technology, and then significantly promote the green change in industry.

Based on the research of two sides, hypothesis 1 is proposed:

H1: Digital finance has a positive impact on enterprises' green innovation.

2.2.   The Regulating Effect of Enterprise Executive Background

According to the Upper Echelons Theory [15], the executive team who is the strategic decision maker of the enterprise, its characteristics of the manager shape their cognition and preferences, and the strategic decision of the enterprise is a mapping of the characteristics of executives. At the time of global financial digitalization, foreign digital finance has developed earlier, especially represented by

the United States and Britain. Those who have been studying or working overseas have transported relevant ideas and technologies to China, which has led to growth of digital finance.

It shows that the higher the education level of senior manager, the longer the term of office, and the background of senior executives will influence enterprises to keep attention on company's social responsibility. According to the Imprinting Theory [16], returnees will regard the experience of studying or working abroad as the imprinting process, forming a cognitive system that matches the overseas environment. Based on this, executives with overseas background will notice the green development and green transformation of enterprises because of the strong green consciousness in foreign countries. In addition, the overseas experience of executives will promote its financing attitude to more in line with the financing order of overseas countries, showing strong debt financing preferences. Therefore, corporate executives with overseas backgrounds will give priority to digital finance as a channel for access to innovative capital support, and they will focus on greening in the process of innovation.

Similarly, highly educated talents will regard the experience of studying in higher learning institutions as an imprinting process, forming a cognitive system that matches cutting-edge knowledge. Based on this, executives with highly educated background will pay more attention to national policy preferences and the latest development direction due to long-term exposure to cutting-edge information, so as to promote the green innovation of enterprises to get closer to the national policy. At the same time, the higher the educational level of executives, the more inclined to obtain capital through channels with lower financing costs [17]. Therefore, executives with high educational background will prefer efficient capital acquisition channels and use them in line with the green development activities advocated by the government.

To sum up, the overseas background and educational background of enterprise executives will influence the degree of concern of enterprises on innovation and green innovation, as well as influence the decision of whether to raise financing and the way of follow-up financing to seek capital support for innovation projects. According to the analysis, the following two hypotheses are proposed:

H2: The overseas background of corporate managers has a regulating effect on the role of digital finance and green innovation.

H3: The education background of corporate managers has a regulating effect on the role of digital finance and green innovation.

3. Research Design

3.1. Data Source

It mainly selects data of Shanghai and Shenzhen A-share listed companies in China, and matching with digital finance index and 31 provincial data. Micro data such as enterprise green innovation are from CSMAR database, digital finance index is from China Digital Finance Research Centre of Peking University, and city-level macro data is from National Bureau of Statistics of China. The data has been standardized. Through data matching, 18,360 research samples from 2011 to 2020 were finally obtained.

3.2. Description of Variables

3.2.1. Explained Variables

Green innovation. It cannot be displayed intuitively from the financial statements. The green patent representative disclosed by the enterprise has been developed and applied to the application, which can directly reflect the company's green innovation capabilities. According to the Green Patent Standard of the World Intellectual Property Organization and the IPC classification number of each

patent, because the design patent does not use IPC for classification, therefore, the number of enterprise green patent applications is used, which contains general green patents and practical new green patents to measure it.

3.2.2. Explaining Variables

Digital finance. It is measured by the Chinese Digital Financial Development Index issued by the Peking University Digital Financial Research Centre. In the meantime, the three sub-dimensional indicators of digital finance (coverage, depth, and digital levels) are also incorporated into empirical evidence.

3.2.3. Regulating Variables

Executive overseas background. It is measured by the scale of executives with overseas backgrounds in the senior management team.

Executive education background. It is measured by the scale of executives with postgraduate education background in the senior management team.

3.2.4. Controlling Variables

Based on previous research, the control variables of the following factors that may affect green innovation are selected from the micro enterprise level and macro city level:

(1) Enterprise size: the total assets of the company; (2) Capital structure: enterprise asset-liability ratio; (3) Company age: calculated by statistical year and registration year; (4) Regional economic development level: GDP per capita of provinces; (5) Urbanization level: measured by regional urbanization rate; (6) Government intervention: the ratio of government fiscal expenditure to GDP.

The descriptive statistical results of the above variables are shown in Table 1.

Table 1: Descriptive statistical results.

