

The Tone of Social Responsibility Text Information and Green Innovation

Yanyan Wang

School of Finance and Economics, Accountancy University, Anhui 233030, China

Abstract

Green innovation has become an important way for enterprises to achieve high-quality development. This paper selects China's A-share listed companies from 2011-2021 as samples, analyzes corporate social responsibility reports from the perspective of tone, and empirically tests the impact of corporate social responsibility text information on green innovation. The research results indicate that the net positive tone in social responsibility reports can significantly promote the output of green innovation. Further research has found that tone information mainly promotes green innovation by alleviating financing constraints. The regression results were still significant after using the Instrumental variables estimation method and the substitution variable method. The research conclusion of this article has positive significance for improving the disclosure system of social responsibility reports and strengthening corporate green awareness.

Keywords

Intonation; Social Responsibility Report; Financing Constraints; Green Innovation.

1. Introduction

Since the reform and opening up, even in the face of various challenges at home and abroad, China's economy has still grown rapidly. In 2021, the gross domestic product reached 114.37 trillion yuan, firmly ranking second in the world. The soaring economy depends largely on limited natural resources. The rough development model leads to excessive consumption of natural resources, Resource depletion, environmental pollution, ecological degradation and other problems. How to reasonably balance the relationship between environmental protection and economic development and achieve the goal of sustainable development is becoming increasingly important. The report of the 20th National Congress of the Communist Party of China proposes to accelerate the green transformation of development methods, and clearly outlines the strategic deployment of promoting green and low-carbon economic and social development. In this context, how to promote the development of green technology and accelerate the transformation of green industries is a key point in coordinating the relationship between environmental protection and economic development. The development of green technology and the realization of green development cannot be achieved without the support of green technology innovation. Unlike traditional technological innovation, green innovation simultaneously takes into account the economic goals of the innovation theme and the environmental consequences caused by economic behavior. As an important direction of the new round of technological revolution, green innovation is necessary for China to achieve overtaking on curves and break free from the status of a follower in technological innovation.

In the era of Big data, accounting information disclosed by listed companies has become a veritable "data treasure". In the face of the vast data world, how to better use Text mining technology to collect and disclose accounting information disclosed by listed companies has become particularly important. The accounting information disclosed by enterprises can be classified into financial information and non-financial information. Compared to quantitative

financial information, non-financial information has advantages such as diverse transmission methods and easy understanding. As an important component of non-financial information, corporate social responsibility reports contain information that is more directly related to stakeholders and have a good supplementary effect on annual report information [2-3]. However, currently in China, there are no specific requirements for the form and textual information of corporate social responsibility report disclosure, which gives enterprises greater autonomy in disclosing social responsibility reports. The tone of social responsibility text information varies, with some tone tending towards neutrality and others leaning towards positivity. Different tone obviously has different economic consequences. At present, there is little research on the characteristics of social responsibility texts in the field of accounting research, and there is also little literature that studies the impact of positive and positive intonation in corporate social responsibility reports on green innovation from the perspective of intonation characteristics.

In view of this, this paper selects A-share listed companies as the research sample, and the research interval is 2011-2021. We empirically tested the impact of corporate social responsibility text information intonation on green innovation. Research conclusion: (1) The level of green innovation in enterprises is influenced by the tone of social responsibility text information. The more net positive tone in social responsibility text information, the higher the output level of green innovation. (2) The reason why the tone of corporate social responsibility text information has an impact on green innovation output is mainly because the positive and positive tone of social responsibility reduces the degree of information asymmetry and increases the trust of stakeholders, Furthermore, it alleviated the pressure of financing constraints. (3) The state-owned attribute and information environment quality have a positive promoting effect on the relationship between the tone of corporate social responsibility text information and green innovation.

Possible contributions of this article: Firstly, starting from a new perspective, this article enriches research related to the economic consequences of the tone of information in corporate social responsibility texts. At present, most academic research on the economic consequences of corporate social responsibility text information starts from its disclosed content, focusing on the impact of social responsibility performance on listed companies themselves, and there is little literature research on the characteristics of the text. This article analyzes the impact of information intonation in social responsibility texts on corporate financing levels, strategic operations, and other aspects from the perspective of intonation. Based on information transmission theory, it is planned to empirically test the impact of information intonation in corporate social responsibility texts on green innovation, and examine whether enterprises with a high degree of positive intonation produce more green innovation output. Secondly, it enriches the research on the influencing factors of green innovation. This study indicates that a positive tone in corporate social responsibility reports can affect a company's green innovation output by alleviating financing constraints,. Therefore, this article expands the research perspective of green innovation. Thirdly, the research conclusions of this article can provide reference for listed companies and regulatory authorities. For listed companies, they can try to improve the quality of social responsibility information disclosure from the perspective of language characteristics, increase the trust of report users, and thereby alleviate financing constraints, promoting the development of green innovative technologies. For regulatory authorities, it is necessary to remind them to strengthen the importance of social reports disclosed by enterprises, continuously improve the disclosure system of corporate social responsibility information, and not only standardize the content and form of social responsibility information disclosure, but also refine textual information such as intonation.

2. Literature Review

The existing literature is mainly based on a company perspective, studying the impact of corporate social responsibility performance on both internal and external aspects of the company. A small amount of literature has studied the impact of information intonation in social responsibility texts. The following will review the existing literature from two aspects: the economic consequences of information intonation disclosure in corporate social responsibility texts and the influencing factors of green innovation.

