



# Research on Enterprise Green Innovation and Debt Financing Costs

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## Abstract

In order to encourage enterprises to strengthen green innovation and cope with increasingly prominent environmental problems, China government has introduced a series of green financial policies. But, how does green innovation affect debt financing costs in practice? The purpose of this paper is to test the impact of green innovation on the cost of debt financing with the sample of Shanghai and Shenzhen A-share listed companies from 2010 to 2019. It is found that there is significantly negative correlation between the debt financing costs of listed companies and their green innovation, and green innovation significantly reduces the debt financing costs. The findings also include that the accounting conservatism strengthens the reduction effect of green innovation on debt financing costs, and the nature of property rights weakens the reduction effect of green innovation on debt financing costs.

**Keywords**-enterprise green innovation; debt financing costs; accounting conservatism

## 1. INTRODUCTION

Recently years, the state has introduced a series of important green finance policies. The implementation of these policies is conducive to guiding social capital flows to green industries, promoting the rapid development of new energy and environmental protection and energy-saving industries, and accelerating the green transformation of the national economy. By the end of 2020, the green credit amount of 21 major domestic banks exceeded CNY 11 trillion, and the cumulative issuance of domestic green bonds exceeded CNY 1.4 trillion. In 2020, China officially announced the 'carbon peak' and 'carbon neutrality' timetable. Green financial policy will provide strong support for China to achieve the goal of carbon peak and carbon neutrality strategy.

In the context of carbon peak and carbon neutrality, corporate credit financing and bond financing will be constrained by green financial policies. Green financial policy requires financial institutions to consider corporate environmental performance in credit approval, bond issuance and interest rate pricing decisions, focusing on supporting green business activities. Therefore, the performance of energy conservation and

emission reduction of enterprises will affect the difficulty of debt financing, scale, term structure and cost.

Corporate debt financing costs are affected by external audit quality, government regulation, corporate governance structure, property rights, environmental information disclosure, environmental investment, green credit policy and other factors. There are few studies on how corporate green innovation costs debt financing. In terms of research methods, there are few studies on how the debt financing costs of enterprise green innovation. Due to the difficulty in obtaining objective datum such as green patents and green R & D, there are few studies using these objective methods to measure green innovation. Most of them are measured by questionnaires, and the objectivity is weak, which cannot accurately reveal the reality of green innovation. [1] The innovation of this paper is using green patent to measure green innovation, and using empirical method to study how green innovation affects debt financing costs, and the moderating effect of accounting conservatism and property right nature on the relationship between them.

## 2. LITERATURE REVIEW AND RESEARCH HYPOTHESIS

### 2.1. *Enterprise green innovation and debt financing costs*

At present, the research on the relationship between environmental protection and debt financing costs is mainly carried out from the aspects of environmental information disclosure, carbon information disclosure, green credit policy and enterprise innovation. One is corporate environmental information disclosure and debt financing costs. Most scholars have found that the quality of corporate environmental information disclosure is negatively correlated with the cost of debt financing. Zhao and He believed that the more sufficient the environmental information disclosed by enterprises, the lower the cost of debt financing; and government regulation would weaken the negative correlation between the two and increased the cost of debt financing.[2] Ni Juan and Kong Lingwen believed that companies to improve the quality of environmental information disclosure, to seek more bank loans and lower debt financing costs.[3] Yao Lei and Wang Yanyan believed that after the implementation of green credit policy, corporate environmental information disclosure more significantly reduced the cost of debt financing. Second, carbon information disclosure and debt financing costs.[4] Zhou Zhifang et al. believed that there was a “U”-shaped relationship between carbon risk and debt financing costs.[5] At a lower level, the increase of carbon risk would reduce the cost of corporate debt financing. After reaching a certain critical value, the continuous increase of carbon risk would increase the cost of corporate debt financing. Liu and Bian believed that the quality of corporate carbon information disclosure was negatively correlated with the cost of debt financing. Third, green credit policy and debt financing costs.[6] Wang Baohui found that the higher the level of information disclosure of heavily polluting enterprises after the implementation of green credit policy, the lower the cost of debt financing.[7] The green innovation of enterprises has delivered good news of environmental performance to the society, effectively alleviates the information asymmetry between creditors and enterprises, helps creditors to understand the environmental of enterprises, reduces the risk of debt environmental protection, and thus reduces the cost of debt. Based on the above analysis, the following assumptions are proposed:

H1 Green innovation capability of listed companies is significantly negatively correlated with debt financing costs.

