NETWORK MEDIA ATTENTION AND GREEN TECHNOLOGY INNOVATION

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ABSTRACT

This paper will provide a novel empirical study for the relationship between network media attention and green technology innovation and examine how network media attention can ease financing constraints. It collected data from listed companies in China's heavy pollution industry and performed rigorous regression analysis, in order to innovatively explore the environmental governance functions of the media. It found that network media attention significantly promotes green technology innovation. By analyzing the inner mechanism further, it found that network media attention can promote green innovation by easing financing constraints. Besides, network media attention has a significant positive impact on green invention patents while not affecting green utility model patents.

KEYWORDS

Media coverage, Green technology innovation, Environmental regulation, Financing constraints.

1. INTRODUCTION

In October 2015, the Fifth Plenary Session of the 18th Central Committee of the Communist Party of China (CPC) put forward five new development concepts of "innovation, coordination, greenness, openness and sharing," which accelerated the pace of the green economy and low-carbon economic development. Green innovation is a new technological innovation that introduces the concepts of ecological environment and green development innovation, aiming to realize the coordination of economic and environmental benefits. [1] Green innovation is not only a socially desirable goal; the economic utility is also highlighted. [2]

It has a "double externality" of knowledge and environment, bringing economic benefits to enterprises and generating ecological and social benefits. [3] However, its positive externality cannot be transformed into the market benefits of technology or products in the process of technology diffusion, and also may lead to the phenomenon of “free rider” in heavy pollution industry, thus leading to market failure. [4] Innovation cannot separate from R&D, but there is a dilemma between R&D expansion and productivity decline in the digital economy. Nowadays, domestic and foreign scholars conduct much research on green technology innovation. Still, they usually focus on the legal systems, including environmental regulation, environmental tax, government subsidies, etc. [5-7], ignoring research based on the extra-legal systems such as media.

With the advent of network information, media plays an essential external role that affects the operation of enterprises, as the fourth force independent of the legislation, justice, administration. [8] The function of the media becomes a complement to the existing system. Some studies have pointed out that the media, as an essential extra-legal system, is one of the leading groups to

promote sustainable innovation of enterprises. [9] Its supervision of public voice is conducive to improving the efficiency of technological innovation of enterprises as a whole. The existing research focuses on media attention and corporate governance [9], capital market, and information disclosure. [10]

At the same time, there is little research on its effect on environmental management at home and abroad. McLeod, a foreign scholar, had found that media coverage can increase attention to environmental issues. [11] Later, Chan's research further demonstrated that the media could also influence environmental behavior through social norms. [12] Foulon points out that using information technology, such as media, could help enterprises improve their environmental performance by monitoring ecological information. [13] In China, due to the late start of China's media industry, Weiqiang & Minzhi (1995) [14] put forward the theory of media environmental governance in 1995. They thought that pressure brought by public opinion is one of the driving forces affecting green technology innovation in enterprises. From an empirical view, Liu Beibei had found that environmental stress from the news media has little impact on the environmental performance of enterprises. [15] However, Wang Yun and other researchers Dongmin, Shasha, & Qianwei (2013) believe that this pressure has a significant effect on environmental investment. As all the above, there are mainly two possibilities of "supervision" and "collusion" in the influence of the media on corporate behavior. However, many studies have found that the media can effectively supervise and govern corporate green behavior. Kong Dongmin and others [16] used the event research method to find that the media exposure to enterprise environmental pollution incidents can effectively urge them to reduce their ecological pollution behavior. By reporting and supervising enterprise environmental pollution incidents, the media force enterprises to increase green investment and improve their environmental behavior. They are finally promoting green technology innovation.

At the same time, in the Internet era, information dissemination is speedy, and the public's access to information has also undergone a fundamental change, from the traditional paper media to the Internet media. As an emerging medium, network media has many characteristics, such as timely and adequate information dissemination, flexible access and convenience, simple information storage, etc. Meanwhile, it is popular to encourage social conversations and stakeholders are connected anytime, anywhere. [17] And network media can play the role to construct the social network.

The public has accepted so that it can produce information transmission and better supervision effect on enterprise management [18] and comprehensively enhance the role of media in corporate governance. On the one hand, the relevant information of enterprise decision-making will be transmitted to external stakeholders through network media. On the other hand, through the implementation process of enterprise decision-making in-depth and continuous follow-up reports, the quality of accounting information disclosure of enterprises is improving, and the information asymmetry with the external capital market is alleviated to play a better external governance effect.

Based on the data of A-share listed companies in the heavy-polluting industry from 2012 to 2018, this paper verifies the impact of network media attention on the green technology innovation measured by applications of green invention patents and green utility models. It takes financing constraints as an intermediary variable in the mechanism analysis. Compared with previous research, the features of this paper is as follows:

(1) Based on the perspective of media attention outside the law, we explore the influence mechanism of media attention on green technology innovation of enterprises. China is in a period of economic transformation when both the degree of perfection of the institutional environment

and the overall level of implementation are low, and there are significant regional differences. Therefore, some local legal systems cannot effectively play their due role. Media will be a compliment at this time.

