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RESEARCH ARTICLE

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The real effects of ESG reporting and GRI standards on carbon mitigation: International evidence

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Abstract

This study explores the real effects of environmental, social, and governance (ESG) reporting and the adoption of global reporting initiative (GRI) standards on carbon mitigation. Using a sample of large international companies, our empirical evidence does not show that a general form of ESG reporting is associated with carbon mitigation. However, after controlling for ESG reporting, firms that follow GRI standards when preparing their ESG reports are more likely to achieve greater carbon mitigation. Channel tests show that such firms tend to set more proactive carbon strategies and policies, make environmental investments, and actively engage with stakeholders. Finally, we find that the real effects of GRI standards tend to occur mainly in weak institutional settings (e.g., countries with less stringent carbon regulations, lower climate consciousness, and weaker legal enforcement). Overall, the central insight of the study is that standardized ESG reporting under GRI plays a soft substituting role in promoting green aspirations in an institution void of a high degree of global warming awareness.

KEYWORDS
carbon accounting, carbon mitigation, climate change, ESG, GHG emissions, global reporting initiative (GRI)

1 | INTRODUCTION

According to the Intergovernmental Panel on Climate Change (2014), the mean surface temperature of the Earth increased by 0.85°C in the period from 1880 to 2012 and is on track to be 2°C, or even 4°C, higher in the next 100 years. The scientific consensus is that further global warming will exacerbate issues such as food and water shortages, the displacement of communities, poverty, and the loss of biodiversity in most inhabited regions. The 2015 Paris Agreement sets, and the 2021 COP 26 Glasgow Climate Pact reaffirms, a climate target to cap global warming well below 2°C or 1.5°C. It is expected that the impacts of climate change on business will be significant, abrupt, irreversible, and far-reaching. As major contributors to carbon emissions, companies are becoming increasingly aware of physical and transitional climate risks. Meanwhile, they are increasingly being implored by a variety of stakeholder groups to manage and mitigate their carbon footprint. In response, growing companies are taking various measures to achieve carbon mitigation and communicate these measures and outcomes to external stakeholders in environmental, social, and governance (ESG) reports[1] (KPMG, 2020).[2] A critical question arises: Does this ESG reporting affect firms' subsequent carbon mitigation, and what is the role of ESG standards?

In the current ESG literature, few studies have addressed the real effects of ESG reporting (Christensen et al., 2021). Proponents of ESG reporting argue that it extends the availability of ESG information to stakeholders and motivates firms to alter their decisions and

behaviors. First, increased information on a company's ESG reduces information asymmetry between firms and stakeholders and among stakeholders (e.g., Dhaliwal et al., 2011; Dhaliwal et al., 2012). It thus facilitates stakeholders' understanding of the firm's carbon risk profile and its relative performance compared to its peers. Stakeholders tend to reward companies that outperform their peers by assigning a higher market valuation, requiring a lower cost of capital, purchasing more products, or providing quality labor and supplies (e.g., Jiang et al., 2021; Plumlee et al., 2015; Schiemann & Sakhel, 2019). Conversely, socially or environmentally irresponsible companies may be deprived of critical resources by stakeholders (Clarkson et al., 2008). In either case, firms have a greater incentive to actively engage in carbon mitigation to strengthen their competitive advantage or avoid punishment or sanctions by stakeholders. Second, studies demonstrate that managers might engage in ESG activities and reporting to pursue personal goals or gain personal benefits, leading to an agency problem (Masulis & Reza, 2015). Because ESG reporting can enhance firms' information environment and overall corporate transparency, it increases the monitoring of managers by corporate outsiders such as analysts or institutional investors (Gu et al., 2013; Neubaum & Zahra, 2006). It may lead to improved managerial decision-making and more efficient corporate investment in ESG activities. Finally, firms can imitate and learn from their peers' ESG reporting. These possible mechanisms lead to the expectation of a positive association between ESG reporting and carbon mitigation.

In contrast, other scholars believe that ESG reporting may have no observable effect or a negative impact on firms' carbon mitigation. This may be because of its voluntary and multidimensional nature. Many companies' ESG reports selectively present only those indicators of non-financial performance that are favorable to them (Kaplan & Ramanna, 2021). These companies may also strategically use positive language to conceal their actual poor performance and alter stakeholder perceptions (e.g., Cho et al., 2009; Crilly et al., 2016). These companies have no intention of changing their underlying carbon reduction activities or improving their carbon performance. Instead, they aim to hide negative news through symbolic and biased ESG reporting. In addition, ESG encompasses a broad spectrum of topics and risks that could be in line with or go against the desires of specific stakeholders. Companies may address certain ESG topics to obtain the approval of stakeholders they believe are critical for their survival and emphasize other topics less. In sum, this perspective predicts a negative association or no significant association between ESG reporting and carbon mitigation. Given these competing arguments, this research question is an empirical one.

We also examine the role of ESG reporting standards in driving real effects on carbon mitigation, with a focus on the global reporting initiative (GRI). According to KPMG (2020), GRI remains the dominant global standard for sustainability reporting. GRI is an independent international standards organization that helps businesses, governments, and other organizations understand and communicate their impacts on human rights, corruption, climate change, and other ESG problems. Its framework helps companies identify, gather, and report information in a transparent and comparable manner. Launched in 2000 and developed by the Global Sustainability Standards Board, the GRI standards are the global standards for ESG reporting. Unlike earlier reporting frameworks, the GRI standards have a modular structure, making it easier to update and adapt. Without guidelines, companies can report whatever they want, in whatever format they desire, typically focusing only on favorable news and positive activities. When companies adopt the GRI standards, the content, format, and other reporting requirements in their ESG reports are standardized. This standardization allows external stakeholders to conduct comparative analyses of how well companies are doing on a sustainability issue of primary public interest (Sullivan & Gouldson, 2012; Waddock, 2008). Adopting the standards is widely considered to enhance the quality and credibility of sustainability reports (Adams, 2004; Willis, 2003). Therefore, we expect that voluntary adoption of GRI reporting standards has real effects on carbon mitigation.

To empirically test the impact of ESG reporting and the adoption of GRI standards on subsequent carbon mitigation, we adopt a panel data fixed-effect model and lag all independent variables as our baseline regression model. Our sample includes all large public companies in the world with prominent ESG aspects and a known carbon footprint from 2002 to 2019. Our baseline results do not statistically support a significant association between a general ESG reporting proxy and carbon mitigation. Given the broad nature of ESG, companies may not be able to address the unique challenges of every component within their ESG reports. This finding is consistent with the view of Kaplan and Ramanna (2021) that the breadth of ESG reporting allows corporations to gloss over (implicit) moral tradeoffs when their activities improve one of the ESG metrics but negatively affect another. However, after controlling for ESG reporting, firms that adopt the GRI standards tend to have greater carbon mitigation. Our evidence indicates that, all else being equal, the adoption of the standards signals a firm's genuine commitment to transitioning to carbon neutrality. The findings imply that the GRI standards represent a framework for ESG reporting without direct governmental interference. In this sense, GRI may act as a soft institution or form of self-regulation that encourages firms to take actual actions that mitigate carbon emissions. In addition, we conduct channel tests, which show that firms that follow the GRI standards tend to design and implement more proactive carbon strategies and policies, make environmental investments, and engage with stakeholders. The results support signaling theory, namely, that firms adopt GRI standards to signal genuine commitment to carbon mitigation. Cross-sectional analyses suggest that strong carbon institutions (stringent carbon regulations, strong carbon consciousness, and a strong legal system) are conducive to firms' carbon mitigation. The adoption of GRI standards acts as a substitute for these carbon institutions.

