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ORIGINAL ARTICLE

The impact of corporate environmental management practices on environmental performance

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Abstract

This study draws on neo-institutional theory to examine how and why corporate environmental management practices might affect environmental performance. It contributes to the literature by using a large, global data set to investigate the impact of 10 corporate environmental management practices on greenhouse gas emissions or emissions intensity. It focuses on greenhouse gas emissions which pose an existential threat to the people and planet, and the environmental management practices of corporations whose effectiveness has provoked cynicism and claims of "greenwash". Our results are based on a dynamic, robust and large-scale econometric analysis, which includes tests of association and Granger causation in comparison with earlier research. A key finding, which is of interest not only to the academic literature but also to policymakers and managers, is that environmental performance impacts environmental management practices but not vice versa, supporting the hypothesis that corporations adopt these practices as a symbolic legitimizing device rather than a genuine attempt derived from moral obligation to reduce their greenhouse gases or carbon intensity.

KEYWORDS
climate change, environmental management practices, environmental performance, greenhouse gases, greenwash, policy effectiveness

1 | INTRODUCTION

Greenhouse gas emissions shift the planet's weather patterns and increase average temperatures, which result in climate change (Met Office, UK, n.d.). Climate change not only affects people and the ecosystem, but also corporations which incur losses arising from droughts, flooding, landslides and wildfires, and costs associated with the adjustment towards a low-carbon economy such as regulatory changes, technology advancement and changes in customers' and investors' sentiments (Basel Committee on Banking Supervision, 2021).

The gap between rhetoric and reality in addressing risks posed by climate change remains large. For example, international governmental climate negotiations began with much fanfare in 1990, but greenhouse gas emissions subsequently increased by 62% (World Meteorological Organization, 2020). At the corporate level, the Global Financial Stability Report (IMF, 2020) examined the long-term physical risks associated with climate change and concluded that corporations must respond more effectively to these risks in terms of risk analysis, operational performance and environmental disclosure.

Whilst corporations have attempted to adopt environmental management practices (EMPs), involving techniques, policies and procedures to monitor and control the impact of their operations on the natural environment, they have been accused of greenwashing (Montabon et al., 2007). For example, a consumer lobby group called for corporations "to confront their greenhouse gas emissions, reporting on them with honesty" (Ethical Consumer, 2021). On a more personal level, a senior safety consultant with a major oil company for 11 years, a period overlapping our research sample, stated: "I can no longer work for a company that ignores all the alarms and dismisses the risks of climate change and ecological collapse … Because, contrary to [the company's] public expressions around net zero, they are not winding down on oil and gas, but planning to explore and extract much more." (Lawson, 2022).

A review of related literature (see Appendix A) shows that many studies examine the association between EMPs and environmental performance (e.g. Alt et al., 2015; Ateş et al., 2012; Doda et al., 2016; Latan et al., 2018; Longoni et al., 2018; Sarkis & Dijkshoorn, 2007; Shetty & Kumar, 2017), but they provide mixed results. Explanations for the inconsistencies include the use of different measures of environmental performance and different aspects of EMPs (e.g. Lülfs & Hahn, 2013; Murphy et al., 2020; Nawrocka & Parker, 2009), lack of generality due to data limitations (Dragomir, 2018) and lack of clarity about how and why environmental management practices are expected to impact environmental performance (Dragomir, 2018; Haque, 2017; Haque & Ntim, 2022; Nawrocka & Parker, 2009; Trumpp et al., 2015). More importantly, prior studies tend to examine a one-way associative relationship, usually from EMPs to environmental performance, explained by a natural resource-based view or no explicit theory at all. No empirical study to date, to the best of the authors' knowledge, has considered the possibility of a two-way relationship, so the question of whether environmental performance might impact EMPs is left unanswered. A last point is that several studies investigate an indirect relationship between EMPs and environmental performance which is mediated through other factors (Alt et al., 2015; Ateş et al., 2012; Latan et al., 2018; Longoni et al., 2018).

This study answers the long-standing research question of how and why environmental management practices might affect environmental performance, by employing a neo-institutional theoretical framework. It determines, through a dynamic and extensive data analysis, whether EMPs are effective or merely a legitimizing device. In popular parlance, the latter outcome is often referred to as "greenwash", or "decoupling" in neo-institutional theory (Graafland & Smid, 2016; Vo et al., 2016). It investigates the impact of 10 corporate environmental management practices on greenhouse gas (GHG) emissions and emissions intensity. This measurement is chosen because GHG emissions are widely considered by scientists to be the main cause of climate change and are generally acknowledged to be a serious, if not existential, threat to our planet and people.

Our study makes three main contributions to the literature. First, it uses a large, cross-country and time series data set which helps increase the generality of the results and enables consideration of the dynamics between EMPs and environmental performance. We use a panel data set which has advantages over cross-sectional or time series sets. Panel data usually provide a larger number of observations, increasing the degrees of freedom and reducing the collinearity problem, thereby improving the efficiency of the econometric estimates. The use of panel data also provides a means to reduce the problems of measurement error and omitted variable bias (Hsiao, 2003). Second, it uses standardized and generally accepted measures of environmental performance in contrast to subjective measures employed in survey studies and non-standardized secondary data studies. Our measure of corporate environmental performance, that is, greenhouse gas emissions and emissions intensity, is considered one of the most important measures of corporate environmental operational performance and one which is connected to a public policy agenda (e.g. Dragomir, 2012, 2018; Hassan, 2018; Hassan & Romilly, 2018). The Bloomberg database provides historical cross-section and time series standardized emissions data for many companies worldwide. This, in turn, makes our results more generalizable and reproducible in contrast to prior survey studies. Thirdly, and perhaps uniquely in this research area, this study examines the potential two-way relationship between EMPs and environmental performance and uses Granger-causality tests to determine whether EMPs affect environmental performance, or vice versa, or both.

The remainder of this paper is structured as follows. The Section 2 develops the theoretical background to the adoption of EMPs, reviews the related research literature and formulates two fundamental hypotheses. The Section 3 describes the data set, the model estimation via vector autoregression, the choice of exogenous and endogenous variables and the distinction between performance targeting based on carbon emissions or emissions intensity. Results based on non-regression analysis are presented in Section 4, whilst the Section 5 presents results and discussion based on tests of association and Granger causality. The closing section summarizes our findings and makes concluding remarks.

2 | CONCEPTUAL FRAMEWORK

2.1 | Theoretical background

Neoclassical economic theory views the firm as an autonomous actor that pursues the profit maximization objective in the marketplace. Subsequent theories of the firm develop a more nuanced approach and conceive the firm not only in economic terms, but also "as multifaceted, durable social structures, made up of symbolic elements, social activities, and material resources" (Scott, 2013, p. 57).

