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RESEARCH ARTICLE

Media reporting, carbon information disclosure, and the cost of equity financing: evidence from China

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Abstract By using Shanghai and Shenzhen A-share listed companies in heavy polluting industry as research object from 2009 to 2014, this paper examines the relationship between media reporting, carbon information disclosure, and the cost of equity financing. The results show that media reporting can improve the quality of carbon information disclosure, and carbon information disclosure level is negatively associated with the cost of equity financing. This study also finds that financial carbon information disclosure and non-financial carbon information disclosure have significant negative relationship with the cost of equity financing respectively. Moreover, this paper shows that media reporting can strengthen the relationship between carbon information disclosure and the cost of equity financing.

Keywords Carbon information disclosure · Media reporting · Cost of equity financing

Introduction

Climate change has become the political and business agenda for many years now. A large amount of greenhouse gas emissions is the main cause of global warming. China is well known as the world largest coal consumer and carbon emitter (IEA (International Energy Agency) 2010). The national carbon emissions trading market will be started from 2017, which covers the main industries in China. Carbon information is not only a yardstick to reflect economic development and coordination degree of energy saving and emission reduction but also the foundation of carbon emission trading mechanism. From the Kyoto Protocol in 1997 to the Marrakesh Agreement in 2001, the rise of low-carbon market and the flourish of carbon trading make carbon information disclosure become a trend gradually (Andrew and Cortese 2011). Carbon information disclosure is the voluntary activity for enterprise in most countries. It has been proved that carbon information disclosure is beneficial to helping enterprise analyze risks and grasp opportunities causing by climate change and also is a reliable platform transmitting carbon emission data and carbon management ability from enterprises to stakeholders; meanwhile, carbon information disclosure can also promote the implementation of carbon emission trading system.

Currently, high-polluted enterprises in China mainly disclose information creating good enterprise image, rather than fulfill social responsibility actively. The main reason of enterprise carbon information disclosure is external pressure that comes from the government, the media, the public, etc. The Chinese government determines the goal that the expected carbon dioxide emissions of unit of gross domestic product (GDP) by 2030 or so will be of 60~65% lower than in 2005. Media is one of the most important sources of information (Kleinschmit and Krott 2008). Whether enterprises can disclose carbon information with high quality when the media participate in the enterprise governance? Whether the cost of equity financing is affected by carbon information disclosure quality? As the rising of media reporting, the effect of carbon information disclosure on the cost of equity financing is promoting function or restraining function. Therefore, it is imperative to study the relationship of media reporting, carbon information disclosure, and the cost of equity financing in order

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to offer policy recommendations for environmental protection and sustainable development.

This paper is organized as follows. The next section is literature review followed by the "Theoretical analysis and hypothesis development". The "Methods" section introduces method sample selection and data sources, definition and measurement of variables, and the models. The "Results and analysis" section focuses on empirical results and analysis of the study. The last section is the concluding remarks of this paper including the main findings, contributions, limitations, and suggests.

Literature review

Many studies have examined carbon information disclosure quality and influence factors and economic effects of carbon information disclosure. Most existing studies are based on CDP (Carbon Disclosure Project) report involving the world top 500 companies. Elijido-Ten (2017) found that recognition of climate change as a net risk is significant and negatively correlated to sustainability performance and the recognition/anticipation of climate change opportunities are found to be significant and positively related to sustainability performance. Doda et al. (2016) used data for 2009 and 2010 from the CDP and found little compelling evidence that commonly adopted management practices are reducing emissions. Gonzalez-Gonzalez and Ramírez (2016) used data for 2012 from the CDP to research on the factors that influence on carbon disclosure. Blanco et al. (2016) used environmental Input-Output Life-Cycle Assessment models to evaluate scope 3 carbon emissions disclosed by many of the largest firms in the USA to CDP. Depoers et al. (2016) found that GHG (greenhouse gas) amounts are significantly lower in the CR (corporate reports) than in the CDP. Guenther et al. (2016) used CDP 2008~2011as the sample to analyze the relationship between carbon disclosure and the relevance of the stakeholder groups. Ben-Amar and McIlkenny (2015) found a positive association between board effectiveness and the firm's decision to answer the CDP questionnaire as well as its carbon disclosure quality. Lee et al. (2015) used CDP Korea 2008 and 2009 as the sample to investigate market responses to firms' voluntary carbon information disclosure. Luo and Tang (2014) found a significant positive association between carbon disclosure and performance. Matisoff (2013) assessed the effectiveness of mandatory carbon reporting programs and the voluntary CDP. Luo et al. (2012) investigate how the global 500 companies respond to the challenge of climate change with regard to their carbon disclosure strategies. Kolk et al. (2008) pointed out that although enterprises participating carbon information disclosure survey are increasing gradually, the comparability and reliability of carbon information disclosure are still insufficient.

The researches about the influencing factors of carbon information disclosure mainly focused on the external economic factors and internal factors, such as Gonzalez-Gonzalez and Ramírez (2016) found that the probability of carbon disclosure and its transparency level are explained by the influence of pressures from society, markets, shareholders, and international interactions, and in the Spanish case, the factors that have shown a stronger influence are the size of the company, financial risk, their listing in the IBEX35 and FT500 indexes, and the ownership concentration. Guo et al. (2016) used the historical data of ten typical provinces and cities in China during 2005~2014 and found that the amount of logistics and GDP has a contribution to carbon emissions and the long-term relationships are different between different cities in China, mainly influenced by the difference among development mode, economic structure, and level of logistic development. Halkos and Skouloudis (2016) found that subscription to externally developed voluntary initiatives, international presence well as operating in environmentally sensitive sectors, are significant variables that positively affect climate change disclosure. Kalu et al. (2016) found that social and financial market were critical determinant factors for carbon disclosure while the economic and institutional factors did not achieve significant effect on voluntary carbon disclosure. Grauel and Gotthardt (2016) showed that both environmental regulations and legal origin are extremely relevant explanatory factors, accounting for more variance than all tested firm-level variables except size. Peng et al. (2015) found that companies operating in high-emission sectors are more likely to make CID and tend to disclose more information and firms which have better performance are more willing to make the CID. Matsumura et al. (2014) examined the effects on firm value of carbon emissions and of act of voluntarily disclosing carbon emissions. Luo et al. (2012) used carbon disclosure leading index, greenhouse gas emissions, and carbon intensity to measure enterprise sustainable development and found that the higher the degree of a country's financial development, the enterprise is more willing to disclose carbon information. Wegener (2010) showed that regional environmental regulation is important to enterprise carbon information disclosure, and strict supervision system and its effective implementation is the key factor affecting carbon information disclosure. Liu and Anbumozhi (2009) argued that the content and degree of information disclosure are the result of internal and external force of enterprises, and external factors are the major cause, and government pressure, industry's environmental sensitivity, and regional market development level have a positive impact on environmental information disclosure quality. Dyck and Zingales (2002) provide both anecdotal and systematic evidence that media affect companies' policy toward the environment and the amount of corporate resources that are diverted to the sole advantage of controlling shareholders. Aerts and Cormier (2009) showed that negative media legitimacy is a driver of environmental press releases but not of annual report environmental disclosures.