### 2.2. *Green innovation of enterprises, accounting conservatism and debt financing costs*

Robust accounting policies help reduce the risk of debt default and the cost of debt financing. Zhang Likun and Yao Meifang found that the higher the level of accounting conservatism, indicating that the smaller the financial risk of enterprises, the lower the cost of debt financing.[8] Deng Yunjun and Pei Xiao found that enterprises with higher accounting conservatism have lower debt financing costs.[9] Zheng Dengjin and Yan Tianyi found that accounting conservatism and audit quality can reduce the cost of debt financing, showing an alternative relationship.[10] Based on the above analysis, the following assumptions are proposed:

H2 Accounting conservatism of listed companies has a positive moderating effect on the negative correlation between green innovation ability and debt financing costs.

### 2.3. *Green innovation, property rights and debt financing costs of enterprises*

For the impact of the nature of property rights on the cost of debt financing, most scholars believe that the nature of property rights is negatively correlated with the cost of debt financing, and the cost of debt financing of state-owned enterprises is significantly lower than that of private enterprises. Qiu Feng and Liu Ke found that the higher the quality of internal control of enterprises is, the lower the cost of debt financing is.[11] Compared with state-owned enterprises, in private enterprises, the more effective the quality of internal control is, the more obvious the reduction effect of debt financing costs is. Zhang found that compared with non-state-owned enterprises, state-owned enterprises negatively moderate the negative correlation between accounting conservatism and debt financing costs.[12] Based on the above analysis, the following assumptions are proposed:

H3 Compared with non-state-owned listed companies, state-owned listed companies have weakened the negative correlation between green innovation capability and debt financing costs.

## 3. RESEARCH DESIGN

### 3.1. *Sample data*

Taking the listed companies in Shanghai and Shenzhen Stock Exchange from 2010 to 2019 as the initial research sample, the samples with missing financial companies, ST, \* ST companies and related variables are excluded, and finally 5632 observations are obtained. Python software is used to capture the green patent data of listed companies from the website of the

State Intellectual Property Office, and other datum are from the CSMAR database.

### 3.2. Variable definition

#### 3.2.1. The explained variable

The explained variable is debt financing costs. Learn from the practices of Zhang Likun and Yao Meifang, namely (interest expense plus capitalized interest expense)/average interest-bearing liabilities. That is, debt financing costs =financial expenses/average interest-bearing liabilities. Interest-bearing liabilities include short-term loans, long-term loans, non-current liabilities due within one year and bonds payable.

#### 3.2.2. Explain variables

Explain the variable as enterprise green innovation. The specific measurement index is the natural logarithm of the sum of the number of green patent applications of listed companies and 1.

#### 3.2.3. Regulate variables

Regulatory variables include accounting conservatism and property rights. Accounting conservatism adopts CSCORE Robust Index Model of Khan and Watts.

#### 3.2.4. Control variables

Referring to the research results of related literature in the past, the controlling variables are listed companies' return on assets, asset-liability ratio, growth rate of operating income and enterprise scale. Specific variables are defined in Table 1.

TABLE 1. VARIABLE DEFINITION TABLE

Variable property	Variable name	variable symbol	Variable definition
Explained variable	Debt financing cost	DFC	Financial expenses/average interest-bearing liabilities.
Explanatory variable	Green innovation	GI	Natural logarithm of the sum of the number of green patent applications of listed companies and 1
regulated variable	Accounting conservatism	CSCORE	Calculated according to K&W model index method
	Nature of the property right	NPR	The value of state-owned enterprises is 1, otherwise it is 0.
Control variable	return on assets	ROA	Ratio of final net profit to average total assets

	Asset-liability ratio	ALR	Book value of ending liabilities/book value of ending assets
	Operating income growth rate	GROR	(Current operating income-previous operating income)/previous operating income
	Industry concentration	HHI	The sum of squares of the percentage of total industry revenue of each market competitor in an industry.
	Scale	SIZE	Natural logarithm of total assets at the end of the period