The institutional structures shape organizational behaviour by establishing legal, moral and cultural–cognitive boundaries for activities. Organizational players are expected to adhere to regulative, normative and cultural–cognitive rules in institutional structures to gain social legitimacy (North, 1990). Regulative rule emphasizes the ability of regulators to shape organizational behaviour through legislation. Normative rule focuses on binding social expectations that identify claims as well as liabilities, and entitlements as well as obligations. Cultural–cognitive rule stresses "shared conceptions that constitute the nature of social reality and create the frames through which meaning is made" (Scott, 2013, p. 67). Legitimate organizations are those playing by the rules whether these are regulations, norms or cultural–cognitive beliefs. Neo-institutional theory enables understanding of the relationship between voluntary EMPs and environmental performance depending on the types of institutional forces (cultural–cognitive or normative)[1] which shape organizational behaviour.

Whilst organizations seek legitimacy by conforming to societal expectations regarding what constitute acceptable environmental management practices to portray an image of rationality and efficiency, they may decouple environment management practices from expectations (Scott & Meyer, 1983). Formal organizational structures or practices in official documents may be distinct from actual practices for economic, practical or other reasons. Formal environmental management practices are more about management's ceremonial portrayal of the organizational self to stakeholders than the efficiency of actual operations (Carruthers, 1995; Khadaroo, 2005). That is, regulative, normative and cultural–cognitive environmental management practices help portray appearances of conformity and confer legitimacy, irrespective of their economic efficiency.

2.2 | Literature review

The review of related empirical studies in Appendix A shows that prior studies on the association between EMPs and environmental performance have reported mixed results. For example, several studies reported an association between EMPs and good environmental performance (e.g. Alt et al., 2015; Ateş et al., 2012; Chen et al., 2015; Dangelico, 2015; Heggen, 2019; Henri & Journeault, 2010; Latan et al., 2018; Longoni et al., 2018). However, most of these studies used primary data collected through survey methods, which means that measures of both environmental practices and performance might be unduly subjective. Murphy et al. (2020) took the view that subjective measures based on perceptions can be valid as a first approach, but a combination of both subjective and objective measures may be desirable in future research. In addition, these studies used small and domestic samples, as well as cross-sectional data which precluded a temporal analysis of the data-generating processes. Moreover, several studies investigated an indirect relationship between EMPs and environmental performance which is mediated through other factors (Alt et al., 2015; Ateş et al., 2012; Latan et al., 2018; Longoni et al., 2018). For example, Longoni et al. (2018) investigated how the deployment of environmental management in the human resource and supply chain functions impacts environmental and financial performance. Using a survey of 96 human resources and 125 supply chain managers across multiple industries in Italy, their results suggest that the deployment of environmental management impacts both environmental and financial performance.

Other studies documented *no association* between EMPs and environmental performance (Doda et al., 2016; Shetty & Kumar, 2017). Similar to the aim of the current study, Doda et al. (2016) examined the association between 23 corporate carbon management practices and greenhouse gas emissions for a sample of 433 companies using ordinary least squares (OLS) regression. Employing data from the Carbon Disclosure Project survey, they documented no association between any of the 23 carbon management practices and greenhouse gas emissions. The authors attributed this result to non-standardized corporate carbon data and management practices information, as well as the delay between the application of EMPs and subsequent greenhouse gas emissions.[2] These conjectures support the use of standardized sample data and appropriate time lags in the research model specification, features which form an integral part of the current study.

Finally, drawing on data collected from a survey of 299 Welsh small- and medium-sized companies, Sarkis and Dijkshoorn (2007) find that EMPs are associated with bad environmental performance. Using non-parametric tests, they investigate the difference in the environmental efficiency in waste management between companies that have and have not published environmental policies. They concluded that companies without environmental policies perform better and suggested that companies adopt EMPs in a reactive manner to help disguise poor environmental performance. No specific tests for causality were used; however, and the sample data were limited to a single country.

The preceding literature does not provide sufficient understanding of the causality between environmental practices and environmental performance, which would help shed light on the extent to which EMPs are genuine attempts to reduce green reduce emissions or are simply symbolic attempts to gain societal legitimacy. Moreover, understanding causality is important because organizations which have poor environmental performance may be tempted to demonstrate good environmental management practices to gain societal legitimacy. Poor environmental performance could lead to improved environmental practices through the institutionalization of mechanisms that promote good corporate governance such as the regulatory pressures to conform, public pressures and lobbying. As suggested in the institutional theory literature (Scott & Meyer, 1983), environmental practices may be symbolic and decoupled from those portrayed in formal documents. Decoupling also implies that formal environmental management processes such as inspection, evaluation and control are minimized to reduce costs or to reconcile inconsistent stakeholder interests (e.g. shareholders v/s government).

2.3 | Hypotheses

Our literature review highlights that prior studies have used different and subjective measures of both environmental performance and management practices and employed small domestic samples. This implies that results from these studies lack generality and reproducibility. More importantly, there is a lack of clarity over how and why environmental management practices impact environmental performance. Moreover, prior studies have used either a natural resource-based view or no explicit theory at all and typically investigated a one-way relationship from environmental management practices to performance. This paper advances knowledge in this area by trying to answer the question of why environmental management practices are associated with environmental performance and the direction of travel between EMPs and environmental performance.

Within the framework of neo-institutional theory, the relationship between voluntary EMPs and environmental performance depends on the types of institutional forces that shape organizational behaviour. For example, cultural–cognitive institutional pressure such as pressure from pro-environmental interest groups can drive firms to symbolically discharge their responsibility towards the natural environment by adopting EMPs to defend, maintain or repair their organizational legitimacy (Haque & Ntim, 2018, 2022). This implies a causal effect from corporate environmental performance to EMPs and thus lends itself to the concept of greenwashing or decoupling, which involves creating and maintaining gaps between formal policies/structures that are ceremonially adopted and actual organizational practices (Vo et al., 2016, p. 248).

Alternatively, normative institutional pressure may motivate firms to take a proactive approach to address societal expectations and reduce their adverse environmental effects. For example, implementing environment management practices not only enables companies to become energy efficient but also reduces costs and lowers greenhouse gas emissions. This increases firms' accountability and responsibility to stakeholders, motivates initiatives to reduce waste and pollution and improves production efficiency, thereby not only improving corporate image and benefiting the environment but also reducing costs. Such a proactive strategy implies a causal effect from EMPs to environmental performance and lends itself to the concept of "responsible business" where organizational behaviour is governed by moral obligations.

Empirical studies have focused on a one-way relationship from EMPs to environmental performance (reflecting the normative hypothesis) often using association tests in which environmental performance is the dependent variable and EMPs are the explanatory variables. This study investigates the associative relationship in greater detail but goes further by investigating the direction of causality between EMPs and environmental performance, hence testing for two potential directions (normative vs. cultural–cognitive). Accordingly, we test the following two basic hypotheses:

Hypothesis 1. There is an association from EMPs to environmental performance.

