Impact of Corporate Social Responsibility on R&D Investment Based on Multiple Regression Analysis
——The Dual Moderating Effect of Media Attention and Marketization Process

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Abstract

Using multiple regression analysis, this paper investigates the relationship between corporate social responsibility and R&D investment, and examines the moderating effect of media attention and marketization process. The study shows that: (1) Corporate social responsibility can promote R&D investment. (2) Under higher media attention, corporate social responsibility can better promote R&D investment. (3) Under higher marketization process, media attention will create stronger moderating effect on corporate social responsibility and R&D investment. (4) Compared with state-owned companies, non-state-owned companies' performance of social responsibilities brings more obvious positive impact on R&D investment. This study provides theoretical support for corporate performance of social responsibilities, which also provides a new perspective for revealing the impact mechanism of corporate R&D investment, and at the same time offers a certain reference for related practices.

***Keywords**: Corporate social responsibility, R&D investment, media attention, marketization process*

I. Introduction

Under the general trend of economic globalization, companies worldwide are constantly seeking R&D and innovation to improve their core competitiveness. As an important force that closely integrates technology and economy, companies are the main force in technological innovation and achievement transformation. At the same time, it has become the consensus of everyone to make companies actively fulfill their social responsibilities, proactively respond to and solve the social issues of concern [1]. As we all know, corporate innovation is inseparable from R&D investment, and corporate performance of social responsibility also needs financial support. Hence, what is the impact of corporate performance of social responsibility on R&D investment? Does it promote or inhibit the latter? Although studies have shown that corporate social responsibility can directly or indirectly promote R&D investment through financing constraints [2, 3], some studies have found that there is a two-way negative influence mechanism between corporate social responsibility and innovation R&D investment [4]. It can be seen that whether corporate social responsibility can promote the increase of R&D investment is still unclearly concluded. However, if there is no correct understanding towards this important issue, it will be difficult for companies to improve the level of technological innovation by formulating appropriate strategies. Therefore, under the current situation in China, investigation into the relationship between corporate social responsibility and R&D investment, studies of how to make companies more actively perform social responsibilities, and how to improve the level of corporate technological innovation have become important research topics.

In corporate business activities, media attention is an important approach in the external supervision mechanism against the company, and marketization process is an important external environmental condition, both of which will greatly impact the fulfillment of corporate social responsibility and the development of R&D activities. In particular, for China amid transformation and upgrading in economic development, significant differences are shown in the level of marketization in various regions [5]. Such difference will lead to different media attention and restrain corporate R&D decisions. Therefore, when exploring the impact of corporate social responsibility on

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R&D activities, we cannot ignore the role of media attention and marketization process.

Based on this, this paper takes domestic A-share listed companies as research objects, integrates corporate social responsibility, media attention, marketization process, and R&D investment into the same analytical framework, uses media attention as a moderator to investigate the impact mechanism between performance of corporate social responsibility and R&D investment. Finally, it studies whether there will be different moderating effects of media attention on corporate social responsibility and R&D investment when the company is in different marketization processes.

The marginal contributions of this paper are mainly as follows: First, although there are abundant literatures on the factors affecting R&D investment, few scholars incorporate corporate social responsibility into the consideration of factors affecting R&D investment; the mechanism between corporate social responsibility and R&D investment lacks in-depth discussion; the definition of the relationship between the two is mostly based on qualitative description. This paper verifies the role of corporate social responsibility in promoting R&D investment, and further enriches the literatures on economic consequences of corporate social responsibility. Second, with the rapid development of information technology, the Internet has become an important channel for the social public from all walks of life to access and disseminate corporate information and influence corporate decision-making. This paper uses media data to measure media attention and takes media attention as a moderating variable to thoroughly investigate the relationship between corporate social responsibility and R&D investment. Third, due to the uneven development between the east and the west in China, marketization degree is greatly different. This paper compares the impact of different levels of marketization on companies, explores the effect of media attention on corporate social responsibility and R&D investment, and analyzes the impact of macro environment on micro corporate decision-making, which will help enrich the researches in the field of corporate social responsibility and R&D investment.