Our study contributes to the current literature in the following three ways. First, it adds to the growing literature on the real effects of ESG reporting on carbon mitigation by highlighting the role of GRI standards. Previous studies only consider the real effects of general ESG reporting and focus on other dimensions of ESG performance, such as pollution, employee health, or corporate donations (Barth

et al., 2017; Chen et al., 2018; Christensen et al., 2017; Downar et al., 2021; Sun, 2016). Our study is the first to examine the real effects of ESG reporting standards on carbon mitigation. Second, we examine the channels through which GRI standards impact carbon mitigation. Our empirical evidence provides strong support for signaling theory: that adopting ESG standards signals a firm's proactive strategies and policies, with a genuine commitment to carbon reduction and stakeholder engagement. Third, our findings contribute to international research by providing important insights into how country-level institutions interact with the adoption of GRI standards to affect firms' carbon mitigation. Climate change is a global issue that requires collective action worldwide. Understanding how different countries' institutional environments play a substitutive or complementary role with GRI standards in driving carbon mitigation is essential when policymakers consider whether it is necessary to mandate ESG standards for the preparation of ESG reporting.

The remainder of this paper is structured as follows. Section 2 provides a literature review. Section 3 is devoted to the development of our hypotheses. Section 4 presents our research design, and Sections 5 and 6 describe the empirical results. Section 7 provides concluding remarks.

2 | LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 | Real effects of ESG reporting on carbon mitigation

We theoretically explore whether a firm's ESG reporting has real effects on its carbon mitigation based on two competing perspectives. The first perspective predicts that ESG reporting is positively associated with carbon mitigation. ESG reporting increases awareness of firms' carbon reduction activities among stakeholders (Luo et al., 2012). Investors and other stakeholders can obtain easier access to information on climate risks, which facilitates their interpretation, assessment, and integration of climate risks and liabilities (Bolton & Kacperczyk, 2021; Jiang et al., 2021). Meanwhile, these stakeholders can use the disclosed information to learn about or benchmark the firm against its peers in terms of its carbon risks and opportunities, commitment to reducing emissions, and resultant carbon performance (Clarkson et al., 2013; Li et al., 2017; Plumlee et al., 2015; Schiemann & Sakhel, 2019). For example, firms well known for low-carbon products can build loyalty and trust among green consumers and develop a green image and reputation, translating into higher future revenues and lower costs (e.g., Cao & Rees, 2020). The literature consistently documents empirical evidence of shareholders and debtholders, as two common providers of capital, rewarding companies with better carbon performance and fewer carbon emissions (Albarrak et al., 2019; Cheng et al., 2014; Choi et al., 2021; Choi & Luo, 2021; Clarkson et al., 2015; Griffin et al., 2017; Jung et al., 2018; Matsumura et al., 2014; Shen et al., 2022). If ESG reporting can help firms more accurately and effectively communicate their carbon performance to stakeholders, it can increase stakeholder awareness and strengthen the link between carbon performance and financial performance (Alsaifi et al., 2020; Choi et al., 2021; Clarkson et al., 2015; Dhanda et al., 2022; Jiang et al., 2021; Tang & Demeritt, 2018).

In a similar vein, revealing a firm's poor carbon performance or high carbon emissions can create negative publicity and damage its reputation. It can create a strong adverse reaction among stakeholders, including public shaming, boycotts, or the imposition of sustainability restrictions along the supply chain (e.g., Dai et al., 2021; Dyck et al., 2008; Villena & Dhanorkar, 2020). For instance, if investors discover that the carbon activities disclosed by companies are not in their best interest or in line with their expectations, they may punish firms by selling shares or, more directly, by voting in a certain way or engaging in activism. They may also require higher returns to finance a firm's operations that engage in irresponsible activities (Cheng et al., 2014). This means that ESG reporting increases the financial implications of climate issues; firms that anticipate adverse impacts tend to adjust their resource allocations to improve carbon performance. In addition, ESG reporting may facilitate external stakeholders' effective monitoring of self-serving management, thereby improving managerial decision-making and leading to more efficient corporate carbon investment (Dhanda et al., 2022; Roychowdhury et al., 2019). Furthermore, better ESG reporting may strengthen interfirm learning. The disclosed information can form stakeholders' expectations of the firm's future carbon performance. These high expectations may motivate managers to imitate and learn from their competitors to achieve better performance (Aerts et al., 2006). Transparent ESG reporting can also foster learning and accelerate the adoption of best practices from peer benchmarking and comparison.

In sum, ESG reporting offers various benefits for strong performers while exerting meaningful pressure on and ensuring monitoring of non-disclosers and poor performers. In turn, firms are likely to actively reduce their carbon emissions. For example, Johnson (2020) finds that disclosing undesirable actions can motivate peers to avoid similar behavior. Christensen (2016) documents that corporate accountability reporting helps firms prevent high-profile misconduct.

In contrast, the second perspective suggests that it may have no real effect or have a negative association with carbon mitigation. This stream of literature points out that ESG reporting in its current form is more of a buzzword than a response to the increased demand for information on corporate ESG performance (Wedari et al., 2021). Currently, there is no widely held consensus on the purpose of companies in the community or society. Managers may opt to engage in symbolic ESG reporting or selectively reveal or highlight only those ESG metrics that are favorable to them to legitimize corporate actions (Diouf & Boiral, 2017). For example, they may use generic, uninformative, and vague disclosures (primarily qualitative) or may not provide details or specific metrics (Lang & Stice-Lawrence, 2015). These disclosures often distract stakeholders from unfavorable performance, include unsubstantiated claims, or generate positive images, which obfuscates or crowds out more relevant information (Christensen et al., 2021; Khan et al., 2022). The benefits of benchmarking hinge on the relevance, reliability, materiality, and comparability of ESG reporting, so

this kind of ESG reporting decreases transparency and prevents stakeholders from using it for effective benchmarking (Adu et al., 2022). Therefore, it may not be possible for ESG reporting to have real effects on carbon mitigation.

Moreover, ESG is not a single concept, and each of its three domains (i.e., the environment, society, and governance) has unique challenges. This is a nuance that is often ignored in the literature. Companies experience difficulties reconciling the various dimensions of ESG. Significant judgments are required for what to measure, how to measure it, or how to aggregate ESG data. Some scholars advocate estimating monetary values for each component so they can be dollarized in an ESG report. However, valuations of the multiple and diverse components of ESG—such as the carbon footprint, employee health, and governance quality—are difficult to calculate. It is extremely challenging to find a meaningful formula to aggregate valuations of the diverse components of ESG, which would entail a universally accepted ethics code to navigate intra-ESG moral tradeoffs between alternative considerations. For example, it is possible to use a universally agreed-upon carbon tax to calculate the social cost of carbon so that each ton of greenhouse gas (GHG) emissions can be expressed as a cash equivalent, but this cannot be done for all components of ESG (Kaplan & Ramanna, 2021). In addition, the measurement system, metrics, and indicators of ESG performance are likely incomplete and noisy. Companies may selectively invest in measuring and reporting some important ESG indicators and ignore those they believe are immaterial or unimportant. Thus, we may not necessarily observe a significant association between ESG reporting and carbon mitigation because of either the unreliability of ESG information or firms' disregard of climate issues.