As the important expression of information disclosure's economic consequences, information disclosure has important influence on the cost of equity financing (Core 2001; Healy and Palepu 2001). Many theoretical and empirical studies have investigated the relationship of information disclosure and the cost of equity financing, such as Yu and Wang (2016) pointed out that the quality of information disclosure of listed companies has become one of the weight factors of equity financing cost. Xu et al. (2015) found that firms with higher CSR scores have significantly lower cost of equity capital. Li and Foo (2015) found that the higher the quality of social responsibility information disclosure, the lower the cost of equity capital with the data of 3012 listed corporations in China. From a global perspective, Feng et al. (2015) found that, in general, firms with better CSR scores are significantly associated with a reduced cost of equity capital in North America and Europe, but the results do not continue to hold in Asian countries. Kim et al. (2015) used GHG emissions data to investigate the effect of carbon risk on the cost of equity capital. Chen et al. (2014) also found that environmental accounting information disclosure is beneficial to reducing investors' error estimation and equity financing cost. Busch and Hoffmann (2011) pointed out that carbon management of enterprises may have a positive impact on companies' financial performance or have a negative impact. It will obtain different results based on different accounting methods of carbon emission. Francis et al. (2004) showed that the enterprises with low information disclosure quality have higher equity financing cost by using listed companies in the USA in 1975–2001 as samples. Based on 34 countries' data from 1986 to 1998, Bhattacharya et al. (2003) found that the higher the equity financing cost of stock market for these countries with poor information disclosure quality was, the less active stock trading would be. Lang and Lundholm (1993, 1996) found that the increase of information disclosure can reduce the analysts' uncertainty forecasting enterprise situation, thus making companies get more the attention from analysts; accordingly, the costs of equity financing are low. Barry and Brown (1984) and Handa and Linn (1993) proved in theory that investors think that stock with low information disclosure level has a higher risk, and thus a smaller demand for such stock, and enterprises' financing costs are higher.

Although numerous studies have been conducted to investigate the influence factors and economic consequences of carbon information disclosure, we still lack a sufficient, systematic understanding about carbon information disclosure. First, few studies have been conducted to investigate the effect of media reporting on carbon information disclosure, and the external factors are mainly focused on macro-environment. Second, carbon information disclosure has not been classified. According to the research of Al-Tuwaijri et al. (2004) and Aerts and Cormier (2009), carbon information disclosure can be divided into financial carbon information disclosure and non-financial carbon information disclosure. Finally, the studies on the relationship of carbon information disclosure and cost of equity financing just focus on unidirectional causality between them, less research estimates media reporting's role in the relationship between carbon information disclosure and cost of equity financing.

Theoretical analysis and hypothesis development

Media reporting and carbon information disclosure

Legitimacy theory suggests that particularly poor performing companies use sustainability disclosure as a legitimation tactic to influence public perceptions regarding their sustainability performance (Deegan 2002). Legitimacy focuses on the society's acceptance of enterprise's activities. Lots of media reporting form the power of the news media to influence enterprise practices. Media coverage affects the market values of the event companies to some extent (Xu et al. 2016). CSR is one of the ways through which firms gain legitimacy. More socially responsible firms receive more favorable news reportage overall; there is a stronger relation between CSR and media favorability when incentives to improve a firm's media image are high (Cahan et al. 2015). Nyilasy et al. (2014) showed that media attention will lead different cognition of governments and different consumer interaction about enterprises' performance, such as consumers will forgive pollution consequences of enterprise low-performance products if media spreads green advertising; the main reason is that enterprises will choose to disclose best-selling products with high environmental performance under the stimulus of advertising and cover up the fact of damaging environment.

On the other hand, enterprises' negative information reporting by media brings huge pressure for enterprises, which make enterprises disclose positive carbon information as much as possible. Jia et al. (2016) found that the more negative the media coverage, and the more local this coverage, the greater the impact on corporations. Kim et al. (2014a) suggested that media coverage affects a firm's information environment. Goosen-Botes and Samkin (2013) showed that when enterprises are faced with a negative incident, they will use their social and environmental reporting as a tool to manage their legitimacy. Fisher-Vanden and Thorburn (2011) showed that as the costs of an adverse selection and the moral hazard of generating friction in capital markets, managers of firms responsible for violations who wish to maximize the value of their firms are incentivized to reduce the degree of information asymmetry by signaling good news to capital markets through information intermediaries to create a separating equilibrium in which their types can be confirmed by investors. Signaling theory examines the role of signals in information asymmetry and is helpful in explaining the behavior of two

parties when they have access to different information (Connelly et al. 2011). In order to get the understanding of government and public, enterprises will disclose more carbon information about eco-environment in the next years. Based on prior studies, it is hypothesized that:

- H1: There is a positive association between media reporting and carbon information disclosure.

Carbon information disclosure and the cost of equity financing

Information asymmetry theory indicates that, in market economy activity, at least one party to a transaction has relevant information but the others do not. Obviously, investors are the important stakeholder of enterprise; due to the disadvantage in the information, it is easy to make inaccurate investment decisions, which leads to adverse selection phenomenon in a market. Signaling theory holds that in order to prevent the adverse selection of investors, enterprises are willing to disclose more information to cause the attention of investors and reduce the degree of information asymmetry as far as possible. According to signaling theory arguments, to distinguish themselves from poor performers, superior environmental performers may provide credible information that cannot be easily replicated by inferior performers (Connelly et al. 2011). The quality of information disclosure of listed companies has become one of the weight factors of equity financing cost (Yu and Wang 2016). Information disclosure can enhance investor awareness for enterprises, reduce the level of information asymmetry, improve the level of investment risk sharing, and reduce the cost of capital (Chen et al. 2014; Francis et al. 2004; Bhattacharya et al. 2003). Firms with higher CSR scores have significantly lower cost of equity capital (Xu et al. 2015; Li and Foo 2015). Latridis (2013) found that environmental information disclosure can affect investor cognition; the higher information disclosure quality and internal management level are, the lower barriers of enterprise accessing capital market are; and its financing level is higher than the same type enterprise with low environmental information disclosure quality. Kock et al. (2012) argued that environmental information disclosure has lag influence on equity capital cost. Environmental information disclosure will bring negative return for enterprises of poor environment quality in the short run, but in the long run, information disclosure will bring positive return for enterprises with good environment quality.

Prior literature indicates that voluntary non-financial or financial information disclosure reduces information asymmetry problems in capital markets. Skouloudis et al. (2014) investigated the status of the non-financial disclosure practices of the top 100 companies operating in Greece. Jensen and Berg (2012) found that the financial report has a weakness in that it does not provide information regarding certain questions, such as the social and environmental aspects of company activities, aspects that are interrelated. Dhaliwal (2011) thought that non-financial information by investor preference has an influence on capital cost, investors give their preference on enterprises with strong environmental responsibility, and environmental information disclosure will alleviate the information asymmetry between investors and enterprises, reduce expected risk and expected return, and then reduce capital cost of enterprises. In this study, the following hypothesis is proposed:

H2: There is a negative association between carbon information disclosure and the cost of equity financing.