II. Literature Review and Research Hypothesis

2.1 Corporate social responsibility and R&D investment

Both corporate social responsibility and R&D investment play an important role in improving corporate competitiveness, and the debate regarding whether there may be an interaction between the two has also been intensified. By sorting the existing literature, some scholars at home and abroad have investigated the relationship between corporate social responsibility and R&D investment, but their conclusions are not uniform. Where, some scholars affirmed the positive impact of corporate social responsibility on R&D investment. For example, in 2000, McWilliams and Siegel confirmed for the first time that there is a high degree of positive correlation between corporate social responsibility and R&D investment [6]. It is believed that such correlation is likely to derive from their joint contributions to corporate production and innovation. The research conducted by Padgett and Galan in 2009 from the perspective of resource-based view also confirmed this conclusion [7]. Fu et al. evaluated the ASSET4ESG data of more than 6000 companies worldwide, and used the ratio of R&D expenses to total assets as a measure of R&D investment [8]. The research conclusions once again confirmed the positive impact of R&D investment on corporate social responsibility. Nevertheless, there are constant controversies from the literatures considering that R&D investment has nothing to do with corporate social responsibility or even there are mutual inhibitions between the two. For example, Subin Wen and Yuan Fang believe that performance of corporate social responsibility will create a negative impact on corporate performance, because corporate social responsibility will take up a lot of funds and carry a greater risk [9]. In the short term, it will not bring a beneficial impact on the company, but may even create a negative impact on the current financial performance, which then affects the company's R&D decisions. Similarly, Gallego-Álvarez et al. explored the relationship between corporate social responsibility and innovation based on the data sample of 1,000 international companies in 2003-2007, finding that there is a two-way negative impact mechanism between CSR and innovation R&D investment [4]. Also, Yongming Zhu and Min Liu supported the views of Subin Wen and Yuan Fang, considering that under insufficient

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resources, corporate social responsibility has an inhibitory effect on R&D investment [9, 10]. This paper believes that performance of corporate social responsibility is consistent with the strategic goals of R&D investment, both of which are important strategic choices for corporate sustainable development. Therefore, there is a positive correlation between performance of corporate social responsibility and R&D investment. For an activity that relies heavily on the needs of stakeholders, whether corporate social responsibility can be smoothly performed will inevitably depend on whether the company can provide the necessary conditions for meeting these needs [8]. According to the stakeholder theory, in the process of performing social responsibilities, companies can well meet the social responsibility demands of stakeholders, enable establishment of close relationships with various stakeholders, and acquire various resources like knowledge, information and talents, thereby driving the increase in R&D investment.

In the general environment of domestic economic transformation and development, more and more companies begin to consciously perform their corporate social responsibilities. While undertaking corporate social responsibility, on the one hand, companies need improve the production process and therefore need pay more attention to upgrading and improvement of production processes to save energy and raw materials. On the other hand, in the eyes of consumers, corporate social responsibility means companies can provide people with healthy and green social responsibility products [11], which is inseparable from corporate R&D investment, so performance of corporate social responsibility will make companies increase R&D investment. In addition, performance of social responsibilities can help companies establish a good corporate image and social reputation, and then gain political legitimacy [12], which can help companies find more reliable partners when carrying out innovative activities, and make it easier for companies to gain the favor of external investors [13], thus bringing important resources such as tax incentives, land, and market access rights. These will help companies acquire more disposable funds from the capital market, and then further expand R&D investment [14]. Therefore, the following hypothesis 1 is proposed:

H1: Corporate social responsibility can promote R&D investment.

2.2 The moderating effect of media attention on corporate social responsibility and R&D investment

Based on the stakeholder theory, companies not only strive to achieve traditional financial indicators, but also pursue the benefits created in interaction with other stakeholders. Van Riel and Fombrun pointed out in the book the importance of two-way communication between companies and external organizations [15]. Through interaction with stakeholders, companies can not only gather more resources, but also improve reputation and legitimacy. The practice of corporate social responsibility is an activity that requires continuous interaction with stakeholders such as the media and consumers, and its communication network characteristics cannot be ignored [16]. With the development and evolution of communication modes in social relations, media such as the Internet, news, or newspapers are playing an increasingly important role in the process of information transmission between internal and external stakeholders. The media's information transmission by reporting corporate behavior has greatly reduced the information asymmetry between internal and external stakeholders. In this process, external stakeholders can easily access corporate information in a relatively short period of time, and companies will have more and more effective channels to acquire information and knowledge, so companies can quickly obtain feedback from the outside world [17]. Moreover, these continuously acquired information and knowledge are bound to promote the transformation of corporate social responsibility into R&D results [18].

