



How do Independent Directors View Carbon Information Disclosure? Evidence From China

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This study examines the effect of independent directors on carbon information disclosure (CID) in China from 2011 to 2017. Additionally, this study investigates the effect of independent director's attributes (gender, academic experience, and political connection) on the CID. To test our hypothesis, we collected data of 511 Chinese listed firms. The empirical results show that independent directors have a positive influence on the CID. Moreover, the independent female directors, independent academic directors and independent politically connected directors also enhances the CID. Our findings offer shareholders, regulators, and other stakeholders an integrating perspective on motivating firms to disclose high quality carbon information.

Keywords: GHG emissions, carbon information disclosure, independent directors, female, political experience, academic experience, China

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INTRODUCTION

Over the last few decades, calamities like hurricanes, floods, global health issues have occurred in a frequent manner. Apart from the natural disasters, the industrial and technological eras have given rise to manufactured global warming. The global warming is the outcome of climate change. Nations around the world have made consensus on actively devise policies to decrease the global warming. Recent studies have shown the greenhouse gas (GHG) emissions as the main cause of global warming (García Martín and Herrero, 2020). Keeping in mind the social responsibility view, the firms specifically in high carbon industries try to gain the confidence of stakeholders, represents the carbon information disclosure (CID) in the annual reports. The CID is the response of the firms in actively participating in green environment.

China being one of the world's largest economy is facing the dilemma of high carbon emission reporting approximately one third of the total emissions (Zhang et al., 2020). Chinese economy competing globally is under the watch of global environment agency to reduce the carbon emission. Unlike the developed nations such as United States, United Kingdom, Japan, France, and Australia where CID is mandatory, the Chinese companies' CID disclosure is voluntary. Among the determinants of CID: firm characteristics, corporate governance mechanism, corporate environment performance and institutional features are important factors discussed in previous studies.

Due to the voluntary nature of CID, the role of board of directors has emerged as a prime importance in achieving the overall organizational environmental goals. Different studies have related different attributes of board of directors with GHG emission. For example, gender diversity (Hossain et al., 2017; Al-Qahtani and Elgharabawy, 2020; Nuber and Velte, 2021; Galletta et al., 2022),

CEO characteristics (Lewis et al., 2014), CEO compensation (Luo et al., 2021), board effectiveness (Ben-Amar and McIlkenny, 2015) and foreign directors (Mardini and Elleuch Lahyani, 2021). Although these studies have shown a significance impact of board of directors attributes on firm's social performance, scholars are still developing a link between the board of directors attributes and firm's social performance. The purpose of this study is to explore the effect of an important corporate governance mechanism which is board independence. The importance of board independence in context of environmental performance is based on the following arguments. First, mostly such studies has been conducted in developed economies (Cucari et al., 2018; Pucheta-Martínez and Bel-Oms, 2019; Mardini and Elleuch Lahyani, 2021). However, it is unclear that the same relationship exists in developing countries where the corporate governance mechanism is weak. Specifically, in China, most of the firms have either state ownership or state influence. The independent directors with political connection in these firms can enhance the social reporting. Secondly, the due to culture difference between the developed countries and China, the role of female independent director in environmental performance is pivotal. Lastly, the Confucianism culture of China has a long history of respect for the academicians (Huang et al., 2016). The academics brings trust and provides advisory function. This study aims to explore how independent academic director influences the volunteer carbon information disclosures.

Previous studies have shown that the firms having presence of independent director on board are more inclined towards the disclosure of CSR (García-Sánchez and Martínez-Ferrero, 2017). However, the independent directors itself reduces the investment in CSR activities based on agency cost hypothesis (Pucheta-Martínez et al., 2019; Chintrakarn et al., 2021). The independent directors are known for their expertise and reputation in the market. The reputable independent directors enhances the CSR activities (Chintrakarn et al., 2020). Moreover, it is a general consensus that the independent directors promote the environment friendly activities due to their reputation is placed on line (Yu et al., 2018). Looking into the extant literature, we find very few studies linking independent directors with corporate environmental performance, having no unanimous conclusion (Yu et al., 2018; Chintrakarn et al., 2020).

Previously, few studies have linked the independent directors presence on board with corporate environmental performance, but the results are inconclusive (García-Sánchez and Martínez-Ferrero, 2018; Naciti, 2019; Pucheta-Martínez et al., 2019; Al Amosh and Khatib, 2021; Chintrakarn et al., 2021; Cosma et al., 2021). Independent directors are more concerned about their reputation, and they are more inclined towards environmentally friendly activities. Drawing on the agency cost hypothesis, we propose that the independent directors help in alignment of interest between the principles and the agents. The independent directors will make sure that the management discloses the carbon information in true sense and timely. Additionally, based on the upper echelons theory, which suggests that the individual attributes have the impact on

organizational outcomes (Boubaker and Nguyen, 2012). An independent director's interpersonal skills, knowledge, experience, and integrity can improve an organizational CID. Keeping in view, the cultural and Confucianism effect in China, this study aims to investigate how independent directors on Chinese listed firms effect the CID. Additionally, this study analyzes the gender, foreign experience, financial and legal background of independent director on firm's CID.

The contribution of this study is manifold. First, studies in developed economies has emphasized the contribution of independent directors in environmental performance (García Martín and Herrero, 2020). However, the role of independent director in Chinese corporate environmental performance is understudied, specifically the role of independent directors in CID is a research gap. Secondly, this study also links different attributes of independent directors with CID. In literature we find female presence, academic experience and political connection related with environmental performance. We investigate how these attributes of independent directors effect the CID. Lastly, this study contributes to the literature of corporate governance specifically the role played by independent directors in emerging market like China.

