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Corporate Environmental, Social and Governance Performance and Carbon Washing in China

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Abstract: By focusing on a specific type of greenwashing behavior concerning carbon emission reductions, (i.e., carbon washing), the aim of this study is to investigate its antecedents in ESG (Environmental, Social and Governance) performance and find relevant solutions in Chinese context. This study is designed under a framework of greenwashing triangle for both analysis and examination. The measurement of carbon washing is based on text analysis and content analysis of non-financial reports, and the results are obtained by ordinary least squares regression. The results show a negative relationship between firms' ESG performance and carbon washing tendency, which is mediated through lowering the standardization of carbon disclosure. To combat it, reducing opportunities and rationalizations are both effective avenues, while reducing pressure leads to complicated results. The results offer enlightenment for the cautious usage and regulation of firms' carbon disclosures. Understanding the causes of carbon washing helps to distinguish good performers from poor performers concerning carbon reductions, hence increasing market efficiency. Finding relevant solutions helps to fight carbon washing acts and improve the quality of carbon information. The value of the study is offering new insights in the mis informativeness of carbon disclosure, which helps avoid the generalities in conventional discussions of greenwashing. The measurement of carbon washing is original, based on previous researches.

Keywords: carbon disclosure, carbon washing, ESG performance, greenwashing triangle.

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INTRODUCTION

Climate change has developed into a widely accepted threat (Stern, 2006; and IPCC, 2019) all over the world, bringing sustainable issues to the attention of the public in general, and corporate stakeholders in particular (Wedari et al.,2021). Realizing the gravity of global warming, China, the world's largest carbon emitter, has attached great importance to address it, such as announcing to have a carbon emission peak before 2030 as well as achieve carbon neutrality before 2060, imposing great pressure to firms. In response, an increasing number of firms release sustainability reports, corporate social responsibility (CSR) reports or environmental, social, and governance (ESG) reports to state efforts and effects in decarbonization, causing great concern about the information quality of these reports (Kazemian et al., 2022; Perkins et al., 2022), especially greenwashing. By exaggerating climate actions or misrepresenting carbon data, firms could gain concrete financial and

reputational benefits, which appears to have resulted in a significant disconnect between firms' claimed ambitions and substantial efforts towards achieving most of their self-declared targets (In & Schumacher, 2021). For instance, researches by the Oxford Net Zero initiative showed that merely 20% of decarbonization targets meet quality tests in present (Black et al., 2021). In China, some carbon data-related deceits have been exposed, such as the false reporting on carbon emissions by Ordos High-tech Materials Co, Ltd in 2017, falsity of test reports and distortion of conclusions by some third-party intermediaries in 2022, which arouse the public attentions regarding the reliability of carbon data. To greenwash the data and disclosures concerning carbon emissions is a primary form of greenwashing among Chinese firms (Huang, 2022). The aforementioned carbon-related greenwashing incidents draw our attention, and following In & Schumacher (2021), we use the term "carbon washing" to adequately describe carbon-related greenwashing incidents, since the term greenwashing discussed in prior studies may be too broad to sufficiently capture the specificity of certain misleading ESG-related actions or activities intentionally or inadvertently; The phenomena of carbon washing are becoming more serious in terms of scope and distribution, and because of the financial values attached to corporate carbon performance, the risk of carbon washing persists, even much more serious than general greenwashing (In & Schumacher, 2021). This arouses our interest to 1) find firms' motivations for conducting carbon washing, and 2) seek solutions for it.

Since climate change has received substantial attention among ESG topics (Tomar, 2023), it gains significant importance and is given a big weight in some ESG scoring methodologies, which provides strong motivations for firms, especially those with relatively poor ESG performance, to carbon wash. As a result, firms benefit concretely through carbon washing, including direct positive impacts on their ESG scores (In & Schumacher, 2021). Thus, we try to unpack the ESG antecedent that induce firms' carbon washing tendency, by introducing Kurpierz & Smith's (2020) analytical framework of greenwashing triangle.

Greenwashing has been discussed by researchers from many aspects, such as its motivations (Lee & Raschke, 2023; Wedari et al., 2021; Zhang, 2022a; Zhang, 2022b), impacts (Lee & Raschke, 2023), and measurements (Quoquab et al., 2020). However, few studies have focused on this behavior relating to carbon disclosure so far, fewer empirically investigate its causes and relevant solutions. Based on a sample of Chinese listed firms from 2019 to 2021, we try to fill the research gap by examining the impact of ESG performance on carbon washing tendency and relevant solutions, within a unified analytical framework.

Our research makes several contributions to literature. First, the extant literature provides valuable insights into the issue of climate change, but not enough attention has been paid to the greenwashing phenomena in it, fewer with empirical examination. This study is closely related to, but distinguishable from previous studies investigating greenwashing problems. We introduce the term carbon washing mentioned by In & Schumacher (2021), and to extend their work, we quantified the tendency of carbon washing using text analysis with content analysis approach's, so as to empirically exam its antecedent, mediating channel and mechanisms of solution under an unified framework, which complements the emerging stream of research regarding climate change and greenwashing.