With more media attention, companies will receive more attention, which will exert invisible pressure on the company and encourage it to make greater contributions to society. Brown and Deegan found that the interaction between companies and the media also follows the theory of legitimacy [19]. When the media reports on the bad behavior of the company, the company will make more complete information disclosure under more intense negative report to meet the public’s expectations as a response. Similarly, media attention with a supervisory role can also make relevant government law enforcement agencies strengthen corporate management, and take it as opportunity to more comprehensively judge whether corporate behavior meets the corresponding rules and regulations [20]. In addition, media attention can broaden the company's R&D resources and vision, ease financing constraints, and enable acquisition of more R&D funds. Bughin and Chui found that about 65% companies can achieve innovation by increasing media attention through social platforms, indicating that media attention and R&D and innovation investment are two interrelated subjects [21]. In the practice of corporate social responsibility, media attention will help companies acquire external resources for R&D activities, create a market environment of mutual integration [22]. Through the above analysis, we can see that in the practice of social responsibility, media attention can alleviate the information asymmetry between the internal and external company stakeholders, improve corporate legitimacy and reputation, and enable acquisition of more resources and policy support for the company's R&D and innovation activities. Therefore, hypothesis 2 is proposed:

H2: Under higher media attention, corporate social responsibility can better promote R&D investment.

2.3 The impact of marketization process on media attention, corporate social responsibility and R&D investment

Since 1978, China's marketization process has achieved remarkable results. The rapid development of the market economy and the diversification of industries have clearly demonstrated the promoting effect of marketization process without exception. Nevertheless, significant regional differences still exist in the marketization process of China [23]. For market as a macro factor, such regional differences will inevitably create an important impact on the micro individuals participating in market activities.

First of all, media attention will produce more obvious supervision and spurring effect in regions with high marketization process. For its reason, the more comprehensive and strict market supervision in regions with high marketization process provides prerequisite for the media’s accurate reporting and complete transmission of information, and the resulting less government intervention also makes media reports more independent and objective[24]. Second, thorough marketization process can provide a more open and transparent competitive environment for corporate social responsibility and R&D and innovation activities. As early as 2018, Vilanova et al. pointed out that companies with good corporate social responsibility performance have greater potential for innovation, and such potential will trigger competition mechanisms in the industry[25]. Later, Fernandez-Kranz and Santalo found that under the fierce market competition environment, companies tend to view active performance of social responsibility as a strategic means and thus perform social responsibility more actively [26]. Finally, regions with high marketization process usually have more comprehensive resource allocation and more complete legal system environment, which to a certain extent weakens the constraints of funds and personnel for R&D activities, and at the same time better protects companies’ technological innovation results, safeguards investors’ legitimate rights and interests[27]. Therefore, on the whole, the excellent development environment created by marketization process, media attention and corporate social responsibility activities can stimulate companies’ R&D enthusiasm, which in turn encourages companies to invest more funds to R&D activities. Therefore, the following hypothesis 3 is proposed:

H3: Under higher marketization process, media attention will create stronger moderating effect on corporate social responsibility and R&D investment.

The hypothetical model of this paper is shown in Figure 1:

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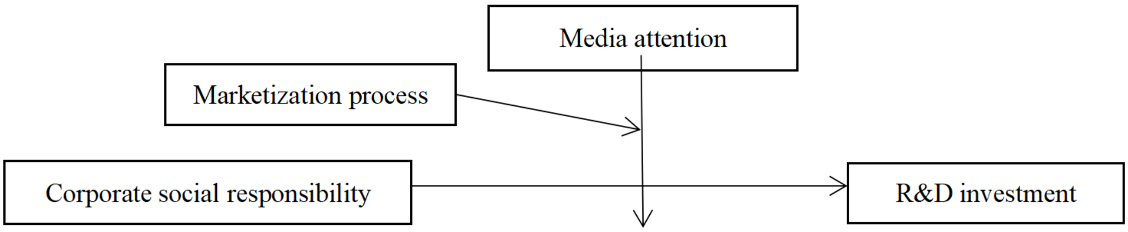

Fig 1: Hypothetical model diagram

III. Research Design

3.1 Sample selection and data sources

This paper selects the annual data of China's A-share listed companies in 2011-2019 as samples. After excluding companies with missing ST, PT, and key values, we finally obtained 4739 observation samples. Data on corporate social responsibility, R&D investment and media attention derives from CNRDS (Chinese Research Data Services Platform), data on marketization progress derives from marketization indexes across China [28], executive incentives, ratio of independent directors and debt leverage, etc. derive from the CSMAR (Cathay Pacific) database.