Media reporting, carbon information disclosure, and the cost of equity financing

According to legitimacy theory, the poor carbon performing enterprises can disclosure more carbon information to obtain legitimacy. Meanwhile, information asymmetry theory and signaling theory suggest that carbon information disclosure is helpful for reducing capital cost. Media reporting transmits the carbon information to stakeholders to increase the transparency of enterprise activities and influences on the cost of equity financing indirectly. The influencing mechanism is shown in Fig. 1.

When media reporting frequency is high, poor environmental performance enterprises under the pressure of legal supervision and media supervision will be forced to disclose carbon information to prove its legitimacy, while good environmental performance enterprises will obtain competitive advantage through good public image and environmental performance and attract lower cost of equity financing. Cahan et al. (2015) found that for firms that demonstrate superior social responsibility and receive more favorable news reporting, there is a significant interaction between social responsibility and media favorability that increases (decreases) a firm's equity valuation (cost of capital). For these enterprises developing environmental protection products, Nyilasy et al. (2014) found that consumers have higher tolerance and attention to enterprises, with the improvement of media supervision level; enterprise external environmental management level is improved; and information asymmetry level between companies and investors and the trade cost of stock investors are reduced. On the other hand, if media reporting frequency is low, enterprises face a lower pressure for carbon information disclosure and the listed companies have strong motivation to reduce carbon information disclosure, especially the information on major environmental accident, apology, and compensation for pollution behavior. Therefore, it is hypothesized that:

H3: The higher media reporting frequency, the more negative the influence of carbon information disclosure on the cost of equity financing.

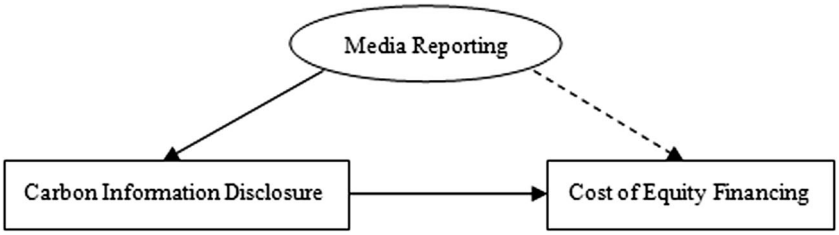

Fig. 1 The influencing mechanism

Methods

Sample selection and data sources

The sample of this study is composed of 161 heavy polluting companies listed on the Shanghai Stock Exchange (SHSE) or the Shenzhen Stock Exchange (SZSE). Companies with no separate sustainability reports or environmental disclosures in annual reports are excluded from samples.

Finally, there are 128 A-share listed companies from 2009 to 2014 as valid samples. Carbon information disclosure is obtained from Social Responsibility Report and Sustainable Development Report, and other data are collected from CSMAR database and RESSET database.

Definition and measurement of variables

Media reporting Aerts et al. (2008) confirmed that listed companies have large sensitivity to negative media reporting, which forces companies to disclose more environmental information to defend itself. According to the content of media reporting, media reporting (MR) is classified into positive reporting, neutral reporting, and negative reporting. Positive reporting is the enterprise activities involving in environmental protection, such as increasing investment in environmental protection of enterprise; neutral reporting includes the content of implementation of national, industry policies and regulations, such as the implementation of "processing industrial water pollutant discharge standards of leather and fur"; negative reporting is related to environmental pollution of enterprise. In this paper, we use the method of Clarkson et al. (2008) to measure the tendency of media reporting by Janis-Fadner coefficient, which means the legitimacy pressure of enterprise. Media reporting is defined as

$$\text{Janis}-\text{Fadner coefficient} = \begin{cases} \frac{(e^2-ec)}{t^2}, & \text{if } e > c \\ \frac{(ec-e^2)}{t^2}, & \text{if } e < c \\ 0, & \text{if } e = c \end{cases} \quad (1)$$

Where e denotes the number of positive media reporting, c represents the number of negative media reporting, and t indicates the sum of e and c. In addition, the Janis-Fadner coefficient ranges from −1 to 1; the more positive media reporting on carbon information disclosure of enterprise is, the closer the Janis-Fadner coefficient is to 1 and the pressure of public opinion is smaller; the more negative media reporting on carbon information disclosure of enterprise is, the closer the Janis-Fadner coefficient is to −1 and the pressure of public opinion is bigger.

Carbon information disclosure According to the research methods of Al-Tuwaijri et al. (2004) and Aerts and Cormier (2009), carbon information disclosure (CID) is divided into financial carbon information disclosure and non-financial carbon information disclosure. In this paper, financial carbon information is composed of low-carbon research investment and achievements, resource utilization, and development; non-financial carbon information includes low-carbon development strategy and the establishment of low-carbon management department (Table 1). The specific formula is as follows:

$$\text{CID}_i = \frac{\sum \text{CIDP}_i}{\text{MCID}} \quad (2)$$

where CID_i represents the level of carbon information disclosure of enterprise i, ΣCIDP_i is the total score of enterprise i, MCID refers to the sum of the highest score among all the disclosure items, and MCID is 14 points in Table 1.

The formula for calculating the level of financial carbon information disclosure is

$$\text{CIDF}_i = \frac{\sum \text{CIDFP}_i}{\text{MCIDF}} \quad (3)$$

where CIDF_i represents the level of financial carbon information disclosure of enterprise i, ΣCIDFP_i is the total financial score of enterprise i, MCIDF refers to the sum of the highest score among all the financial disclosure items, and MCIDF is 6 points in Table 1.

The formula for calculating the level of non-financial carbon information disclosure is

$$\text{CIDNF}_i = \frac{\sum \text{CIDNFP}_i}{\text{MCIDNF}} \quad (4)$$

where CIDNF_i represents the level of non-financial carbon information disclosure of enterprise i, ΣCIDNFP_i is the total non-financial score of enterprise i, MCIDNF refers to the sum of the highest score among all the non-financial disclosure items, and MCIDNF is 8 points in Table 1.

Table 1 Specifications of carbon information disclosure

Disclosure items	Score	Instructions
Low-carbon development strategy	0, 1	Having low-carbon development strategy records 1 point, otherwise 0 point
Establishing the low-carbon management department	0, 1	Possessing a special management department records 1 point, otherwise 0 point
Enhancing the low-carbon awareness of employees	0, 1	Having propagation records 1 point, otherwise 0 point
Carbon emissions	0, 1, 1.5, 2, 3	Simple qualitative description records 1 point, detailed description records 1.5 points, simple quantitative and quantitative description records 2 points, detailed qualitative and quantitative description record 3 points, otherwise 0 point
Low-carbon research investment and achievements	0, 1, 2	Qualitative description records 1 point, qualitative and quantitative description record 2 points, otherwise 0 point
Resource utilization and development	0, 1, 2	Qualitative description records 1 point, qualitative and quantitative description record 2 points, otherwise 0 point
Recognition of carbon emissions by government	0,1	Recognition records 1 point, otherwise 0 point
Developing low-carbon economy to get benefits	0, 1, 2	Qualitative description records 1 point, qualitative and quantitative description record 2 points, otherwise 0 point
Putting low-carbon development into the performance evaluation system	0, 1	Including low-carbon development records 1 point, or 0 point