Second, existing research has discussed the motivation of greenwashing in perspective of legitimacy theory (Lee & Raschke, 2023), signaling theory (Zhang, 2022b), voluntary disclosure theory (Wedari et al., 2021; Zhang, 2022a), socio-political theory (Wedari et al., 2021), the theory of motivated cheating and the social cognitive theory (Quoquab et al., 2020). Few analyze greenwashing integrated within the fraud triangle, until Kurpierz & Smith (2020) propose the framework of greenwashing triangle enlightened from the fraud triangle to theoretically summarize the three incidents, namely, pressure, opportunity and rationalization, as well as corresponding solutions. Different from their research, we focus on carbon-related greenwashing issues and

concentrate on one incident, that is, ESG performance, examining their cause-and-effect relationship as well as the mediating channel and relevant solutions with empirical verification, which expands the existing research.

Third, although studies have examined the impact of ESG performance on corporate behavior from several perspectives, few have noticed its consequences in opportunism in climate-related reporting. We extend our knowledge by discovering the impact of ESG performance on carbon washing tendency, which contributes to filling the research gap regarding ESG. In general, this paper contributes to the proposals of Han et al. (2018) and Linnenluecke et al. (2017) concerning academic study on environmental and social topics in emerging markets.

METHODS

Our initial sample comprised A-share listed companies of eight high carbon emission industries that have released sustainability reports, ESG reports or social responsibility reports from 2019 to 2021, which is almost the latest and includes the moment when "Dual Carbon" announcement of China was released. According to the carbon emissions trading systems pilot initiated by Chinese government in 2011, eight industries of petrochemical, chemical, building materials, non-ferrous metals, steel, papermaking, electricity, and aviation are involved in the pilot due to their high level of carbon emissions and intensity. These industries are representative, due to their relatively greater pressure and space in decarburization, as well as consequent carbon washing tendency. After subtracting the firms listed on the special treatment list, on the initial public offerings or with missing data, 85 sample firms were obtained with a total of 255 sample observations as our balanced panel data set.

The main data sources used in this paper are as follows: 1) The initial data of carbon washing come from Juchao: http://www.cninfo.com/, including the sustainability reports, ESG reports or social responsibility reports (hereinafter referred to as "reports") collected by web scraping programs; 2) The ESG scores come from the CSMAR database and the WIND database; 3) The data of government supervision come from Institute of Public and Environmental Affairs (IPE): http://wwwen.ipe.org.cn/; 4) The initial data of public concern come from Baidu Index: https://index.baidu.com/; 5) The data of EMS implementation are based on China quality certification center: https://www.cqc.com.cn/ and firms' reports; 6) Other financial and non-financial data were derived from the CSMAR database, the CNRDS database and the CNKI database. We analyzed the data using Nvivo 12, R 14, and Stata 15.

Dependent variable. In & Schumacher's (2021) introduce the term "carbon washing" as "an adequate taxonomical framing of carbon-related greenwashing instances". Incorporate this with Zhang (2022a; 2022b) definition and measurement of greenwashing, we define carbon washing as seeking for a decarbonization image through aggressive carbon disclosure while performing poorly in real carbon reduction and measure a firm's peer-relative carbon washing tendency to align with our definition. As for the indicators of aggressive carbon disclosure and carbon performance, we use text analysis combined with content analysis approaches to measure them, considering China has not established a mature carbon information database (Zhou et al., 2020).

Counting words was used by researchers to determine the level of environmental disclosure (Deegan & Gordon, 1996; Gray et al., 1995), and following this approach we measure the aggressiveness of carbon disclosure by calculating the frequency of carbon-related phrases in firms' reports. First, we conduct an initial round of content analysis to the reports of our sample firms to find out phrases commonly used in communicating carbon performance. Second, we check these phrases in "Guidelines for the Construction of Carbon Peak and Carbon Neutrality Standard System" (GCCPCNSS) jointly issued by Chinese ministries. The two long-term goals of carbon peak and carbon neutrality are crucial for China (Wang et al., 2023), thus the content of GCCPCNSS

contains the main phrases concerning carbon reduction. Third, we keep the phrases which appear in GCCPCNSS and then establish our carbon-related vocabulary 1) Finally, we conduct a subsequent round of text analysis to the reports with our established vocabulary and divide the number of carbon-related phrases by the total words to count a frequency in each report, 2) as a carbon disclosure aggressiveness score.

Prior studies use absolute greenhouse gas (GHG) emissions, GHG emission intensity (Liesen et al., 2016) or energy saving (Wang et al., 2019) to measure carbon performance. Extending these measurements, we determine carbon performance as substantive results in carbon reduction from four aspects, and based on the reports we score a firm' carbon performance as follows: a firm reducing absolute GHG emissions (and quantitatively disclosed) compared to prior year receives one point (and zero otherwise); a firm reducing GHG emission intensity (and quantitatively disclosed) compared to prior year receives one point (and zero otherwise); a firm totally complying with its carbon allowance receives one point (and zero otherwise); a firm taking steps to achieve a reduction of carbon emission or energy consumption (and quantitatively disclosed) receives one point (and zero otherwise).- As such,a carbon performance score could range from zero to four.

After obtaining the two indicators, we score the level of a firm 's peer-relative carbon washing (CW1) by calculating the gap between a firm's standardized position relative to its peers in the distribution of the carbon disclosure aggressiveness score and a firm's standardized position relative to its peers in the distribution of the carbon performance score. A larger gap represents a higher tendency of carbon washing. As a robustness check, we calculate a firm's carbon washing score (CW2) alternatively by dividing a firm's (SoftMax) normalized carbon disclosure aggressiveness score by its (SoftMax) normalized carbon performance score.