Variable name	Symbol	Quantity	Mean	Standard deviation	Minimum	Maximum
Green innovation	$green$	18360	0.491	0.952	0	7.342
Digital finance	dif	18360	5.337	0.597	2.786	6.068
Coverage	wid	18360	5.234	0.668	0.673	5.984
Depth	dep	18360	5.367	0.559	1.911	6.192
Digital levels	dig	18360	5.484	0.779	2.026	6.136
Executive overseas background	abr	18360	0.088	0.104	0	1
Executive education background	edu	18360	0.377	0.276	0	1
Enterprise size	$size$	18360	22.530	1.530	18.950	31.140
Capital structure	cap	18360	0.443	0.211	0.007	1.957
Company age	age	18360	2.815	0.388	0	3.738
Economic development level	gdp	18360	11.080	0.454	9.675	12.010
Urbanization level	urb	18360	0.642	0.131	0.222	0.941
Government intervention	gov	18360	0.198	0.092	0.120	1.354

3.3. Description of Variables

3.3.1. Regression Model

To explore the relationship between digital finance and enterprises' green innovation, it constructs a basic regression model, as shown in formula (1):

$$green_{i,t} = \alpha_0 + \alpha_1 dif_{i,t} + \alpha_2 CV_{i,t} + \sum year_{i,t} + \sum ind_{i,t} + \varepsilon_{i,t} \tag{1}$$

In the model, $green_{i,t}$ is expressed as the level of enterprise green innovation, $dif_{i,t}$ is expressed as the level of digital finance development of i region in t year, CV represents a series of control variables in year t of region i, $year_{i,t}$ and $ind_{i,t}$ expressed year fixed effect and industry fixed effect respectively, and ε represents the random disturbance term.

3.3.2. Regulatory effect Model

In order to test the regulatory effect of overseas background and education background of senior executives in the process of digital finance promoting enterprise green innovation, it adds the interaction terms of overseas background with digital finance and the interaction terms of education background with digital finance respectively on the basis of formula (1). For specific models, as shown in formula (2) and (3):

$$green_{i,t} = \alpha_0 + \alpha_1 dif_{i,t} + \alpha_2 abr_{i,t} + \alpha_3 dif_{i,t} * abr_{i,t} + \alpha_4 CV_{i,t} + \sum year_{i,t} + \sum ind_{i,t} + \varepsilon_{i,t} \tag{2}$$

$$green_{i,t} = \beta_0 + \beta_1 dif_{i,t} + \beta_2 edu_{i,t} + \beta_3 dif_{i,t} * edu_{i,t} + \beta_4 CV_{i,t} + \sum year_{i,t} + \sum ind_{i,t} + \varepsilon_{i,t} \tag{3}$$

In the model, $abr_{i,t}$ and $edu_{i,t}$ represents the overseas background and the education background of the senior executives of each company in each period.

4. Empirical Analysis

4.1. Regression Analysis

Since the Hausman test result (13.81*) is significant at the 10% level and rejects the null hypothesis, it is determined to choose the fixed effect model for this regression. The regression results of digital finance on green innovation are shown in Table 2.

Table 2: Regression result.

Explaining variables	Digital finance		Coverage	Depth	Digital levels
	(1)	(2)	(3)	(4)	(5)
dif	0.153***	0.0939***	-	-	-
	(13.01)	(5.41)	-	-	-
wid	-	-	0.0779***	-	-
	-	-	(4.99)	-	-
dep	-	-	-	0.0904***	-
	-	-	-	(4.75)	-
dig	-	-	-	-	0.0567***

Table 2: (continued).

		-	-	-	-	(5.22)
size	-	0.191***	0.191***	0.192***	0.191***
	-	(32.97)	(33.08)	(33.19)	(33.09)
cap	-	-0.217***	-0.219***	-0.221***	-0.220***
	-	(-5.35)	(-5.40)	(-5.43)	(-5.42)
age	-	-0.219***	-0.214***	-0.214***	-0.212***
	-	(-10.75)	(-10.58)	(-10.52)	(-10.58)
gdp	-	0.0733*	0.0884**	0.0823**	0.117***
	-	(1.87)	(2.29)	(2.05)	(3.33)
urb	-	-0.394***	-0.451***	-0.410***	-0.397***
	-	(-3.60)	(-4.24)	(-3.72)	(-3.63)
gov	-	-0.556***	-0.530***	-0.516***	-0.560***
	-	(-6.84)	(-6.58)	(-6.44)	(-6.87)
Constant	-0.323***	-4.045***	-4.110***	-4.161***	-4.367***
	(-5.13)	(-11.87)	(-12.02)	(-12.19)	(-13.87)
N	18360	18360	18360	18360	18360
r2	0.00915	0.0832	0.0830	0.0829	0.0831
r2_a	0.00904	0.0828	0.0826	0.0825	0.0827

Note: *, ** and *** are significant at the level of 10%, 5% and 1% respectively, as shown in the following table.