The cost of equity financing This paper selects economic growth model to measure the cost of equity financing (CEF). The reasons why we choose the model are that data availability is stronger, do not need to assume that dividend payment, and do not need to estimate book value and ROE. To ensure the reliability of results, finally, we will use PEG ratio model to calculate the cost of equity financing in order to robustness check. The specific formula is as follows:

$$\mathrm{CEF} = \frac{1}{2}\left[(\gamma-1) + \frac{\delta \times \mathrm{eps}_1}{p_0}\right] + \sqrt{\frac{1}{4}\left[(\gamma-1) + \frac{\delta \times \mathrm{eps}_1}{p_0}\right]^2 + \frac{\mathrm{eps}_1}{p_0}\left[\frac{\mathrm{eps}_2 - \mathrm{eps}_1}{\mathrm{eps}_1} - (\gamma-1)\right]} \quad (5)$$

where CEF is the cost of equity financing, γ-1 is the long-term earnings growth, δ is the stock average dividend payment rate for the past 3 years, eps_1 is the earnings per share in $t+1$ year, eps_2 is the earnings per share in $t+2$ years, P_0 is the stock closing price in the end of $t-1$ year.

Other control variables To avoid model misspecification, we control for additional variables, which might also impact on carbon information and the cost of equity financing. The control variables are composed of ratio of asset (RA), financial lever (FL), operating income grow rate (OIGR), corporation scale (CS), the proportion of first shareholders (PFS), board scale (BS), the proportion of independent directors (PID), book to market (BM), turnover rate (TR), β coefficicent (β), dual position (DP), ownership (OW), and listed years (LY) (Table 2).

Models

The following models are used to test the hypotheses about the relationships between media reporting, carbon information disclosure, and the cost of equity financing:

$$\begin{aligned}\mathrm{CID_{i,t}} = {} & a_0 + a_1\mathrm{MR}_{i,t} + a_2\mathrm{RA}_{i,t} + a_3\mathrm{FL}_{i,t} + a_4\mathrm{OIGR}_{i,t} \\ & + a_5\mathrm{CS}_{i,t} + a_6\mathrm{PFS}_{i,t} + a_7\mathrm{BS}_{i,t} + a_8\mathrm{PID}_{i,t} \\ & + a_9\mathrm{BM}_{i,t} + a_{10}\mathrm{TR}_{i,t} + a_{11}\beta_{i,t} + a_{12}\mathrm{DP}_{i,t} + a_{13}\mathrm{OW}_{i,t} \\ & + a_{14}\mathrm{LY}_{i,t} + \varepsilon_{i,t}\end{aligned} \quad (6)$$

$$\begin{aligned}\mathrm{CEF}_{i,t} = {} & b_0 + b_1\mathrm{CID}_{i,t} + b_2\mathrm{MR}_{i,t} + b_3\mathrm{CID}_{i,t} \times \mathrm{MR}_{i,t} \\ & + b_4\mathrm{RA}_{i,t} + b_5\mathrm{FL}_{i,t} + b_6\mathrm{OIGR}_{i,t} + b_7\mathrm{CS}_{i,t} + b_8\mathrm{PFS}_{i,t} \\ & + b_9\mathrm{BS}_{i,t} + b_{10}\mathrm{PID}_{i,t} + b_{11}\mathrm{BM}_{i,t} + b_{12}\mathrm{TR}_{i,t} + b_{13}\beta_{i,t} \\ & + b_{14}\mathrm{DP}_{i,t} + b_{15}\mathrm{OW}_{i,t} + b_{16}\mathrm{LY}_{i,t} + \lambda_{i,t}\end{aligned} \quad (7)$$

Results and analysis

Descriptive statistics and correlation analysis for the variables

Descriptive statistics Table 3 presents descriptive statistics of variables. Table 3 shows that the mean of CID is 0.305 and illustrates that the overall level of carbon information disclosure for heavy pollution listed company is not high. The mean values of CIDNF and CIDF are 0.379 and 0.178, respectively, which indicates that financial carbon information disclosure level is lower than the whole level of carbon information

Table 2 Variable definition and explanation

Symbol	Variable name	Variable explanation
CID	Carbon information disclosure	General situation of carbon information disclosure
CIDNF	Non-financial carbon information disclosure	General situation of non-financial carbon information disclosure
CIDF	Financial carbon information disclosure	General situation of financial carbon information disclosure
CEF	Cost of equity financing	Measured by OJN model
MR	Media reporting	Tendency of news reporting
RA	Ratio of asset	Return rate of total assets
FL	Financial lever	Asset-liability ratio
OIGR	Operating income grow rate	Operating income growth rate
CS	Corporation scale	The logarithmic of total assets at the end of the year
PFS	Proportion of first shareholders	Proportion of first shareholders
BS	Board scale	The logarithmic of board's total membership
PID	Proportion of independent directors	Proportion of independent directors in total membership
BM	Book to market	Net assets per share divided by share price
TR	Turnover rate	The sum of turnover rate of tradable shares this year
β	β coefficicent	β coefficicent
DP	Double position	If the chairman is CEO, D is equal to1, or D is equal to 0.
OW	Ownership	If enterprises are state-owned, OW is equal to 1, or OW is equal to 0.
LY	Years' listed	The number of years of enterprise reporting minus the listed years

disclosure relative to non-financial carbon information disclosure. Further, the mean of CEF is 0.203, and the maximum and minimum values of CEF are 0.978 and 0.004, respectively, which illustrates that the cost of equity financing has great difference. Besides, the maximum value, minimum value, and standard deviation of MR are 1.000, −1.000, and 0.480, respectively.

Table 3 Descriptive statistics for variables

Variables	Number	Min	Max	Mean	Std. Dev.	Median
CID	768	0.000	1.000	0.305	0.193	0.037
CIDNF	768	0.000	1.000	0.379	0.219	0.048
CIDF	768	0.000	1.000	0.178	0.208	0.043
CEF	768	0.004	0.978	0.203	0.172	0.030
MR	768	−1.000	1.000	0.603	0.480	0.230
RA	768	−0.326	0.477	0.048	0.056	0.003
FL	768	0.016	1.112	0.531	0.201	0.040
OIGR	768	−0.703	1.390	0.123	0.244	0.060
CS	768	19.304	28.509	23.447	1.659	2.754
PFS	768	0.050	0.864	0.440	0.165	0.027
BS	768	1.386	3.526	2.533	0.312	0.097
PID	768	0.000	0.750	0.351	0.104	0.011
BM	768	−0.067	4.921	0.525	0.395	0.156
TR	768	0.014	23.498	3.367	3.526	12.435
β	768	0.053	1.893	1.100	0.292	0.085
DP	768	0.000	1.000	0.117	0.322	0.104
OW	768	0.000	1.000	0.719	0.450	0.202
LY	768	1.000	30.000	14.938	4.512	20.361

The mean values of RA and OIGR are 0.048 and 0.123, respectively, that is, profitability and growth of companies are good. The mean of FL is 0.531, which indicates that the debt paying ability of companies is ideal. The mean and standard deviation of CS are 23.447 and 1.659, respectively, which means that the scale of sample companies has obvious difference. The mean of PFS is 0.440, which implies that the equity of some samples is concentrated. The mean of BS is 2.533, which indicates that company scale is relative small. The mean values of BM and TR are 0.525 and 3.367, respectively, which illustrates that the growth and liquidity of companies remain the average level. The mean of β is 1.100, indicating the existence of high risk. The mean values of DP, OW, and LY are 0.117, 0.719, and 14.938, respectively. On the whole, the volatility and discrete degree of sample data are low, and sample companies have good stability, which means that sample selection is relatively reasonable and has certain representativeness.