Drawing on the stakeholder theory, this study is motivated by the role of independent directors in an emerging economy. Additionally, the segregation of independent directors into different attributes brings a more refine lens in overall function of independent directors among the board of directors. The academicians comprise of more than 75% of independent directors in Chinese listed firms (He et al., 2021b). How independent director's academic background effects the CID is an underexplored area. We are also motivated by role female independent directors in Chinese listed firms. Despite the male dominant culture, the female directors are linked with high sustainable performance (Wang et al., 2021) and social responsibility (Khidmat et al., 2021). Lastly, the studies in context of China have shown the influence of politically connected directors on different corporate policies (Ren and Zhao, 2020). How independent director with political background influence the CID, is an under explored area and this study aims to answer this question.

The remainder of this paper is structured as follows: *Literature Review* is the review of literature, followed by *Research Design*, which is research design. *Results* reports the results. While the paper is concluded in *Conclusion*.

LITERATURE REVIEW

Theoretical Background

The relationship between the independent directors and CID is based on the following theories.

The Stakeholder Theory

The stakeholders in an extension of the agency theory, which focuses on the board to safeguard the interest of the shareholders. This theory extends the role played by the board members to not only protecting the interest of the shareholders but also of all the

TABLE 1 | Sample distribution based on industries.

Industry name	Number of firms	Percentage
Power	60	11.74
Steel and associated	40	7.83
Cement	47	9.20
Coal and mining	48	9.39
Chemicals	105	20.55
Paper	18	3.52
Brewing	45	8.81
Pharmaceuticals	90	17.61
Food processing	20	3.91
Leather	8	1.57
Textile	25	4.89
Transport and allied	5	0.98
Total	511	100

related parties known as stakeholders such as social, environmental and social considerations (Freeman, 1984; Donaldson and Preston, 1995). Nicholson and Kiel (2004) explained the importance of the stakeholder's theory and elaborated that the organizations and societies are interdependent and therefore the purpose of the managers is not only to maximize the shareholder's wealth but also to serve the interest of all the stakeholders.

The stakeholder's theory in literature has taken two views; the broad perspective and the narrow view. The originator of the stakeholder theory, Freeman (1984), considered the more general view and defined the stakeholders as "any group or individual who can affect or is affected by the achievement of the organization's objectives" (p. 46). However, the narrow view of the stakeholder theory suggested by Clarkson (1994) stated that "voluntary stakeholders bear some form of risk as a result of having invested some form of capital, human or financial, or something of value, in a firm. Involuntary stakeholders are placed at risk as a result of a firm's activities. But without the element of risk, there is no stake" (p. 5). The risk is regarded as the essential ingredient of the narrow approach, and every stakeholder should be dealt with accordingly. The word stakeholders have been explained by Mitchell et al. (1997) as 1) has influential power 2) has the legitimacy of relationship with the firm 3) claim on the organization in a time of need.

Summing up, the crux of the stakeholder's theory is built on the principle of integrating with all the stakeholders rather than focusing only on the shareholders. As suggested by Freeman (2004) the idea of value creation for shareholders by stating "business is about putting together a deal so that suppliers, customers, employees, communities, managers, and shareholders all win continuously over time".

Based on the stakeholder's theory we propose that the independent directors due to their neutral role are likely to engage with all the stakeholders. As an essential element of corporate governance mechanism, the independent directors lead to monitoring efficiency and effective decision making to promote the sustainable performance. In close association with the resource dependence theory, the stakeholder theory proposes that the diverse background of board of directors (here independent directors) can be a useful resource in engaging all

the stakeholder's interest. But understanding the stakeholders interest, we propose that the independent directors can lead to volunteer disclosure of carbon emission.

Board Diversity and the Upper Echelons Theory

The academicians over the last decade have focused their studies on the demographic features of the top management teams. Upper echelon theory argues that the managers are task oriented and different personal attributes give an extra drive to the organization, resulting in better decisions and overall performance (Carpenter et al., 2004; Cannella et al., 2009; Nielsen, 2010). Hambrick and Mason (1984) came up with the idea of upper echelon theory in their seminal paper on the upper echelon's perspective: the organization is a reflection of its top managers (the so-called "upper echelons"). The theory recognizes that the choices of individual top managers can have a significant impact on the organizational results, which in turn are influenced by the characteristics of managers. Hambrick and Mason (1984) additionally assume that the characteristics of the upper echelons and their strategic choices help explain the performance of an organization.

The presence of independent directors among the board of directors have lead the organizations to be vigilant on the opportunistic behavior of the management as well as can held the managers accountable for their actions. Based on the effecting monitoring the management now feels more responsible in their doings which leads them to perform to best of their abilities and influence their subordinates as well. Different attributes of independent directors have different influence on the management. For example, the independent directors with academic background have knowledge leadership. Similarly, the independent directors having political background has experience and can influence others through their great personality. The top management sets higher standards resulting in the organizational success. The employee takes top management as a benchmark and when the upper echelon is motivated, success driven and goal focused then the synergies passes up to all the employees of the organizations. Summing up, the independent director's attributes can influence the management in voluntarily disclosing the carbon disclosure.