Hypothesis 2. There is a causation between EMPs and environmental performance.

3 | METHODOLOGICAL FRAMEWORK

3.1 | Data summary

The sample companies for this study are taken from the S&P Global 1200 index[3] for the years 2009 to 2017, consciously avoiding the 2007/8 financial crisis. The S&P Global 1200 index comprises 70% of global market capitalization, which enables a much wider coverage compared to the small and country-focused data employed in many related studies. These very large, listed companies not only have the resources to act responsibly towards the natural environment but also have high organizational visibility (e.g. Hassan, 2018), which makes them subject to social and public pressure to reduce the adverse effect of their operations on the environment. The index comprised 1187 corporations with 10,683 firm-year observations, but missing observations reduced the sample to 862 companies with 6030 firm-year observations from 29 different countries. This sample is the basis for the descriptive statistics in Tables 2 and 3. The five most represented countries in our sample, in terms of firm-year observations, are the United States (2122), Japan (1212), Britain (894), France (406) and Canada (378). The sample is further condensed to 5189 firm-year observations in the model regressions because of the inclusion of two-time lags. To reduce the potential influence of outliers, each continuous variable is winsorized at the 5% level of each tail end.

3.2 | Model estimation

The schematic framework which underpins the model estimation in the current study is illustrated in Figure 1. It shows that this study examines not only the association between EMPs and environmental performance but also the direction of causation between them after considering a range of control variables.

Researchers often advocate structural equation modelling to estimate complex relationships among the variables of interest (e.g. Antonakis et al., 2010; Leuz & Wysocki, 2016). However, structural equation modelling relies heavily on economic theory which might fail to suggest the exact choice of variables and the nature of the dynamics, that is, time lags, in the model specification. Estimation is further complicated if the variables of interest are potentially endogenous and simultaneously determined. In such cases, a non-structural approach is an alternative. This study employs vector autoregression (VAR) analysis, a rarely used methodology in this research area, which posits no ad hoc restrictions on the research model such as those imposed by structural modelling. Using VAR with several economic and social control variables, we examine the associative relationship between 10 environmental management practices and three measures of environmental performance. The VAR methodology can also be used to investigate the causal relationship(s) between EMPs and performance. Because the data set contains time series variables, both associative and causal tests include (two) annual time lags. The rationale for the tests is

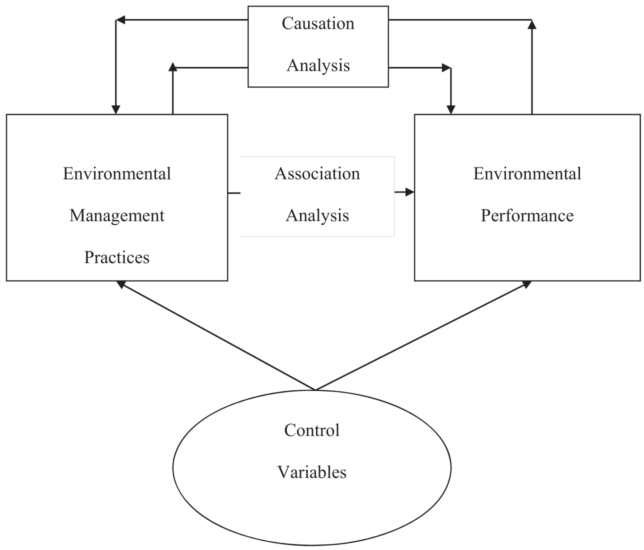

FIGURE 1 A schematic framework for model estimation.

straightforward: if the practices are effective, then there should be a statistically significant associative and causal relationship between EMPs and performance within the lagged 2-year period considered.

An important advantage of VAR is that where there are many regressors, as in the model considered here, endogeneity and consequent simultaneity (Gujarati, 2015) are not an issue because the current values of the endogenous variables do not appear on the right-hand side of the equations. Each endogenous (dependent) variable is a function of its own lagged values, the lagged values of other endogenous variables in the system and the current values of the exogenous (control) variables. The number of equations in the VAR system is equal to the number of endogenous variables, implying a total of 11 equations in each of Tables 5 and 6. The mathematical representation of the VAR model is as follows:

$$Y_t = A_1 Y_{t-1} + \ \dots \ + A_P Y_{t-P} + \beta X_t + \epsilon_t$$

where Y_t is a k vector of endogenous variables, X_t is a d vector of exogenous variables, A_1, ..., A_P and β are matrices of coefficients to be estimated and ϵ_t is a vector of innovations. Coefficient estimation is performed by OLS and applied equation by equation. Although the innovationsϵ_t may be contemporaneously correlated, they lack serial correlation and are uncorrelated with the variables on the right-hand side of the equation, thus OLS estimators are consistent and efficient.

3.3 | Exogenous variables

Our VAR specification includes a range of widely used exogenous variables to control for firm-level and country-level characteristics (e.g. Alt et al., 2015; Hassan, 2018; Hassan & Romilly, 2018; Longoni et al., 2018). Firm-level controls are firm size, measured by sales revenue (SA) and industry type (IND).

Country-level controls are gross domestic product per capita (GDP) and six governance indicators comprising control of corruption (COC), government effectiveness (GE), political stability and absence of violence/terrorism (PS), rule of law (RL), regulatory quality (RQ) and voice and accountability (VA). Each indicator ranges from −2.5 to +2.5, with higher values indicating better governance performance. Country governance represents the overarching set of formal and informal rules, norms and structures that define how a nation is governed and how political, economic and social interactions occur within that country. It encompasses a range of institutional elements, making it a fundamental construct for understanding the institutional context in which organizations operate. In addition, while GDP is not itself an institutional construct, it is a valuable economic indicator that can be used within the context of institutional theory to assess the impact of economic development on environmental management and performance.

At the company level, industry type and total sales are included as control variables. Within the context of institutional theory, the relationship between industry type and environmental management and performance is of particular interest, as it underscores how external institutional pressures, norms and expectations shape organizations' behaviour in the environmental sustainability domain. Institutional theory suggests that organizations tend to mimic the behaviours and practices of others in their industry, a phenomenon known as mimetic isomorphism. Companies within the same industry are more likely to adopt similar environmental practices and standards, as they seek legitimacy and conformity with industry norms. Industry type can influence which environmental practices are considered appropriate and legitimate within a specific sector. In addition, different industries often face varying degrees of environmental regulation and oversight. Some industries are subject to more stringent environmental laws and regulations due to the nature of their operations and potential environmental impact. Institutional theory highlights how organizations respond to these regulatory pressures, with industry type playing a critical role in determining the regulatory landscape. Furthermore, industries develop their own norms and expectations regarding environmental performance. Institutional theory explains how companies within a specific industry conform to these norms or challenge them where industry-specific norms can be a powerful driver of environmental practices.