Correlation analysis Table 4 presents Pearson correlation coefficients of variables. The correlation coefficient of CID and MR is 0.116 and is significant at the 0.01 significance level, which indicates that the more media reporting, the greater motivation of carbon information disclosure. The correlation coefficient of CID and CEF is −0.108 at the 0.01 significance level, which means that the increase of

Table 4 Correlation analysis results of variables

	CID	CEF	MR	RA	FL	OIGR	CS	PFS	BS	PID	BM	TR	β	DP	OW	LY
CID	1															
CEF	−0.108***	1														
MR	0.116***	−0.018	1													
RA	−0.104***	0.034	0.012	1												
FL	0.104***	0.108***	0.052	−0.549***	1											
OIGR	−0.009	0.107***	0.051	0.262***	0.008	1										
CS	0.354***	−0.041	0.149***	−0.160***	0.457***	−0.032	1									
PFS	0.229***	−0.145***	0.054	0.029	0.010	−0.093**	0.435***	1								
BS	0.203***	0.059	0.043	−0.148***	0.165***	−0.057	0.309***	0.078**	1							
PID	−0.051	−0.059	−0.044	0.071**	−0.132***	0.048	−0.096***	0.044	−0.321***	1						
BM	0.128***	−0.003	0.034	−0.229***	0.199***	−0.152***	0.441***	0.097***	0.089**	−0.059*	1					
TR	−0.092**	0.023	−0.066*	0.049	−0.110***	0.058	−0.365***	−0.150***	−0.071**	−0.005	−0.352***	1				
β	0.040	−0.176***	0.041	−0.114***	0.000	0.004	−0.195***	−0.098***	−0.021	−0.016	−0.134***	0.297***	1			
DP	−0.143***	−0.093***	−0.059*	0.027	−0.051	−0.075**	−0.103***	−0.083**	−0.127***	0.047	0.012	−0.036	−0.047	1		
OW	0.269***	−0.061*	0.038	−0.230***	0.257***	−0.030	0.351***	0.332***	0.312***	−0.192***	0.027	−0.089**	−0.034	−0.195***	1	
LY	−0.111***	0.029	−0.123***	−0.036	−0.032	−0.102***	−0.145***	−0.284***	0.064*	−0.096***	0.102***	−0.226***	−0.125***	−0.119***	−0.132***	1

Note: ***at 1% level; **at 5% level; *at 10% level

carbon information disclosure can obviously decrease the cost of equity financing. CID has significant and positive effects on FL, CS, PFS, BS, BM, and OW, which indicates that the worse the debt paying ability of companies, the more the amount of carbon information disclosure; meanwhile, the greater proportion of first shareholders and board scale, enterprises are willing to disclose more carbon information. CEF has significant and positive effects on FL and OIGR, which implies that the higher financial leverage is, the greater the cost of equity financing is. CEF has significant and negative effects on PFS and DP, which illustrates that the more concentrated enterprise equity is, the lower the cost of equity financing is. In addition, the correlation coefficients of CEF, MR, CS, PID, BM, and OW are negative, but not significant.

As the correlation coefficients of variables are significant, we further test multicollinearity problem of variables, including tolerance and variance inflation factor (VIF) of explanatory variables and control variables. In model 6, the tolerance values of MR, RA, FL, OIGR, CS, PFS, BS, PID, BM, TR, β, DP, OW, and LY are 0.952, 0.560, 0.499, 0.857, 0.398, 0.655, 0.760, 0.857, 0.683, 0.712, 0.865, 0.937, 0.701, and 0.772, respectively; the VIF values are 1.050, 1.786, 2.002, 1.167, 2.511, 1.528, 1.317, 1.166, 1.464, 1.404, 1.155, 1.068, 1.426, and 1.295, respectively. In model 7, the tolerance values of CID, MR, RA, FL, OIGR, CS, PFS, BS, PID, BM, TR, β, DP, OW, and LY are 0.325, 0.283, 0.555, 0.493, 0.856, 0.378, 0.650, 0.756, 0.857, 0.683, 0.712, 0.857, 0.930, 0.690, and 0.771, respectively; the VIF values are 3.080, 3.530, 1.801, 2.028, 1.168, 2.645, 1.539, 1.323, 1.167, 1.465, 1.405, 1.166, 1.075, 1.450, and 1.297, respectively. In conclusion, all VIF values in model 6 and model 7 are smaller than 4, and all tolerance values in model 6 and model 7 are bigger than 0.2, which illustrates that models do not exist multicollinearity problem.

Regression analysis

Media reporting and carbon information disclosure This paper examines the relationship between MR and CID using ordinary least squares (OLS) and generalized least squares (GLS), and the GLS results as shown in Table 5. The regression coefficients of MR and three kinds of CID are 0.056, 0.062, and 0.033, respectively, and CID and CIDNF are both significant at the 10% level, meaning that enterprise carbon information disclosure and non-financial carbon disclosure are effected obviously by media reporting, and the more social opinion pressure to enterprise is, the more carbon disclosure information and non-financial carbon disclosure are. Meanwhile, state-owned enterprises, board of directors, and enterprises with bigger scale are willing to disclose more carbon information. Therefore, MR has significant and positive effect on carbon disclosure information level, that is, MR can promote the increasing of carbon information disclosure level, which means that hypothesis 1 is correct.

Table 5 Regression results of MR and CID

	CID	CIDNF	CIDF
MR	0.056*	0.062*	0.033
	(1.676)	(1.825)	(0.954)
RA	−0.091**	−0.087**	−0.070
	(−2.068)	(−1.967)	(−1.536)
FL	−0.144***	−0.138***	−0.111**
	(−3.101)	(−2.938)	(−2.315)
OIGR	0.027	0.019	0.029
	(0.751)	(0.536)	(0.788)
CS	0.329***	0.266***	0.320***
	(6.325)	(5.055)	(5.940)
PFS	0.042	0.073*	−0.011
	(1.032)	(1.784)	(−0.274)
BS	0.069*	0.070*	0.047
	(1.828)	(1.850)	(1.211)
PID	0.016	0.021	0.006
	(0.462)	(0.587)	(0.153)
BM	−0.002	−0.008	0.006
	(−0.057)	(−0.205)	(0.157)
TR	0.007	−0.062	0.097**
	(0.189)	(−1.577)	(2.408)
β	0.093***	0.107***	0.049
	(2.648)	(2.999)	(1.348)
DP	−0.067**	−0.071**	−0.042
	(−1.972)	(−2.074)	(−1.206)
OW	0.125***	0.113***	0.107***
	(3.194)	(2.845)	(2.634)
LY	−0.015	0.000	−0.029
	(−0.392)	(−0.010)	(−0.760)
Constant	−0.752***	−0.655***	−0.881***
	(−5.459)	(−4.147)	(−5.403)
Adjusted *R*-squared	0.173	0.154	0.115

Note: ***at 1% level; **at 5% level; *at 10% level

Media reporting, carbon information disclosureand the cost of equity financing Table 6 shows the results of GLS in model 7. When CID is the only explanatory variable, the regression coefficient of CID and CEF is −0.070 and is significant at the 10% level. It indicates that CID can reduce CEF. The result supports hypothesis 2.