Independent Directors and Carbon Information Disclosure

Keeping in view the last couple of decades, the global warming issue has been significantly highlighted in the literature. One of the main contributors of GHG emissions are the industries and firms emitting high quantity of carbon. The firms are required by the national as well as international regulatory authorities to disclose the exact amount of carbon being emitted in the environment (Luo et al., 2012). From investment point of view, the literature suggests that the value of the firm which disclosed carbon information is higher than the firm do not (Matsumura et al., 2014). Keeping in view the restriction being posed by the regulatory authorities as well as to attract the investment, most of the firms voluntarily discloses the carbon emission information (Mayorova, 2019).

Existing literature has identified several influencing factors of CID. Among these factors firm specific determinants are

TABLE 2 | Components of CID.

Factor	Explanation	Measurement
Score 0 to 3		No information scores 0, general non-quantitative information scores 1, and some quantitative information scores 2
F1	Targets and results of emission reduction	Detailed quantitative information scores 3 (e.g., the time, quantitative targets, completeness of targets)
F2	Method of measuring carbon emission	Detailed measuring process scores 3 (e.g., the method used, the formula used, and the parameter applied)
F3	Scope 1 emission data: direct greenhouse gas emissions	Detailed quantitative information scores 3 (e.g., the boundaries used for scope 1, 2, or 3 greenhouse gas inventory and emissions figures in metric tons of CO ₂)
F4	Scope 2 emission data: indirect greenhouse gas emissions of energy	Detailed quantitative information scores 3 (e.g., the boundaries used for scope 1, 2, or 3 greenhouse gas inventory and emissions figures in metric tons of CO ₂)
F5	Scope 3 emission data: other indirect greenhouse gas emissions	Detailed quantitative information scores 3 (e.g., the boundaries used for scope 1, 2, or 3 greenhouse gas inventory and emissions figures in metric tons of CO ₂)
F6	Energy consumption of total operation in the reporting year	Detailed quantitative information scores 3 (e.g., fuel consumption data in tons and per value)
F7	Emissions trading	No information scores 0, general nonmonetary information scores 1, other concrete nonmonetary information scores 2, and monetary information records 3
F8	Other carbon-related information	No information scores 0, general nonmonetary information scores 1, other concrete nonmonetary information scores 2, and monetary information records 3

primarily investigated by different researchers. For example, firm size (Guenther et al., 2016; Kouloukoui et al., 2019), leverage (Ben-Amar and McIlkenny, 2015) and profitability (Faisal et al., 2018). In addition to the firm specific characteristics, corporate governance plays a vital role in CID. Among the internal governance mechanism, the top management team (TMT) attributes have been linked with corporate environmental performance by numerous studies. The features of TMT associated with corporate environmental performance are gender diversity (Ben-Amar, Chang, & McIlkenny, 2017; Ben-Amar et al., 2017; Hollindale et al., 2019; Hollindale, Kent, Routledge, & Chapple, 2019), board size (Prado-Lorenzo and

Garcia-Sanchez, 2010), CEO overconfidence (Lee, 2021), board committees (Krishnamurti and Velayutham, 2018) and CEO's compensation (Luo et al., 2021). Among the other corporate governance mechanism researchers have identified institutional ownership (Akbaş and Canikli, 2018), family ownership (Terlaak et al., 2018) and board effectiveness (Ben-Amar and McIlkenny, 2015). In addition to the firm specific factors and corporate governance factors, some studies have linked GHG emissions with some other factors such as industry regulations (Peng et al., 2015), stakeholders pressure (Liesen et al., 2015), legal system (Luo and Tang, 2016) and culture (Freedman and Jaggi, 2005; He et al., 2021a). However, how the independent director plays a role in

TABLE 3 | Variables definition.

Variables	Symbol	Definition
Carbon information disclosure	CID-DUMMY	A dummy variable, that takes the value of 1, if the firm voluntarily discloses the carbon information and 0 otherwise
Carbon information disclosure	CID-Score	Measured through content analysis, disclosure comprising of eight factors is shown in Table 2
Independent directors	IDR	Measured by dividing total independent directors by total directors on board
Independent directors	ID-DUMMY	A dummy variable which takes the value of 1, if a firm has at least three independent directors in board during a specific year; zero otherwise
Independent female director	IFD	A dummy variable, that takes value of 1, if the firm in a specific year has independent female director, otherwise marked zero
Independent academic director	IAD	A dummy variable which takes the value of 1 if a firm has independent academic director presence in a specific year, 0 otherwise
Independent politically connected director	IPCD	A dummy variable that takes the value 1, if an independent director is politically connected, zero otherwise
Return on assets	ROA	Net Income Scaled by Total Assets
Tobin's Q	TQ	Market Value Equity and debt scaled by book value of total assets
Firm size	FS	Natural logarithm of total assets
Leverage	Lev	The ratio of total debt to total assets
Ownership concentration	Top 10	Calculated by taking the top 10 shareholders ratio
State ownership	SO	A dummy variable which takes the value of 1 if the firm is state or state entity, 0 otherwise
Board size	BS	The total number of directors on board
Duality	Dual	A dummy variable which takes the value of 1, if the CEO also serves on the advisory board, zero otherwise
Auditor	Big 4	Big four is measure by a dummy variable which takes the value of 1, if the firm is audited by big four auditor, zero otherwise
Firm age	Age	We measure the firm age since the firm got publicly listed

TABLE 4 | Descriptive statistics.