We also use total sales as a control variable. Institutional theory highlights the importance of legitimacy for organizations. Companies with higher total sales may face increased scrutiny from various stakeholders, including customers, investors and regulatory authorities. To maintain or enhance their legitimacy and reputation, larger firms may be more inclined to adopt environmentally responsible practices. In addition, companies often mimic the behaviour and practices of other organizations in their industry or sector, that is, mimetic isomorphism. Larger firms with higher sales may serve as industry leaders or role models, influencing other organizations to adopt similar environmental practices. This imitation can lead to a convergence of environmental strategies within an industry. Furthermore, companies with higher total sales may have a greater regulatory footprint due to their size and scope of operations. Consequently, they may be subject to more regulatory pressures, which can include efforts to improve environmental performance. Moreover, institutional theorists emphasize the importance of satisfying stakeholders' expectations. Larger firms often have a broader and more diverse set of stakeholders, including customers, investors, employees and the public. Meeting the environmental expectations of these stakeholders can be a driving force behind efforts to improve environmental performance.

The variable definitions are provided in Table 1. Firm-level and country-level data are obtained from the Bloomberg and the World Bank databases respectively.

3.4 | Endogenous variables and performance targets

Environmental performance is measured using greenhouse gas emissions (GHGe), in levels, which are widely regarded as an existential threat to people and planet, and emissions intensity (GHGi; GHGi2) to which consider emissions relative to production capacity.

Greenhouse gas emissions intensity (GHGi) is defined here as the ratio of total emissions to total assets. In terms of available data, we prefer to use total assets rather than sales revenue as our main measure of firm size, because total assets include infrastructure investment, which represents long-term production commitment and is thus more likely to be aligned with corporate environmental commitment. For robustness and brevity, the analysis also makes selective reference to the results for two other measures of corporate environmental performance—GHGi2, defined as the ratio of total emissions to total sales revenue, and GHGe which is greenhouse gas emissions.

The study uses a varied range of environmental management practices to determine whether a firm has implemented initiatives and/or taken measures to improve its environmental performance, namely: energy efficiency policy (EFP), climate change policy (CCP), green buildings policy (GBP), waste recycling policy (WRP), biodiversity policy (BDP), environmental quality management policy (EQM), emissions reduction initiatives (ERI), environmental supply chain management (ESCM), water policy (WP) and sustainable packaging (SP). These 10 EMPs are all the environmental management practices captured by the Bloomberg database at the time of collecting data for this study.

4 | DESCRIPTIVE STATISTICS

4.1 | Key data metrics

Table 2 shows that average firm size measured by net sales is 23,998 million USD, with minimum and maximum values of 1256 and 87,489 million USD respectively. Thus, the sample covers large to very large firms, which are likely to have the greatest environmental impact. These firms emitted 134 thousand tonnes of greenhouse gases per million USD of total assets on average. Almost 30% of the firms come from environmentally sensitive industries. The most widely adopted EMPs are energy efficiency policy and energy reduction initiatives (95% and 94% of firms respectively), while the least adopted are green buildings policy and sustainable packaging (38% and 26% respectively). Over half the sample firms have a biodiversity policy.

The average GDP per capita is 45,801 USD, implying that most companies originate from higher income countries. Consistent with this, all the country governance performance indicators are positive, suggesting a reasonable level of performance, although political stability (PS) is noticeably lower than the others.

4.2 | Equality of means *t* test

Table 3 provides the results of an equality of means *t* test to determine whether firms adopting a particular environmental practice (group one) have a significantly different environmental performance compared to non-adopters (group 0) across the three measures of environmental performance. There is a reassuring consistency in the results. The *t*-values are highly significant and negative for firms adopting green building policy, environmental supply chain management and sustainable packaging, implying that the adopters of these practices significantly improved their environmental performance compared to non-adopters.

Firms adopting climate change policy, biodiversity policy, environmental quality management policy, emissions reduction initiatives and water policy have highly significant but positive *t*-values, implying that adopters have a worse environmental performance than non-adopters. This is a particularly noteworthy result in the case of firms adopting emissions reduction initiatives. One might expect such a fundamental management practice to improve environmental performance, not make it worse. Later, we comment in more detail on this variable. In the case of firms adopting energy efficiency and waste recycling policies, there is less consistency in the results. One would expect energy efficiency policy to have significant and negative *t*-values, but this is not the case for two of the three performance measures. An interesting result occurs in the ALL category, where firms adopting all 10 EMPs have highly significant and negative *t*-values for all three environmental performance measures. This suggests that such firms are committed to improve environmental performance, although the number of observations in this category is small. As expected, firms in environmentally sensitive industries have positive and highly significant *t*-values across the three measures, that is, they have a significantly worse environmental performance than other firms. Although the equality of means *t* test does not control for the influence of other variables, several results are compatible with the subsequent VAR analysis of association and causation.

Finally, it is worth noting that eight of the 10 individual EMPs are highly significant across all three environmental performance measures, and the remaining two have partial significance across at least one measure. This is an indication that all the individual EMPs considered in this study should be included in the subsequent analysis.

TABLE 1 Variables and definitions.