In order to further examine the relationships between MR, CID, and CEF, this study continues to introduce the interactive variable of CID × MR. Table 6 shows that the regression coefficient of interactive variable is −0.060, which is significant at the 0.10 significance level. To some degree, the increase of MR can strengthen the negative relationship of CID and CEF; the result supports hypothesis 3.

Table 6 Regression results of MR, CID, and CEF

	(1)	(2)
CID	−0.070*	−0.103*
	(−1.846)	(−1.716)
MR		−0.047
		(−0.733)
CID × MR		−0.060*
		(−1.724)
RA	0.094**	0.096**
	(2.058)	(2.095)
FL	0.212***	0.212***
	(4.347)	(4.351)
OIGR	0.065*	0.065*
	(1.757)	(1.748)
CS	−0.126**	−0.125**
	(−2.282)	(−2.247)
PFS	−0.095**	−0.098**
	(−2.250)	(−2.302)
BS	0.094**	0.093**
	(2.380)	(2.358)
PID	−0.034	−0.034
	(−0.918)	(−0.910)
BM	0.041	0.040
	(0.981)	(0.959)
TR	0.037	0.037
	(0.920)	(0.919)
β	−0.212***	−0.212***
	(−5.751)	(−5.722)
DP	−0.115***	−0.114***
	(−3.238)	(−3.206)
OW	-0.065	-0.063
	(−1.583)	(−1.521)
LY	−0.034	−0.036
	(−0.879)	(−0.919)
Constant	0.513***	0.522***
	(3.926)	(3.972)
Adjusted *R*-squared	0.102	0.101

Note: ***at 1% level; **at 5% level; *at 10% level

Table 7 Regression results of MR, CIDNF, CIDF, and CEF

	(1)	(2)	(3)	(4)
CIDNF	−0.069*	−0.083		
	(−1.843)	(−1.447)		
CIDNF × MR		−0.028		
		(−0.330)		
CIDF			−0.071**	−0.098*
			(−1.964)	(−1.650)
CIDF × MR				−0.033
				(−0.513)
MR		−0.027		−0.024
		(−0.397)		(−0.522)
RA	0.095**	0.096**	0.094**	0.116***
	(2.066)	(2.081)	(2.041)	(2.646)
FL	0.212***	0.212***	0.212***	0.225***
	(4.361)	(4.355)	(4.357)	(4.683)
OIGR	0.064*	0.064*	0.060	0.061
	(1.744)	(1.738)	(1.627)	(1.640)
CS	−0.131**	−0.130**	−0.125**	−0.123**
	(−2.387)	(−2.354)	(−2.267)	(−2.207)
PFS	−0.093**	−0.095**	−0.100**	−0.110***
	(−2.197)	(−2.229)	(−2.366)	(−2.612)
BS	0.094**	0.093**	0.092**	0.090**
	(2.382)	(2.364)	(2.340)	(2.290)
PID	−0.034	−0.034	−0.034	−0.031
	(−0.910)	(−0.917)	(−0.914)	(−0.830)
BM	0.040	0.040	0.038	0.032
	(0.971)	(0.953)	(0.919)	(0.764)
TR	0.032	0.032	0.047	0.047
	(0.799)	(0.782)	(1.143)	(1.148)
β	−0.211***	−0.210***	−0.218***	−0.218***
	(−5.719)	(−5.678)	(−5.930)	(−5.912)
DP	−0.115***	−0.115***	−0.114***	−0.117***
	(−3.244)	(−3.232)	(−3.209)	(−3.309)
OW	−0.066	−0.066	−0.067*	−0.065
	(−1.609)	(−1.597)	(−1.647)	(−1.577)
LY	−0.033	−0.034	−0.032	−0.039
	(−0.855)	(−0.877)	(−0.837)	(−1.013)
Constant	0.524***	0.529***	0.509***	0.514***
	(4.045)	(4.050)	(3.904)	(3.933)
Adjusted *R*-squared	0.102	0.100	0.103	0.099

Note: ***at 1% level; **at 5% level; *at 10% level

Media reporting, carbon information disclosureand the cost of equity financing The paper also examined the relationship between MR, CIDF, CIDNF, and CEF. The GLS regression results are showed in Table 7. In Table 7, the second column shows that the regression coefficient of CIDNF and CEF is −0.069, which is significant at the 10% level. This confirms that CIDNF may reduce CEF. At present, China enterprises mainly adopt the mode of voluntary carbon information disclosure, and enterprises may disclose non-financial carbon information to cater to low-carbon economy development trend. After introducing the interactive variable of CIDNF × MR, the regression coefficient of interactive variable is −0.028 in the third column and is not significant at the 10% level, which means that MR can affect CIDNF. MR may intensify the negative relationship between CIDNF and CEF, but the effect is not obvious.

In Table 7, the fourth column shows that the regression coefficient of CIDF and CEF is −0.071, which is significant at the 5% level. This means that CIDF can decrease CEF. The regression coefficient of interactive variable of CIDF × MR is −0.033 and is not significant at the 10% level, which means that MR may intensify the negative relationship between CIDF and CEF, but the effect is not obvious.

Sensitivity testing

First, this paper recalculates CEF using PEG ratio model and replaces the key dependent variables. Under the background of zero dividend payment policy, the model assumes the difference between stock price and book value can represent residual income. The equation of PEG ratio model as follows:

$$\mathrm{PEG} = \sqrt{\frac{\mathrm{eps}_2 - \mathrm{eps}_1}{p_0}} \tag{8}$$

According to the research of Shen and Feng (2012), this study obtains substitution variable of CID, and the substitution variable is expressed by CIDR. CIDR is calculated by the number of rows of carbon information in Social Responsibility Report and Sustainable Development Report. The sensitivity test results are listed in Table 8. Tables 8 shows that the regression coefficients of CIDR, MR, and CIDR × MR are −0.125, −0.086, and −0.149, respectively, and all variables are significant at the 10% level. In a word, sensitivity test results basically agree with the former analysis results, which further illustrates that previous conclusions are stable.