Independent variables. We use Bloomberg ESG scores to proxy firms' ESG performance as our independent variable, because it is seen as a representation of sustainable performance for its extensiveness, objectivity, and comprehensive, and commonly used by scholars (Wang et al., 2022; Zhang, 2022a; Zhang, 2022b). In order to relieve bias caused by variable selection, we use ESG scores provided by the WIND ESG database as our independent variable in the robustness test.

The standardizations of carbon disclosure released by the Task Force on Climate-related Financial Disclosures (TCFD) and the Carbon Disclosure Project (CDP) are influential internationally, and the Global Reporting Initiative (GRI) also has proposed requirements for carbon disclosure within a broader framework of sustainability and participated in international cooperation on carbon disclosure standardization (Shen, 2022). Considering this, we employ a dummy variable (standard) to measure the standardization of carbon disclosure. It is equal to 1 if a firm's report has refered to TCFD, CDP or GRI, otherwise 0. Equally to 1 of this variables means a high level of standardization of carbon disclosure.

Following Song et al. (2019), the proxy of government supervision (gov) is chosen as the Pollution Information Transparency Index (PITI) developed by IPE, as it assesses the level of pollution information transparency of Chinese municipal governments in terms of environmental supervision information, pollution source self-disclosure, interactive response, enterprise emission data and environmental impact assessment information. The greater the PITI index, the greater the pressure of government supervision. With the popularization of the Internet, public demands can spread online in a faster way, making searching indexes come into use by scholars (Kahn & Kotchen, 2011; Luo & Wu, 2022); Following Luo & Wu (2022), we collect cities' Baidu Index based on three keywords of "carbon emission", "climate change" and "global warming", and after dividing them by urban population to eliminate population size effect, we use the average number of past two years to measure cities' public concern (public). The greater the average number, the greater the pressure of public concern. We use business credits (cre_a) measured by sum of accounts payable, notes payable, and advance receipts divided by total assets, as the proxy of vendor support. The greater the number of business credits, the greater the

pressure of vendor support. We determine firms' implementation of EMS (ems) by the certification of EMS in current year. It is a dummy variable, equal to 1 if a firm is certified by EMS in current year, otherwise 0. Equally to 1 of this variable means less carbon washing, namely, reducing opportunities to carbon wash. We measure firms' social responsibility ethics (insuffi) by determining if any deficiencies concerning social responsibility are disclosed in reports. It is a dummy variable, equal to 1 if a firm has disclosed deficiencies concerning social responsibility in the current year, otherwise 0. Equally to 1 of this variable means less willingness to rationalize carbon washing acts, namely, reducing rationalizations to carbon wash.

Control variables. In addition to the core variables mentioned above, we introduce several control variables in our empirical models. We employ firms' size and age, considering small and young firms may be more likely to conduct carbon washing; we employ firms' financial leverage, sales growth, return on assets and tangible assets ratio, considering financial and operation conditions may affect firms' decisions of disclosure; We also employ firms' CEO duality and ownership (state-owned). In addition, zone, industry and year dummies are also included in our empirical models. Zone is a binary variable to distinguish between developed and underdeveloped regions, following the measurement of Song et al. (2019). All variables are defined in Table 1.

Table 1 Definition and measurement of variables

Variable	Definition and measure
CW1	The gap between a firm 's standardized position relative to its peers in the distribution of the carbon disclosure aggressiveness score and a firm's standardized position relative to its peers in the distribution of the carbon performance score
CW2	Quotient of a firm's (softmax) normalized carbon disclosure aggressiveness score by its (softmax) normalized carbon performance score
ESG	ESG scores provided by the Bloomberg ESG database
standard	Dummy 1 for the reference of TCFD, CDP or GRI, and 0 otherwise
gov	Pollution Information Transparency Index (PITI) developed by IPE
public	Cities' Baidu Index based on three keywords, and after dividing them by urban population, use the average number of past two years
cre_a	Sum of accounts payable, notes payable, and advance receipts divided by total assets
ems	Dummy 1 for certification of EMS in current year, and 0 otherwise
insuffi	Dummy 1 for disclosing deficiencies concerning social responsibility in the current year, and 0 otherwise
size	Firm size (natural logarithm of total assets)
age	Years of incorporation
lev	Financial Leverage
growth	Percentage change in operating revenue
roa	Profitability (net profits / total assets)
tangiratio	(Total assets - intangible assets - goodwill)/ total assets
dua	Dummy 1 for CEO duality, and 0 otherwise
state	Dummy 1 for state-owned, and 0 otherwise
zone	Dummy 1 for developed regions, and 0 otherwise
industry	Dummy variable of industry
year	Dummy variable of year

Research models. To explore the relationship between ESG performance and carbon washing, we construct Model 1) for empirical testing. The mediating effect models proposed by Baron & Kenny (1986) are used to examine the channel effect, and we construct Model 2) and Model 3). On the basis of Model 1), we construct Model 4) by introducing the interaction of ESG performance and variables of combating carbon washing, to test the effects of reducing pressure, opportunities and rationalizations to combat carbon washing.

$$CW_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t-1} + \alpha_2 Controls_{i,t} + zone + industry + year + \varepsilon \quad (1)$$

$$logit(standard_{i,t} = 1) = \alpha_0 + \alpha_1 ESG_{i,t-1} + \alpha_2 Control_{i,t} + zone + industry + year + \varepsilon \quad (2)$$

$$CW_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t-1} + \alpha_2 standard_{i,t} + \alpha_3 Control_{i,t} + zone + industry + year + \varepsilon \quad (3)$$

$$CW_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t-1} + \alpha_2 ESG_{i,t-1} \times M_{i,t} + \alpha_3 M_{i,t} + \alpha_4 Control_{i,t} + zone + industry + year + \varepsilon \quad (4)$$

Considering that the impact of ESG performance on carbon washing has a certain hysteresis, we processed the variable of ESG performance 1-year lagged to help alleviate the potential endogenous problems of the reverse causality effect. $ESG_{i,t-1}$ represents ESG performance in previous year; $CW_{i,t}$ represents the level of carbon washing; $Controls_{i,t}$ represents the control variables, and the zone, industry and year fixed effects are also controlled in our empirical models. The variable $standard_{i,t}$ is the mediating variable to be tested, which represents the standardization of carbon disclosure. And we introduce Bootstrap test for mediating effect. $M_{i,t}$ represents each of the variables to combat carbon washing.