(2) In the perspective of media attention, we innovatively choose network media instead of traditional media. It is in line with the current characteristics of the internet era and more comprehensive than paper media to measure media attention.

(3) We enrich the literature about the impact of the media on enterprises. The research on the effects of the media on enterprises mainly focuses on corporate governance, information disclosure, and social responsibility, and few scholars explore the environmental governance functions of the media.

(4) Taking account of the different impacts on green technology innovation. We carefully consider the quality differences of green innovation, that is, the difference between green invention patents and utility models, to discuss substantial innovation and strategic innovation, respectively.

2. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

2.1. The relationship between network media attention and green technology innovation

Two potential associations have emerged between green technology innovation and network media attention. On the one hand, enterprises will face up to the information provided by media attention and accordingly adopt other measures I [19] n line with stakeholder demands and social values to obtain legitimacy social reputation, which plays a governance role and improves the level of corporate governance. For example, media attention has expanded the performance losses caused by pollution problems. At this time, the company's best decision is to strengthen environmental activities, so media attention can promote enterprises to increase ecological investment.

On the other hand, high-intensity media attention leads enterprises to limit themselves to public opinion pressure, so enterprises take more short-sighted measures to avoid the current negative impact, that is, the role of force. For example, media attention triggered enterprises to conduct "greenwash" to cope with the public opinion pressure urgently. [20] Therefore enterprises may adopt other informal means, such as false propaganda, emission fraud, etc., to reduce the negative impact of media attention. Comprehensive analysis of the above comment that network media attention, as a basic form of external governance of the company, can play a better role in promoting the implementation of green technology innovation strategy in heavy-polluting enterprises, according to which the following assumptions are put forward:

H1a: Network media attention can significantly enhance the green technology innovation of manufacturing enterprises; that is, the two are significantly positively correlated.

H1b: Network media attention can significantly inhibit green technology innovation in manufacturing enterprises. That is, the two are significantly negatively correlated.

2.2. Mechanism Analysis

The information function hypothesis holds that the media acts as an information intermediary in the capital, [21] which means the existence of the media can effectively alleviate the information asymmetry between enterprises and stakeholders and make the information audience more aware of the business situation through information processing, packaging, and dissemination. Media can enhance the transparency of information of enterprises and reduce information friction in the market. Media provide an opportunity for big data analytics, which may play a role in consumer finance, credit card finance in China. [22]

When the degree of financing constraints is high, the ability of enterprises to obtain green innovation funds is weak. In the face of external media attention and media attention caused by the pressure of investors, enterprises may prefer to choose temporary measures to achieve short-term effects of energy conservation and emission reduction, and lack of financial capacity to green innovation, resulting in the weakening of green innovation effect of enterprises. When enterprise financing constraints are low, enterprises have a solid ability to obtain green innovation funds; enterprises are more inclined to carry out more green innovation activities to achieve sustainable development of enterprises. From another perspective, when enterprises receive a high degree of network media attention, they pass on management's financial decisions to the external capital market through the information transmission effect, so management will send a signal of "competence" to the external capital market through the active implementation of green technology innovation, to obtain better financing opportunities and social prestige. Therefore, the hypothesis is made:

H2: Network media attention promotes green technology innovation by easing the financing constraints of enterprises.

3. RESEARCH DESIGN AND SAMPLE SELECTION

3.1. Data sources and processing

Referring to the research of [23], this paper focuses on listed companies in heavy pollution industries from 2012 to 2018. Data such as network media attention, number, and patent applications are from the CNRDS database. Corporate profitability and annual report data are from the CSMAR database. Considering that the WSVI database collects and collates the data of the Web Search Index from 2011 to 2019, which takes the stock code, shorthand for the company, and the company's full name as keywords. The Chinese government made the strategic decision of "building ecological civilization" in 2012, but Green innovation and some macro data were only updated to 2018, so this study chose 2012-2018 as the sample observation period.

This paper deals with the sample as follows:

(1) In the process of screening sample companies, mainly according to the relevant provisions in Chapter 4 of the Environmental Protection Law of the People's Republic of China on pollution prevention and control, combined with the relevant definition of high-polluting industries(including chemical, pharmaceutical and so on) in "listed companies environmental information disclosure guidelines" (draft for comments) issued by the former Ministry of Environmental Protection (now the Ministry of Ecological Environment) in 2010;

(2) Exclude incomplete samples of data required for the study.

(3) Exclude outliers, such as companies with an asset-liability ratio greater than 1. Based on the above criteria, 1783 company-year observations were obtained, and the relevant continuous variables in the model were condensed at 1% and 99%.