In column (1), it showed that regardless of the influence of other factors, the regression factor of digital finance is significant at the 1% level and plays a positive role. Column (2) shows the results of digital finance regression after considering several influential factors. The overall digital finance index passed the 1% significance level test, which shows that it has a significant positive effect on eco-innovation in companies. The robustness test of the lower dimension of digital finance shows that columns (3), (4), and (5), which show the width of coverage, using depth and degree of digitization are also significant at the 1% level. It can conclude that digital finance positively promotes improvements in green innovation, and hypothesis 1 is valid.

In column (2), among them, capital structure, enterprise age, regional urbanization level and government intervention have significant negative relationship with green innovation level. When the ratio of debt in the capital structure of enterprises is relatively low, enterprises are more willing to finance through digital finance to promote corporate green innovation. The longer a company is established, the lower the level of green innovation. This is due to the fact that the more time a company has to operate, the more factors it has to consider for large-scale green innovation. From another perspective, the longer the survival time line of an enterprise, the greater the probability of its market share, the weaker the ability to accept new things, and the lower the possibility of green innovation and development under relatively stable operation. Contrasted with traditional finance, digital finance is inclusive, so compared with areas with higher urbanization level, its promotion effect on areas with lower urbanization level will be more obvious. Government intervention will subjectively affect market changes and trends. The stronger the degree of government intervention, the stronger the restriction on enterprises, and the higher the innovation investment cost of enterprises' innovation, thus affecting the enthusiasm of enterprises' green innovation. Therefore, the government intervention should be moderate, guide the green growth of enterprises, and give enterprises the space to play and pursue interests.

The scale of enterprises and the level of regional economic development have a significant positive effect on the green innovation of enterprises, and the larger the scale of enterprises, the higher the level of provincial economic development is favorable to the improvement of the level of green innovation of enterprises. The larger the enterprise scale, the stronger the capital and ability of the enterprise, and the relatively low demand for daily operation financing. When enterprises make innovation and transformation, large enterprises can provide perfect planning and strong backing for innovation and green innovation, greatly increasing the success probability of digital financing. The strong level of local economic development indicates that the economic development of the region is high and stable, and the transformation of green development needs to be carried out. It is able to support green innovation of enterprises and thus affect high-quality economic development.

4.2. Regulatory Effect Analysis

Table 3 reports the regulatory impact of senior managers' overseas background and education background on the process of digital finance promoting green innovation.

Table 3: Regulatory effect result.

Explaining variables	Overseas background		Education background	
	(1)	(2)	(3)	(4)
dif	0.0937***	0.0949***	0.0812***	0.0944**
	(5.40)	(5.04)	(4.67)	(2.01)
abr	0.275***	0.380	-	-
	(4.02)	(0.63)	-	-
dif*abr	-	0.195**	-	-
	-	(3.17)	-	-
edu	-	-	0.219***	0.408*
	-	-	(8.71)	(1.77)
dif*edu	-	-	-	0.116***
	-	-	-	(2.74)
size	0.186***	0.186***	0.181***	0.181***
	(31.48)	(31.48)	(30.71)	(30.67)
cap	-0.206***	-0.206***	-0.195***	-0.201***
	(-5.08)	(-5.06)	(-4.80)	(-4.95)
age	-0.218***	-0.217***	-0.206***	-0.208***
	(-10.68)	(-10.65)	(-10.12)	(-10.19)
gdp	0.0734*	0.0739*	0.0864**	0.0787**
	(1.87)	(1.88)	(2.21)	(2.00)
urb	-0.423***	-0.425***	-0.431***	-0.412***
	(-3.87)	(-3.87)	(-3.95)	(-3.77)
gov	-0.551***	-0.550***	-0.522***	-0.534***
	(-6.79)	(-6.76)	(-6.44)	(-6.57)
Constant	-3.951***	-3.963***	-4.008***	-3.722***
	(-11.57)	(-11.36)	(-11.78)	(-10.46)
N	18360	18360	18360	18360
r2	0.0840	0.0840	0.0870	0.0874
r2_a	0.0836	0.0835	0.0865	0.0869

In column (1) and (2), it can be seen that regardless of whether the interaction item between senior executives' overseas background and digital finance is introduced, digital finance plays a positive role in promoting corporate green innovation. After the introduction of the interaction term between digital finance and the overseas background of executives, the interaction term coefficient is positive and passes the 5% statistical level test, showing that the overseas background of executives plays a positive regulating role in the process of digital finance promoting enterprise innovation, that is, with the increase of the scale of executives with overseas background in enterprises, digital finance is gradually strengthening the role of promoting green innovation of enterprises. Digital finance initially arose overseas and preceded the development of China's business. In addition, due to the different environment and atmosphere from abroad, talents with overseas study experience or work experience will be better able to accept new things to some extent than talents who have been developing in China. Therefore, when the scale of executives with overseas background in the enterprise is higher, the willingness to try to carry out capital operation through digital finance will be stronger, thus positively regulating digital finance and green innovation in corporate. The above results prove the correctness of hypothesis 2, that is, the overseas background of senior executives plays a regulating effect in the process of digital finance promoting enterprise green innovation.