RESULTS AND DISCUSSION

Table 2 provides descriptive statistics for the data of variables. The mean value for CW1 is 0, the maximum and minimum values are 3.079 and −3.397, the median is 0.0120; The mean value for CW2 is 1.109, the maximum and minimum values are 3.236 and 0.295, the median is 1.005, indicating a heterogeneity of carbon washing tendency among sample firms. The mean value of ESG is 31.29, the maximum and minimum values are 55.37 and 16.53, the median is 28.93, suggesting obvious differences among sample firms in ESG performance, and the overall ESG performance of the sample firms are low, which might motivate firms with low ESG performance to carbon wash.

Table 2 Descriptive statistics

Variables	Obs.	Mean	Std. Dev.	Min.	Median	Max.
CW1	255	0	1.070	−3.397	0.0120	3.079
CW2	255	1.109	0.530	0.295	1.005	3.236
ESG	255	31.29	9.259	16.53	28.93	55.37
size	255	24.42	1.501	20.68	24.48	28.64
age	255	22.99	4.126	11	22	37
lev	255	0.531	0.166	0.107	0.550	0.979
growth	255	0.162	0.379	−0.515	0.100	4.776
roa	255	0.0420	0.0640	−0.644	0.0330	0.226
tangiratio	255	0.936	0.0530	0.714	0.951	1
dua	255	0.361	0.481	0	0	1
state	255	0.788	0.409	0	1	1

To determine whether multiple collinearities exist in the model, we provide a Pearson correlation test. It shows ESG performance (ESG) is negatively correlated with carbon washing (CW1 and CW2), indicating that low ESG performance may be an incentive to carbon wash with preliminary evidence of low significance. Results are still supposed to be verified by the model. Apart from the three coefficients are slightly greater than 0.5, the other variables are within the normal range (less than 0.5), indicating that there is no serious collinearity problem. On this basis, the variance inflation factors of the regression Model (1) have been tested and found to be all less than 10, which can be used to posit that there is no possibility of serious multiple collinearity.

We perform a baseline regression test based on Model (1), with the results shown in Table 3. Column (1) and (2) display the regression results without the control variables, and ESG performance (ESG) exhibits a negative and statistically significant ($p < 0.01$) association with carbon washing (CW1 and CW2); Column (3) and (4) display the regression results adding the control variables, and ESG performance still (ESG) exhibits a negative and statistically significant ($p < 0.05$ and $p < 0.1$ respectively) association with carbon washing (CW1 and CW2). Results of Model (1) provide support that ESG performance has a negative impact on carbon washing, suggesting that firms with poor ESG performance are more likely to carbonwash than firms with good ESG performance.

Table 3 Baseline regression results

	(1)	(2)	(3)	(4)
Variables	CW1	CW2	CW1	CW2
ESG	-0.0336***	-0.0164***	-0.0222**	-0.0090*
	(-4.3184)	(-4.1262)	(-2.4224)	(-1.9828)
size			-0.1287*	-0.0872**
			(-1.7808)	(-2.4642)
age			0.0089	0.0000
			(0.4511)	(0.0001)
lev			0.4229	0.2276
			(0.7134)	(0.7212)
growth			-0.0862	-0.0532
			(-0.5801)	(-0.8254)
roa			0.5527	0.6448
			(0.5964)	(1.3693)
tangiratio			2.1841	1.5101*
			(1.3531)	(1.7557)
dua			0.2591	0.0581
			(1.4505)	(0.5801)
state			0.1933	0.1093
			(0.8725)	(1.0657)
Constant	1.1014***	1.6488***	1.1275	1.8475*
	(3.5388)	(8.7564)	(0.5282)	(1.7099)
zone	YES	YES	YES	YES

industry	YES	YES	YES	YES
year	YES	YES	YES	YES
N	255	255	255	255
Adj.R^2	0.198	0.165	0.209	0.195

Standard errors clustered at the firm level are reported in parentheses.
***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively

To enhance the reliability of the results, we conducted a number of robustness tests, with results displayed in Table 4. (a) We modify Model (1) to a binary logit model by dividing the dependent variable (CW1 and CW2) as binary according to the median value, and the results remain basically unchanged after the regression analysis, as shown in Column (1) and (2). (b) We replace the proxy of ESG performance by data from WIND ESG database, and the results are found to be consistent with the previous conclusions as shown in Column (3) and (4). (c) To mitigate the impact of extreme values on the results, we minorize all continuous variables by 5% up and down, and the results remain the same as shown in Column (5) and (6).