Because there are competing arguments predicting the association between ESG reporting and carbon mitigation, our first hypothesis is formalized in the null form:

> **H1.** There is no association between ESG reporting and carbon mitigation.

2.2 | Adoption of GRI standards and carbon mitigation

We next consider the association between the adoption of GRI standards and carbon mitigation. The GRI standards are widely used by multinational organizations, governments, small and medium enterprises, non-governmental organizations (NGOs), and industry groups in more than 90 countries. These globally applicable guidelines enable organizations to voluntarily disclose the environmental, social, and economic dimensions of their activities to a level equivalent to that of generally accepted accounting principles for financial reporting in terms of rigor, comparability, auditability, and general acceptance (Willis, 2003). We argue that the adoption of GRI standards is positively associated with carbon mitigation.

First, the decision to adopt the standards shows that the reporting entity is more committed to information transparency around environmental and climate change management than an entity that does not adopt them. Using the standards may also reflect managers' awareness of climate risks and strengthen stakeholder pressure, which signals an incentive for managers to improve carbon mitigation. Second, the standards promote standardization and comparability of ESG information, which has strong governance and peer benchmarking effects. Information asymmetry may arise in the absence of ESG standards. The inability of investors to identify good carbon performers also reduces any incentive for companies to invest in carbon mitigation. Conversely, firms adopting GRI standards can mitigate information asymmetry by providing more comparable information, allowing investors to identify differences in carbon risk and performance across companies. Meanwhile, by revealing differences between companies, ESG reporting may also increase the degree of product differentiation in the market. Demand for better carbon performers may increase, and demand for poor carbon performers may decrease. As a result, firm value may rise for good carbon performers and fall for poor carbon performers (Matsumura et al., 2014). In addition, voluntary disclosure may reduce search and learning costs for investors regardless of an individual company's carbon performance and may encourage investors to invest in companies they otherwise would not have considered.

Finally, adopting well-known ESG standards may generate better communication, feedback, and learning effects than not following the standards (Massa et al., 2015). We argue that GRI reporting standards improve internal decision-making through enhanced stakeholder dialog (Barth et al., 2017). High-quality ESG reporting allows stakeholders to interact with the company more meaningfully based on relevant information. Ultimately, these interactions should result in measurable contributions to carbon mitigation in the areas the company reports on (Barkemeyer et al., 2015). Hess (2007) points out that organizational transparency through ESG reporting is the key to meaningful stakeholder engagement, allowing stakeholders to provide feedback and enabling managers to document learning and changes that result from their actions (Sharma & Henriques, 2005).

Finally, the GRI standards can significantly limit or reduce the use of boilerplate language by prescribing, in detail, what information firms have to provide and how they must provide it, depending on the specificity of the standards. The standards can make it easier to benchmark firms' performance and allow investors to hold managers accountable. They improve monitoring by stakeholders, and the resulting pressure can motivate firms to avoid adverse external effects. Thus, we establish the second hypothesis as follows:

> **H2.** There is a positive association between the adoption of GRI standards and carbon mitigation.

3 | RESEARCH DESIGN

3.1 | Empirical model

To test H1 and H2, we estimate Equation (1) using ordinary least squares regression with robust standard errors clustered by firm (Petersen, 2009). The equation is as follows:

$$CM_{i,t+1} = \beta_0 + \beta_1 ESG\_DIS_{it} + \beta_2 GRI_{it} + \beta_3 SIZE_{it} + \beta_4 ROA_{it} + \beta_5 LEV_{it} + \beta_6 TOBINQ_{it} + \beta_7 NEW_{it} + \beta_8 CAPSPEND_{it} + \beta_9 GROWTH_{it} + \beta_{10} BETA_{it} + \beta_{11} IO_{it} + \beta_{12} FOREIGN_{it} + \beta_{13} WGI_{it} + \beta_{14} GDPPC_{it} + \theta_t + \nu_i + \varepsilon_{it}, \quad (1)$$

where our dependent variable $CM_{i,t+1}$ represents a firm's carbon mitigation, which captures improvements in the intensity of carbon emissions. It is measured as the absolute reduction in the natural logarithm of total carbon emissions divided by total sales (Luo, 2019; Luo & Tang, 2014).[3] Please note that carbon mitigation is measured at year $t + 1$, whereas all independent variables are measured at year t. The research design aims to alleviate endogeneity concerns caused by simultaneity or a reverse causal concern. Firms with greater carbon mitigation might be more willing to opt into higher-quality ESG reporting and comply with GRI standards.

The independent variables of interest are ESG reporting (*ESG_DIS*) and the adoption of GRI standards. *ESG_DIS* represents general ESG reporting, which is measured based on ESG scores obtained from the Refinitiv ESG database (García-Sánchez et al., 2019). Refinitiv's ESG score is an overall company score based on the self-reported information on the ESG pillars. We argue that although the scores may capture a firm's ESG performance, they also reflect the amount of ESG information available for the potential rating process. *GRI* is a dummy variable that equals 1 if the company's ESG report is published in accordance with the GRI standards and 0 otherwise.[4] According to H1, the coefficient of β_1 can be positive or negative. According to H2, we expect the coefficient of β_2 to be positive, indicating that firms that adopt GRI standards tend to have greater carbon mitigation.

Also, following prior studies, we include a series of control variables to address potential confounding effects (e.g., Clarkson et al., 2008; Haque, 2017; Luo & Tang, 2021). Larger firms and more profitable firms have more resources and funds to invest in carbon mitigation (Bewley & Li, 2000; de Villiers et al., 2011). Thus, firm size (*SIZE*) is employed, measured as the natural logarithm of total assets. To measure profitability, we use return on assets (ROA), calculated as net income before extraordinary items/preferred dividends divided by total assets. Highly leveraged firms are financially constrained from pursuing carbon mitigation (Barnea & Rubin, 2010). *LEV* is the ratio of total debt to total assets. Tobin's Q (*TOBINQ*) represents growth opportunity and is calculated as the company's total market value based on the year-end price and number of shares outstanding, plus preferred shares, the book value of long-term debt, and current liabilities, divided by the book value of total assets. *GROWTH* is 3-year annual sales growth in net sales. Firms that spend more on clean technology are likely to have better performance. *NEW* and *CAPSPEND* are proxies for investment in clean technologies. They are calculated as capital spending divided by total sales and as the ratio of net property, plants, and equipment (PPE) scaled by gross PPE, respectively. Lower systematic risk increases the ability to pursue carbon mitigation endeavors because of more stable economic performance (Cormier & Magnan, 2004; de Villiers et al., 2011; Roberts, 1992). Beta (*BETA*) is based on between 23 and 35 consecutive month-end price percent changes and their relativity to a local market index. Previous environmental studies find that a firm's ownership structure can affect its environmental performance or $CM_{i,t+1}$ (Haque, 2017; Jo & Harjoto, 2012). We thus include two ownership variables in our base model: *IO* and *FOREIGN*. *IO* represents institutional ownership, which is measured as the percentage of total strategic shares held by investment banks or institutions. *FOREIGN* is the percentage of strategic shareholdings held in a country outside that of the issuer. In general, only holdings of 5% or more are counted as strategic.