Variable	Obs	Mean	SD	Minimum	Maximum
CID-Dummy	3,066	0.482	0.49	0	1
CID-Score	3,066	1.32	1.96	0	16
IDR	3,066	0.41	0.04	0.17	0.66
ID-DUMMY	3,066	0.58	0.03	1	0
IFD	3,066	0.16	0.07	1	0
IAD	3,066	0.31	0.11	1	0
IPCD	3,066	0.11	0.61	1	0
ROA	3,066	0.049	0.072	-0.34	0.48
TQ	3,066	1.83	1.59	0.09	22.38
FS	3,066	22.02	2.02	18.66	27.01
Lev	3,066	0.44	0.22	0.06	0.88
Top 10	3,066	0.59	0.15	0.012	0.92
SO	3,066	0.48	0.08	1	0
BS	3,066	8.79	2.91	7	24
Dual	3,066	0.23	0.44	0	1
Big 4	3,066	0.097	0.19	0	1
Age	3,066	3.03	0.73	0	18

CID is yet to be investigated, specifically in Chinese context. Recent studies have emphasized the role played by the board of directors in achieving an effective corporate governance mechanism (Boubaker et al., 2012). Among the board of directors, the independent directors catch the eye of regulators and investors. Independent directors are playing a pivotal role in efficient monitoring the affairs of a company. Such as independent directors reduces; the earnings management (Wu et al., 2016), cost of debts (Bradley and Chen, 2015) and corporate over investment (Tran, 2019). The independent directors are also linked with corporate social responsibility (CSR) (Disli et al., 2022). Researcher have found that the independent directors are positively associated with CSR activities (Fernández-Gago et al., 2018). However, how independent directors influence the CID is still to be comprehensively investigated specifically in context of China.

We propose that independent directors enhance the CID. Our proposition is based on the following arguments. First, grounded on agency theory, the independent directors align the interest of the managers with shareholders (Moscariello et al., 2019). Independent directors provide the supervisory functions and due to their superior knowledge and experience, they can direct the managers to work in the best interest of the shareholders. Secondly, based on the resource dependence theory, the independent directors can link the external sources such as knowledge, skills, networking and experience (Hillman et al., 2000). The independent directors can provide the resources and direction to the firms in CID. Lastly, the upper echelons theory proposes that the top management views any specific problem from their own critical lens (Hambrick and Mason, 1984). The heterogeneity in top management arises from different beliefs, culture, experience, and personalities. Based on the upper echelon theory, the independent directors sets high moral values and are concerned about their reputation (Bryan and Mason, 2020). Due to reputation concern, the independent directors encourage the management to disclose the carbon emission information timely. Additionally, the independent directors are considered as law abiding and

follow the rules set by the regulators. The independent directors make sure that the management also follow the suite in voluntarily disclosing the carbon emission.

Based on theoretical evidence the independent directors bring efficient monitoring, plays effective supervisory and advisory role, and brings the resources necessary to contribute to CID. Based on arguments above, we propose the following hypothesis.

Hypothesis 1. Independent directors have a positive effect on the carbon information disclosure

Independent Directors Attributes and Carbon Information Disclosure

Researchers have been on the consensus that the board of directors characteristics influence the corporate policies (Bradley and Chen, 2015; Wu et al., 2016; Tran, 2019). The first important attribute of independent director is gender. It has been cited by various researchers that the female directors are more leads to better performance (Low et al., 2015), curbs managerial expropriations and enhance social responsibility. The female on board has also been linked with the corporate environmental performance. For example the presence of female on board is positively associated with carbon reduction initiatives (Haque, 2017). Also, the firms with gender diversity are linked with CID (Boubaker and Nguyen, 2012; Haque, 2017). The female directors like independent directors have high moral standards, concern for reputation and brings a different prospectus to the organizational change. The female independent director can enhance the communication with the stakeholders regarding the environmental issues. Based on the agency theory and resource dependence theory, we propose the following hypothesis.

Hypothesis 2. Independent female directors have a positive effect on the carbon information disclosure

The second attribute of the independent directors discussed in this study is the academic affiliation. When the independent directors are having an academic position (hereafter independent academic director) in Chinese universities or research institute, then they can enhance the CID. The independent academic director is well reputed due Confucianism culture of China (He et al., 2021b). Reputed directors enhances the overall value of firm (Okpamen and Ogbeide, 2020). The previous studies on the directors having academic position have shown that they curtail the managerial expropriations (Khan et al., 2022) and enhance the corporate philanthropy (Cho et al., 2017). Academics can collaborate with different stakeholders and act as catalyst in an organization networking, both internal and external. An independent academic therefore can enhance the carbon information disclosure due to superior knowledge, effective communication, and immaculate character. Accordingly, we propose our next hypothesis as follow.

Hypothesis 3. Independent academic directors have a positive effect on the carbon information disclosure

The last attribute of independent director discussed in this study is their political ground. An independent director currently having or had worked in government is said to be having political connections. We propose that an independent politically connected directors can enhance CID. We present our case on