Table 4 Robustness test

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	CW1	CW2	CW1	CW2	CW1	CW2
ESG	-0.0419*	-0.0419*	-0.2299**	-0.1089**	-0.0202**	-0.0082*
	(-1.8990)	(-1.8903)	(-2.2016)	(-2.0573)	(-2.2305)	(-1.8784)
Controls	YES	YES	YES	YES	YES	YES
Constant	6.7441	8.3906	4.9853***	2.7110	0.7763	1.5379
	(1.1969)	(1.5276)	(3.4158)	(1.3453)	(0.3531)	(1.5193)
zone	YES	YES	YES	YES	YES	YES
industry	YES	YES	YES	YES	YES	YES
year	YES	YES	YES	YES	YES	YES
N	255	255	255	255	255	255
(pseudo/Adj.) R^2	0.1936	0.1857	0.2016	0.2093	0.2209	0.2152

Standard errors clustered at the firm level are reported in parentheses.
***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively

To this point, there still exists other endogenous problems such as measurement error bias. Following Breuer et al. (2018), we use the ESG performance of two lag periods of the initial sample period, that is, 2017 (blesg2017), and the (1-year lagged) industry-year average ESG performance (L_blesgave) as two instruments for a two-stage Generalized Method of Moments (GMM) procedure. Both variables are likely to affect the current ESG performance but are unlikely to directly affect the current carbon washing tendency.

Results of the GMM procedure are displayed in Table 5. In the first stage, we regress ESG on the instruments and other controls, and then replace ESG in Model (1) with the fitted value from the first-stage regression. Column (2) and (3) report the results for the second stage, which substantially support our previous findings. The coefficients of the explanatory variables are still (and even more) significantly negative, suggesting that low ESG performance increases carbon washing tendency.

From the results of the first stage reported in Column (1), both instruments are significantly correlated with ESG, indicating an explanatory power, and the F statistic is 61.14 which is greater than 10, rejecting the null hypothesis that our instruments are weak. Moreover, we test for over-identification by calculating Hansen's J statistic, and the test fails to reject the null hypothesis that all instruments are exogenous (Hansen's J statistic = 0.5092 and 2.0361, respectively, p-value = 0.4755 and 0.1536, respectively).

Table 5 Endogenous test

	First Stage	Second Stage	
Variables	ESG	CW1	CW2
L_blesgave	0.2981**		
	(2.4904)		
blesg2017	0.7453***		
	(10.5406)		
ESG		−0.0274***	−0.0133***
		(−2.7982)	(−2.7099)
Controls	YES	YES	YES
Constant	−17.5526*	1.0271	1.4121
	(−1.7432)	(0.6414)	(1.6416)
zone	YES	YES	YES
industry	YES	YES	YES
year	YES	YES	YES
Hansen's J (P Value)		0.4755	0.1536
N	255	255	255
Adj.R^2	0.795	0.207	0.189

***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively

Although not seen as a form of fraudulent reporting traditionally, greenwashing is structurally similar to fraud; and a framework of greenwashing triangle modified from the fraud triangle is developed, building on the insights from their similarities (Kurpierz & Smith, 2020). Based on this framework, we discuss why ESG performance induce carbon washing tendency in the three aspects of the triangle——pressure, opportunity, and rationalization in Chinese context.

China has placed great emphasis on the issue of carbon emissions by taking a successive of actions, since the low-carbon city pilot policy in 2010, to the "Dual Carbon" announcement in 2020. This also arouses public consciousness in the profile of climate change and creates significant retail demand for products with a link to the low-carbon transition, leading to competitive pressure around low-carbon products (In & Schumacher, 2021). In this case, Chinese firms face tremendous legitimacy pressure of decarbonization from the governmental coercion (Zhou et al., 2020) and the public, to reduce their carbon footprints all over the supply chains. On the other hand, firms are encouraged to transfer to climate-neutral commercial models and low-carbon supply chains (In & Schumacher, 2021) for economic interests such as credit granting and financing support. High-quality ESG engagement sends positive signals both to the financial market and the public and creates a good corporate image of climate-neutral business, which may promote relationships with a wide range of

stakeholders (He et al., 2022). Whereas poor ESG performance generally suggests insufficient concerns and lacking actions towards environmental issues including carbon mitigation. It leads to two kinds of pressure, one is harm of losing legitimacy (from the government and public) due to perceived noncompliance, and the other is loss of benefits from vendor support (from suppliers) as well as financing interests (from financial institutions) for perceived compliance. As a result, the corresponding pressure from low ESG scores drive firms sparing no effort to reverse their negative image, including carbon washing in their reports.

ESG performance includes a governance dimension, which means good ESG engagement promotes internal and external governance as well as manager self-discipline (He et al., 2022), and leads to transparency (Kim et al., 2012). On the contrary, poor ESG performance reflects weak corporate governance system and manager's poor self-regulatory, thus exacerbating agency problems and opacity, inducing opportunistic practices like carbon washing. In China, there has not established an institutional system, nor explicit standards for carbon disclosure yet (Shen, 2022), which means that carbon information is currently not subject to regulation, and carbon disclosure generally remains voluntary. This leaves substantial discretionary space for firms with low-quality ESG performance to opportunistically disclose carbon information in a selective way. Lacking self-discipline, managers with poor ESG engagement are more intended to make use of the absence of harmonized reporting requirements to exaggerate their carbon awareness and efforts in climate change mitigation, so as to establish a low carbon image and favorable reputation. The information ambiguity caused by the lack of unified reporting requirements along with the future-oriented decarbonization strategies encourage firms to claim frontloaded impact data not existing yet (In & Schumacher, 2021), contributing to the murky nature of carbon disclosure. Lacking internal transparency, ESG poor performers are more likely to take advantage of it by overstating their climate actions and misrepresenting their carbon data. Besides, some ESG agencies assign heavy weight to relative numbers such as level of GHG mitigation, greater than absolute carbon reduction, which is obviously not conductive to address the issue of climate change, but leaves room for opportunism; In this condition, ESG poor performers are motivated to cater the preference of agencies and disclose carbon information accordingly rather than reduce their actual carbon footprints for the purpose of improving ESG ratings (Huang, 2022), which increases the risk of carbon washing substantially. Overall, in the condition of discretion and murky nature of carbon disclosure, absence of harmonized reporting requirements and biased ESG evaluation methodologies, poor ESG performers, with weaknesses in corporate governance and poor managers' self-regulatory, are more tended to conduct opportunistic acts in carbon disclosures like carbon washing.