### 3.3. Model design

In order to test Hypothesis 1, the influence of green innovation of listed companies on debt financing costs is investigated, and the model (1) is established.

$$DFC = \alpha + \beta_1 GI + \beta_2 control + \varepsilon \quad (1)$$

In order to test Hypothesis 2, this paper investigates the moderating effect of accounting conservatism of listed companies on the relationship between green innovation and debt financing costs, and establishes model (2)

$$DFC = \alpha + \beta_1 GI + \beta_2 CSCORE + \beta_3 GI * CSCORE + \beta_4 control + \varepsilon \quad (2)$$

In order to test Hypothesis 3, we investigate the moderating effect of property rights of listed companies on the relationship between green innovation and debt financing costs, and build a model (3).

$$DFC = \alpha + \beta_1 NPR + \beta_2 GI * NPR + \beta_3 control + \varepsilon \quad (3)$$

## 4. EMPIRICAL RESULTS AND ANALYSIS

### 4.1. Descriptive statistics

Descriptive statistical results are shown in Table 2. The average cost of debt financing is 0.0191, and the median is 0.0173, indicating that the proportion of financial costs in total liabilities is 1.91 % and 1.73 %. The maximum value is 0.9262, and the minimum value is -0.0566. The mean value of corporate green innovation is 0.3358, the median is 0, the maximum is 6.7708, and the minimum is 0. The mean value of accounting conservatism is -58.7385, the median value is 0.0273, the maximum value is 40.9821, and the minimum value is -247221.9, indicating that there are great differences in accounting policy conservatism among different listed companies.

TABLE 2. DESCRIPTIVE STATISTICAL RESULTS OF MAIN VARIABLES

	sample number	average / mean value	standard deviation	minimum value	median	maximum
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DFC	5632	0.0191	0.0189	-0.0566	0.0173	0.9262
GI	5632	0.3358	0.7625	0.0000	0.0000	6.7708
CSCORE	5632	-58.7385	2623.9670	-247221.900	0.0273	40.9821
ROA	5632	0.0386	0.0744	-1.8591	0.0369	0.6754
ALR	5632	0.4428	0.2150	0.0084	0.4330	1.7584
GROR	5632	0.3895	14.7621	-1.3092	0.1087	1878.3720
HHI	5632	0.1302	0.1455	0.0184	0.0842	1.0000
SIZE	5632	3.9822	1.5129	-0.7794	3.7403	12.6152

#### 4.2. Regression analysis

In order to test the influence of environmental green innovation on debt financing costs of listed companies, regression test is carried out according to model (1). The test results are shown in Table 3 (1). The results show that the green innovation ability coefficient of listed companies is -0.0017, and it is significant at 1 % level, indicating that the debt financing costs of listed companies is negatively correlated with green innovation. The stronger the green innovation ability of listed companies, the lower the debt financing costs. In terms of control variables, the correlation coefficient between the cost of corporate debt financing and the return on assets is -0.0264, and is significant at the 1% level; the correlation coefficient between corporate debt financing costs and asset-liability ratio is 0.0187, which is significant at the level of 1 %; the relationship between enterprise debt financing costs and business income growth rate, industry concentration and enterprise scale is not obvious.

**TABLE 3.** EMPIRICAL TEST RESULTS OF ENTERPRISE GREEN INNOVATION, ACCOUNTING CONSERVATISM AND DEBT FINANCING COSTS

Column	DFC (1)	DFC (2)	DFC (3)
GI	-0.0017*** -5.3393	-0.0017 -5.4532	-0.0022 -5.5101
CSCORE		0.0003 1.3522	
GI1*CSCORE		-0.0002* -1.8390	
NPR			-0.0027 -4.4629
GI1*NPR			0.0012 1.9096
ROA	-0.0264*** -9.5572	-0.0264*** -9.5254	-0.0266 -9.4499
ALR	0.0187*** 12.2974	0.0186*** 12.1812	0.0189 12.3003
GROR	-0.0001 -0.9917	-0.0001 -0.9950	-0.0001 -1.0162
HHI	0.0021 1.1178	0.0018 0.9883	0.0024 1.2844
SIZE	-0.0001 -0.6325	-0.0001 -0.5363	0.0001 0.5647

Note:\*\*\*, \*\* and \* mean that the correlation coefficient is significant at 1%, 5% and 10% respectively. Under the coefficients in columns (1)- (3) are T values.