TABLE 5 | Correlation analysis.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	VIF	
1. CID-Dummy	1																		
2. CID-Score	0.58***	1																	2.62
3. IDR	0.05**	0.886***	1																2.03
4. ID-DUMMY	0.076***	0.0595	0.0743	1															
5. IFD	0.044***	0.101**	0.0688	0.448***	1														1.98
6. IAD	0.052***	0.236***	0.200***	0.346***	0.106**	1													1.42
7. IPCD	0.249***	0.237***	0.213***	0.245***	0.0947*	0.902***	1												2.01
8. ROA	-0.068***	-0.24***	0.202***	0.409***	0.0797	0.886***	0.714***	1											2.22
9. TQ	-0.109**	-0.112**	0.0816*	0.295***	0.0889*	0.562***	0.562***	0.642***	1										1.51
10. FS	0.154***	0.165***	0.177***	0.0249	0.0327	0.125***	0.138***	0.113**	0.0973**	1									1.05
11. Lev	0.0841*	0.183***	0.189***	0.0219	0.0317	0.110**	0.120**	0.108**	0.0832*	0.976***	1								1.87
12. Top 10	0.0122	0.248***	0.222***	-0.452***	-0.0551	0.495***	0.610***	0.635***	0.583***	0.0813*	0.0813*	1							2.66
13. SO	0.169***	0.201***	0.212***	-0.261***	-0.0574	0.529***	0.515***	0.463***	0.414***	0.0158	0.0309	0.495***	1						1.34
14. BS	0.179***	0.081*	-0.0735	-0.482***	-0.0555	0.424***	0.335***	0.445***	0.329***	0.00148	-0.000213	0.557***	0.360***	1					1.88
15. Dual	-0.056***	-0.009	0.0798	-0.334***	-0.0772	0.204***	0.174**	0.221***	0.180***	0.0410	0.0401	0.368***	0.350***	0.429***	1				1.64
16. Big 4	0.101**	0.089*	0.15***	0.139***	0.0262	0.0860*	0.0862*	0.0809*	0.0188	0.00511	0.00269	-0.0515	-0.371***	-0.124**	-0.12**	1			1.29
17. Age	0.340***	0.61***	-0.571***	-0.00742	-0.0569	-0.100**	-0.106**	-0.123**	-0.0201	-0.0488	-0.0482	-0.0892*	-0.0879*	0.0986**	0.0372	0.0106	1		1.44

Note: ***p < 0.01, **p < 0.05, and *p < 0.1.

the following arguments. First, the environmentally friendly policies are being used by the organizations to gain confidence of domestic and international agencies. For example, corporate social responsibility is being linked with achieving public and policy outcomes (Zhang et al., 2018). Secondly, since the CID is discretionary matter, therefore the firms lack the ability to properly implement the CID. However, directors with political background timely respond to the requirements by the regulators due to networking and competence (Hillman et al., 2000). The politically connected directors have experience is government controlled entities and as result they are in better position to cope with regulations and policy related issues (Zhuang et al., 2018). Academics can also train the other members of the organization by superior knowledge. A study conducted by (Kraai and Mashau, 2020) shows that the board of directors in NGO's enhances through training content delivery.

Secondly, the Guanxi culture in China leads to better coordination between the firms and government (Park and Luo, 2001). The presence of independent politically connected directors helps the Chinese firms in better projection about the future government environmental policies. Thus, the firms with presence of independent politically connected on board have more propensity to voluntary disclose the carbon emission information. We propose our next hypothesis as:

Hypothesis 4. Independent politically connected directors have a positive effect on the carbon information disclosure

RESEARCH DESIGN

Data Collection

In contrary to the qualitative studies on social disclosures (Czajka-Cieszyńska et al., 2021; Nassar and Tvaronavičienė, 2021), this study is performed on secondary data. The data collected in this study is taken from multiple sources. Firstly, based on the study conducted by (He et al., 2021a), we collect data for CID from the Ministry of Environmental Protection of China, which has identified the 16 industries involved in polluting the environment. These industries are, thermal power generation, steel, cement, electrolytic aluminum, coal, metallurgy, chemicals, petrochemicals, building material, paper, brewing, pharmaceuticals, fermentation, textile, leather, and mining. In addition to polluting industries, GHG emission industries has also been identified by (Peng et al., 2015). Evident from previous studies, there is homogeneity among the industry with high on pollution and the industries higher ranked on GHG emissions. The data of CID is taken from the high carbon industries and top 13 GHG emission industries.

Secondly, the independent variable and control variables data is collected from CSMAR (China Stock market and Accounting Research) and RESSET database. Initial sample comprises of all the Chinese A-listed firms for the period 2012 to 2017. However, the sample is reduced when we excluded the ST (Special Treatment) and PT (particular treatment) firms. The ST and PT firms are financially distressed firms. Also excluded from the sample are financial firm's data due to financial statements preparation and presentation style. We choose the firms having large size as they have more economic significance. Additionally, the large firms easily cope

TABLE 6 | Effect of Independent directors on CID.

	CID-dummy				CID-score			
	Coefficient	z-values	Coefficient	z-values	Coefficient	t-values	Coefficient	t-values
IDR	0.322***	3.585			0.33***	3.258		
ID-DUMMY			0.26***	3.257			0.19***	3.35
ROA	-0.0314	-1.02	-0.036	-1.14	-0.047	-1.41	-0.049***	-3.11
TQ	-0.0827	-1.56	-0.081	-1.261	-0.06	-1.37	-0.055	-1.02
FS	0.0773***	2.27	0.0528***	2.119	0.0581***	3.167	0.0967***	2.963
Lev	0.0478	1.599	0.0587	1.407	0.0619	1.207	0.105	0.889
Top 10	0.0529	0.0639	3.645	0.0632	4.863	0.815	0.049	1.28
SO	0.039***	3.169	0.014***	3.001	0.013***	4.015	0.010***	3.012
BS	0.00314***	3.043	0.0098***	3.316	0.0307*	1.95	0.0017	4.66
Dual	-0.046	-1.17	-0.031	-1.003	-0.039	-0.99	-0.001	-1.11
Big 4	0.088***	4.47	0.095***	4.26	0.089***	4.49	0.077***	4.07
Age	0.039***	3.05	0.015***	3.18	0.004***	3.22	0.0014***	2.98
Constant	-10.92***	-9.24	-11.26***	-8.16	-8.44***	-6.11	-7.46***	-5.82
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066
Pseudo-R ²		0.10		0.33				
R ²						0.089		0.31