The environmental dimension of ESG conveys a willingness to take consideration of the environment, and the social dimension of ESG suggests that firms should take social responsibility as an ethical obligation by doing what is morally right, fostering a corporate culture with high ethical standards (He et al., 2022). Therefore, poor ESG performance generally demonstrates a lower level of environmental consciousness and moral concepts, which breeds a higher tendency of taking environmental misconduct for granted. With growing stakeholders' focus on firms' duties of society, firms tend to comply, at least in appearance, with stakeholders' expectations, by communicating their ESG conducts strategically instead of implementing them (Lee & Raschke, 2023), which results in a massive degree of corporate impact frontloading in terms of climate change mitigation-related public relations (In & Schumacher, 2021). Lacking environmental responsibility and morality, poor ESG performers are more likely to treat sustainable responsibility as an advertising instrument rather than material disclosure. Meanwhile, firms benefit a lot from their inactions such as vague climate-related announcements but would not be penalized in general (In & Schumacher, 2021), creating a similar "low risk - high reward" environment for

greenwashing (ESMA, 2021), including carbon washing acts. This is more likely to deliver a mistaken message to ESG underperformers, who lack ethical standards and environmental consciousness, that fraud only affects financial reports. In short, poor ESG performers, ignoring their environmental and ethical obligations, are more inclined towards advertising attitudes and aleatory presumptions of carbon disclosure, driving them to rationalize their carbon washing behaviors.

In this subsection, we try to further explore the channel through which ESG underperformers carry out carbon washing. The regression results of Model (2) and Model (3) are reported in Table 6, to explore the channel of conducting carbon washing by ESG underperformers, that is, reducing the standardization of carbon disclosure.

Table 6 Channel of carbon washing

	(1)	(2)	(3)
VARIABLES	standard	CW1	CW2
standard		-0.7424***	-0.3830***
		(-4.2673)	(-4.5512)
ESG	0.1204***	-0.0061	-0.0007
	(3.6714)	(-0.6143)	(-0.1420)
Controls	YES	YES	YES
Constant	-9.8372	0.4628	1.5046
	(-1.5901)	(0.2439)	(1.6100)
zone	YES	YES	YES
industry	YES	YES	YES
year	YES	YES	YES
N	255	255	255
(pseudo/Adj.) R^2	0.316	0.286	0.279

Standard errors clustered at the firm level are reported in parentheses.
***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively

The results of Model (2) displayed in Column (1) show the coefficient of ESG is significantly positive at the level of 1%. This suggests that firms with poor ESG performance tend to avoid the compliance of common criteria's in their reports and reduce the standardization of carbon disclosure. One of the benefits is leaving room for discretionary reporting, such as releasing exaggerated future-oriented decarbonization strategies and deliberately or selectively communicating information not matched with actual environmental impacts (In & Schumacher, 2021).

The low quality of climate-related disclosures may cause information asymmetry, weaken investors' ability to identify good performers, and finally result in adverse selection in market. According to signaling theory, "good" firms are motivated to disclose as high-quality information as possible in order to differentiate themselves from "poor" ones, while it is difficult for "poor" firms to imitate due to the relevant costs, which helps to address the "lemon" problem. By developing a common reporting framework for ESG/sustainability

reporting, Standardization like GRI allows cross-company and cross-industry comparisons (Waddock, 2008), thus help external stakeholders to analyze firms' engagement on sustainable issues such as climate change mitigation. Hence, good ESG performers are motivated to adopt generally recognized ESG standards in their reports, so as to signal their proactive strategies for ESG commitment and bring better communication and feedback (Luo & Tang, 2022). Conversely, poor ESG performers, who may contribute limitedly to environmental affairs such as carbon reduction and lack transparency in information disclosing process, are generally reluctant to establish effective communication to external stakeholders, for fear of being identified as unseriousness and inaction in addressing environmental problems like climate-related risk. Considering China lacks harmonized reporting requirements for carbon disclosure to date, ESG underperformers are more tended to take advantage of it and choose the most favorable reporting criteria's to follow (Huang, 2022) to disclose carbon information, rather than more standardized ones.

The results of Model (3) displayed in Column (2) and Column (3) show the coefficients of standard are both significantly negative at the level of 1%. In the bootstrap test, none of the 95% confidence intervals of indirect effect contain zero, irrespective of the dependent variable as CW1 or CW2, suggesting a significant indirect effect. This indicates that reports are more vulnerable to carbon washing in the absence of standardization of carbon disclosure.