2.1. The Economic Consequences of Social Responsibility Text Information Intonation

At present, academic research on corporate social responsibility mainly starts from the characteristics of internal companies and external stakeholders. In terms of its impact on the internal performance of a company, firstly, corporate performance has become a focus of academic research. Hao Xiuqing et al. (2011) examined the impact of social responsibility performance on business performance from the perspective of social capital. The study found that corporate social responsibility performance did not have a significant impact on short-term and long-term performance, but had a strong direct impact on social capital [4]. However, Wen Subin and Fang Yuan (2008) found in their research on Panel data of listed companies in China that corporate social responsibility performance has a negative impact on short-term business performance, and in the long run, it has a positive role in promoting business performance [5]. Ogden and Watson (1999) reached the same conclusion using tap water supply enterprises as samples [6]. Secondly, in terms of capital cost, good social responsibility performance can significantly reduce the equity capital cost of enterprises, improve their responsibility to investors, and this effect is better in the sample of state-owned enterprises [7-8]. Finally, in terms of corporate innovation, Gu Qun et al. (2019) found a positive correlation between corporate social responsibility performance and innovation activities, using A-share listed companies from 2008 to 2017 as a sample. Compared to the impact on overall innovation activities, social responsibility performance has a greater impact on exploratory innovation [9]. Bai Min and Wang Renxiang (2020) combined theoretical analysis with empirical testing and found that corporate social responsibility performance has a positive impact on sustained innovation, and this impact is more significant among voluntary disclosure companies compared to mandatory disclosure companies [10]. The impact of social responsibility on the external environment mainly focuses on auditing, supply chain, and other aspects. In terms of auditing, Zhai Huayun et al. found that companies with good social responsibility performance have lower fees for auditors [11]. Further considering the nature of equity, this negative impact is more significant in state-owned enterprises [12]. However, when Chen Jun et al. (2016) studied the value of social contribution per share as a proxy variable for corporate social responsibility performance, they found that good social responsibility performance may be a way for managers to shift the attention of stakeholders to earnings management, which increases auditors' fees [13]. In supply chain related research, Zhang Zhengyong and Deng Bofu (2018) confirmed that companies with good social responsibility performance are more likely to gain the trust of supply chain partners and can obtain more commercial credit financing [14]. Intonation is an important application of textual information in the financial field (Loughran and McDonald, 2011) [15]. Compared to quantitative textual information, non-standard textual information conveys richer content and meaning, and has more diverse channels of transmission (Lin Le and Xie Deren, 2016) [16]. However, Huang Pingping and Li Sihai (2020) found in their tone of social responsibility reports that, motivated by easing financing constraints, the net positive tone of social responsibility reports has become a tool for companies to conceal negative information, instead increasing the risk of stock price crashes.

2.2. The Influencing Factors of Green Innovation

At present, research on the influencing factors of green innovation mainly focuses on two aspects: internal characteristics and external environment. External factors such as economic policies, environmental regulations, market factors, etc. Yang Fei et al. (2022) used heavily polluting enterprises in China as research samples to discuss the impact of low-carbon pilot policies on green technology innovation. The study confirmed the promoting effect of low-carbon pilot policies on green innovation, and the impact of low-carbon pilot policies on green innovation of eastern enterprises and non-state-owned enterprises is more significant [21]. In addition, the uncertainty of environmental policies can also promote green innovation by increasing research and development investment (BL00M, 2009) [22]. Wang Han and He Xiaoyin (2022) used the spatial Durbin model to confirm that industrial agglomeration and environmental regulation can improve the efficiency of green innovation in the region, while industrial agglomeration strengthens the promoting effect of environmental regulation on green innovation efficiency [23] Jin Xin et al. (2022) empirically tested the specific impact of seven environmental regulations on green innovation and found that the number of environmental legislation, the amount of simultaneous investment, and the amount of pollution charges have a positive impact on the time lag effect of green innovation; The immediate effect of environmental law enforcement and the number of people on green innovation has significantly improved [24]. In terms of market factor research, the development of the capital market can significantly promote technological innovation in green industries, especially the promotion effect of the stock market (Xu Feng and Ding Youwei, 2016) [25]. However, the attention of China's capital market to green innovation is not very high, and it cannot play a good incentive role (Wei Ping and Li Jiaying, 2022) [26].

The research on the impact of internal characteristics on green innovation mainly focuses on executive characteristics, equity nature, and information disclosure. In terms of executive characteristics, female executives are more sensitive to environmental issues compared to men, and they are able to actively take on the social responsibility demonstrated by green innovation, and are more inclined to invest in research and development of green innovation [27]. In addition, CEOs with green experience have a good reserve of green knowledge [28], which contributes to the innovation of green technology [29]. Regarding the impact of property rights on green innovation, Zhong Youhui and Yang Zhijiang's (2021) research shows that state-owned enterprises have a higher willingness to green innovation compared to private enterprises, and their level of green innovation is also higher. The cumulative number of years of green technology innovation is longer [30]. In terms of information disclosure, the disclosure of corporate environmental information can alleviate financing constraints and enhance the level of green technology innovation of enterprises by increasing credit financing. Yu Zhimai (2022) analyzed the relationship between management tone and green innovation based on speech act analysis, and confirmed the concept of information increment, that is, the more positive the management tone, the higher the level of green innovation of the enterprise [31].

3. Theoretical Analysis and Research Hypotheses

The disclosure of the net positive tone of corporate social responsibility text information conveys positive information to the market, provides incremental information for stakeholders, can gain more trust from investors and banks, receive more financial support, and alleviate the funding demand for green innovation research and development investment. Therefore, the following will analyze the impact of corporate social responsibility text information intonation on green innovation and the mechanism of action between the two.

Firstly, based on signal transmission theory, due to the existence of information asymmetry, external stakeholders have a much lower understanding of information than the company itself.