Variable	Measurement
GHGe[a]	*Company greenhouse gas emissions*: measured in levels (thousands of tonnes): equal to company Scope 1 and Scope 2 emissions but not including Scope 3 emissions. If GHG emission data are unavailable, carbon dioxide (CO_2) emissions are used instead. This enables comparability among firms which disclose either GHG or CO_2 emissions, but not both. The difference between the two measures is negligible
GHGi[a] (GHGi2[a])	*Greenhouse gas emission intensity*: the ratio of company greenhouse gas emissions (tonnes) per million USD to total assets (sales revenue)
EFP[a]	*Energy efficiency policy*: a binary variable equals one if the firm has introduced energy-saving measures, and zero if no such measures are expressly disclosed in the firm's annual or sustainability reports (ASR)
CCP[a]	*Climate change policy*: a binary variable equals one if the firm has defined its intention to help minimize greenhouse gas emissions of its continuing activities and/or the use of its goods and services, and zero if no such efforts are expressly revealed in its ASR
GBP[a]	*Green building policy*: a binary variable equals one if the firm has taken measures to use environmental technology and/or environmental principles in the design and construction of its buildings, and zero if no such efforts are expressly revealed in its ASR
WRP[a]	*Waste reduction policy*: a binary variable equals one if the firm has implemented initiatives to reduce the waste from its operations, and zero if no such efforts are expressly revealed in its ASR. Production and dissemination of new items release greenhouse gases, contributing to climate change, and demand substantial quantities of materials and energy. Hence, minimizing waste and reusing resources stand as the most efficient approaches to both conserve natural resources and reduce greenhouse gases
BDP[a]	*Biodiversity policy*: a binary variable equals one if the firm has taken any measures to protect biodiversity (including trees, vegetation, wildlife and endangered species) and zero if no such efforts are expressly revealed in its ASR. Preserved or restored habitats possess the capacity to extract carbon dioxide from the atmosphere, thus aiding in climate control through carbon storage. Furthermore, the conservation of intact ecosystems, such as mangroves, can reduce the catastrophic consequences of climate change, including flooding and storm surges
EQM[a]	*Environmental quality management policy*: a binary variable equals one if the firm has implemented any type of environmental management systems and/or environmental quality management to help minimize the environmental footprint of its operations, and zero if no such efforts are expressly revealed in its ASR
ERI[a]	*Emission reduction initiatives*: a binary variable equals one if the firm has taken any measures to decrease its environmental pollution to air, and zero if no such efforts are expressly revealed in its ASR
ESCM[a]	*Environmental supply chain management*: a binary variable equals one if the firm has adopted policies to minimize the adverse environmental effects of its supply chain, and zero if no such measures are expressly revealed in its ASR. A reduction of the environmental footprint can be accomplished by minimizing waste and environmental pollution or by focusing on the implementation of environmental management systems in the supply chain
WP[a]	*Water policy*: a binary variable equals one if the firm has undertaken measures to minimize its use of water or increase the efficiency of its processes and if the company considers possible water stress in its operational areas, and zero if no such efforts have been expressly revealed in its ASR. The processes of filtering, heating and pumping water into homes require energy, so reducing water consumption diminishes one's carbon footprint. Additionally, utilizing less water means more remains within ecosystems for afforestation and reforestation for example
SP[a]	*Sustainable packaging*: a binary variable equals one if the firm has taken measures to make its packaging more environmentally friendly (this may include attempts to boost packaging recyclability, use of less environmentally hazardous products in packaging, etc. which helps reduce material waste and lower carbon emissions) and zero if no such measures have been expressly disclosed in its ASR
SA[b]	*Firm size*: It is measured by net sales revenue (million USD) at the financial year-end. Net sales revenues are total operating revenues less discounts, allowances, insurance charges and relevant taxes.
TA[b]	*Firm size*: It is measured by total assets (million USD) at the financial year-end
IND[b]	*Industry type*: a binary variable equals one if the firm is in the energy, utility or industrial sectors according to the Bloomberg Industry Classification System (BICS) and zero otherwise. These industries produce more GHG emissions relative to other industries, hence they cause more damage to the natural environment and attract more environmental concerns
VA[b]	*Voice and accountability*: an indicator which represents expectations of the degree to which citizens of a country can engage in the choice of their government, have freedom of speech, freedom of association and free media
PS[b]	*Political stability and absence of violence/terrorism*: an indicator that measures views of the probability of political instability, including terrorism, and/or politically motivated crime
GE[b]	*Government effectiveness*: a measure that represents the expectations of public service efficiency, the quality of the civil service and the degree of its independence from political constraints, the quality of policy formulation and implementation and the integrity of the government's commitment to these policies

(Continues)

TABLE 1 (Continued)

Variable	Measurement
RQ[b]	*Regulatory quality*: an indicator that represents views of the government's ability to formulate and enforce sound policies and regulations that enable and facilitate the growth of the private sector
RL[b]	*Rule of law*: an indicator which represents perceptions of the degree to which agents have confidence in and abide by the laws of society, and the quality of contract enforcement, property rights, the police and the courts, as well as the probabilities of crime and violence
COC[b]	*Control of corruption*: an indicator which represents perceptions of the degree to which private benefits are exerted by public power, including both small and large forms of corruption, as well as "capture" of the state by elites and private interests
GDP[b]	*Gross domestic product per capita*: (USD, current prices) in the firm's country of origin

[a]Endogenous variable.

[b]Exogenous variable.

TABLE 2 Descriptive statistics.

Variable	Mean	Median	Max.	Min.	Skewness	Kurtosis
GHGi	133.87	31.10	864.97	0.17	2.20	3.87
GHGi2	237.75	42.30	1669.27	2.25	2.31	4.33
GHGe	4568.01	660.17	35,078.94	20.99	2.48	5.19
EFP	0.95	1.00	1.00	0.00	−4.00	14.03
CCP	0.73	1.00	1.00	0.00	−1.05	−0.90
GBP	0.38	0.00	1.00	0.00	0.48	−1.77
WRP	0.87	1.00	1.00	0.00	−2.21	2.90
BDP	0.53	1.00	1.00	0.00	−0.13	−1.98
EQM	0.73	1.00	1.00	0.00	−1.05	−0.90
ERI	0.94	1.00	1.00	0.00	−3.90	13.18
ESCM	0.78	1.00	1.00	0.00	−1.36	−0.15
WP	0.66	1.00	1.00	0.00	−0.67	−1.55
SP	0.26	0.00	1.00	0.00	1.10	−0.79
SA	23,998.23	14,483.50	87,488.75	1255.80	1.41	0.94
TA	75,707.99	25,512.89	435,053.1	2598.28	2.18	3.58
IND	0.28	0.00	1.00	0.00	0.98	−1.05
VA	1.18	1.13	1.74	−1.70	−2.91	23.05
PS	0.69	0.64	1.59	−0.85	−0.49	0.64
GE	1.52	1.53	2.27	−0.29	−2.48	8.62
RQ	1.41	1.45	2.26	−0.29	−1.15	3.00
RL	1.48	1.61	2.10	−0.62	−2.66	7.05
COC	1.51	1.55	2.45	−0.93	−1.70	4.59
GDP	45,801.28	47,575.61	55,017.25	24,495.71	−1.26	1.55

Note: $N = 6030$ firm-year observations. The variable definitions are provided in Table 1.

5 | REGRESSION ANALYSIS

5.1 | Tests of association: Results and discussion

Before running a VAR analysis, we identify the adequate lag length using various information criteria (e.g. Brooks, 2008; Gujarati & Porter, 2022) as shown in Table 4. Lag signifies the number of lags considered in the VAR model, representing the time delay between the current variable value and its preceding values utilized in the model. LogL denotes the log-likelihood value associated with each lag order, measuring the goodness of fit to the data. Higher log-likelihood values indicate superior model fit. The sequential modified likelihood ratio (LR) test statistic compares model fits across different lag orders, revealing the extent of improvement in model fit with added lags. The selected lag order is the one with the highest LR value or the first significant result. The final prediction error (FPE) criterion gauges the mean squared forecast error of the model, where smaller FPE values imply greater forecasting accuracy. The Akaike

TABLE 3 *T* test for equality of means (test variables: GHGi, GHGi2 and GHGe).