3.2 Variable selection

3.2.1 Dependent variable
R&D investment (R&D). With reference to the research methods of Bai Yang and Lin Chuan and Du Liu et al.[2,29], this paper conducts logarithmic treatment on company R&D investment to avoid heteroscedasticity.

3.2.2 Independent variable
Corporate Social Responsibility (CSR). Since corporate social responsibility behavior involves multiple dimensions and is difficult to comprehensively quantify, the theoretical community currently lacks a unified and authoritative measurement method. According to Carroll social responsibility structure pyramid model, charitable donation responsibility is the highest level of corporate social responsibility and is a voluntary responsibility [30]. Active participation in charitable donations indicates that the company has a high sense of social responsibility. Therefore, this paper draws on the research of Sihai Li et al. and Yaqian Wu et al., and uses corporate donation data from the Chinese Research Data Services Platform (CNRDS) as a proxy variable for corporate social responsibility [31, 32].

3.2.3 Adjustment variables
(1) Media attention (Media). There are currently two methods for measuring media attention: one is to use the number of online news, and the other is to use the number of newspaper media. However, due to the massive and complex online information, it is difficult to determine whether there is correlation with listed companies. According to the research of Liping Xu and Yu Xin, newspaper media has a significant positive correlation with online news, and the credibility of online news is far smaller compared to traditional newspaper media [33]. Hence, this paper refers to the research of scholars such as Guobao Xiong and Yuanda Luo, and Yanyan Gao and Yunxia Bi [34,35], and uses the number of quantified reports on financial news from CNRDS (Chinese Research Data Services Platform) to reflect the degree of media attention. Specifically, there are total media report, positive media report, neutral media report and negative media report.

(2) Marketization process (Market). With reference to the practices of Hong Chen et al., Gaobao Xiong and

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Yuanda Luo[34,36], the marketization process data is derived from the synthetic score of annual marketization index of each province in the "Marketization Index of China's Provinces: NERI Report (2018)" compiled by Xiaolu Wang et al.[28].

3.2.4 Control variables

With reference to literature by Bai Yang and Lin Chuan, Hong Chen et al. and Yan Song and Xiaojun Sun[2,3,36], the following control variables are introduced in the model herein based on research questions: corporate profitability, debt leverage, ratio of independent directors, equity concentration, executive incentives, company size. Specific variable definitions are shown in Table 1:

Table 1 Definition of main variables

Name	Symbol	Definition
R&D investment	*R&D*	Ln (the amount of corporate annual R&D investment +1)
Corporate Social Responsibility	*CSR*	corporate donation data on Chinese Research Data Services Platform (CNRDS)
Media attention	*Media*	The number of quantified reports on the financial news of Chinese listed companies/1000
	Media1	Total number of positive media reports/ 1000
	Media2	Number of neutral media reports/1000
	Media3	Total number of negative media reports/1000
Marketization process	*Market*	synthetic score of annual marketization index of each province in the "Marketization Index of China's Provinces: NERI Report (2018)" compiled by Xiaolu Wang et al.[28]
Company Nature	*Soe*	State-owned company is indicated by 1, otherwise it is 0
Corporate Profitability	*Roe*	Total Asset Profitability
Debt leverage	*Lev*	Annual asset-liability ratio
Ratio of independent directors	*Ind*	The ratio of the number of independent directors to the number of board of directors
Equity Concentration	*Large*	Share ratio of the largest shareholder multiplied by 100
Executive Incentives	*Incentives*	The natural logarithm of the annual salary of the top 3 executives
Company size	*Size*	Natural logarithm of the number of employees

3.2 Model specification

To test Hypothesis 1, this paper constructs the following model (1):

$$R\&D=\alpha_0+\alpha_1 CSR+\sum\alpha_k Controls+\varepsilon \qquad (1)$$

Where, model (1) examines the impact of corporate responsibility on R&D investment. When the corporate responsibility coefficient α_1 is greater than 0 and significant, H1 is supported.