#### 4.3. Accounting conservatism adjustment effect test

In order to test the moderating effect of accounting conservatism of listed companies on the relationship between environmental green innovation and debt financing costs, the regression test is carried out according to Model (2). The test results are shown in Column (2) of Table 3. The results show that the cross-multiplication coefficient of green innovation and accounting conservatism of listed companies is -0.0002, and it is obvious at the level of 10 %, indicating that accounting conservatism of listed companies strengthens the negative correlation between debt financing costs and green innovation. Compared with the listed companies with lower accounting conservatism, green innovation has more obvious effect on reducing the cost of debt financing in the listed companies with higher accounting conservatism.

#### 4.4. Property right nature adjustment effect test

In order to test the moderating effect of the property right nature of listed companies on the relationship between green innovation and debt financing costs, the regression test is carried out according to model (3). The test results are shown in Table 3 (3). The results show that the cross-multiplier coefficient of green innovation and property right nature of listed companies is 0.0012, and it is significant at the level of 10 %, indicating that the property right nature of listed companies plays a significant negative moderating effect on the relationship between green innovation and debt financing costs.

### 5. CONCLUSIONS AND SUGGESTIONS

#### 5.1. Research conclusions

Through the above research, the following main conclusions are obtained:

Firstly, the debt financing costs of listed companies is significantly negatively correlated with green innovation. The stronger the green innovation ability of listed companies, the more green patent technology they have, indicating that the stronger the green manufacturing ability of listed companies, the smaller the debt environmental risk faced by creditors, the lower the expected yield of creditors and the lower the cost of debt financing.

Secondly, accounting conservatism of listed companies strengthens the negative correlation between green innovation and debt financing costs. The green innovation ability of listed companies helps to reduce the cost of debt financing. Compared with the listed companies with weak accounting conservatism, the

information transmitted by the listed companies with strong accounting conservatism to the society is more real, the degree of information asymmetry between creditors and enterprises is further reduced, the risk of bond default faced by creditors is further reduced, the expected return rate is lower, and the effect of green innovation on the reduction of debt financing costs is more obvious.

Thirdly, the nature of property rights of listed companies weakens the negative correlation between green innovation and debt financing costs. Compared with state-owned enterprises, the green innovation of private enterprises has a more obvious effect on reducing the cost of debt financing. This may be because the cost of debt financing of state-owned enterprises is lower than that of private enterprises, so the effect of green innovation on reducing the cost of debt financing of state-owned enterprises is not obvious.

### 5.2. Policy recommendations

Based on the above research conclusions, the following suggestions are put forward:

Firstly, enterprises should vigorously strengthen green innovation. Enterprises should make full use of national policies, strengthen environmental protection R & D investment, establish and improve green innovation incentive mechanism, strengthen green technology innovation, transform traditional manufacturing technology with green manufacturing technology, optimize traditional process flow with green technology, develop green products, carry out green services, and implement green transformation of enterprises.

Secondly, enterprises should implement sound accounting policies to improve the quality of accounting information. Enterprises should implement sound accounting policies to improve the quality of accounting information, which helps to alleviate information asymmetry and help creditors understand the true information of business operations. Enterprises should improve the information disclosure system, fully disclose business information, so that creditors can timely understand the enterprise performance ' real information '.

Thirdly, the government should use market mechanism to activate the green innovation ability of private enterprises. Private enterprises are encouraged to participate in major national science and technology projects, establish green innovation research and development teams, actively strive for green financial policy support, strive to strengthen green innovation, effectively fulfill social responsibilities, carry out green manufacturing, improve resource and energy efficiency, and improve environmental performance.

For Future researches, we suggest that the impact of different types of green innovation activities, such as green technology innovation, green technology innovation, green product innovation, green organization innovation, on debt cost, credit cost and bond cost needs further research.

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