Adopting well-known ESG standards helps to enhance the accountability and informativeness of ESG reports (Adams, 2004). Luo & Tang (2022) indicate that, since standardization like GRI may act as a soft institution or form of self-regulation that encourages firms to take actual actions that mitigate carbon emissions, the adoption of generally recognized standards shows entities' more commitment to information transparency around climate change management than those who does no adopt them; They find the adoption of the standards signals a firm's genuine commitment to transitioning to carbon neutrality. On the contrary, avoiding the compliance of reporting standardization weakens the comparability and accountability of carbon disclosures, reduces informativeness and transparency when communicating with external stakeholders regarding climate actions, which exacerbates agency problems and opportunism tendency, such as treating carbon disclosure as advertising tools instead of responsibility, and results in carbon washing. In & Schumacher (2021) also indicate that, the relatively slow pace of sustainability reporting standards establishment provides misaligned incentives to firms to selectively or deliberately communicate information not matching their real environmental impacts or make commitments with little or no substance. Overall, poor ESG performance may lead to low standardization of carbon disclosure, thereby results in high carbon washing tendency; That is, reducing the standardization of carbon disclosure becomes a mediating channel through which ESG underperformers conduct carbon washing.

The above-mentioned results together indicate that the standardization of carbon disclosure mediates the relationship in our baseline regression and demonstrate that ESG underperformers tend to take the opportunity of reducing the standardization of carbon disclosure, for ease of conducting carbon washing acts.

Further, we try to find ways to combated ESG underperformers' carbon washing tendency under the framework of greenwashing triangle, for it is regarded as a tool to fight greenwashing (Kurpierz & Smith, 2020). By affecting the three legs of greenwashing triangle, that is, reducing pressure, opportunities and rationalizations, we explore the effects of different approaches in intervening carbon washing acts of firms with poor ESG performance. The results of Model (4) are reported in Panel A and Panel B of Table 7 to verify approaches to combat carbon washing.

Table 7 Combating carbon washing

	(1)	(2)	(3)	(4)	(5)
Variables	M= gov	M=public	M= cre_a	M=ems	M= insuffi
Panal A Dependent variable= CW1					
ESG	-0.0528	0.0259	-0.0570***	-0.0378***	-0.0208**
	(-0.9696)	(1.1874)	(-4.2815)	(-2.9057)	(-2.2756)
ESG×M	0.0004	-0.1831**	0.3028***	0.0293*	0.1461***
	(0.5376)	(-2.5739)	(2.8362)	(1.8794)	(3.6698)
M	0.0107	5.9078***	-6.4734**	-1.1141**	-3.4543***
	(0.4978)	(2.6670)	(-2.4392)	(-2.1367)	(-3.3193)
Controls	YES	YES	YES	YES	YES
Constant	1.3860	-1.9140	1.7553	0.8305	1.8303
	(0.6486)	(-0.7627)	(0.8401)	(0.4174)	(0.8458)
zone	YES	YES	YES	YES	YES
industry	YES	YES	YES	YES	YES
year	YES	YES	YES	YES	YES
N	255	255	255	255	255
Adj.R^2	0.238	0.229	0.240	0.220	0.216
Panal B Dependent variable= CW2					
ESG	-0.0233	0.0146	-0.0224***	-0.0183***	-0.0080*
	(-0.7402)	(1.2479)	(-2.9539)	(-2.6511)	(-1.7707)
ESG×M	0.0002	-0.0893**	0.1181**	0.0168**	0.1022***
	(0.4333)	(-2.1611)	(2.1864)	(2.0862)	(5.1415)
M	0.0050	2.9577**	-2.3623	-0.6181**	-2.3934***
	(0.4038)	(2.1810)	(-1.5794)	(-2.1175)	(-4.8130)
Controls	YES	YES	YES	YES	YES
Constant	1.9677*	0.3273	2.0422*	1.7334*	2.3501**
	(1.6701)	(0.2629)	(1.8066)	(1.7725)	(2.2760)
zone	YES	YES	YES	YES	YES
industry	YES	YES	YES	YES	YES
year	YES	YES	YES	YES	YES
N	255	255	255	255	255
Adj.R^2	0.220	0.215	0.214	0.209	0.218

Standard errors clustered at the firm level are reported in parentheses.
***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively

From the regression results in Column (1) to Column (3), it can be seen that the coefficients of the interaction of ESG performance (ESG) and the three terms of pressure (gov, public and cre_a) are not significantly positive, significantly negative and significantly positive respectively. This means that, on one hand, government supervision does not significantly contribute to combat carbon washing of firms with poor ESG performance, thereby reducing pressure of government supervision does not work; on the other hand, public concern (vendor support) induces (curbs) firms with poor ESG performance to carbon wash, which conversely indicates reducing the pressure of public concern (vendor support) inhibits (encourages) ESG underperformers to carbon wash. The above different results are coherent with prior arguments that reducing the pressure is one of the more complex and difficult options (Kurpierz & Smith, 2020) to combat carbon washing. Column (4) shows the coefficients of the interaction of ESG performance (ESG) and reducing opportunities (ems) are significantly positive, indicating that reducing opportunities (by implementing EMS) inhibits firms with poor ESG performance to carbon wash. Consistent with previous arguments that reducing greenwashing opportunities is an effective tactic (Kurpierz & Smith, 2020), we verify it in combating carbon washing. Column (5) shows the coefficients of the interaction of ESG performance (ESG) and reducing rationalizations (insuffi) are significantly positive, indicating that reducing rationalizations (by enhancing social responsibility awareness) inhibits firms with poor ESG performance to carbon wash. The results suggest there is more room to prevent rationalization leg of the greenwashing triangle compared to traditional fraud triangle (Kurpierz & Smith, 2020).