To test Hypothesis 2, this paper constructs the following model (2):

$$R\&D=\alpha_0+\alpha_1 CSR+\alpha_2 Media+\alpha_3 CSR*Media+\sum\alpha_k Controls+\varepsilon \qquad (2)$$

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Where, *CSR*Media* represents the interaction term between media attention and corporate social responsibility. Model (2) examines the moderating effect of media attention on the relationship between corporate responsibility and R&D investment. When the interaction coefficient α_3 is greater than 0 and significant, H2 is supported.

To test Hypothesis 3, this paper constructs the following model (3):

$$R\&D=\alpha_0+\alpha_1 CSR+\alpha_2 Media+\alpha_3 Market+\alpha_4 CSR*Media+\alpha_5 CSR*Market+\alpha_6 Market*Media+\alpha_7 CSR*Media*Market+\sum\alpha_k Controls+\varepsilon \quad (3)$$

Where, *CSR*Media*Market* represents the interaction term between corporate social responsibility, media attention and marketization process. Model (3) examines the moderating effect of marketization process on media attention, corporate social responsibility and R&D investment. *CSR*Media*Market* is the main observation indicator.

IV. Empirical Analysis

4.1 Descriptive statistical results

Table 2 lists the descriptive statistics and correlation coefficients of the variables. It can be seen from Table 2 that the average R&D value is 18.385 and the standard deviation is 1.935, indicating quite different R&D investment of the sample companies; the average CSR value is 2.103 and the standard deviation is 1.427, indicating that corporate social responsibility of listed companies in China is quite different, and the overall performance level is not high; the mean value of media attention is 0.172, the standard deviation is 0.490, which is significantly positively correlated with R&D at the level of 0.1%, indicating that different companies receive quite different media attention from newspapers, and companies with higher levels of attention have higher EPS. The correlation coefficient between corporate social responsibility and R&D investment is 0.270, there is significant positive correlation at the 1% level, indicating that corporate social responsibility has a significant promotion effect on R&D investment, which initially verifies hypothesis 1. In addition, it can be seen from the correlation test results that the correlation coefficient value of each variable is small, indicating that there is no serious multicollinearity problem among the variables.

Table 2 Descriptive statistics and correlation coefficients

Variable	1	2	3	4	5	6	7	8	9	10
R&D	1									
CSR	0.270^{***}	1								
Media	0.225^{***}	0.177^{***}	1							
Market	0.181^{***}	0.113^{***}	0.036^{**}	1						
Lev	0.190^{***}	0.138^{***}	0.122^{***}	-0.058^{***}	1					
Ind	0.111^{***}	0.052^{***}	0.069^{***}	0.019	0.080^{***}	1				
Incentives	0.383^{***}	0.345^{***}	0.175^{***}	0.301^{***}	0.100^{***}	0.048^{***}	1			
Large	0.060^{***}	0.026^{*}	0.080^{***}	-0.032^{**}	0.132^{***}	0.091^{***}	-0.095^{***}	1		
Size	0.562^{***}	0.361^{***}	0.316^{***}	-0.002	0.424^{***}	0.121^{***}	0.385^{***}	0.246^{***}	1	
Roe	0.080^{***}	0.079^{***}	0.023	0.081^{***}	-0.376^{***}	-0.019	0.187^{***}	0.052^{***}	0.002	1

Mean	18.385	2.103	0.172	8.314	0.468	0.377	14.652	0.374	8.571	0.048
SD	1.935	1.427	0.490	1.895	0.196	0.060	0.731	0.160	1.334	0.065

4.2 Multiple regression analysis

4.2.1 Impact of Corporate Social Responsibility on R&D Investment

Model (1) in Table 3 reports the regression analysis results of corporate social responsibility against R&D investment. Where, the CSR coefficient is 0.044, which is significant at the 1% level. The results show that corporate social responsibility is significantly positively correlated with R&D investment. That is, corporate social responsibility can promote R&D investment. In addition, from the results of the control variables, it can be seen that the asset-liability ratio, equity concentration are significantly negatively correlated with R&D investment, indicating that under higher corporate debt leverage and equity concentration, corporate R&D investment is lower. Corporate profitability, executive incentives, ratio of independent directors and company size are all significantly positively correlated with R&D investment at the 1% level, indicating that companies with better profitability, more executive incentives, higher ratio of independent directors, and larger company size are more likely to invest in corporate R&D. These empirical results are consistent with the results of existing studies, which verifies hypothesis 1 proposed herein.