Therefore, before providing financial support, they will try their best to collect information and reduce the losses caused by information disadvantage. The intonation in social responsibility text information provides incremental information to the outside world, reduces information opacity, alleviates the degree of information asymmetry and negative expectations with stakeholders [32]. In addition, according to the Social identity theory, the net positive tone sends a positive signal to consumers. Customers have a high sense of identity with such enterprises and are more willing to support such companies [33]. Enterprises that gain public trust have obvious competitive advantages in the industry and are more likely to achieve high performance, so they have sufficient profits to be retained for the research and development of long-term green innovative technologies. Secondly, the net positive tone in social responsibility text information can not only reduce the degree of information asymmetry, but in informal systems, disclosing positive social responsibility information can help companies gain higher reputation [34]. Corporate reputation, as a powerful intangible asset, can further enhance corporate competitiveness and establish a good corporate image, which helps to establish good relationships with stakeholders and enhance their understanding and trust. According to the principal-agent theory, the supervision of stakeholders is conducive to alleviating the Principal-agent problem, avoiding the short-sighted behavior of the management, making the management pay more attention to long-term interests when making investment decisions, and improving the enthusiasm for green innovation [36]. Finally, compared with traditional technological innovation, green innovation has the characteristics of long cycle, large investment and high risk, and faces high risks and challenges. This leads to green innovation being affected by the level of enterprise Assumption of risk, and enterprises with high Assumption of risk are more willing and able to carry out green innovation. Based on the resource dependence theory, the positive tone of the corporate social responsibility report conveys a good relationship with other stakeholders, so that enterprises can also obtain more resource support, thus improving the level of Assumption of risk of enterprises. Such enterprises are more willing and able to bear the high risks of green innovation projects [37]. Based on the above analysis, the following assumptions are proposed:

H1: The net positive tone of corporate social responsibility text information promotes green innovation.

Compared to traditional innovation, green innovation has the characteristics of large capital investment, long project cycle, and high risk. Therefore, green innovation projects often require a large amount of financial support from enterprises. Financing constraints are a topic that cannot be avoided by enterprise innovation. Enterprise innovation requires continuous financial support, but financing constraints make it difficult for enterprises to obtain funds and inhibit R&D investment. Moreover, the inherent characteristics of green innovation make the financing constraints caused by information asymmetry more severe, which is not conducive to carrying out green innovation activities. The net positive tone in social responsibility reports can bring more financing opportunities to enterprises. Firstly, the framework effect theory suggests that different language descriptions of the same thing can have completely different impact effects. MacGregor (2000) found that a positive framework description can trigger stakeholders' good imagination of the evaluation object, so the net positive tone in social responsibility text information can leave a good impression on external information users who are willing to provide financial support [39]. Secondly, high-quality social responsibility information can enhance the credit financing ability of enterprises. For financial institutions such as banks, the information disclosed by enterprises becomes an important reference for conducting risk assessments, credit reviews, and other assessments to assess the solvency of enterprises [40]. The net positive tone of social responsibility reports can largely alleviate the degree of information asymmetry between banks and enterprises, and banks have relatively loose credit policies for such enterprises. Finally, the net positive tone of social responsibility

information can enhance the satisfaction of supply chain partners and support the business credit of enterprises [42]. Good social responsibility performance helps to establish strategic mutual trust with suppliers, enabling them to have a deeper understanding of the company's future growth ability and industry competitiveness, reducing the risk of supply chain breakage, and making it easier to obtain commercial credit. Furthermore, a positive tone of social responsibility reporting can better demonstrate a company's culture and integrity [43], leave a positive impression on regulatory authorities, reduce negative regulatory actions, and reduce the social responsibility risk assessment of trading partners towards the company, thereby providing more commercial credit supply. The easing of financing constraints has enabled enterprises to have sufficient funds to support green innovation projects, promoting the output of green innovation. Based on the above analysis, this article proposes the following assumptions:

H2: Under the same other conditions, financing constraints play a mediating role between the net positive tone of social responsibility text information and green innovation.

4. Research Design

4.1. Sample Source and Data Selection

This research uses Python software to obtain the corporate social responsibility report of Chinese listed companies in 2011-2021, and uses Python's "Jieba" Chinese word segmentation module to conduct word frequency statistics to obtain the intonation data of corporate social responsibility report. And according to the research needs, the research samples were processed as follows: (1) excluding financial and insurance listed companies; (2) Exclude ST or PT listed companies; (3) Remove observation samples with missing variable observations; (4) Perform bilateral 1% tail reduction on the observed samples. The remaining data in this article are sourced from Guotai An Database and Wind Database.

4.2. Variable Definition and Description

4.2.1. The Dependent Variable.

Green innovation (GTI) refers to the study by Lian Chao et al. (2019), which measures green innovation from the perspective of innovation output. The green innovation level of enterprises is measured by adding 1 logarithmic value to the number of green innovation patent applications [44].

4.2.2. Explanatory Variable

Firstly, this article uses Python software to obtain corporate social responsibility reports of listed companies, and uses Python's "stuttering" segmentation module to conduct positive and negative word frequency statistics on social responsibility text information. Finally, drawing on the approach of Liu Jianqiu (2022), according to formula (1) and (2), the net positive tone of the social responsibility report TONE1 and TONE2 [19]. POSPCT is the number of positive vocabulary and NEGPCT is the number of negative vocabulary.

$$\text{TONE1} = \frac{\text{POSPCT} - \text{NEGPCT}}{\text{POSPCT} + \text{NEGPCT}} \quad (1)$$

$$\text{TONE2} = \frac{\text{POSPCT} - \text{NEGPCT}}{\text{TOTAL NUMBER OF WORDS}} \quad (2)$$

4.2.3. Control Variables

Referring to Zhang Zhengyong's (2018) research, this paper selects the following control variables: company size (SIZE), asset liability ratio (LEV), total Return on assets (ROA), independence of the board of directors (INDEP), company age (FIRMAGE), management

shareholding ratio (MSHARE), total asset turnover (ATO), number of directors (BOARD), and equity balance (BALANCE) [42]. The specific calculation method is shown in Table 1.