Country-level economic and institutional factors may also influence carbon mitigation. We expect that firms in better-governed countries are more likely to have greater carbon mitigation. *WGI* captures the overall quality of governance in the country. Following Choi and Luo (2021), we measure a country's regulatory governance based on the mean value of six Worldwide Governance Indicators as reported by Kaufmann et al. (2010), namely, the voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption indexes. In addition, we measure the country's economic development using the gross domestic product (GDP) per capita (*GDPPC*), which is the natural logarithm of per capita GDP (in constant 2010 US dollars). Finally, we control for year- and firm-fixed effects. We winsorize all continuous variables at the 1st and 99th percentiles of their distributions.

3.2 | Sample and data

The initial sample includes all listed companies covered by the Refinitiv ESG database between 2002 and 2019. We follow prior research and exclude two types of firm-year observation: (1) those in the financial sector because the sector operates differently and is subject to different accounting requirements; and (2) those with missing data. Because our dependent variable, carbon mitigation, is calculated 1 year ahead of the control variables, we lose all firm years in 2019. Thus, our final sample includes 19,547 firm-year observations that satisfy the above selection criteria and represent 10 Global Industry Classification Standard (GICS) sectors across 53 countries.

Data on GHG emissions and other ESG variables are retrieved from the Refinitiv ESG database, a leading global source of information on ESG (Haque, 2017). We download the financial data from the DataStream and WorldScope databases. Data on country-level governance and per capita GDP are obtained from the World Bank.

4 | EMPIRICAL RESULTS

4.1 | Distribution of sample observations

Panel A of Table 1 provides the distribution of firm-year observations by GICS sector. The top three sectors in our sample are industrials, consumer discretionary, and materials, accounting for 23.68%, 17.87%, and 13.82% of the observations, respectively. They represent

TABLE 1 Descriptive statistics by GICS sector, year, and country

Panel A: Descriptive statistics by GICS sector

GICS sector	*N*	Percent	*GRI*	CM_{t+1}
Basic materials	2702	13.82%	0.669	0
Consumer discretionary	3494	17.87%	0.477	0.016
Consumer staples	1665	8.52%	0.631	0.021
Energy	1625	8.31%	0.599	−0.008
Health care	1205	6.16%	0.52	0.036
Industrials	4629	23.68%	0.522	0.013
Real estate	295	1.51%	0.444	0.002
Technology	1452	7.43%	0.602	0.019
Telecommunications	878	4.49%	0.65	−0.020
Utilities	1602	8.20%	0.611	0.019

Panel B: Descriptive statistics by year

Year	*N*	Percent	*GRI*	CM_{t+1}
2002	96	0.49%	0.115	0.069
2003	133	0.68%	0.188	0.08
2004	244	1.25%	0.205	−0.042
2005	445	2.28%	0.229	0.086
2006	550	2.81%	0.24	0.077
2007	726	3.71%	0.428	−0.037
2008	891	4.56%	0.534	0.033
2009	1136	5.81%	0.54	0.005
2010	1329	6.80%	0.576	0.051
2011	1430	7.32%	0.615	0.018
2012	1481	7.58%	0.647	−0.049
2013	1553	7.94%	0.628	−0.031
2014	1627	8.32%	0.629	−0.097
2015	1803	9.22%	0.601	−0.01
2016	1918	9.81%	0.595	0.096
2017	2130	10.90%	0.603	0.027
2018	2055	10.51%	0.614	0.043

Panel C: Descriptive statistics by country/region

ISO2	Country	*N*	Percent	*GRI*	CM_{t+1}
AE	United Arab Emirates	6	0.03%	0.5	0.063
AR	Argentina	12	0.06%	0.75	0.061
AT	Austria	91	0.47%	0.637	0.011
AU	Australia	799	4.09%	0.471	0.027
BE	Belgium	146	0.75%	0.76	−0.004
BR	Brazil	333	1.70%	0.856	−0.071
CA	Canada	913	4.67%	0.581	0.011
CH	Switzerland	392	2.01%	0.653	0.003
CL	Chile	80	0.41%	0.75	−0.015
CN	China	162	0.83%	0.537	0.002
CO	Colombia	58	0.30%	0.931	−0.077
CZ	Czech Republic	9	0.05%	0.222	0.052

TABLE 1 (Continued)

Panel C: Descriptive statistics by country/region

ISO2	Country	*N*	Percent	*GRI*	CM_{t+1}
DE	Germany	673	3.44%	0.666	0.019
DK	Denmark	193	0.99%	0.534	0.024
EG	Egypt	3	0.02%	0	−0.311
ES	Spain	334	1.71%	0.877	0.011
FI	Finland	279	1.43%	0.738	−0.007
FR	France	875	4.48%	0.616	0.002
GB	United Kingdom	2612	13.36%	0.264	0.016
GR	Greece	65	0.33%	0.877	−0.01
HK	Hong Kong	518	2.65%	0.502	−0.026
HU	Hungary	21	0.11%	1	0.035
ID	Indonesia	60	0.31%	0.867	−0.019
IE	Ireland	43	0.22%	0.395	0.048
IL	Israel	34	0.17%	0.559	0.007
IN	India	299	1.53%	0.796	0.016
IT	Italy	270	1.38%	0.826	−0.005
JP	Japan	3064	15.68%	0.536	−0.004
KE	Kenya	4	0.02%	1	0.091
KR	Korea	477	2.44%	0.822	0.013
KW	Kuwait	6	0.03%	0	−0.102
KY	Cayman Islands	2	0.01%	0	0.086
LK	Sri Lanka	6	0.03%	1	−0.154
LU	Luxembourg	25	0.13%	0.16	0.04
MA	Morocco	5	0.03%	0.6	−0.13
MX	Mexico	139	0.71%	0.799	0.022
MY	Malaysia	161	0.82%	0.658	0.003
NL	The Netherlands	298	1.52%	0.842	0.017
NO	Norway	211	1.08%	0.545	−0.005
NZ	New Zealand	112	0.57%	0.33	0.038
PE	Peru	8	0.04%	0.75	−0.033
PH	The Philippines	66	0.34%	0.894	−0.07
PL	Poland	70	0.36%	0.786	0.005
PT	Portugal	77	0.39%	0.753	0.019
QA	Qatar	2	0.01%	0	−0.24
RU	Russian Federation	110	0.56%	0.655	−0.044
SA	Saudi Arabia	13	0.07%	0.615	0
SE	Sweden	446	2.28%	0.765	0.035
SG	Singapore	127	0.65%	0.728	−0.059
TH	Thailand	144	0.74%	0.875	0
TR	Turkey	80	0.41%	0.738	0.012
US	United States	4067	20.81%	0.518	0.04
ZA	South Africa	547	2.80%	0.812	−0.008

Notes: ISO2 = ISO 3166-1 alpha-2 codes or two-letter country codes; *N* = the number of observations; GICS = Global Industry Classification Standard; GRI, global reporting initiative.

approximately half of our sample. Real estate, telecommunications, and health care are the least represented sectors, accounting for 1.51%, 4.49%, and 6.16% of the observations. Firms in the materials sector are the most likely to adopt the GRI standards, whereas those in the real estate and health-care sectors are the least likely. Panel B of Table 1 shows the sample distribution by year. It shows a noticeable increase in sample size from 96 in 2002 to 2055 in 2018. The percentage of companies that adopt the GRI standards when preparing their ESG reports is relatively stable at around 20% between 2002 and 2006, but this increases to approximately 42.8% in 2007 and then climbs to more than 50% after 2008. The percentage remains stable at more than 60% for each period from 2011 to 2018. We observe significant variation in carbon mitigation across years. Panel C of Table 1 reports the distribution of observations by country/region. The United States has the highest number of observations, accounting for 20.81% of our final sample. The second most represented group is Japan (15.68%), followed by the United Kingdom (13.36%). It is noteworthy that the number of firm-year observations is widely distributed across countries/regions, with some countries having fewer than 10 observations. We address this even distribution of observations in Section 4.4 on sensitivity tests.