Table 8 Sensitivity testing results

	PEG
CIDR	−0.125**
	(−2.152)
MR	−0.086*
	(−1.767)
CIDR × MR	−0.149**
	(−2.241)
RA	0.099**
	(2.170)
FL	0.215***
	(4.422)
OIGR	0.063*
	(1.703)
CS	−0.133**
	(−2.373)
PFS	−0.106**
	(−2.504)
BS	0.096**
	(2.433)
PID	−0.027
	(−0.727)
BM	0.043
	(1.041)
TR	0.042
	(1.031)
β	−0.210***
	(−5.677)
DP	−0.104***
	(−2.922)
OW	−0.068*
	(−1.649)
LY	−0.033
	(−0.840)
Constant	0.521***
	(3.960)
Adjusted *R*-squared	0.102

Note: ***at 1% level; **at 5% level; *at 10% level

Concluding remarks

According to the results above, there is a positive association between media reporting and carbon information disclosure, that is, the level of media reporting can promote the quality of carbon information disclosure in Chinese heavy pollution industry. Carbon information disclosure of enterprises is mainly the result of social opinion pressure, and enterprise itself is a passive practitioners. Under the media supervision, enterprises actively express low-carbon management experience and tend to disclose more carbon information. In addition, carbon information disclosure and non-financial carbon disclosure are affected obviously by media reporting, and the more social opinion pressure to enterprises is, the more carbon disclosure information and non-financial carbon disclosure are.

Carbon information disclosure is negatively associated with the cost of equity financing, meaning that carbon information disclosure can reduce the enterprise cost of equity financing. The financial carbon information disclosure and non-financial carbon information disclosure have significant negative relationship with the cost of equity financing respectively. To avoid risk, investors believe that enterprises with low-carbon information disclosure have higher information asymmetry. On the other hand, investors consider that enterprises with high-carbon information disclosure are more powerful and have more strong environmental protection consciousness. Carbon information disclosure will give investors a signal, namely the investor pay more attention to the behavior of enterprise low-carbon management. The transparent information can enhance financial liquidity and financing efficiency and further provide decision-making basis for investment. Therefore, carbon information disclosure decreases enterprise cost of equity financing.

Media reporting can intensify the negative relationship between carbon information disclosure and the enterprise cost of equity financing. Media reporting gives social pressure to enterprises, and to a certain extent, it promotes the investors to pay attention to carbon information disclosure and reduce the information asymmetry. In a word, media reporting improved

the quality of investment decisions and is helpful to strengthen the existing negative relation between carbon information disclosure and the enterprise cost of equity financing.

With the rapid development of economy, the international status of China has been improved, and the Chinese people become rich too. Meanwhile, people pay more attention to the environmental issues, as pollution in China became an unprecedented problem in recent years. Energy saving and carbon emission reduction have been widely concerned by the Chinese people. The enlightenment of the research results shows that media reporting brings huge pressure to enterprises, which makes enterprises disclose more carbon information as much as possible. So the improvement of carbon information disclosure requires the media actively play a role of public supervision. The relevant department of government should make use of the media to supervise the enterprises in environmental protection issues. Furthermore, high-carbon information disclosure can reduce enterprise cost of equity financing. Media has become an important bridge between the public and enterprises.

Based on legitimacy theory, information asymmetry theory, and signaling theory with the media reporting perspective, our research develops the existing literature from four aspects. First, this paper analyzes the effect of carbon information disclosure on cost of equity financing from two aspects of financial carbon information disclosure and non-financial carbon information disclosure. Moreover, media reporting is divided into negative media reporting and positive media reporting, and we construct comprehensive index of media reporting. Thirdly, this paper explores the influence mechanism of media reporting on cost of equity financing. Finally, apart from the empirical contributions, we make the comprehensive dataset of carbon information disclosure in Chinese heavy pollution industry. According to the Carbon Disclosure Project China's report, it shows that, in CDP China 100 survey, the number of enterprises that reply questionnaires and provide carbon information is 21, 23, 32, and 45, respectively, in 2011~2014. Obviously, in the invited 100 companies, less than 50% of companies are willing to participate in this survey. As the actual situation of CDP China's report is not ideal, this paper chooses corporate social responsibility and sustainable development report instead of CDP as data source of carbon information disclosure, and the result can be more accurately reflecting the carbon information disclosure situation of the listed companies in China. So the study enriches the existing literature of carbon information disclosure scope.

Despite the extensive dataset and clear theoretical perspective, our research has some limitations. On the one hand, while we can account for the role of media reporting in the relationship between carbon information disclosure and the enterprise cost of equity financing in the Chinese heavy pollution industry, we do not know whether the result makes sense in several other industries, such as real estate industry, auto industry, and retail industry. This could be a limitation as understanding this role of media reporting in the whole China. We leave it up to future research to address this question. On the other hand, future researchers should also consider the negative media reporting. In our study, we distinguish between the positive and negative media reporting and construct the comprehensive index of media reporting, but we do not examine the influence of the negative media reporting on the relationship between carbon information disclosure and the enterprise cost of equity financing alone. Enterprises are faced with a negative incident, and they will use their social and environmental reporting as a tool to manage their legitimacy (Goosen-Botes and Samkin 2013). Accordingly, the issue of the negative media reporting is one that needs addressing in future media reporting research.

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References

Aerts W, Cormier D (2009) Media legitimacy and corporate environmental communication. Acc Organ Soc 34(1):1–27

Aerts W, Cormier D, Magnan M (2008) Corporate environmental disclosure, financial markets and the media: an international perspective. Ecol Econ 64(3):643–659

Al-Tuwaijri SA, Christensen TE, Hughes KE (2004) The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach. Acc Organ Soc 29(5–6):447–471

Andrew J, Cortese C (2011) Carbon disclosures: comparability, the carbon disclosure project and the greenhouse gas protocol. Australasian Accounting, Business & Finance Journal 5(4):5–18

Barry CB, Brown SJ (1984) Differential information and the small firm effect. J Financ Econ 13(2):283–295

Ben-Amar W, McIlkenny P (2015) Board effectiveness and the voluntary disclosure of climate change information. Bus Strateg Environ 24: 704–719

Bhattacharya U, Daouk H, Welker M (2003) The world price of earnings opacity. Account Rev 78:641–678

Blanco C, Caro F, Corbett CJ (2016) The state of supply chain carbon footprinting: analysis of CDP disclosures by US firms. J Clean Prod 135:1189–1197

Busch T, Hoffmann VH (2011) How hot is your bottom line? Linking carbon and financial performance. Business & Society 50:233–265

Cahan SF, Chen C, Chen L, Nguyen NH (2015) Corporate social responsibility and media coverage. J Bank Financ 59:409–422

Chen JC, Cho CH, Patten DM (2014) Initiating disclosure of environmental liability information: an empirical analysis of firm choice. J Bus Ethics 125(4):681–692

Clarkson PM, Li Y, Richardson GD, Vasvari FP (2008) Revisiting the Relation between Environmental Performance and Environmental Disclosure: an Empirical Analysis. Acc Organ Soc 33(4-5):303–327

Connelly BL, Certo ST, Ireland RD, Reutzel CR (2011) Signaling theory: a review and assessment. J Manag 37(1):39–67

Core JE (2001) A review of the empirical disclosure literature: discussion. J Account Econ 31(1–3):441–456