4.2.2 Moderating effect of media attention and marketization process

To test whether media attention has a moderating effect on corporate social responsibility and R&D investment, this paper introduces media attention and the interaction term between media attention and corporate social responsibility. From the model (2) in Table 3, it can be found that the CSR*Media coefficient (0.049, $p<0.05$) is positive and significant, indicating that media attention positively regulates the relationship between corporate social responsibility and R&D investment. That is, under higher market attention, corporate social responsibility can better promote R&D investment. Hypothesis 2 is thus verified.

To test the moderating effect of media attention on corporate social responsibility and R&D investment under different marketization process backgrounds, this paper introduces the interaction term (CSR*Media*Market) of marketization process, media attention and corporate social responsibility. The model (3) in Table 3 reports the empirical results regarding the impact of the three interaction terms of marketization process, media attention and corporate social responsibility on corporate R&D investment. It can be found that the regression coefficient of Media (0.172, $p<0.01$) is positive and significant, the interaction term CSR*Media*Market has a coefficient 0.062, which is significantly positively correlated with R&D at the level of 1%. The results show that with higher marketization process in the region where the company is located, media attention exerts more obvious moderating effect on corporate social responsibility and R&D investment. Hypothesis 3 is thus verified.

Table 3 Results of multiple regression analysis

Variable	R&D		
	Model (1)	Model (2)	Model (3)
CSR	0.044***	0.031*	0.027***
	(2.588)	(1.727)	(4.150)
Media		-0.015	0.171***
		(-0.158)	(2.965)
Market			0.172***
			(16.128)
CSR*Media		0.049**	0.004

		(2.036)	(0.175)
CSR*Market			-0.010***
			(-2.592)
Media*Market			-0.316***
			(-6.471)
CSR*Media*Market			0.062***
			(4.008)
Lev	-0.245*	-0.217	0.087
	(-1.802)	(-1.593)	(1.595)
Ind	1.616***	1.582***	1.455***
	(4.396)	(4.305)	(9.137)
Incentives	0.443***	0.442***	0.226***
	(12.654)	(12.596)	(15.391)
Large	-0.700***	-0.721***	-0.822***
	(-4.763)	(-4.906)	(-13.612)
Size	0.728***	0.711***	0.741***
	(34.409)	(32.796)	(82.207)
Roe	1.156***	1.203***	1.241***
	(3.036)	(3.154)	(8.771)
N	4739	4739	4739
Adj.R^2	0.365	0.366	0.787
F value	389.324***	305.157***	1352.066***

4.3 Further examination

4.3.1 Moderating effect of Media (Nature) on CSR and R&D

To better test the mediating effect of media attention on the relationship between CSR and R&D, this paper subdivides media attention into positive media reports (Media1), neutral media reports (Media2) and negative media reports (Media3). Media1, Media2 and Media3 are introduced for further in-depth examination. According to the models (1), (2) and (3) in Table 4, the regression coefficients of the interaction terms of CSR*Media1, CSR*Media1 and CSR*Media1 are 0.089, 0.161 and 0.278, respectively, which are all significantly positively correlated, indicating that regardless of positive, neutral or negative media, the moderating effect on the relationship between CSR and R&D remains unchanged, thus further testing the conclusion of Hypothesis 2. As for the reasons why media attention of different natures creates the same moderating effect on CSR and R&D, one is that positive media reports are a “good thing” for companies. Reports on positive corporate events will help the company create a good external environment for. Corporate innovative activities and strengthen the impact of CSR and R&D. Second, as far as neutral media reports are concerned, they tend to publish original reports, and the market has a strong response to original reports, which will form greater pressure for listed companies and also strengthen the impact of CSR on R&D. Thirdly, as far as negative media reports are concerned, stakeholders respond quickly to negative news and are prone to media effect of "group attack". To meet public expectations as a feedback, companies tend to perform social responsibilities more actively in order to restore their honor and image.