To combat carbon washing by reducing the pressure of ESG underperformers may lead to complicated results. The pressure is composed of high standards to punish for failure, and large incentives to reward for success (Kurpierz & Smith, 2020). The high standards could stem from the government supervision as well as public concern, and the large incentives include vendor support of the supply chain. However, public interventions have been strongly recommended by economists to internalize the negative externalities of carbon emissions through economic activities, as a solution to climate change (In & Schumacher, 2021). As a result, reducing the pressure is one of the more complex and difficult options, since pressure is reasonable and desirable to maintain sustainability (Kurpierz & Smith, 2020). Therefore, we argue that reducing pressure (from government supervision, public concern, and vendor support) may both inhibit and encourage ESG underperformers to carbon wash.

Reducing opportunities is an important step in helping honest firms, because greenwashing cannot survive strong internal controls, rigorous reporting standards and thorough record-keeping (Kurpierz & Smith, 2020). Reducing energy consumption and improving energy efficiency are at the forefront of the global climate change agenda; The Energy management systems (EMS) developed by ISO aims for improvement of energy performance, and can lead firms to meet overall climate change mitigation goals by reducing their energy-related greenhouse gas emissions; It emphasizes on internal controls such as the endurance of responsibilities and authorities for relevant roles; It attaches importance to reporting standards in terms of recommendations for communication and specific requirements for documented information; And it clarified record-keeping details about the size, complexity, resources, measurement, and monitoring equipment of the data, as well as collection methods and retaining frequency (ISO, 2018). The implementation of the EMS contributes to reducing the opportunities of firms with poor ESG performance to carbon wash, for example by preventing them claim frontloaded impact data that does not exist yet. Therefore, we argue that reducing opportunities (by implementing the EMS) may inhibit ESG underperformers from carbon washing.

In contrast to traditional difficulty of affecting the rationalization leg, there is more room to convince firms of the value of environmental sustainability and be honest, that is, prevent rationalization, since it happens

internally to actors (Kurpierz & Smith, 2020). Rationalization such as publicizing view towards carbon disclosure and wishful thinking of evading punishment for carbon washing actions reflects lacking sense of social responsibility. Thus, firms with social responsibility ethics are more likely to treat truthfulness or independent belief in sustainability as an important value, thereby are less likely to rationalize carbon washing behaviors. Therefore, we argue that reducing rationalizations (by enhancing social responsibility ethics) may inhibit ESG underperformers to carbon wash.

CONCLUSION

This study examined the impacts of ESG performance on carbon washing tendency as well as relevant solutions. A central finding is that firms with poor ESG performance are more tended to carbon washing than firms with high ESG performance. This reflects that poor ESG performance brings pressure and induces opportunism as well as rationalized attitude, motivating firms to carbon wash. This verifies In & Schumacher (2021) view that carbon washing is a byproduct of regulatory pressures, current methodological shortcomings, and reputational incentives, and provides new insights to the literature concerning the consequences of ESG. Further, we find that ESG underperformers tend to wash their carbon disclosures by lowering the standardization, highlighting the significance and urgency to establish a comprehensive institution system of carbon disclosure in China. Afterwards, we explore the interventions in this tendency from the three aspects of the greenwashing triangle and find that reducing opportunities and rationalizations are both effective, whereas reducing pressure have complicated effects. This offers enlightenment for the external and internal stakeholders to effectively regulate firms' reporting of carbon information in a proper way. For scholars, we offer new insights regarding firms' climate actions by focusing on their opportunism in disclosing carbon information and investigating its antecedent in ESG performance and relevant solutions, within a novel analyzing framework and corresponding empirical verification; We also offer new evidence of the consequence of ESG on organizational opportunistic behaviors. We offer insights to stakeholders who use firms' carbon information to determine their carbon performance. According to our findings, it is recommended to use firms' carbon disclosure combined with other related information such as the implementation of EMS, and firms' social responsibility ethics, to avoid misinformation and make comprehensive assessments. For policymakers and non-governmental organizations, a better understanding of carbon washing issues will contribute to policy-design and public advocacy to enhance the reliability and transparency of climate-related reporting. For example, an overall standardization of carbon disclosure framework for compliance is urgent, in order to strengthen the normalization of carbon information and thus block the channel of carbon washing; Comprehensively applying the EMS will provide firms a framework of requirements for energy management and help evaluating their energy performance, thereby reduce opportunities to carbon wash; And advocating and encouraging corporate social responsibility is useful to convince firms of the value of sustainability, thereby reduce rationalizations to carbon wash. Notably, it should be cautious when reducing the pressure, which even may not be advisable (Kurpierz & Smith, 2020), owing to the complicated consequences in combating carbon washing. This study has several limitations. First, we use a policy document (GCCPCNSS) as a benchmark to establish our carbon-related vocabulary in the measurement of carbon washing, due to the lack of a mature carbon information database in China (Zhou et al., 2020), leading to subjectivity to some degree. Second, it covers the period from 2019 to 2021 only, although it is almost the latest and includes the moment when "Dual Carbon" announcement of China was released. Furthermore, it focuses on high carbon emitters only, and sample size is small, hence, the findings

may not be generalizable to other industries. To overcome these limitations, future research can summarize relevant policy documents to develop a Chinese carbon-related dictionary and extend the study period as well as industry to improve the generalizability of results.

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