Deegan C (2002) The legitimizing effect of social and environmental disclosures: a theoretical foundation. Accounting Auditing & Accounting Journal 15(3):282–311
Depoers F, Jeanjean T, Jérôme T (2016) Voluntary disclosure of greenhouse gas emissions: contrasting the carbon disclosure project and corporate reports. Journal Business Ethics 134:445–461
Dhaliwal D (2011) Voluntary non-financial disclosure and the cost of equity capital: the initiation of corporate social responsibility reporting. Account Rev 86(1):59–100
Doda B, Gennaioli C, Gouldson A, Grover D, Sullivan R (2016) Are corporate carbon management practices reducing corporate carbon emissions? Corp Soc Responsib Environ Manag 23:257–270
Dyck A, Zingales L (2002) The Coporate Governance Role of the Media. NBER Working Paper, No. 9309
Elijido-Ten EO (2017) Does recognition of climate change related risks and opportunities determine sustainability performance? J Clean Prod 141:956–966
Feng ZY, Wang ML, Huang HW (2015) Equity financing and social responsibility: further international evidence. Int J Account 50: 247–280
Fisher-Vanden K, Thorburn KS (2011) Voluntary corporate environmental initiatives and shareholder wealth. J Environ Econ Manag 62(3): 430–445
Francis J, LaFond R, Olsson PM, Schipper K (2004) Cost of equity and earnings attributes. Account Rev 79:967–1010
Gonzalez-Gonzalez JM, Ramírez CZ (2016) Voluntary carbon disclosure by Spanish companies: an empirical analysis. International Journal of Climate Change Strategies and Management 8(1):57–79
Goosen-Botes V, Samkin G (2013) BP's use of posture to respond to the deepwater horizon crisis. Journal of Economic and Financial Sciences 6(2):359–382
Grauel J, Gotthardt D (2016) The relevance of national contexts for carbon disclosure decisions of stock-listed companies: a multilevel analysis. J Clean Prod 133:1204–1217
Guenther E, Guenther T, Schiemann F, Weber G (2016) Stakeholder relevance for reporting: explanatory factors of carbon disclosure. Business & Society 55(3):361–397
Guo XP, Ren DF, Shi JX (2016) Carbon emissions, logistics volume and GDP in China: empirical analysis based on panel data model. Environ Sci Pollut Res 23:24758–24767
Halkos G, Skouloudis A (2016) Exploring the current status and key determinants of corporate disclosure on climate change: evidence from the Greek business sector. Environ Sci Pol 56:22–31
Handa P, Linn S (1993) Arbitrage pricing with estimation risk. J Financ Quant Anal 28(1):81–100
Healy PM, Palepu KG (2001) Information asymmetry, corporate disclosure, and the capital markets: a review of the empirical disclosure literature. J Account Econ 31(1–3):405–440
IEA (International Energy Agency) (2010) World Energy Outlook 2010. http://www.iea.org/techno/etp/etp10/Chinese_Executive_Summary.pdf
Jensen JC, Berg N (2012) Determinants of traditional sustainability reporting versus integrated reporting: an institutionalist approach. Bus Strateg Environ 21(5):299–316
Jia M, Tong L, Viswanath PV, Zhang Z (2016) Word power: the impact of negative media coverage on disciplining corporate pollution. Journal Business Ethics 138:437–458
Kalu JU, Buang A, Aliagha GU (2016) Determinants of voluntary carbon disclosure in the corporate real estate sector of Malaysia. J Environ Manag 182:519–524
Kim JB, Zhang H, Li L, Tian G (2014a) Press freedom, externally-generated transparency, and stock price informativeness: international evidence. J Bank Financ 46:299–310
Kim YB, An HT, Kim JD (2015) The effect of risk on the cost of equity capital. J Clean Prod 93:279–287
Kleinschmit D, Krott M (2008) The media in forestry: government, governance and social visibility. In: Sikor T (ed) Public and private in natural resource governance: a false dichotomy? Earthscan, London, pp 127–141
Kock CJ, Santalo J, Diestre L (2012) Corporate governance and the environment: what type of governance creates greener companies? J Manag Stud 49(3):492–514
Kolk A, David L, Jonatan P (2008) Corporate responses in an emerging climate regime: the institutionalization and commensuration of carbon disclosure. European Accounting Review 17(4):719–745
Lang M, Lundholm R (1993) Cross-sectional determinants of analysts' ratings of corporate disclosures. J Account Res 31:246–271
Lang M, Lundholm R (1996) Corporate disclosure policy and analyst behavior. Account Rev 71:467–493
Latridis GE (2013) Environmental disclosure quality: evidence on environmental performance, corporate governance and value relevance. Emerg Mark Rev 14(3):55–75
Lee SY, Park YS, Klassen RD (2015) Market responses to firms' voluntary climate change information disclosure and carbon communication. Corp Soc Responsib Environ Manag 22:1–12
Li YH, Foo CT (2015) A sociological theory of corporate finance: societal responsibility and cost of equity in China. Chinese Management Studies 9(3):269–294
Liu X, Anbumozhi V (2009) Determinant factors of corporate environmental information disclosure: an empirical study of Chinese listed companies. J Clean Prod 17:593–600
Luo L, Tang QL (2014) Does voluntary carbon disclosure reflect underlying carbon performance? Journal of Contemporary Accounting & Economics 10:191–205
Luo L, Lan YC, Tang QL (2012) Corporate incentives to disclose carbon information: evidence from the CDP global 500 report. Journal of International Financial Management & Accounting 23(2):93–120
Matisoff DC (2013) Different rays of sunlight: understanding information disclosure and carbon transparency. Energy Policy 55:579–592
Matsumura EM, Prakash R, Vera-Muñoz SC (2014) Firm-value effects of carbon emissions and carbon disclosures. Account Rev 89(2):695–724
Nyilasy G, Gangadharbatla H, Paladino A (2014) Perceived greenwashing: the interactive effects of green advertising and corporate environmental performance on consumer reactions. J Bus Ethics 125(4): 693–707
Peng J, Sun JF, Luo R (2015) Corporate voluntary carbon information disclosure: evidence from China's listed companies. World Econ 38(1):91–109
Shen HT, Feng J (2012) On the choice of China's governmental accounting conceptual framework. Accounting Research 2:72–79 (In Chinese)
Skouloudis A, Jones N, Malesios C, Evangelinos K (2014) Trends and determinants of corporate non-financial disclosure in Greece. J Clean Prod 68:174–188
Wegener M (2010) The Carbon Disclosure Project, An Evolution in International Environmental Corporate Governance: Motivations and Determinants of Market Response to Voluntary Disclosures. Working Paper, Brock University
Xu S, Liu DC, Huang JB (2015) Corporate social responsibility, the cost of equity capital and ownership structure: an analysis of Chinese listed firms. Aust J Manag 40(2):245–276
Xu XD, Zeng SX, Zou HL, Shi JJ (2016) The impact of corporate environmental violation on shareholders' wealth: a perspective taken from media coverage. Bus Strateg Environ 25:73–91
Yu G, Wang BY (2016) The impact of information disclosure quality on the cost of equity financing: based on time series perspective. Journal of Financial Risk Management 5:107–112