Finally, the data covers 20 heavily polluting industries, including pharmaceutical and chemical raw materials manufacturing. Non-state-controlled companies account for 48.80% of the observations, and state-controlled companies account for 51.2%

3.2. Variable Definition

3.2.1. Independent Variables: Network Media Attention MA

WSVI database collected and collated Web Search Index data that takes China's listed companies stock code, company abbreviation, and full name as keywords from 2011-2019. Based on CNRDS data, this paper takes the natural logarithm of the mean value of each company's annual Web Search Index plus one as the proxy variable, represented by Media Attention (MA). The higher the value of MA, the higher the network media attention on the enterprise.

3.2.2. Dependent Variables: Enterprise Green Technology Innovation GTI

This paper measures the innovation output by the enterprise's annual new green patent application volume. [24] Match the IPC classification number of the invention patent and utility model filed by the enterprise with the IPC Green List to record the number of green patents. This paper adopts the application volume of the invention patent rather than the grant amount because of the lag in the granting of the invention patent and the short sample period. Besides, the number of invention patent applications more accurately reflects the CEO's innovation motivation and innovation consciousness. [25, 26] China's patents can be divided into invention patents, utility models, and designs, of which the invention patent is of the most outstanding value, the highest degree of investor recognition. Based on the definition of Patent Law in China and the discussion of existing research literature, [27, 28] in the green innovation heterogeneous test, green innovation is divided into substantial innovation (measured by the amount of green invention patent application) and strategic innovation (measured by the number of applications for green utility models), to further test whether the impact of network media attention on green innovation is a substantial promotion or a promotion at the strategic level.

3.2.3. Control Variables

Controls based on previous literature [29, 30], the article mainly controls the following variables: the nature of property rights (SOE), the size of the company (size), fixed assets ratio, return on assets (ROA), debt ratio lev, company age, growth rate and so on.

3.2.4. Fixed Effect:

We control the year effect and industry effects. In addition, there are significant differences in green technology innovation among industrial enterprises in China, so it makes sense for us to continue to control this fixed effect in the provinces.

Table 1. Variable Table

Name	**Symbol**	**Description**
Online Media Attention	MA	ln(Web Search Index+1)
Green Technology Innovation	GTI	annual application number of green patent
Substantial Green Innovation	green_invia	annual application number of green invention patent
Strategic Green Innovation	green_umia	annual application number of green utility model
nature of property right	SOE	if it is a state-owned enterprise, let SOE equal to 1; otherwise, let SOE equal to 0.
corporate size	size	ln(asset)
fixed asset ratio	fixasset_ratio	fixed asset/total asset
Return on asset	ROA	net profit/total asset
Leverage ratio	lev	liability/asset
Age	age	the time span since the enterprise came into the market
Growth of Income	GrowthofIncome	the growth rate of operating income

3.3. Basic model

This study uses multi-year, multi-enterprise panel data, so the panel regression model is used in the process of regression analysis. This method can effectively expand the sample size of this study. For baseline hypothesis 1, the regression model of this study is as follows:

$$GTI = \alpha + \beta_1 \ MA + \gamma Controls + \varepsilon \quad (1)$$

β_1 represents the coefficient of the explanatory variable, and its direction is the focus of this study, which indicates the impact of network media attention on green technology innovation.

4. EMPIRICAL ANALYSIS

4.1. Multiple regression analysis

Table 2. OLS Regression Results

VARIABLES	GTI	GTI	GTI	GTI
MA		1.762***	1.206*	1.762**
		-0.68	-0.678	-0.695
SOE	1.885***	1.732**	2.145***	1.732**
	-0.702	-0.704	-0.673	-0.758

lev	-0.0646***	-0.0647***	-0.0712***	-0.0647***
	-0.0215	-0.0214	-0.0214	-0.0219
ROA	2.745	0.276	-3.682	0.276
	-6.503	-6.561	-6.615	-6.553
Growth of Income	-0.0909	-0.0199	0.549	-0.0199
	-0.826	-0.825	-0.839	-0.709
Fixed asset ratio	-0.0690***	-0.0672***	-0.0843***	-0.0672***
	-0.0226	-0.0226	-0.0224	-0.0215
size	4.170***	3.703***	3.867***	3.703***
	-0.331	-0.377	-0.373	-0.429
Province	YES	YES	NO	YES
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
Constant	-78.87***	-79.98***	-82.49***	-79.98***
	-7.112	-7.113	-6.735	-8.669
Observations	1,783	1,783	1,783	1783
R-squared	0.251	0.253	0.192	0.253

The first column displays the regression results prior to adding the explanatory variable. The coefficient of control variable SOE is considerably positive at the 1% level, indicating that state-owned enterprises will significantly affect the green innovation of enterprises. However, the ratio of assets to liabilities and fixed assets will suppress green innovation at a 1% level.