Table 1. Variable Definition

Variable name	Variable symbol	Specific definition
Green innovation	GTI	Ln (number of green patent applications+1)
Net positive tone of social responsibility report	TONE1	(POSPCT-NEGPCT)/(POSPCT+NEGPCT)
	TONE2	(POSPCT NEGPCT)/Total number of words
Company size	SIZE	Natural logarithm of total assets at the end of the year
Asset liability ratio	LEV	Total liabilities at the end of the year/total assets at the end of the year
Return on total assets	ROA	Net profit/average balance of total assets
Independence of the Board of Directors	INDEP	Number of independent directors/total number of directors
Company age	FIRMAGE	Ln (year of the year - company year+1)
Management shareholding ratio	MSHARE	Management shareholding data/total equity
Total asset turnover rate	ATO	Operating income/average total assets
Number of directors	Board	The number of directors is taken as Natural logarithm
Equity balance system	BALANCE	Second largest shareholder's shareholding ratio/first largest shareholder's individual shareholding ratio

4.3. Model Construction

4.3.1. Model Construction of the Impact of Net Positive Tone of Corporate Social Responsibility Text Information on Green Innovation

In order to test the impact of net positive tone in social responsibility reports on commercial credit financing, this article constructs the following model for testing based on the research of Zhang Zhengyong et al. (2018) [42]:

$$GTI = \alpha_0 + \alpha_1 TONE1_{i,t} + \sum CONTROLS + \varepsilon_{i,t} \tag{3}$$

$$GTI = \beta_0 + \beta_1 TONE2_{i,t} + \sum CONTROLS + \varepsilon_{i,t} \tag{4}$$

4.3.2. Model Construction of the Net Positive Tone of Corporate Social Responsibility Text Information on the Path of Green Innovation

To test whether financing constraints constitute a net positive tone of corporate social responsibility and affect the mechanism of commercial credit financing, this article draws on the approach of Kaplan and Zingales (1997) and selects the KZ index to measure the degree of financing constraints faced by enterprises [45]. And construct a model (5).

$$KZ = \gamma_0 + \gamma_1 TONE1/2_{i,t} + \sum CONTROLS + \varepsilon_{i,t} \tag{5}$$

5. Empirical Results and Analysis

5.1. Descriptive Statistics

Table 2 reports the descriptive statistical results of the main variables. The average net positive intonation of social responsibility text information, TONE1 and TONE2, were 0.764 and 0.076, respectively, with a median of 0.782 and 0.074, indicating that the overall tone of the social responsibility report of the sample company is relatively positive. The minimum value of green

innovation output is 0, and the maximum value is 7.364. The significant difference in green innovation output level indicates that the sample companies attach different importance to green innovation projects.

Table 2. Descriptive Statistical Results

	N	MEAN	SD	MIN	MEDIAN	MAX
TOTAL	6725	1.328	1.478	0.000	0.693	7.364
TONE1	6725	0.764	0.119	0.154	0.782	0.989
TONE2	6725	0.076	0.025	0.010	0.074	0.205
SIZE	6725	23.046	1.432	16.161	22.908	28.509
LEV	6725	0.476	0.199	-0.195	0.487	1.399
ROA	6725	0.051	0.105	-0.609	0.041	7.109
INDEP	6722	0.376	0.058	0.125	0.364	0.800
FIRMAGE	6725	2.868	0.353	0.698	2.944	4.143
MSHARE	6725	0.076	0.330	0.000	0.000	22.567
ATO	6725	0.683	0.517	0.002	0.570	7.871
BOARD	6725	2.188	0.210	1.386	2.197	2.890
BALANCE	6725	0.651	0.611	0.004	0.442	3.932

5.2. Multiple Regression Analysis

5.2.1. Basic Regression Results

Table 3. Basic Regression Results

	(1)	(2)
TONE1	0.467***	
	(4.274)	
TONE2		1.103**
		(2.033)
SIZE	0.574***	0.532***
	(45.934)	(41.002)
LEV	-0.313***	-0.179*
	(-3.426)	(-1.886)
ROA	0.579***	0.670***
	(4.642)	(4.981)
INDEP	0.269	0.128
	(1.067)	(0.476)
FIRMAGE	-0.108**	-0.156***
	(-2.508)	(-3.432)
MSHARE	-0.006	0.044
	(-0.120)	(0.876)
ATO	0.057*	0.111***
	(1.854)	(3.676)
BOARD	0.169**	0.058
	(2.265)	(0.741)
BALANCE	-0.016	0.025
	(-0.745)	(1.078)
CONS	-12.846***	-11.487***
	(-34.231)	(-32.261)
N	6532	6532
R2_A	0.531	0.450

Table 3 provides the regression results of the impact of social responsibility text information intonation on the level of green innovation. Columns (1) and (2) respectively report the two measurement methods of net positive tone of social responsibility text information and the OLS regression results of green innovation. From the first two rows of the table, it can be seen that the coefficients of the net positive intonation of corporate social responsibility text information are significantly positive, indicating that the more positive the intonation of social responsibility text information, the higher the output of green innovation. The above conclusion validates hypothesis 1 of this article.