***p < 0.01, **p < 0.05, *p < 0.1.

up the pressure exerted by the stakeholders (Patten, 2002). Study has shown that the large firms are more likely to disclose the carbon information (Clarkson et al., 2008). For the above two reasons, our initial sample consists of 511 Chinese A-listed firms covering a period of 6 years (2012–2017). The distribution of sample according to industry is depicted in **Table 1** below.

Variables Measurement

The variables used in this study are measured as follow.

Carbon Information Disclosure

We have taken two measures of CID in this study. The first variable taken is a dummy variable, that takes the value of 1, if the firm voluntarily discloses the carbon information and 0 otherwise. The dummy variable is depicted by CID-Dummy. The second variable denoted by CID-score, is measured through content analysis. Following Peng et al. (2015), carbon information disclosure comprises of eight factors is shown in **Table 2**. **Table 2** also reports the criteria for assigning the scores.

Independent Directors

Based on the vast research in Chinese listed firms on independent directors effect on corporate policies, we have used the independent director ratio (IDR) and independent director dummy (ID-Dummy) (Pang et al., 2020; He et al., 2021b). Additionally, this study investigates the effect of different attributes of independent directors on the CID. Among the attributes, the first attribute taken is the gender of the independent directors. Studies have shown that the firms with female presence on board are more socially responsible (Wang et al., 2021). An independent female director can have more say in an organization based on agency theory. Therefore, we propose a positive effect of independent female director on CID. The independent female director, denoted by IFD, is a dummy variable, that takes value of 1, if the firm in a specific year has independent female director, otherwise marked zero.

Literature has identified the role of academics in corporate policies (Wang, 2020; Huang and Teklay, 2021; Khan et al., 2022). We propose that the independent academic directors can enhance the CID based on upper echelons theory. We measure the independent academic director (IAD) as a dummy variable which takes the value of one if a firm has independent academic director presence in a specific year, 0 otherwise. Last variable used in this study is the independent politically connected directors (IPCD). The political connection of directors helps the firms formulating the environmentally friendly policies. The independent political directors therefore can bridge the communication between the government agencies and organization based on their earlier experience (Zhuang et al., 2018). We measure IPCD as a dummy variable that takes the value 1, if an independent director is politically connected, zero otherwise. By political connection, we infer that a director has a previous or current working experience in government entities (Zhuang et al., 2018).

Control Variables

The larger firms are more scrutinized by the regulators as well as the investors keep a close eye on them. The firm size has a positive association with the CID (Hermawan and Gunardi, 2019; Kouloukoui et al., 2019). We measure the firm size by taking the natural logarithm of the total assets. Another important contributing factor towards CID is leverage. The financial levered firms must timely meet the financial obligations. These firms have low propensity for CID. Previous studies have found a negative effect of leverage on CID (Li et al., 2017). We measure leverage as the ratio of total debt to total assets.

We also took profitability as control variable. Firms that are earning profit have funds at their disposal, which encourages the management in adopting the CID. Furthermore, the profitable firms are under the radar of investors and other

TABLE 7 | Effect of independent director's attributes on CID.

	Model 1: CID-dummy			Model 2: CID-score			
	Coefficient	z-values	t-values	Coefficient	t-values	Coefficient	t-values
IFD	0.158***	4.46		0.171***	4.66	0.149***	3.95
IAD							
IPCD							
ROA	-0.051	-1.105	0.093**	-0.017	-0.45	-0.011	-0.052
TQ	-0.011	1.77	-0.044	-0.006	-0.96	-0.017	-0.99
FS	0.002***	3.07	-0.001	0.017***	3.72	0.014***	3.83
Lev	0.015	1.88	0.003***	0.034	1.69	0.055	1.72
Top 10	0.004	1.24	0.004	0.006	0.38	0.001	0.51
SO	0.028***	3.59	0.019	0.052	1.60	0.075	1.58
BS	0.001***	3.45	0.008**	0.043***	3.26	0.016***	3.49
Dual	-0.092	-1.06	-0.047	-0.022	-1.33	-0.01	-1.62
Big 4	0.144***	4.19	0.121***	0.138***	3.35	0.127***	3.66
Age	0.005***	3.62	0.003**	0.151***	3.14	0.129	0.78
Constant	-14.47***	8.72	-14.01***	-14.08***	-7.48	-14.98***	-5.07
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,066	3,066	3,066	3,066	3,066	3,066	3,066
Pseudo-R ²	0.14		0.15	0.22		0.21	
R ²							0.22

***p < 0.01, **p < 0.05, *p < 0.1.

government agencies. The management under the pressure from external stakeholders, will voluntarily adopt CID. We used return on assets as proxy from profitability (Luo et al., 2012). Besides the book value, this study also focuses on the market measure of performance. We used Tobin's Q as market performance measure. Previous studies have identified an inverse relationship between the Tobin's Q and CID. Another control variable incorporated in this study is the age of the firm. The older the firm, the more chances that it adopts environment friendly policies. We measure the firm age since the firm got publicly listed.