Column (3) and (4) show the regression results with the educational background of senior executives as the regulating variable, in which digital finance still promots corporate green innovation. After the interaction term of executive education background is added, the interaction term coefficient is positive and significant at the level of 1%, that is, the education background of corporate executives plays a positive regulating role in the process of digital finance promoting green enterprise innovation. When the scale of executives with high education background in the enterprise is higher, the green innovation effect of digital finance on the enterprise is stronger. Institutions of higher learning are one of the most convenient channels to receive cutting-edge information about related majors. Therefore, compared with those with lower education levels, these with higher education levels are more willing to adopt new things and methods. Therefore, the higher the education background of senior executives in enterprise, the more likely the enterprise is to create prerequisites for green innovation through digital finance, which will not be limited to the traditional means of capital turnover to promote the development of corporate green innovation. To sum up, hypothesis 3 is valid, that is, the education background of senior executives plays a regulating effect in the process of digital finance promoting enterprise green innovation.

4.3. Robustness Test and Endogeneity Test

In addition to the above robustness test, in order to further verify the reliability of the empirical results.

Table 4: The result of robustness test and endogeneity test.

Explaining variables	Standard regression	Lag one year	Instrumental variable
	(1)	(2)	(3)
dif	0.0939***	-	-
	(5.41)	-	-
l.dif	-	0.0926***	-
	-	(5.27)	-
tel	-	-	0.0356**
	-	-	(2.41)
size	0.191***	0.193***	0.196***
	(33.08)	(31.11)	(33.98)
cap	-0.219***	-0.203***	-0.240***

Table 4: (continued).

	(-5.40)	(-4.64)	(-5.92)
age	-0.214***	-0.256***	-0.176***
	(-10.58)	(-11.01)	(-9.11)
gdp	0.0884**	0.0651	0.199***
	(2.29)	(1.56)	(6.37)
urb	-0.451***	-0.387***	-0.587***
	(-4.24)	(-3.26)	(-5.76)
gov	-0.530***	-0.593***	-0.268**
	(-6.58)	(-6.80)	(-2.40)
Constant	-4.110***	-3.875***	-5.340***
	(-12.02)	(-10.37)	(-16.92)
N	18360	16515	18360
r2	0.0830	0.0828	0.0820
r2_a	0.0826	0.0824	0.0816

Table 4 will consider the time lag of digital finance, that is, it takes a certain amount of time for digital finance to be put into use and take effect, so the digital finance index will be tested one stage behind. The specific regression results are shown in column (2). It can be seen that the digital finance index lags one period and the benchmark regression results have no significant change, which proves the robustness of the above estimates.

The growth of digital finance cannot be separated from the support of Internet technology, and the region with better Internet development is also the region with a high rate of fixed-line telephones in history. Therefore, using the fixed telephone rate of each region as an instrumental variable of digital finance, the results are in column (3). Both instrumental variables and digital finance index passed the significance level test, indicating that the development of digital finance has indeed improved the green innovation.

5. Conclusions and Suggestions

Based on the data of companies listed in A-share in China from 2011 to 2020. First, we use the regression model to study the role of digital finance in the green innovation in enterprises. Second, we introduce the overseas background and educational background of senior management as regulating variables and study their influence.

By means of the above empirical tests, we can draw the following conclusions. (1) In the background of dual-carbon, digital finance has a positive impact on the development of green innovation. The three sub- dimensions of coverage, using depth and digitization level also greatly promote the improvement of the green innovation level of enterprises. (2) The high-level overseas background has a positive regulatory effect on the impact of digital finance on green innovation of companies. The larger the scale of managers with overseas experience, the stronger the role of digital finance in promoting green innovation in companies. (3) The high-level of education has a positive regulating effect on the impact of digital finance on green innovation in companies. The higher the scale of highly educated senior managers, the stronger the role of digital finance in promoting green innovation in companies.

In accordance with the conclusions, the suggestions are put forward: (1) Continue to strengthen the digital finance, especially to promote green-related financial service projects, so as to increase the role of digital finance in accelerating green innovation of enterprises. Establish a platform to

strengthen the connectivity between high-end technologies, further improve the functions, and enhance the efficiency of digital finance. (2) The enterprise can consciously promote some talents with overseas background or high education, or establish a training system to train the current executives to learn and apply cutting-edge knowledge. Correctly understand the risks and benefits brought by digital finance, and properly apply it in the enterprises' green development.

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