5.2.2. Regression Results of Mechanism of Action

Table 4 reports the regression results of Model 3, with columns (1) and (2) corresponding to the two net positive tones of TONE1 and TONE2, respectively. As shown in rows (1) and (2) of Table, the coefficient of TONE1/2 is significantly negative and significant at least at the 5% level. This indicates that the higher the positive level of information tone in social responsibility texts, the smaller the financing constraints faced by enterprises. Previous studies have confirmed that the level of green innovation in enterprises is influenced by financing constraints [46], High financing constraints are not conducive to green innovation in enterprises, while the tone of social responsibility text information can alleviate financing constraints, thus helping to promote the output of green innovation. The regression results in Table (4) indicate that the tone of corporate social responsibility text information promotes green innovation output by alleviating financing constraints.

Table 4. Mechanism Regression Results

	(1)	(2)
TONE1	-0.473***	
	(-2.708)	
TONE2		-2.016**
		(-2.482)
SIZE	-0.278***	-0.288***
	(-13.946)	(-14.842)
LEV	7.224***	7.223***
	(49.588)	(50.875)
ROA	-2.343***	-2.575***
	(-11.768)	(-12.794)
	(1.141)	(1.451)
FIRMAGE	0.178***	0.186***
	(2.597)	(2.730)
MSHARE	-0.449***	-0.475***
	(-6.069)	(-6.344)
ATO	-0.642***	-0.540***
	(-13.137)	(-11.949)
BOARD	0.006	0.000
	(0.049)	(0.004)
BALANCE	0.025	-0.004
	(0.703)	(-0.123)
CONS	6.184***	6.238***
	(10.320)	(11.707)
N	6502	6532
R2_A	0.498	0.479

5.3. Robustness Testing

5.3.1. Replace Variables

We draw inspiration from the research of Zhao Shukuan et al. (2022), and if a company has green innovation output in that year, we will take 1, otherwise we will take 0 to replace the original green innovation measurement method [47]. Columns 1-2 of Table 5 report the regression results after replacing the green innovation measurement method. The coefficients of TONE1 and TONE2 are 0.153 and 0.580, respectively, which are significant at the 1% level and consistent with the basic regression results.

Table 5. Replacement Variable Regression Results

	(1)	(2)
TONE1	0.153***	
	(3.568)	
TONE2		0.580***
		(2.824)
SIZE	0.141***	0.125***
	(28.870)	(25.465)
LEV	-0.112***	-0.047
	(-3.125)	(-1.306)
ROA	0.147***	0.153***
	(3.019)	(3.000)
INDEP	-0.122	-0.131
	(-1.236)	(-1.293)
FIRMAGE	0.030*	0.010
	(1.797)	(0.565)
MSHARE	0.008	0.020
	(0.454)	(1.053)
ATO	0.012	0.039***
	(0.960)	(3.427)
BOARD	0.073**	0.031
	(2.512)	(1.047)
BALANCE	-0.034***	-0.021**
	(-3.969)	(-2.445)
CONS	-3.182***	-2.712***
	(-21.659)	(-20.115)
N	6502	6532
R2_A	0.367	0.301

5.3.2. Instrumental Variables Estimation Method

In the basic regression analysis, we used a fixed effects model to absorb the influence of variables that do not change over time or industry, and to some extent solved the endogeneity problem. Further considering the endogenous problem caused by missing variables, we use the Instrumental variables estimation method to test the robustness. We drew on the research of Huang Pingping and Li Sihai (2020) and selected the average TONE1 of the net positive tone of social responsibility text information from other companies in the same industry and year_Mean as a Instrumental variables estimation [48]. The (1) and (2) columns of Table 4 report the regression results of the second stage of the two-stage least squares (2SLS) method for TONE1 and TONE2, respectively. The coefficients of TONE1/2 in the table are significant at the 1% level. Our conclusion still holds after considering endogeneity issues.

Table 6. Regression results of Instrumental variables estimation method

	(1)	(2)
TONE1	4.294***	
	(4.519)	
TONE2		30.927***
		(4.044)
SIZE	0.541***	0.649***
	(31.524)	(17.572)
LEV	-0.605***	-0.887***
	(-4.835)	(-5.034)
ROA	0.245	0.253
	(0.475)	(0.408)
INDEP	0.616*	0.748*
	(1.794)	(1.773)
FIRMAGE	-0.222***	-0.194***
	(-4.387)	(-3.454)
MSHARE	0.074	0.087
	(0.765)	(0.798)
ATO	0.249***	0.236***
	(6.262)	(5.614)
BOARD	0.057	0.138
	(0.561)	(1.149)
BALANCE	0.084***	0.060*
	(2.827)	(1.717)
CONS	-14.089***	-15.751***
	(-15.283)	(-11.009)
N	6419	6419
R2_A	0.147	0.046

6. Further Discussion

6.1. Heterogeneity Analysis of Equity Nature

There are significant differences in business models, investment decisions, and other aspects between state-owned and non-state-owned enterprises, which may lead to different effects of the tone of corporate social responsibility text information on commercial credit financing. On the one hand, state-owned enterprises are subject to stricter supervision and regulations, with information disclosure levels often higher than non-state-owned enterprises [49], and the tone of management disclosure is more optimistic. This is mainly because the political nature of state-owned enterprises makes them more sensitive to tone and less prone to using negative vocabulary. On the other hand, when state-owned enterprises face operational difficulties such as fund shortages, the government will provide financial support through subsidies, tax incentives, and other means, which reduces the risk of debt default faced by state-owned enterprises [50] and ensures their debt repayment ability. Both credit financing channels and credit financing channels face lower financing constraints, while private enterprises have less obvious operational credit advantages, and their debt repayment ability is easily suspected. Therefore, obtaining less financing is not conducive to green innovation. Therefore, this article groups state-owned and non-state-owned enterprises to examine the impact of equity nature

on the net positive tone of social responsibility text information on the relationship between green innovation.