In this study we used some controlled variable pertaining to corporate governance as well. Studies have shown that ownership concentration effects the CID (He et al., 2021a). In countries where corporate governance is weak, ownership concentration acts as a substitute (Shleifer and Vishny, 1986). We measured the ownership concentration by taking the top 10 shareholders ratio. The second corporate governance measure taken is the duality. The firms having duality brings unanimity in decision making, and this effect the corporate social responsibility (Bear et al., 2010). Since the decision making as well as the supervisory function is performed by the same person, the chance of CID is less in such companies because of less pressure. Duality in this study is measured by a dummy variable which takes the value of 1, if the CEO also serves on the advisory board, zero otherwise.

A well reputed external auditor ensures the integrity of financial statements specifically related to the disclosure (Dunn and Mayhew, 2004). In China big four auditors are responsible for monitoring efficiency. We propose that a firm audited by big four auditor enhances the CID. Big four is measure by a dummy variable which takes the value of 1, if the firm is audited by big four auditors, zero otherwise. Lastly, we studied how ownership type effects the CID. The ownership type is based on state and non-state-owned companies. The state-controlled firms are larger in stature and are actively involved with the environmental and government agencies in enhancing CID. We measure state ownership by a dummy variable which takes the value of one if the firm is state or state entity, 0 otherwise.

Model

We want to investigate the effect of independent directors on the carbon information disclosure. The relationship pertaining to hypothesis 1, can be modelled from the following equation

$$CID(Dummy; Index) = f(Independent Director, Control Variables) \tag{1}$$

$$CID(Dummy; Index) = \beta_0 + \beta_1 IDR + \beta_2 ROA + \beta_3 TQ + \beta_4 Size + \beta_5 Leverage + \beta_6 Top10 + \beta_7 SOE + \beta_8 BS + \beta_9 Duality + \beta_{10} Big4 + \beta_{11} Age + \epsilon \tag{2}$$

For hypothesis 2,3 and 4, we use the following equation

TABLE 8 | Effect of Independent directors on CID with fixed effect and GMM estimates.

	Fixed effect				System GMM			
	Dependent variable: CID-score							
	Coefficient	t-values	Coefficient	t-values	Coefficient	t-values	Coefficient	t-values
IDR	0.347	3.36			0.264	3.24		
ID-DUMMY			0.219	3.72			0.147	3.06
Lag-CID-Score					0.483	6.02	0.431	5.52
ROA	-0.002	1.27	-0.45	-1.41	-0.031	-1.47	-0.014	-0.95
TQ	-0.024	1.05	-0.04	-0.72	-0.004	-1.02	-0.008	-0.79
FS	0.15	3.01	0.172	2.98	0.127	2.62	0.148	1.38
Lev	-0.009	1.11	-0.06	-0.23	-0.007	-0.55	-0.071	-0.44
Top 10	0.022	1.69	0.274	1.06	0.056	1.36	0.058	1.08
SO	0.153	3.55	0.189	3.47	0.172	3.03	0.122	3.11
BS	0.227	3.22	0.261	3.16	0.211	2.66	0.238	1.46
Dual	-0.005	1.68	-0.062	-0.62	-0.001	-1.04	-0.003	-1.07
Big 4	0.091	4.02	0.09	3.82	0.045	3.16	0.052	3.66
Age	0.056	3.85	0.079	3.39	0.061	2.67	0.072	2.10
Constant	-3.32	-5.05	-3.06	-4.62	-4.01	-3.34	-3.92	-3.55
Year		Yes		Yes		Yes		Yes
Industry		No		No		Yes		Yes
N								
R ²	3,066		3,066		3,066		3,066	
Arellano–Bond AR (1) (z, p value)	0.046		0.044		-4.21*** (p-value<0.01)		-3.75*** (p-value<0.01)	
Arellano–Bond AR (2) (z, p value)					1.48 (p-value = 0.15)		1.06	0.44
Sargan test (chi-square, p value)					121.44 (p-value<0.01)		114.06 (p-value<0.01)	
Hansen test (chi-square, p value)					12.92 (p-value = 0.12)		10.06 (p-value = 1.61)	

$$\begin{aligned}
 CID(Dummy; Index) = & \beta_0 + \beta_1(IFD; IAD; IPCD) + \beta_2ROA \\
 & + \beta_3TQ + \beta_4Size + \beta_5Leverage \\
 & + \beta_6Top10 + \beta_7SOE + \beta_8BS \\
 & + \beta_9Dualilty + \beta_{10}Big4 + \beta_{11}Age \\
 & + E
 \end{aligned}
 \tag{3}$$

The definition and symbols of dependent, independent and control variables are shown in Table 3.

RESULTS

Descriptive Statistics and Correlation Analysis

Table 4 shows the descriptive statistics of variables used in this study. The standard deviation of carbon information disclosure among the companies is relatively high, depicting the voluntary nature. The independent director ratio has an average value of 0.41, suggesting that the Chinese firms belonging to high GHG emission industries favors independent director on board. Around 58 percent of the firms in the sample have at least three or more independent directors. At least 16 percent of the firms have at least on independent female director on board. The presence of female directors signifies the importance of female in implementing environment friendly policies. About 31 percent of the firms have

an independent academic director on board while 11 percent of the independent directors have political connections.