4.2 | Descriptive statistics

Table 2 presents descriptive statistics for the dependent and independent variables. The mean *GRI* is 0.568, which suggests that 56.8% of our sample companies publish their ESG reports following the GRI standards. The mean *CM* is 0.011, which indicates that on average our sample companies mitigate the overall intensity of their carbon emissions. The average natural logarithm of total assets is 15.884, implying that our sample consists of relatively large firms. The mean *ROA* is approximately 5%, suggesting that our sample firms are moderately profitable. In addition, the mean *LEV* is 25.9%. On average, our sample firms possess important growth opportunities, as implied by the average *TOBINQ* of 1.594, which is close to the values reported by Luo and Tang (2021) for the United Kingdom. The average ratio of net PPE to gross PPE is 50.9%. On average, capital spending is 9.7% of total revenue. The sample companies' average 3-year sales growth opportunity (*GROWTH*) is 6.051%. The average beta is 1.041. Among these firms, 6.51% of strategic shareholdings are held in a foreign country, and investment banks or institutions own 4.87% of total shares.

TABLE 2 Descriptive statistics ($N = 19{,}547$)

Variable	Mean	SD	Median	P25	P75
CM_{t+1}	0.011	0.291	0.027	−0.089	0.134
GRI	0.568	0.495	1	0	1
ESG_DIS	55.401	17.039	56.06	43.46	68.07
SIZE1	15.884	1.38	15.842	14.95	16.818
ROA	0.05	0.066	0.046	0.021	0.08
LEV	0.259	0.16	0.25	0.145	0.358
TOBINQ	1.594	1.001	1.264	0.968	1.843
NEW	0.509	0.165	0.49	0.383	0.627
CAPSPEND	0.097	0.128	0.051	0.028	0.11
GROWTH	6.052	12.204	4.6	−0.42	10.73
BETA	1.042	0.498	0.99	0.682	1.34
IO	4.872	7.091	0	0	8
FOREIGN	6.51	14.364	0	0	6
WGI	1.187	0.528	1.283	1.203	1.473
GDPPC	10.506	0.674	10.722	10.59	10.823

Notes: N = the number of observations; SD = standard deviation; P25 = 25th percentile; P75 = 75th percentile. Continuous variables are winsorized at the top and bottom 1%.

4.3 | Multivariate analyses

Table 3 presents our baseline results regarding the impact of ESG reporting and the adoption of GRI standards on carbon mitigation. In Columns (1) and (2), we only include *ESG_DIS* or *GRI* together with control variables. In Column (3), we show both *ESG_DIS* and *GRI* and all control variables. We conduct our analysis mainly based on the results presented in Column (3).

We find that *ESG_DIS* does not have a significant coefficient, so we cannot reject our null hypothesis, H1. However, after controlling for *ESG_DIS*, the coefficient of *GRI* is 0.015 and significant at the $p < .05$ level, which, holding ESG reporting scores and other control variables constant, suggests that firms that adopt GRI standards (*GRI*) tend to have greater carbon mitigation (*CM*). The results provide strong empirical support for H2 and imply that firms that comply with GRI standards tend to have larger reductions in carbon emissions intensity. Our results stand in contrast to those of Haque and Ntim (2018), which show that UK firms tend to symbolically conform to frameworks of environmental and sustainable development (GRI) without substantively improving actual carbon emissions. However, our results are consistent with other studies (Qian & Schaltegger, 2017). For instance, Tomar (2021) finds that U.S. facilities reduce emissions by 7.9% following the mandatory disclosure of GHG emissions, mainly because of peer benchmarking. Wang et al. (2004) find that public dissemination of firms' environmental performance rating through the GreenWatch program has a significant influence on firms' pollution activities. They argue that this public disclosure program contributes to more effective governance in China.

Among our control variables, we find a significant negative relationship between *SIZE* and *CM*. Large firms are likely to face increased stakeholder pressure to remain proactive in regard to climate change and to manage carbon-reduction initiatives more effectively. In addition, we find that *LEV* is significantly negatively associated with carbon mitigation, which shows that highly leveraged firms tend to be constrained by debtholders to engage in more aggressive carbon mitigation. This is consistent with Hong et al. (2000), which finds that less financially constrained firms care more about stakeholders. In

TABLE 3 Results of the baseline regression

Variable	(1) CM_{t+1}	(2) CM_{t+1}	(3) CM_{t+1}
GRI		0.015**(2.098)	0.017**(2.205)
ESG_DIS	−0.000(−0.459)		−0.000(−1.035)
SIZE	−0.063***(−5.701)	−0.304***(−4.532)	−0.064***(−6.399)
ROA	−0.302***(−4.494)	−0.076**(−2.116)	−0.303***(−5.459)
LEV	−0.075**(−2.067)	0.032***(5.984)	−0.076**(−2.172)
TOBINQ	0.032***(5.978)	0.068(1.389)	0.032***(5.881)
NEW	0.067(1.379)	0.142***(2.849)	0.067*(1.667)
CAPSPEND	0.142***(2.865)	−0.001***(−4.221)	0.141***(3.637)
GROWTH	−0.001***(−4.265)	−0.014*(−1.783)	−0.001***(−5.141)
BETA	−0.014*(−1.818)	−0.000(−0.791)	−0.014*(−1.686)
IO	−0.000(−0.804)	−0.000(−0.008)	−0.000(−0.730)
FOREIGN	−0.000(−0.005)	−0.109***(−2.653)	−0.000(−0.025)
WGI	−0.111***(−2.688)	−0.173*(−1.846)	−0.112***(−2.660)
GDPPC	−0.164*(−1.752)	2.945***(3.050)	−0.168*(−1.806)
Constant	2.838***(2.937)	−0.065***(−5.846)	2.892***(3.051)
Observations	19,547	19,547	19,547
Number of unique firms	2985	2985	2985
Firm fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Adjusted R^2	0.0457	0.0459	0.0459
F	30.05	30.19	29.24
Prob > *F*	0	0	0

Note: This table presents the results of panel fixed-effects regressions of the impact of *GRI* on carbon mitigation. Robust *t* statistics clustering at the firm level are in parentheses. Continuous variables are winsorized at the top and bottom 1%.
*p < .10. **p < .05. ***p < .01.

addition, *TOBINQ* is positively associated with *CM*, which shows that firms with superior economic performance are in a better financial position to achieve carbon mitigation (Hassan & Romilly, 2018). Consistent with our expectation, firms with substantial capital expenditures (*CAPSPEND*) are more likely to show greater mitigation of carbon emissions. The negative association between *GROWTH* and *CM* indicates that firms with high sales growth are in a fast-growth stage and thus tend to prioritize economic development and devote fewer resources to carbon mitigation. Furthermore, the coefficient of *BETA* on *CM* is negative but non-significant. Finally, we find a negative association between *GDPPC* and carbon mitigation. This result is surprising, as more private investment results in less need for state involvement to encourage employment and other factors related to economic development or to provide necessary services to local citizens.