The regression results are shown in Table 7, where State=1 represents state-owned enterprises and State=0 represents non-state-owned enterprises. In the sample with SOE=1, it can be seen that the relationship between the net positive tone of social responsibility text information and green innovation is still significantly positive. However, in the sample with SOE=0, the relationship between the two is no longer significant, indicating that state-owned nature has a promoting effect on the relationship between the two.

Table 7. Regression Results of Equity Property Grouping

	SOE=1		SOE=0	
TONE1	0.543***		0.024	
	(3.423)		(0.153)	
TONE2		1.423*		0.571
		(1.860)		(0.733)
	(37.285)	(32.678)	(23.414)	(22.222)
LEV	-0.710***	-0.384***	0.088	0.188
	(-5.194)	(-2.743)	(0.647)	(1.335)
ROA	0.171	0.605	0.580***	0.633***
	(0.406)	(1.370)	(4.544)	(4.589)
INDEP	0.083	-0.133	0.108	0.396
	(0.254)	(-0.381)	(0.262)	(0.907)
FIRMAGE	-0.167***	-0.179***	-0.046	-0.112*
	(-2.618)	(-2.628)	(-0.768)	(-1.793)
MSHARE	-0.877	1.303	0.012	0.027
	(-1.108)	(1.567)	(0.230)	(0.494)
ATO	0.066	0.134***	0.029	0.080*
	(1.491)	(3.073)	(0.665)	(1.889)
BOARD	0.120	0.095	0.134	0.073
	(1.210)	(0.900)	(1.122)	(0.590)
BALANCE	-0.045	-0.016	0.062**	0.065**
	(-1.163)	(-0.386)	(2.156)	(2.171)
CONS	-14.380***	-12.077***	-10.140***	-10.318***
	(-26.365)	(-22.567)	(-17.661)	(-18.462)
N	3548	3570	2954	2962
R2_A	0.586	0.499	0.472	0.383

6.2. Heterogeneity Analysis of Information Environment

The quality of information disclosure can directly affect the tone of social responsibility text information and its impact on stakeholders. Enterprises with a good information environment can alleviate the adverse effects of information asymmetry, reflected in the higher authenticity and reliability of their intonation. Due to stakeholders evaluating the development prospects and growth opportunities of a company through information released by the company, companies with a good information environment can provide more incremental information through the tone of their social responsibility reports. The net positive tone conveys positive information, reduces the degree of information asymmetry, and provides more financing opportunities to secure funding for green innovation projects. Therefore, this article refers to the study by Li Sheng and Wang Yanyan (2006), which uses the modified Jones model to

calculate the controllable accrued profit to measure the quality of the information environment [51], and conducts group regression analysis on the entire sample based on the annual average of information transparency industry to discuss the relationship between social responsibility report intonation and commercial credit financing under different information environments. The regression results are shown in Table 8. Among the samples with good information environments, the relationship between the net positive tone of social responsibility text information and green innovation is still significantly positive. However, in the samples with poor information environments, the relationship between the two is no longer significant, indicating that the quality of information environment has a promoting effect on the relationship between the two.

Table 8. Heterogeneity Analysis of Information Environment

	Good information environment		Bad information environment	
TONE1	0.708***		0.013	
	(5.156)		(0.073)	
TONE2		1.658**		0.704
		(2.353)		(0.791)
SIZE	0.603***	0.553***	0.511***	0.496***
	(37.955)	(32.818)	(24.369)	(23.799)
LEV	-0.281**	-0.003	-0.348**	-0.316**
	(-2.279)	(-0.025)	(-2.551)	(-2.272)
ROA	-0.191	0.161	0.639***	0.670***
	(-0.558)	(0.442)	(4.864)	(4.750)
INDEP	0.188	0.110	0.802*	0.397
	(0.596)	(0.328)	(1.882)	(0.883)
FIRMAGE	-0.142**	-0.155***	-0.044	-0.113
	(-2.561)	(-2.607)	(-0.599)	(-1.496)
MSHARE	0.087	0.469***	0.082	0.151
	(0.641)	(3.278)	(0.707)	(1.248)
ATO	0.084**	0.132***	0.043	0.065
	(2.013)	(3.220)	(0.968)	(1.475)
BOARD	0.256***	0.139	0.061	0.014
	(2.695)	(1.394)	(0.475)	(0.103)
BALANCE	-0.013	-0.014	-0.029	0.026
	(-0.465)	(-0.476)	(-0.762)	(0.630)
CONS	-13.882***	-12.368***	-11.237***	-10.535***
	(-26.721)	(-25.839)	(-17.683)	(-17.956)
N	4120	4142	2261	2269
R2_A	0.550	0.463	0.504	0.424

7. Research Conclusion and Enlightenment

7.1. Research Conclusion

At present, there is little research on the characteristics of social responsibility texts, and there is also little literature on the impact of corporate social responsibility report intonation on green innovation. This paper selects A-share listed companies in 2011-2021 as the research sample, examines the impact of the net positive tone of corporate social responsibility text information on green innovation, and explores the role of financing constraints in both.

Research has found a significant positive correlation between the net positive tone of corporate social responsibility text information and the level of green innovation output. Further research has found that the nature of state-owned enterprises and the quality of information environment have a certain promoting effect on the net positive tone of corporate social responsibility text information and green innovation.

The research conclusions of this paper can help the management to formulate corporate strategies, improve social responsibility awareness and green, and play a certain role in promoting the sustainable development of enterprises.