The average ROA reported is 4.9 percent while Tobin’s Q value is 1.83. The higher value of TQ suggests that the companies have been valued by the market. The ownership concentration of the sample firms is 59 percent while half of the firms are owned by the state. The higher proportion of state ownership symbolizes the Chinese socialist culture and dominance of CCP (Chinese Communist Party). The board size of listed sample firms is in between seven directors to 24 directors. About 23 percent of the sample has duality while approximately 10 percent gets audited by Big four auditors.

The correlation analysis and VIF diagnosis is provided in Table 5. We find a positive and statistically significant relationship between CID proxies and independent director variables. Also, the coefficient of IFD, IAD and IPCD are positive and statistically significant. The VIF between the independent variables is much lower than the critical value, suggesting no sign of multicollinearity.

Regression Analysis

Effect of Independent Directors on Carbon Information Disclosure

The effect of independent director on CID is estimated through probit regression. Two measures of independent directors namely independent director ratio and independent director dummy is used as main explanatory variables. The results are depicted in Table 6. We find a positive effect of IDR and ID-Dummy on CID-Dummy and CID-Score. The coefficients of IDR and ID-Dummy are statistically

significant at 1 percent probability. The reported results infer that independent director presence on board leads to higher CID. Our findings are in alignment with the previous study conducted in United Kingdom, that found a positive impact of independent directors presence on GHG emission (Liao et al., 2015).

The control variables effect on the CID is also depicted in the **Table 6**. We find a positive and statistically significant association of firm's size, state ownership, board size, auditor, and firm age with CID. Some previous studies have also shown a positive association of these control variables with CID (Akbaş and Canikli, 2018; García Martín and Herrero, 2020). The coefficient of ROA, TQ and Duality reported a negative effect on CID, however the said relationship is not statistically significant.

Effect of Independent Director's Attributes on Carbon Information Disclosure

To test the hypothesis 2 to 4, we run ordinary least square (OLS) regression and the results are shown in **Table 7**. The attributes of independent director's attributes taken are independent female directors (IFD), independent academic directors (IAD) and independent politically connected directors (IPCD). The table reports a positive effect of IFD on the CID (coefficient = 0.158; p -value = <0.01). The result signifies that the female independent directors enhance the carbon information disclosure through efficient monitoring. Previous studies have also reported a positive association of female directors on the GHG emissions (Hossain et al., 2017; Hollindale et al., 2019).

To test hypothesis 3, we investigate the effect of IAD on the CID. We find a positive and statistically effect of IAD on CID, significant at 1% level. The independent directors have knowledge and experience to guide the firms in environmentally friendly policies. The effect of IPCD on CID is also reported in **Table 7**. We find a positive effect of IPCD on the carbon information disclosure (Model 1: coefficient = 0.093; p -value = <0.01, Model 2: coefficient = 0.06; p -value = <0.01).

Robustness Tests

Alternative Estimation Techniques

For robust analysis, we performed the alternative estimation techniques. The studies in corporate governance have been linked with endogeneity problem. Endogeneity problem arises due to the omitted variable bias or reverse causality. These variables are linked with both the dependent and independent variables; such as culture effect both the independent directors as well as has an impact on the CID. To remove the endogeneity problem, the fixed effect is used to address the omitted variable bias, while generalized method of momentum (GMM) is used to cater the reverse causality.

Table 8 reports the results of fixed effect model and system GMM. It is quite possible that the independent directors choose the firms having environmentally friendly policies. The results still hold while incorporating the fixed effect model and system GMM. We infer that the independent directors enhance the CID in Chinese listed firms.

CONCLUSION

This study aims in investigating the effect of independent directors on corporate information disclosure of Chinese listed firms. For this

purpose, data is collected for the period 2012–2017. CID is measured through a dummy variable as well as through carbon information disclosure index. The results show that the independent directors have a positive and significant effect on the CID. Furthermore, this studies also explore the independent director's attributes on the CID. The results show that the independent director gender, academic experience, and political connection enhances the CID. The results are robust by taking alternative estimation techniques to cater for endogeneity.

Based on the agency theory and the upper echelons theory, this study adds to the literature of corporate governance by signifying the importance of independent directors in organization policies. An independent director sees events through the lens of neutral observer. The experience, connection and advisory role of independent directors encourages the firms in disclosing the carbon related information. This study contributes to the existing literature in several aspects. First our study indicates the importance of independent directors in voluntary carbon disclosure. The independent directors not only supervise and advise the board but have also high sense of social responsibilities in Chinese context. Secondly, the teaching profession in China has a long history of respect and the presence of academic independent directors among board enhances the CID. Lastly, in a male dominate society, this study gives insight about the role played by female directors in enhancing voluntary carbon emission disclosures.

This study has some piratical implications. First the independent director's presence improves the carbon information disclosures. The firms shall hire more independent directors on board to increase the environmental sustainability. The Chinese government can encourage the firms to mandatory apply the quota of having independent directors on board. Secondly, the importance of academics in Chinese culture is evident by their contribution in enhancing the volunteer disclosure of carbon emission. The scholars, practitioners and the government officials shall pay more attention to the composition of independent directors specifically the independent academic directors can enhance CID. Lastly, academia and the government should actively promote the dissemination of female directors among independent directors. Gender diversity among independent directors can promote the monitoring effect on independent director which will ultimately enhance the environmental governance. The independent director's attributes such as gender, academics experience and political connection can be viewed by the regulators as an efficient driver of CID. The investors prefer the firms that adopts the voluntary CID; therefore, the attributes of independent directors can be seen by the investors has positive indicator of CID.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

Conceptualization by HU. Formal Analysis SA. Writeup WK.

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