4.4 | Sensitivity tests

We conduct a battery of sensitivity tests to check the robustness of the main results. First, we adopt two sets of alternative measures for general ESG reporting. We replace our ESG scores with environmental pillar scores (*ENV_DIS*) and social pillar scores (*SO_DIS*) obtained from the Refinitiv ESG database and rerun the regression model. The results (untabulated) still show no significant associations for these alternative measures, consistent with the results for the overall ESG reporting variable (*ESG*) in Column (1) of Table 5.

Second, we use a few alternative measures of carbon mitigation to provide further support for our inferences. Instead of using the absolute reduction in carbon emissions intensity, we use the percentage reduction in the intensity of carbon emissions (*LNCP*) at year $t+1$ ($CM1_{t+1}$). We further use the absolute and percentage reduction in absolute carbon emissions (*LNEMIS*) at year $t+1$, where *LNEMIS* is calculated as the natural logarithm of total carbon emissions (labeled $CM2_{t+1}$ and $CM3_{+1}$, respectively). We find that the coefficients of *GRI* remain positive and significant, at least at the conventional level (the data are not reported). This suggests that our hypotheses are still supported when we use alternative measures of our independent variable.

Third, as shown in Panel C of Table 2, US firms make up a large proportion of our international sample. We thus conduct regression analyses excluding US firms to address the concern that our results

may be driven by the disproportionately large number of US firms. Our data (not reported) are qualitatively the same as our main results reported in Table 5. To further address the uneven distribution of our sample, we also repeat the tests using a sample excluding countries with fewer than 10 observations. Our inferences remain unchanged.

Fourth, the fact that firms may non-randomly choose to adopt the GRI standards creates a self-selection problem, which can lead to biased coefficients. In particular, pre-existing traits that may make a firm more or less likely to adopt GRI standards may also influence its carbon mitigation. Thus, any relation between the adoption of GRI standards and carbon mitigation could be due to fundamental differences between the types of firms that choose to follow GRI standards rather than due to the adoption of GRI standards itself. To address the concern, we conduct the analysis adopting a propensity score–matched sample. We first estimate a logit model in which we regress *GRI* on a set of the same control variables in our main regression as regressors. Then we estimate the propensity score using the one-to-one matching method without replacement and a caliper value of 0.05 to match control firms with treatment firms within the same sector for a particular year. This procedure results in a propensity score–matched sample of 8984 firm-year observations. Based on this sample, we re-estimate the regression as specified in Equation (1). The results (untabulated) show that *GRI* loads significantly with the expected signs further support our main hypotheses.

5 | FURTHER ANALYSES

5.1 | The impact of adopting the GRI standards on corporate carbon initiatives

In this section, we present the results of three empirical analyses to shed light on the channels through which adopting GRI standards promotes carbon mitigation. First, we examine whether firms that adopt the standards are more aware of stakeholder pressures and thus adopt more proactive strategies, policies, and sustainability initiatives (including reduction policies, actions, and governance structures). Firms can achieve strategic environmental targets once a GHG inventory has been taken, thus empowering decision-makers to implement corporate governance. Caritte et al. (2015) argue that to achieve far-reaching sustainability goals, a committee with in-depth knowledge of sustainability must first envision and develop low-carbon roadmaps that address all areas of the business's carbon footprint. The committee can regularly review the impacts of its sustainability strategies by assessing the progress made on GHG emissions in each area of the company. We examine whether firms that adopt GRI standards are more likely to set emissions-reduction policies and targets, establish a board-level sustainability committee, or implement environmental initiatives, all of which facilitate carbon mitigation activity. *D_POL* is a dummy variable that equals 1 if the company has a policy to improve emissions reduction and 0 otherwise. *D_TAR* is a dummy variable that equals 1 if the company has set targets or objectives for emissions reduction and 0 otherwise. *D_COM* is a dummy variable that equals 1 if the company has a board-level or senior management committee responsible for decision-making in regard to corporate social responsibility (CSR) strategy and 0 otherwise. *D_ERI* is a dummy variable that equals 1 if the company has implemented any initiatives to restore the environment, such as restoration, rehabilitation, clean-up, or remediation activities and 0 otherwise.

Second, we investigate whether these firms make a more significant investment in the environment. *D_EI* is a dummy variable that equals 1 if the company has made proactive environmental investments or expenditures to reduce future risks or increase future opportunities and 0 otherwise. *LnEXP* is the natural logarithm of the total amount of environmental expenditures, including all investments and expenditures to protect the environment or prevent, reduce, or control environmental impacts or hazards. It also includes expenditures for disposal, treatment, sanitation, and clean-up.

Third, we explore whether firms committed to adhering to GRI standards have more active stakeholder engagement. Prior studies support the notion that stakeholder pressure enhances environmental performance (Buysse & Verbeke, 2003; Henriques & Sadorsky, 1999;

TABLE 4 Channel tests: The impact of the adoption of GRI standards on ESG initiatives

Variable	(1) xtlogit *D_POL*	(2) xtlogit *D_TAR*	(3) xtlogit *D_COM*	(4) xtlogit *D_ERI*	(5) xtlogit *D_EI*	(6) xtreg *lnEXP*	(7) xtlogit *D_PROD*	(8) xtlogit *D_STAKE*
GRI	0.767***	0.619***	1.138***	0.599***	0.324***	0.524**	0.400***	1.365***
	(4.440)	(6.286)	(7.730)	(5.822)	(2.959)	(2.481)	(2.697)	(11.319)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5239	7625	6658	6625	6059	16,279	8011	7228
Number of unique firms	592	866	696	677	606	2524	791	788
Firm fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table presents the results of panel fixed-effects regressions of the impact of *GRI* on carbon reduction initiatives. Robust *t* statistics are in parentheses. Continuous variables are winsorized at the top and bottom 1%. GRI, global reporting initiative; ESG, environmental, social, and governance.
*$p < .10$. **$p < .05$. ***$p < .01$.