4.3.2 The impact of the nature of corporate property rights on CSR and R&D

There are obvious differences between state-owned companies and non-state-owned companies in terms of operating systems, financing modes, and operating models, which leads to different goals, strengths and motivations of enterprises with different attributes in performance of corporate social responsibility or R&D investment. Then, whether the property rights nature of an enterprise will affect the relationship between CSR and R&D? In order to further examine the relationship between corporate property rights nature, CSR and R&D, this paper divides the sample companies into groups based on the nature of property rights, namely non-state-owned company group and state-owned company group. From the regression results of models (4) and (5) in Table 4, it can be seen that in the non-state-owned company group, the CSR coefficient is significantly positive (0.059, $p<0.01$), while in the state-owned company group, CSR has insignificant effect on R&D, indicating that the social responsibility behaviors of state-owned companies based on political orientation rather than economic factors cannot well promote R&D investment. However non-state-owned companies are different, which need actively perform social responsibilities to strengthen the relationship with the government, thus better driving corporate innovation development through social responsibility behavior.

Table 4 Moderating Effect of Media (Nature) on CSR and R&D

Variable	R&D	R&D	R&D	Non-state-owned company group	State-owned company group
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
CSR	0.031^{*}	0.030^{*}	0.032^{*}	0.059^{***}	0.010
	(1.734)	(1.708)	(1.805)	(2.687)	(0.424)
Media1	0.180				
	(0.978)				
Media2		-0.304			
		(-1.241)			
Media3			-0.680		
			(-1.327)		
CSR*Media1	0.089^{*}				
	(1.832)				
CSR*Media2		0.161^{**}			
		(2.422)			
CSR*Media3			0.278^{**}		
			(2.203)		
Lev	-0.218	-0.215	-0.215	-0.094	-0.193
	(-1.603)	(-1.573)	(-1.571)	(-0.532)	(-0.960)
Ind	1.585^{***}	1.587^{***}	1.616^{***}	0.449	1.710^{***}
	(4.319)	(4.314)	(4.393)	(0.884)	(3.291)
Incentives	0.438^{***}	0.445^{***}	0.447^{***}	0.424^{***}	0.544^{***}
	(12.499)	(12.674)	(12.726)	(10.037)	(9.447)
Large	-0.717^{***}	-0.718^{***}	-0.719^{***}	-0.798^{***}	-0.297
	(-4.883)	(-4.882)	(-4.883)	(-4.058)	(-1.312)
Size	0.704^{***}	0.718^{***}	0.721^{***}	0.584^{***}	0.838^{***}

	(32.610)	(33.163)	(33.224)	(19.826)	(27.595)
Roe	1.212***	1.212***	1.209***	1.372***	0.728
	(3.186)	(3.176)	(3.165)	(3.235)	(1.093)
N	4739	4739	4739	2122	2617
Adj.R^2	0.368	0.365	0.365	0.379	0.372
F value	307.238***	304.180***	303.817***	185.850***	222.302***

4.4 Robustness test

To verify robustness of the research conclusions, this paper tests and controls the industry factors and annual factors of the empirical test sample. The robustness test results are shown in Table 5. Model (1) shows that the CSR coefficient is significantly positive (0.047) at the level of 1%. Hypothesis 1 is further verified. Model (2) shows that the CSR*Media coefficient (0.055, $p<0.05$) is positive and significant, which verifies the conclusion of hypothesis 2. Model (3) shows that the Media coefficient (0.187, $p<0.01$) is positive and significant, and the CSR*Media*Market coefficient is 0.058, which is significantly positively correlated with R&D at the level of 1%, thus verifying the conclusion of hypothesis 3. It can be seen that the robustness test results have not changed substantially from the previous regression results, which indicates high reliability of the research conclusions in this paper.

Table 5 Robustness test

Variable	R&D		
	Model (1)	Model (2)	Model (3)
CSR	0.047***	0.034*	0.027***
	(2.780)	(1.845)	(4.195)
Media		-0.047	0.187***
		(-0.512)	(3.230)
Market			0.190***
			(19.587)
CSR*Media		0.055**	0.001
		(2.302)	(0.007)
CSR*Market			-0.013***
			(-3.551)
Media*Market			-0.296***
			(-6.475)
CSR*Media*Market			0.058***
			(3.898)
Lev	-0.154	-0.123	0.080
	(-1.144)	(-0.911)	(1.414)
Ind	1.129***	1.186***	1.160***
	(3.320)	(3.231)	(7.188)
Incentives	0.448***	0.448***	0.271***
	(12.814)	(12.798)	(16.699)