7.2. Research Inspiration

Based on the conclusion of this article, the following insights are drawn: firstly, for enterprises, they can try to improve the quality of social responsibility information disclosure from the perspective of language characteristics, and increase the trust of report users. Actively fulfilling social responsibility, reducing information asymmetry by disclosing high-quality and positive social responsibility information, alleviating financing constraints, preparing more funds for green innovation projects, and enhancing one's sustainable development capabilities. Secondly, for interest related parties, while paying attention to quantitative information of enterprises, they should also pay attention to non textual information such as social responsibility reports, which can obtain more incremental information from their intonation

Thirdly, for regulatory agencies, if they want to encourage green innovation in enterprises, they should not only standardize the content and form of social responsibility information disclosure, but also refine textual information such as intonation to further improve the information quality of corporate social responsibility reports. At the same time, reward and punishment measures can be taken to motivate enterprises to fulfill their social responsibilities and strengthen supervision of their performance.

References

- [1] Ma Yuan, Hou Guisheng, Yin Hua. The Evolution of Technological Innovation: From Traditional to Green [J]. Science and Technology Management Research, 2014,34 (19): 11-15.
- [2] Dhaliwal D S. Radhakrishnan S, Tsang A, Yang Y G. Non financial disclosure and analyze forecast accuracy: International evidence on corporate social responsibility disclosure [J] The Accounting Review 2012.87 (3): 723-759.
- [3] Harjoto M A. Jo H. Legal vs. normal CSR: Differential impact on analyze dispersion, stock return volatility, cost of capital, and firm value [J] Journal of Business Ethics, 2015, 128 (1): 1-20.
- [4] Hao Xiuqing, Tong Yunhuan, Hu Chenggen. Research on the Impact of Corporate Social Performance on Business Performance from the Perspective of Social Capital [J]. Science and Technology Management, 2011,32 (10): 110-116.
- [5] Wen Subin, Fang Yuan. An empirical study on the relationship between corporate social responsibility and financial performance - Panel data analysis from the perspective of stakeholders [J]. China Industrial Economy, 2008 (10): 150-160.
- [6] Ogden, S And R. Watson, "Corporate Performance and Stakeholder Management: Balancing Shareholders and Customer Interests in the UK Privated Water Industry," Academy of Management Journal, 1999,42 (5): 526-538.
- [7] Huang Jianyuan, Jin Yue. Research on the Impact of Corporate Social Responsibility on the Cost of Equity Capital: Based on the Perspective of Corporate Social Responsibility Reporting and Assurance [J]. Industrial Economic Research, 2016 (02): 87-95.
- [8] Xu Shan, Huang Jianbai. Corporate Property Rights, Social Responsibility, and Cost of Equity Capital [J]. Southern Economics, 2015 (04): 76-92.

- [9] Gu Qun, Wang Wenwen, Zheng Yang. Will corporate social responsibility affect innovation—— From the perspective of R&D heterogeneity and property right nature [J]. Journal of Guizhou University of Finance and Economics, 2019 (06): 66-75.
- [10] Bai Min, Wang Renxiang. How Corporate Social Responsibility Affects Continuous Innovation in Enterprises [J]. China Science and Technology Forum, 2020 (01): 107-115.
- [11] Zhai Huayun, Zheng Jun, Fang Fang. Social Responsibility Performance, Report Verification, and Audit Pricing [J]. Securities Market Introduction, 2014 (06): 32-37.
- [12] Zhu Min, Liu Zheng, Shi Xianwang. Equity Nature, Corporate Social Responsibility, and Audit Fees: An Empirical Study Based on Chinese Listed Companies [J]. Jianghuai Forum, 2015 (02): 50-54.
- [13] Chen Jun, Yang Xudong, Zhang Zhihong. Environmental Uncertainty, Corporate Social Responsibility, and Audit Fees [J]. Audit Research, 2016 (04): 61-66.
- [14] Zhang Zhengyong, Deng Bofu. Corporate Social Responsibility, Monetary Policy, and Commercial Credit Financing [J]. Scientific Research Management, 2018,39 (05): 94-102.
- [15] Loughran T, McDonald B. When is a Liability Not a Liability? Textual Analysis, Dictionaries, and 10-Ks [J] The Journal of Finance, 2011, 66 (1): 35-65.
- [16] Lin Le, Xie Deren. Will investors listen and listen-- Empirical Research Based on Management Intonation [J]. Financial Research, 2016,42 (07): 28-39.
- [17] Liu Jianqiu, Long Yuhong, Yin Guangying. Intonation of corporate social responsibility report and audit fees [J]. Journal of Yunnan University of Finance and Economics, 2022,38 (06): 92-110.
- [18] Liu Jianqiu, Yin Guangying, Wu Jinghua. The tone of corporate social responsibility reports and analyst predictions: signal or cater? [J] Audit and Economic Research, 2022, 37 (03): 62-72.
- [19] Liu Jianqiu, Yin Guangying, Wu Jinghua. The Intonation of Corporate Social Responsibility Reports and Asset Mispricing [J]. Accounting Research, 2022 (05): 131-145.
- [20] Huang Pingping, Li Sihai. The Tone of Social Responsibility Reports and the Risk of Stock Price Collapse [J]. Audit and Economic Research, 2020,35 (01): 69-78.
- [21] Yang Fei, Shen Neng, Hu Ao. Research on the green technology innovation effect of low-carbon pilot policies - evidence based on micro quasi Natural experiment [J]. Soft Science: 1-12 [2022-12-06].
- [22] Bloom N. The Impact of Uncertain Shocks [J], Econometrica 2009,77 (3), 623-685.
- [23] Wang Han, He Xiaoyin. Industrial Agglomeration, Environmental Regulation, and Green Innovation Efficiency [J]. Statistics and Decision Making, 2022 (22): 184-188.
- [24] Jin Xin, Guan Haoxin, Chen Song. How do environmental regulation tools affect green technology innovation in enterprises-- Research on Heterogeneity Effects from a Dual Perspective [J]. Frontiers of Engineering Management Technology, 2022,41 (04): 62-68.
- [25] Xu Feng, Ding Youwei. The Effect of Capital Market Support for Green Industry Technology Innovation [J]. Science and Technology Management Research, 2016,36 (21): 25-33.
- [26] Wei Ping, Li Jiaying. Does China's capital market pay attention to green technology innovation? [J] Financial Development Research, 2022 (07): 76-84.
- [27] Wang Weidong, Shen Yue, Wang Xiaonan, Lu Na. Women's Executive Power and Green Innovation in Enterprises [J/OL]. East China Economic Management: 1-11 [2023-01-09].
- [28] Can the green experience of CEO in Jiangguang Province promote green innovation in enterprises? [J] Economic Management, 2022,44 (02): 106-121.
- [29] Kassinis, G, Panayiotou, A, Dimou, A, Katsifaraki, G. Gender and Environmental Sustainability A Longitudinal Analysis [J], Corporate Social Responsibility and Environmental Management, 2016, 23, (6): 399412.
- [30] Zhong Youhui, Yang Zhijiang. Are state-owned enterprises more willing to innovate in green technology-- Empirical research from manufacturing listed companies [J]. Journal of Yunnan University of Finance and Economics, 2021,37 (05): 88-98.
- [31] Yu Zhimai Is the tone of management a signal of green innovation? [J] Foreign Economics and Management, 2022,44 (06): 18-33.