TABLE 5 The effects of the adoption of GRI standards on carbon mitigation

Panel A: Role of stringent carbon regulations						
Variable	(1) CM_{t+1} *ETS* = 1	(2) CM_{t+1} *ETS* = 0	(3) CM_{t+1} *TAX* = 1	(4) CM_{t+1} *TAX* = 0	(5) CM_{t+1} *INTSEC* = 1	(6) CM_{t+1} *INTSEC* = 0
GRI	0.019	0.018*	0.011	0.025**	0.015	0.019*
	(1.400)	(1.767)	(0.869)	(2.359)	(1.380)	(1.656)
ESG_DIS	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000
	(−0.893)	(−0.745)	(−0.708)	(−1.121)	(−0.657)	(−0.749)
Controls	YES	YES	YES	YES	YES	YES
Observations	7904	11,643	8244	11,303	10,558	8989
Number of unique firms	1284	1983	1211	2116	1549	1436
Firm fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
Adjusted R^2	0.0936	0.0441	0.0745	0.0429	0.0618	0.0396
F	25.23	14.80	20.90	13.68	19.71	10.35
Prob > *F*	0	0	0	0	0	0

Panel B: Role of carbon consciousness				
Variable	(1) CM_{t+1} *HEPI* = 1	(2) CM_{t+1} *HEPI* = 0	(3) CM_{t+1} *HCCPI* = 1	(4) CM_{t+1} *HCCPI* = 0
GRI	0.009	0.028**	0.019	0.019*
	(0.707)	(2.327)	(1.316)	(1.704)
ESG_DIS	−0.001	0.000	−0.001	−0.000
	(−1.455)	(0.293)	(−1.178)	(−0.025)
Controls	YES	YES	YES	YES
Observations	9634	9393	9086	8738
Number of unique firms	2328	1835	2113	2031
Firm fixed effects	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Adjusted R^2	0.0819	0.0429	0.0658	0.0557
F	21.63	11.24	20.39	15.15
Prob > *F*	0	0	0	0

Panel C: Role of legal system				
Variable	(1) CM_{t+1} English	(2) CM_{t+1} French	(3) CM_{t+1} German	(4) CM_{t+1} Socialist or Scandinavian
GRI	0.015	0.057**	0.005	0.024
	(1.504)	(2.349)	(0.419)	(0.704)
ESG_DIS	−0.000	−0.001	−0.000	0.001
	(−1.094)	(−0.641)	(−0.926)	(0.429)
Controls				
Observations	10,394	2940	4697	1501
Number of unique firms	1660	495	554	271
Firm fixed effects	YES	YES	YES	YES

TABLE 5 (Continued)

Panel C: Role of legal system				
Variable	(1) CM_{t+1} English	(2) CM_{t+1} French	(3) CM_{t+1} German	(4) CM_{t+1} Socialist or Scandinavian
Year fixed effects	YES	YES	YES	YES
Adjusted R^2	0.0587	0.0764	0.0901	0.0845
F	18.39	8.614	14.40	5.395
Prob > F	0	0	0	0

Note: This table presents the regression results of the moderating role of institutional environments on the relationship between the adoption of GRI standards and carbon mitigation based on the panel fixed-effects model. Robust t statistics clustering at the firm level are in parentheses. Continuous variables are winsorized at the top and bottom 1%.
$^{*}p < .10$. $^{**}p < .05$. $^{***}p < .01$.

Kassinis & Vafeas, 2006). *D_PROD* is a dummy variable that equals 1 if the company has at least one product line or service that is designed to have positive effects on the environment or that is environmentally labeled and marketed and 0 otherwise. *D_STAKE* is a dummy variable that equals 1 if the company reports its engagement with stakeholders and 0 otherwise.

Table 4 reports the regression results. Because these variables are all dummy variables, we estimate a firm fixed-effects logit model with each as the dependent variable, keeping the independent variables the same as those used in the main regressions. We find that the coefficients of *GRI* are all positive and significant at $p < .01$. The results show that firms committed to adopting GRI standards are more likely to adopt more proactive carbon policies and initiatives, invest in the environment, and engage with stakeholders, which provides further empirical support for our main hypothesis. The findings also support signaling theory, namely, that firms adopt GRI standards to signal their proactive carbon strategy and policy, demonstrating a genuine commitment to carbon reduction investment and active stakeholder engagement.

5.2 | Moderating effects

5.2.1 | Moderating effects of stringent carbon regulations

We use three proxies for the stringency of a country's carbon regulations: the presence of a national carbon pricing program (i.e., an emission trading scheme [ETS] or a carbon tax) and operation in a carbon-intensive sector (Luo, 2019). *ETS* is a dummy variable that takes a value of 1 if the firm operates in a country with a nationwide ETS and 0 otherwise. *TAX* is a dummy variable that takes a value of 1 if the firm operates in a country with a national carbon tax and 0 otherwise. *INTSEC* is a dummy variable that takes a value of 1 if the firm operates in a carbon-intensive sector (i.e., energy, materials, or utilities) and 0 otherwise. We partition the sample into firms from countries with stringent carbon regulations and those from countries with lax carbon regulations and estimate regressions separately for the two subsamples (stringent vs. lax carbon regulation).

Columns (1), (3), and (5) of Table 5 Panel A present results for the subsample of firms from countries with stringent carbon regulations ($ETS = 1$, $TAX = 1$, and $INTSEC = 1$), whereas Columns (2), (4), and (6) report findings for the subsample of firms from countries with lax carbon regulations ($ETS = 0$, $TAX = 0$, and $INTSEC = 0$). We find significant positive coefficients of *GRI* only in Columns (2), (4), and (6), which suggests that the positive association between the adoption of GRI standards and carbon mitigation is found for firms in countries with lax carbon institutions (i.e., countries without a national ETS or a national carbon tax policy) and firms that do not operate in carbon-intensive sectors. In contrast, we do not find significant effects of GRI standards on carbon mitigation in countries with stringent carbon regulations. These findings suggest that ESG reporting standards are a substitute for carbon regulations and have a more important influence on carbon mitigation when a country's carbon regulations are less stringent. Stringent carbon regulations promote innovation and produce credible disciplinary mechanisms to ensure that companies are environmentally responsible and achieve carbon mitigation (e.g., Carrión-Flores & Innes, 2010; He et al., 2021; Long et al., 2022; Porter & van der Linde, 1995), so they may reduce the marginal effects of the adoption of GRI standards on carbon mitigation outcomes. This is why firms in countries with less stringent carbon regulations tend to experience greater carbon mitigation when adopting GRI standards to prepare ESG reports. The positive effects of adopting GRI standards on carbon mitigation can be diminished or even disappear if a country has implemented stringent carbon regulations.

5.2.2 | Moderating effects of carbon consciousness

We measure a country's carbon consciousness based on its environmental performance index (*HEPI*) and climate change performance index (*HCCPI*). Developed by the Yale Center for Environmental Law and Policy, the country-level EPI provides a quantitative basis for comparing and analyzing the environmental performance of countries

around the world (Luo et al., 2018). To calculate the index, we score and rank individual countries on their environmental performance using data from the 10 most recent years. The overall EPI comprises two measures: environmental health and ecosystem vitality. The final index is calculated as the mean of these two measures. The higher the EPI score, the closer a country is to achieving its environmental goals (i.e., the better its environmental performance). The CCPI was developed by Germanwatch and Climate Action Network Europe based on national carbon profiles and changes in GHG emissions and government climate change policy. A higher score on the index represents higher carbon consciousness in the country.