			GHGi		GHGi2		GHGe	
EMP	Group	*N*	Mean	*t* test	Mean	*t* test	Mean	*t* test
EFP	1	5712	134.50	0.92	235.27	−1.89*	4618.04	1.85*
	0	318	122.51		282.34		3669.46	
CCP	1	4416	148.89	8.59***	265.91	8.41***	5476.58	13.28***
	0	1614	92.76		160.70		2082.12	
GBP	1	2309	88.49	−12.45***	163.77	−10.55***	2933.71	−11.34***
	0	3721	162.03		283.65		5582.15	
WRP	1	5252	133.63	−0.21	230.87	−3.21***	4522.35	−1.03
	0	778	135.47		284.18		4876.28	
BDP	1	3206	181.82	18.03***	341.88	20.60***	6792.23	21.42***
	0	2824	79.43		119.53		2042.93	
EQM	1	4413	144.57	6.10***	248.87	3.30***	5155.02	8.50***
	0	1617	104.66		207.41		2966.00	
ERI	1	5697	137.68	5.43***	243.76	4.47***	4725.00	5.67***
	0	333	68.71		134.97		1882.27	
ESCM	1	4711	120.67	−8.63***	201.10	−12.59***	4253.86	−5.18***
	0	1319	181.01		368.66		5690.06	
WP	1	3978	144.71	5.20***	263.04	6.34***	5221.87	7.97***
	0	2052	112.86		188.72		3300.45	
SP	1	1563	78.88	−11.30***	95.49	−15.39***	2341.92	−11.60***
	0	4467	153.11		287.52		5346.92	
ALL	1	295	52.94	−6.33***	63.36	−7.13***	2497.04	−4.10***
	0	5735	138.03		246.72		4674.54	
IND	1	1694	241.04	24.11***	473.61	28.13***	9464.72	28.39***
	0	4336	92.00		145.60		2654.95	

Note: This table shows the results of an equality of means *t* test to determine whether firms adopting a particular EMP (group one) have a significantly different environmental performance compared to non-adopters (group 0) across the three measures of environmental performance (GHGi, GHGi2 and GHGe). ALL refers to adopters of all 10 EMPs. Superscripts ***, **, *: *t*-values are significant at the 1%, 5%, and 10% levels (two-tailed) respectively. *N* = 6030. The variable definitions are provided in Table 1.

information criterion (AIC) balances model fit and complexity where lower AIC values signify better-fitting models. The SC is like the AIC but more stringent in penalizing for the number of parameters, where lower SC values indicate better-fitting models. The Hannan–Quinn information criterion (HQ), like AIC and SC, strikes a balance between model fit and parsimony where lower HQ values denote superior model fits.

Table 4 shows the lag length selection criteria for lag orders ranging from 0 to 8. The chosen lag order for each criterion is denoted by an asterisk (*). For instance, while SC and HQ suggest a lag order of 1, both FPE and AIC advocate for a lag order of 2. Given the slight disparities in the optimal lag order recommended by each criterion, the decision is made to select the lag order that is consistent across multiple criteria. Based on the results obtained from various information criteria, we can select a lag order of 1 or 2. To further rationalize the decision, we apply Gujarati and Porter's (2022, p. 753) rule of thumb, which is to choose a lag length equivalent to one-third to one-quarter the length of the time series. In this study, with a time series length of 9, the recommended lag length ranges from 2.25 to 3, aligning more with the choice of a lag order of 2.

Table 5 shows the VAR results of the regressions containing GHGi and the EMPs. As a robustness check, selective reference is made below (but not tabulated) to the regressions containing GHGi2 and GHGe. The association tests contain a total of 32 explanatory variables (including the constant and time lags) for the dependent variable GHGi. The same number applies when each EMP is treated as the dependent variable. Overall, this generates 352 estimated coefficients. This estimation procedure is replicated for the other performance measures, that is, GHGi2 and GHGe, meaning that our analysis and conclusions are based on over one thousand coefficient estimates.

Production requires substantial investments in physical and human capital, especially in environmentally sensitive industries such as energy. It is reasonable to expect a degree of "stickiness" in firms' ability to adjust their operating processes and thus their carbon efficiency. Accordingly, two-time lags are included in the

TABLE 4 Choosing the adequate lag length for the VAR analysis.

VAR lag order selection criteria						
Endogenous variables: LOG (GHGI) EFP CCP GBP WRP BDP EQM ERI ESCM WP SP						
Exogenous variables: C LOG (SA) IND VA PS GE RQ RL COC LOG (GDP)						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	−3673.630	NA	2.80e−11	6.917057	7.419558	7.107208
1	4243.694	15,530.69	1.81e−17	−7.335820	−6.280569[a]	−6.936504[a]
2	4392.338	288.5919	1.72e−17[a]	−7.386358[a]	−5.778356	−6.777876
3	4500.974	208.7330	1.76e−17	−7.363755	−5.203003	−6.546108
4	4626.416	238.5000	1.74e−17	−7.371875	−4.658373	−6.345063
5	4704.083	146.1060	1.89e−17	−7.292657	−4.026404	−6.056679
6	4788.835	157.7277[a]	2.02e−17	−7.226389	−3.407386	−5.781245
7	4853.638	119.2997	2.24e−17	−7.123653	−2.751899	−5.469344
8	4929.819	138.7124	2.44e−17	−7.041716	−2.117211	−5.178241

Abbreviations: AIC, Akaike information criterion; FPE, final prediction error; HQ, Hannan–Quinn information criterion; LR, sequential modified LR test statistic (each test at 5% level); SC, Schwarz information criterion.

[a]Lag order selected by the criterion.

model to allow for the effects of inertia (or hysteresis) in the data-generating processes. The variables GHGi, GHGi2, GHGe, TA, SA and GDP are expressed in natural logarithm form to alleviate the effect of outliers and enable an estimation of their (constant) elasticity in response to changes in other variables.

Twenty out of the 22 time lag coefficients are significant or highly significant, highlighting the importance of hysteresis in the sample data. Time series variables often have strong associations with their past values, but the extent and strength of the hysteresis is a surprise. Another surprise is how little statistical associations EMPs have with GHGi (see the first column of Table 5). Of the 20 EMPs coefficients, only one—the second lag of emissions reduction initiatives—is significant, and this finding also applies to GHGi2 and GHGe. Thus, this finding is very robust. These results contrast with those of several other studies (e.g. Alt et al., 2015; Ateş et al., 2012; Chen et al., 2015; Dangelico, 2015; Heggen, 2019; Latan et al., 2018; Longoni et al., 2018), but, as noted earlier, these studies tend to investigate contemporaneous association only. The fact that nine out of 10 EMPs have no statistically significant associations whatsoever with any measure of environmental performance, even after allowing for the influence of time, provides a strong indicator that overall, such EMPs have very limited influence on environmental performance. In terms of our first hypothesis (H1: There is an association from EMPs to environmental performance), we conclude that, apart from one exception out of 10, we are unable to accept it.