After adding the explanatory variable- new_search2- the regression result is shown in the second column. New_search2 is known to have a significant positive effect on GTI (coefficient equals 1.762) at the 1% level. After adjusting for the province, industry, and year effect, the model's fit is 0.253, higher than that without controlling for province fixed effect (0.192), and network media attention and other control variables could explain 25.3% of the influence on GTI. At the same time, after controlling for the province effect, the effect of network media attention (new_search2) on GTI is more significant (at 1% level). The overall regression results of the model are in a relatively good state.

As shown in the fourth column in the table, we conduct a White robust standard error test. The coefficient of explanatory variable new_search2 is 1.762, positively correlated with the explanatory variable, and conforms to the assumption. Moreover, it meets the criteria at a 5% significance level.

4.2. The mediation effect of financing constraints

In exploring the impact of network media attention on the green innovation of enterprises, we cannot but examine the regulatory role of financing constraints in it. The SA, KZ, WW, and other indicators are widely used in academia to measure financing constraints. We use SA indices that do not rely on endogenous financial indicators for endogenous reasons. The formula is

$$SA = -0.737 \times Size + 0.043 \times Size^2 - 0.040 \times Age \quad (2)$$

According to relevant literature [31, 32], the controlled variables above can also influence financing constraints. The intermediary effect analysis method is used in three steps in this paper:

The first step is to verify that network media attention is conducive to improving the level of green innovation GTI. The second step tests the relationship between network media attention and financing constraints. The third step is to integrate network media attention, SA index, and green enterprise innovation into the same model to test the existence of the intermediary effect.

It can be seen that the regression coefficient of network media attention to SA equals to1.144336, and it is significantly positive at 1%. Moreover, the regression coefficient of SA to green enterprise innovation (-0.04767) is highly positive at 1%, and the regression coefficient of network media attention to green enterprise innovation (3.327369) is significantly positive at 1%. It is explained that financing constraints mitigate the impact of network media attention and corporate green innovation. Besides, the ratio of intermediary development to the total product was 95.01%. Specifically, network media attention can increase the SA index while decreasing the financing constraint, implying that network media will alleviate financing constraints; The more significant the SA index, the smaller the financing constraint, the stronger the green innovation of enterprises. That is, the financing constraints inhibit the green innovation of enterprises; Therefore, the network media attention through the easing of financing constraints to promote green innovation. With the increase of media attention, it can effectively reduce the information asymmetry between enterprises and banks, and other creditors. Financial institutions can better understand the business and profitability of enterprises improve the transparency of enterprises so that enterprises face fewer financing constraints. When companies get more external funding, they lay the foundation for green innovation activities.

4.3. Heterogeneity test

Green patents include green invention patents, green utility model patents, and green design patents. In the degree of substantial innovation, green invention patents are the highest, green utility model patents are second, and green design patents are the lowest. According to relevant studies [28, 33, 34], Green invention patents are substantial innovations, whereas green utility model patents were divided into strategic innovation. To further test whether the above findings depend on the level of innovation, we divide green patents into green invention and green utility, and it was discovered that network media attention has no significant effect on green strategic innovation(coefficient equals 0.338，$p>0.1$) but had a significant impact on substantive green innovation. (coefficient equals to 0.861, $p<0.05$)

Table 3. Heterogeneous Regression Results

VARIABLES	greinvia_all	greumia_all
MA	0.861**	0.338
	-0.365	-0.27
Controls	YES	YES
Province_	YES	YES
Industry	YES	YES
Year	YES	YES
Constant	-35.83***	-35.28***
	-3.819	-2.826
Observations	1783	1783
R-squared	0.24	0.267

5. CONCLUSIONS

The conclusion of this paper states: First, we should further develop the information function of network media, improve enterprise governance through the media and alleviate the information asymmetry in the market, ease financing constraints, and obtain funds for enterprise's green innovation activities. Second, the network media attention can play a role in promoting innovation performance. A big reason is based on government departments and market reputation mechanism and the resulting supervision effect, so the government should timely capture the media information disclosure of enterprises to achieve timely treatment of corporate violations. At the same time, we should further improve the manager market, give full play to the media attention based on the reputation mechanism to play the role of supervision to regulate the behavior of managers reduces agency costs effectively. Third, from the guiding significance of policy, under the background of China's transition economy, to guide enterprises from the passive innovation under regulatory pressure to active creation to obtain an excellent public opinion-oriented transformation. Emphasize that the role of the media as an external system of environmental governance is being strengthened, not just relying on the mandatory ecological regulation of our government. The government should give full play to the role of extra-legal supervision of the media, drive the mainstream public opinion and establish a multi-pluralistic environmental governance system.

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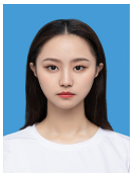

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