We partition the entire sample into two subsamples at the medians of the environmental performance measures, with firms falling below the median classified as the low carbon consciousness group and those falling above it classified as the high carbon consciousness group. We run separate sets of regressions for each subsample (high and low). Columns (1) and (3) of Table 5 Panel B present the results for the subsample of firms from countries with high carbon consciousness ($HEPI = 1$ and $HCCPI = 1$), whereas Columns (2) and (4) report findings for the subsample of firms from countries with low carbon consciousness ($HEPI = 0$ and $HCCPI = 0$). Columns (2) and (4) show that the GRI coefficients are significant with an expected positive sign. In contrast, Columns (1) and (3) show that the coefficients of *GRI* are statistically non-significant and smaller in magnitude than those in Columns (2) and (4). These results suggest that the adoption of GRI standards is significantly positively associated with carbon mitigation when a country's carbon consciousness is low, which is consistent with previous studies showing that carbon consciousness is important in shaping firms' financial and environmental decisions and behaviors (Farrow et al., 2017; Hong & Kacperczyk, 2009). Strong carbon consciousness tends to heighten climate risks and exert significant pressure on firms to demonstrate environmentally responsible behaviors, resulting in better carbon performance. Given strong carbon consciousness and high stakeholder expectations, ESG reporting may play a small or negligible role in addressing climate change and mitigating firms' GHG emissions. Our findings thus suggest a substitutive role between ESG reporting and carbon consciousness.

5.2.3 | Moderating effects of legal system

We argue that the extent of the association between the adoption of GRI standards and carbon mitigation depends on a country's legal system. We measure a country's legal system based on its legal origin collected from Djankov et al. (2003), which can be generally classified into four types: English common law (English), French civil law (French), German civil law (German), and Socialist or Scandinavian civil law. We run separate regressions for each subsample based on legal origin. Table 5 Panel C presents the results. The results in Columns (1)–(4) show that the coefficient of *GRI* is positive and significant in the French group. In contrast, the coefficients are not statistically significant in the English, German, or Socialist or Scandinavian groups. La Porta et al. (1998) show that Scandinavian, German civil law, and English common law countries are ahead of French civil law countries in law enforcement, suggesting a weaker legal system in French civil law countries. The results thus indicate that the positive effect of the adoption of GRI standards on carbon mitigation primarily occurs in countries with a weaker legal environment. ESG reporting may play a stronger governance role in weak legal environments than in strong ones because it serves as a governance substitute for the legal protection of outside shareholders. These results are consistent with Herda et al. (2014) and Choi and Wong (2007), which show that external auditors generally play a more critical governance function in countries where legal institutions are weak than in countries where legal institutions are strong.

6 | CONCLUSION

Corporate ESG reporting is complex because it involves a large group of interested stakeholders with diverse beliefs about the beneficial and detrimental impacts of corporations on society. Thus, it is well recognized that ESG reporting is characterized by a wide-ranging, multifaceted set of indicators and themes that are often long-term, non-monetary, and intangible in nature. Empirical evidence of the real effects of ESG reporting is scant in the literature (Christensen et al., 2021). Motivated by this knowledge gap, we investigate the impact of ESG reporting and the role of ESG standards on carbon mitigation. We narrow the scope of ESG in this paper to carbon performance because excessive emissions generate substantial externalities related to global warming. Thus, this is where the global community agrees on what constitutes good or harmful social outcomes. In addition, managerial motivation for GHG mitigation is likely driven by pressure and factors that are different from what triggers other ESG activities.

Our findings should inform policymakers, corporate directors, managers, and investors. First, our research responds to an urgent call for international organizations and policymakers to strengthen ESG reporting standards. The International Sustainability Standards Board (ISSB)/International Financial Reporting Standards (IFRS) Foundation has recently proposed a set of sustainability and climate-related disclosure standards.[5] We find a non-significant association between general ESG reporting and carbon mitigation. These results suggest that an increase in general ESG reporting would not signal an enhancement of an actual performance indicator such as carbon mitigation (Christensen et al., 2021). This is because ESG reporting inherently includes multiple (possibly conflicting) heterogeneous dimensions. Carbon performance may not be the priority of the reporting entity. It is also recognized that ESG reports could contain boilerplate or biased information. However, our results show that when firms follow the GRI standards to prepare their ESG reports, a reduction in carbon emissions is observed in the subsequent period. In other words, ESG reporting standards have a real effect on carbon abatement. GRI reporting standards are well-recognized and widely adopted by many strategic organizations worldwide for sustainability reporting purposes. Such a set of standards can improve the

standardization and comparability of ESG reporting. Adopting the GRI standards would facilitate benchmarking and comparison of actual performance in ESG. As carbon performance is an essential dimension of ESG, this would encourage management to take action to improve carbon mitigation. The adoption of GRI standards indicates a strong commitment of the governance body of an organization to sustainability issues. Hence, firms that adopt them are expected to take genuine actions to reduce or avoid GHG emissions. Our findings are consistent with the general trends in the worldwide convergence of sustainability reporting practices. Our research thus offers empirical evidence supporting a step toward a mandate for sustainability and climate-related disclosure. A more harmonized sustainability reporting practice is needed to enhance benchmarking and comparability of ESG scores, which may trigger serious, responsible responses to environmental and social challenges.

Second, our findings are of great relevance to policymakers in different countries. We document that the real effect of GRI standards depends on a country's legal, regulatory, and social institutions. Specifically, we reveal that if a country's carbon institutions are strong (stringent carbon regulations, a high degree of carbon consciousness, and strict legal enforcement), the marginal benefits of ESG reporting standards on carbon mitigation decrease. These findings imply that the real effect of ESG reporting standards on carbon mitigation matter more when managerial incentives are weaker due to a lack of other vigorous carbon institutions. In such institutional environments, governments, investors, NGOs, and the general public may have already put mounting pressure on firms to prioritize their ESG performance over financial outcomes. For example, if a country has a national ETS, additional governance and self-regulation mechanisms may be redundant, which would dilute the impact of ESG on carbon mitigation. Therefore, policymakers are encouraged to weigh the benefits and costs when deciding whether to mandate ESG reporting and GRI standards and should also take these institutional factors into account when making relevant decisions.

Third, our study offers valuable insights and suggestions for company executives in designing their carbon strategies. Our analysis indicates that adopting GRI standards to prepare ESG reports could be an effective signal to stakeholders. Therefore, company executives can strategically use this tool to signal their proactive carbon strategies and superior carbon performance to increase their legitimacy and obtain stakeholder support.

Finally, our findings are relevant to companies' investors. When investors know about a firm's (non)adoption of GRI standards, it may help them to infer the company's carbon mitigation efforts and outcomes. Thus, they can better understand and evaluate the firm's future carbon risks and opportunities and wisely allocate their critical capital resources. Our analysis of national institutional factors suggests that investors should also incorporate information regarding social norms and legal and regulatory environments when valuating companies.

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CONFLICT OF INTEREST

None.

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ENDNOTES

[1] We use the terms *ESG*, *CSR*, and *sustainability* interchangeably to denote corporate actions that assess, manage, or govern a firm's responsibilities for and impacts on society and the environment. Their definitions are very similar.

[2] According to KPMG (2020), more than 95% of Global 250 companies report on ESG, and high ESG reporting rates are found in all regions.

[3] As a robustness test, we do not conduct logarithm transformation of intensity of carbon emission. The results (not shown) suggest that our main inferences are sustained.

[4] We assign a value of 0 to companies with missing values for the *GRI* variable. The rationale of the treatment is that if a company adopts the GRI standards, it will have incentive to disclose the good news in various channels and thus non-disclosure would mean that the firm does not follow the standards.

[5] See https://www.ifrs.org/news-and-events/news/2022/03/issb-delivers-proposals-that-create-comprehensive-global-baseline-of-sustainability-disclosures/.

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