The equation with GHGi as the dependent variable has the highest adjusted R^2 (0.98), but the combination of a high R^2 and insignificant EMP coefficients might indicate a multicollinearity problem. However, the regression also contains nine exogenous variables (excluding the constant), seven of which are statistically significant, suggesting that multicollinearity is not an issue. In addition, this study employs panel data, hence the effect of multicollinearity on the regression results should be reduced anyway (Hsiao, 2003). However, as a further robustness check, since the six-country governance indicators exhibit moderate to high levels of intra-correlation in Spearman correlation tests (not tabulated), a principal component analysis is conducted to potentially pare down the number of variables. The first two principal components[4] were used to replace the six governance variables, but the results for the associations between EMPs and GHGi remain qualitatively unchanged.

What of the intra-association among the EMPs? There is no clear evidence of consistent, significant association between a given EMP variable and the others. Although the second lag of ERI has four instances of significance out of a possible nine, both lags of GBP, for example, have none. There are no variables which have more than 50% significant association (i.e. five or more from a possible nine) with others. A detailed consideration of these intra-EMP relationships would take us well beyond the primary concern of this paper. We suggest future research to pinpoint the reasons for some of these results, for example, why the past values of waste recycling policy and emission reduction initiatives are significant determinants of the current values of energy efficiency policy. Finally, we run a principal component analysis on the 10 EMPs to check whether we can streamline their number. The results show that the first two principal components account for only 54% of the variation in the EMPs implying that these practices have more individual uniqueness than commonalities and hence they should all be considered in the analysis.

Seven of the exogenous variable coefficients (excluding the constant) are significant, the exceptions being two governance variables, namely, voice and accountability (VA) and rule of law (RL). Of the non-governance exogenous variables, IND is significant and has the expected positive coefficient sign, which means that, ceteris paribus, companies in environmentally sensitive industries have higher emissions intensities than those which are not. The GDP coefficient sign is significant and negative, implying that higher income

TABLE 5 Tests of association.

Dependent/explanatory	Ln(GHGi)	EFP	CCP	GBP	WRP	BDP	EQM	ERI	ESCM	WP	SP
ln(GHGi (−1))	0.728***	0.001	0.019*	−0.008	0.004	0.020*	9E−05	−4E−04	0.011	0.008	−0.004
ln(GHGi (−2))	0.262***	−0.001	−0.016	−0.004	0.002	−0.010	0.004	-3E−04	−0.014	0.001	0.008
EFP (−1)	0.012	0.624***	−0.087***	−0.050*	0.030	−0.016	0.014	0.003	-3E−04	0.061**	0.033
EFP (−2)	0.003	0.020	0.053**	0.026	0.011	0.048**	−0.034	0.021	0.046**	−0.035	−0.038**
CCP (−1)	0.009	−0.003	0.720***	−0.008	0.001	0.042***	−0.015	0.010	0.024*	0.014	−0.012
CCP (−2)	−0.007	0.007	0.057***	−0.007	−0.012	0.003	2E−05	−0.008	−0.009	−0.024	5E−04
GBP (−1)	−0.021	0.001	0.003	0.764***	−0.013	0.007	0.007	−0.007	0.014	0.003	0.014
GBP (−2)	−0.013	0.007	0.007	0.068***	0.017	−0.012	−0.015	0.006	−0.010	0.013	−0.013
WRP (−1)	0.009	0.037***	0.007	0.014	0.682***	−0.024	0.008	−0.003	−0.014	0.032*	−0.007
WRP (−2)	0.013	−0.028***	−0.021	−0.009	0.034***	0.005	−0.017	0.004	0.023	−0.013	0.024*
BDP (−1)	−0.016	0.003	0.034**	−0.003	0.003	0.790***	0.009	0.011	−0.008	0.048***	−0.009
BDP (−2)	0.023	−0.001	−0.008	0.006	−0.001	0.032**	−0.010	−0.004	0.003	−0.013	−0.001
EQM (−1)	−0.005	0.002	−0.025*	0.009	0.027**	0.014	0.755***	−0.012	0.024*	−0.011	−0.017
EQM (−2)	0.001	0.005	0.023	−0.015	−0.023*	0.002	0.082***	0.014	0.010	0.023	0.020
ERI (−1)	0.035	−0.047***	0.024	0.030	−0.014	0.029	−0.022	0.582***	0.040*	−0.041	−0.042**
ERI (−2)	−0.052*	−0.001	0.028	−0.061**	−0.063***	−0.044*	0.021	0.010	−0.102***	0.008	0.010
ESCM (−1)	−0.011	−0.002	−0.004	−0.021	−0.002	−0.013	0.017	6E−05	0.722***	0.018	−0.014
ESCM (−2)	0.026	0.003	0.017	0.023	0.029**	0.017	−0.004	0.007	0.033**	−0.009	0.013
WP (−1)	0.015	−0.004	0.016	0.012	0.017	0.022*	0.004	2E−04	−0.015	0.696***	0.007
WP (−2)	0.007	0.006	−0.012	−0.009	−0.010	−0.020	0.002	0.002	0.017	0.068***	0.004
SP (−1)	−0.010	0.010	0.002	0.017	-2E−04	0.005	0.008	0.006	0.007	0.038**	0.822***
SP (−2)	0.015	−0.006	−0.005	−0.011	0.008	−0.008	−0.009	−0.009	0.004	−0.024	0.081***
C	1.397***	0.568***	0.238	−0.494	0.017	0.369	0.721**	0.349**	0.021	−0.519	−0.557**
ln(SA)	−0.008**	0.005***	0.012***	0.010***	−0.003	0.003	-4E−04	0.001	0.010***	0.006	0.007**
IND	0.022**	0.003	−0.025***	0.024**	−0.014**	0.004	0.008	0.003	−0.012	−0.008	−0.029***
VA	0.033	−0.005	−0.011	−0.031	0.004	−0.027	−0.005	0.003	−0.023	0.026	0.012
PS	0.048***	−0.008	0.006	−0.046***	−0.009	0.008	0.013	−0.007	−0.014	−0.024	−0.021*
GE	0.074**	0.023	−0.004	0.160***	0.046**	0.022	0.070***	0.034**	0.032	0.015	0.045**
RQ	−0.074***	−0.018*	−0.008	0.000	−0.040***	−0.086***	−0.049***	−0.007	−0.007	0.037*	−0.002
RL	0.010	−0.003	−0.002	−0.001	0.002	−0.012	−0.003	−0.004	−0.008	0.007	−0.006
COC	−0.046*	0.010	0.003	−0.097***	−0.027	0.040*	−0.026	−0.011	−0.006	−0.061***	−0.039**
ln(GDP)	−0.129***	−0.024	−0.015	0.051	0.027	−0.027	−0.053*	−0.001	0.010	0.055*	0.051**
Akaike AIC	0.467	-1.203	−0.052	0.183	−0.423	0.019	−0.160	-1.130	−0.184	0.187	−0.434
Schwarz SC	0.508	-1.162	−0.012	0.223	−0.382	0.059	−0.120	-1.090	−0.143	0.227	−0.394
S.E. equation	0.305	0.132	0.235	0.264	0.195	0.244	0.223	0.137	0.220	0.265	0.194