Large	-0.999^{***}	-1.021^{***}	-1.030^{***}
	(-6.744)	(-6.889)	(-15.423)
Size	0.772^{***}	0.696^{***}	0.722^{***}
	(33.892)	(32.331)	(78.978)
Roe	1.126^{***}	1.315^{***}	1.166^{***}
	(3.352)	(3.487)	(7.484)
Year	60.371^{***}	60.865^{***}	69.296^{***}
	(6.999)	(7.064)	(18.035)
industry	-0.021^{***}	-0.021^{***}	-0.005^{***}
	(-7.201)	(-7.105)	(-4.158)
N	4739	4739	4739
Adj.R^2	0.379	0.380	0.782
F value	322.149^{***}	265.491^{***}	1131.427^{***}

V. Research Conclusions and Significance

5.1 Research conclusions

Using China's 2011-2019 Shanghai and Shenzhen A-share listed companies as samples, this paper empirically tests the impact of corporate social responsibility on R&D investment, and further considers the moderating effect of media attention and marketization process on relationship between corporate social responsibility and R&D investment. The study found that: (1) Corporate social responsibility behavior has a positive promotion effect on R&D investment. (2) Under higher media attention, corporate social responsibility can better promote R&D investment. When the company receives more media attention, the company can receive more resources and policy support while performing social responsibility, which will make the company increase investment in R&D projects. The research results also show that regardless of positive, neutral or negative media attention, its moderating effect on the relationship between corporate social responsibility and R&D investment is still significant. (3) Further analysis from the perspective of external environment found that when a company is located in a region with higher marketization process, media attention exerts more obvious positive moderating effect on corporate social responsibility and R&D investment. (4) Compared with state-owned companies, the performance of social responsibilities by non-state-owned companies exerts a more obvious positive impact on R&D investment.

5.2 Research significance

5.2.1 Theoretical significance

On the one hand, by incorporating corporate social responsibility into the research and analysis framework of R&D investment, this paper thoroughly analyzes the impact of corporate social responsibility on R&D investment, and finds the positive impact of corporate social responsibility on R&D investment from the perspective of stakeholders. The finding not only expands the research content about the factors affecting corporate characteristics in the field of R&D investment, but also enriches the research on the direction of corporate social responsibility, thus providing new ideas for the exploration into consequences of corporate social responsibility. On the other hand, this paper introduces contextual factors such as media attention and marketization process into the research framework, verifies the adjustment mechanism of media attention and marketization process, and reveals the mechanism of corporate social responsibility against R&D investment from a macro perspective. It makes up for the deficiency in existing literature on how contextual factors affect the relationship between corporate social responsibility and R&D investment, thus enriching relevant literature researches.

5.2.2 Practical significance

First, business managers should change their business development concepts, set up a correct concept of corporate social responsibility, and incorporate corporate social responsibility into corporate strategic decisions to seek a comprehensive and sustainable corporate social responsibility strategy. At the same time, it is necessary to give full play to the role of corporate social responsibility in promoting R&D investment, adhere to the principle of grasping two key links at the same time, integrate R&D investment and corporate social responsibility, and create the "two-wheel" driven synergistic effect of responsibility and innovation, thereby driving the sustainable development of companies.

Second, media reports should be used to strengthen the positive relationship between corporate social responsibility and R&D investment, thereby promoting corporate innovation and development. Companies should strive to increase their awareness of information sharing, let the media know more about themselves, and standardize the company business behavior by taking advantage of media attention, thereby promoting sustainable development of the company.

Third, the government should further accelerate the pace in deepening market-oriented reforms, actively coordinate and promote the marketization process of regional economies, and create a good external environment for corporate innovation activities, thereby stimulating corporate innovation vitality. Hence, the government and companies should consider the influence of marketization process and property rights nature, and build an innovation incentive and promotion system that matches the marketization process in China from the dual perspectives of corporate regional heterogeneity and property rights heterogeneity.

5.2.3 Research limitations and prospects

This research has the following limitations, which requires future related studies for solution. (1) This paper only confirms the impact of corporate social responsibility of listed companies in China on R&D investment. However, due to the different corporate development environment and different requirements for marketization process in various countries, this conclusion may not be fully applicable to other companies in different development stages under different national conditions. (2) In the selection of contextual factors, this paper only analyzes the relationship between corporate social responsibility and R&D investment from the perspectives of media attention and marketization process. The correlation may also be affected by other factors such as the characteristics of the senior management team, corporate strategy, etc. In future studies, we can further explore other potential influencing factors, thereby gaining more comprehensive understanding of the mechanism by which corporate social responsibility affects R&D investment.

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