- [32] Shen Hongtao, Wang Liyan, Wan Tuo. Can social responsibility reports and authentication transmit effective signals-- Analysis Based on Corporate Reputation Theory [J]. *Audit Research*, 2011 (04): 87-93.
- [33] Lichtenstein D R. Drumwright M E, Braig B M. The effect of corporate social responsibility on customer Donations to corporate supported non-profit [J] *Journal of Marketing*, 2004, 68 (4): 16-32.
- [34] Lian Chunhui, Wang Yuetang. Empirical Research on Corporate Social Responsibility Information, Corporate Reputation and Investment Intention [J]. *Journal of Southeast University (Philosophy and Social Sciences Edition)*, 2018,20 (03): 53-59+147.
- [35] Zhang Xu, Song Chao, Sun Yaling. Empirical Analysis of the Relationship between Corporate Social Responsibility and Competitiveness [J]. *Scientific Research Management*, 2010,31 (03): 149-157.
- [36] Zhong Yuxiang, Lv Huaili, Li Wanli. Management myopia, accounting conservatism, and corporate innovation inhibition [J]. *Nankai Management Review*, 2017,20 (06): 163-177.
- [37] Wang Jianling, Li Yueting, Wu Xuan. Corporate social responsibility and Assumption of risk: based on the perspective of resource dependence theory [J]. *Forecast*, 2019, 38 (03): 45-51.
- [38] Banerjee, S.B. Corporate Citizenship and Individual Stackholders: Exploring a New Dynamic of Organizational Stackholder Relationships [J] *Journal of Corporate Citizenship*, 2001. (1); 39-55.
- [39] Macgregor DG, Slovic P, Dreman D, Berry M. Imagery Effect and Financial Judgment [J] *Journal of Behavioral Finance*, 2000,1 (2): 104-110.
- [40] Liu Xing, Chen Xichan. CSRC punishment, analyst tracking and corporate bank debt financing - Empirical evidence from information disclosure violations [J]. *Accounting Research*, 2018 (01): 60-67.
- [41] Bao Cuihua. Environmental Information Disclosure, Commercial Credit, and Corporate Banking Credit Financing [J]. *Accounting Research*, 2020 (10): 35-44.
- [42] Zhang Zhengyong, Deng Bofu. Corporate Social Responsibility, Monetary Policy, and Commercial Credit Financing [J]. *Scientific Research Management*, 2018,39 (05): 94-102.
- [43] Hillman A J, Keim G D. Sharehouse Value Stackholder Management and Social issues what's the Bottom Line? [J] *Strategic Management Journal*, 2001,22 (2): 125-138.
- [44] [J] *Audit and Economic Research*, 2019,34 (02): 79-90.
- [45] Kaplan, S. N., and L. Zingales 1997. Do investment cash flow sensitivities provide useful measures of financing constraints *Quarterly Journal of Economics* 112 (1): 169 – 215.
- [46] Yang Guozhong, Xi Yuting. Empirical study on financing constraints of green technology innovation activities of enterprises [J]. *Industrial Technology Economy*, 2019, 38 (11): 70-76.
- [47] Zhao Shukuan, Zhang Baichen, Cai Jiaming. The impact of green innovation on enterprise performance: based on Panel data of Chinese listed companies [J]. *Science and Technology Management Research*, 2022,42 (06): 211-220.
- [48] Huang Pingping, Li Sihai. The Tone of Social Responsibility Reports and the Risk of Stock Price Collapse [J]. *Audit and Economic Research*, 2020,35 (01): 69-78.
- [49] Li Qiang, Feng Bo. Environmental regulation, political connection and environmental information disclosure quality - based on Empirical evidence of heavily polluted listed companies [J]. *Economics and Management*, 2015, 29 (04): 58-66.
- [50] Zhang Chuancai, Chen Hanwen. Product Market Competition, Property Nature, and Internal Control Quality [J]. *Accounting Research*, 2017 (05): 75-82+97.
- [51] Yu Lisheng, Wang Yanyan. Information Uncertainty and Post Earnings Announcement Drift (PEAD) -- Empirical evidence from Chinese Listed Companies [J]. *Management World*, 2006 (03): 40-49+56+171-172.