Note: This table shows the results for tests of association between ln(GHG_i) and EMPs using VAR after considering firm-level and country-level controls. ***, **, *: Coefficients are significant at the 1%, 5% and 10% levels (two-tailed) respectively. N = 5189 firm-year observations. Number of coefficients = 352. The variable definitions are provided in Table 1. Dependent variables are headers of the columns whereas explanatory variables are headers of the rows.

TABLE 6 Tests of causation.

Dependent/explanatory	Ln(GHGi)	EFP	CCP	GBP	WRP	BDP	EQM	ERI	ESCM	WP	SP
ln(GHGi)		0.155	6.701**	39.062***	18.384***	30.645***	6.081**	0.484	5.590*	20.022***	9.548***
EFP	0.409		12.069***	3.164	6.735**	5.226*	2.861	5.274*	8.584***	4.759*	4.135
CCP	0.243	1.132		2.035	2.544	25.227***	3.314	1.618	4.524*	2.814	2.788
GBP	11.192***	2.812	1.828		2.705	0.913	1.940	0.915	1.549	3.088	1.924
WRP	2.213	15.354***	2.553	0.545		3.010	1.555	0.167	2.546	3.464	4.992*
BDP	1.932	0.313	12.365***	0.177	0.164		0.615	3.047	0.550	19.429***	2.364
EQM	0.154	1.803	2.859	0.913	4.763*	3.318		2.619	17.315***	2.547	2.623
ERI	3.308	23.474***	8.259**	6.529**	29.771***	3.603	1.098		29.434***	3.318	6.063**
ESCM	2.797	0.171	2.577	2.164	13.952***	1.396	2.807	1.802		1.410	1.469
WP	4.183	0.994	1.753	0.691	2.865	3.251	0.450	0.186	2.281		2.813
SP	0.610	1.669	0.171	1.076	1.199	0.282	0.311	0.905	1.789	5.043*	
All other endogenous variables	31.542**	47.581***	60.567***	73.834***	80.859***	89.313***	23.396	22.956	65.632***	81.942***	39.458***

Note: This table shows the results of tests of causation between ln(GHG_i) and EMPs using VAR Granger causality block exogeneity Wald tests. *p*-values in parentheses. ***, **, *: coefficients are significant at the 1%, 5% and 10% levels (two-tailed) respectively. If the *p*-value is significant, reject the null hypothesis and conclude that the explanatory variable Granger causes the dependent variable. VAR lag length = 2. N = 5189 firm-year observations. The variable definitions are provided in Table 1. Dependent variables are headers of the columns whereas explanatory variables are headers of the rows.

countries have lower emissions intensities, ceteris paribus. This is plausible since more affluent countries are likely to have both the awareness of and ability to mitigate adverse environmental effects. The firm size coefficient is also significant and negative, which we speculate could be a consequence of economies of scale and/or scope (larger companies might produce a given output with fewer inputs than smaller companies) or societal pressure (larger companies might face greater public scrutiny and pressure to reduce emissions).

Since the information criteria SC and HQ suggested a lag order of 1 when testing for the adequate lag length to include in the analysis (Table 4), we compare the results of the VAR analysis using one-time lag with those obtained in Table 5 (two-time lags). Statistics for the information criteria Akaike AIC and Schwarz SC (Table 5) show lower values for all the endogenous (dependent) variables included in the VAR model, which provide evidence of the goodness of fit of the VAR analysis employed in this paper.

The first lag of GHGi has a significant positive association with each of climate change policy (CCP) and biodiversity policy (BDP), suggesting that the adoption of at least some EMPs might be a response to increasing GHGi. We test this conjecture in the next section. This result coincides with those of Doda et al. (2016) and Shetty and Kumar (2017), namely, that companies can still reveal a significant amount of information about their EMPs even though they are ineffective in reducing pollution caused by their activities.

5.2 | Tests for Granger causation: Results and discussion

The VAR analysis of the preceding section determines the association between the variables but not the causation. Investigating causality is potentially problematic. Given a regression between sunshine and crop growth, it is not unreasonable to assume that sunshine causes crop growth rather than the reverse. But other cases are less clear, particularly in the social sciences. What is the direction of causation between inflation and money wage growth, for example, or between EMPs and environmental performance? Is it possible to establish whether there is causality and, if so, is it one way or bidirectional?

A commonly used econometric causality test is that of Granger (1969). Some consider it to be a "quasi-causal" test and favour the term "Granger-causation", a practice to which we adhere. Using the Granger methodology to answer the question of whether an EMP causes changes in GHGi is to test whether the past values of GHGi explain its current value and then to investigate whether adding lagged values of the EMP enhances the explanation. If the EMP improves the prediction of GHGi (i.e. if the coefficients on the lagged EMP are significant), the EMP is said to Granger-cause GHGi. In effect, the test depends on the fact that one can use the past to predict the future, but not the other way around, and is thus a test of precedence and information content. The test can also determine if GHGi Granger causes any of the EMPs, and cases of bi-directional Granger causation are not uncommon. Using the block exogeneity Wald test, one can assess not only the causal influence of an individual variable but also the joint influence of multiple variables.

The results in Table 6 (column one) show the individual causal significance of the 10 EMPs on GHGi as well as their joint significance (the ALL variable). For robustness, we report selected causation test results for GHGi2 and GHGe, but for brevity, we do not tabulate them.

Consistent with the results of the association tests, only one of the EMPs (green buildings policy) has a statistically significant causal effect on GHGi. This limited influence also extends to GHGi2 and GHGe: only three EMPs (green buildings, biodiversity and energy efficiency policy) have significant causal effects on GHGi2, and only one EMP (waste reduction) has a significant causal effect on GHGe. Thus, these results of limited causality of EMPs on environmental performance are robust. In this context, special mention should be made of the two most widely adopted EMPs, namely: energy efficiency policy (EFP) and emissions reduction initiatives (ERI). Given their extremely high adoption rates, one might assume they are of fundamental importance in determining performance. Yet, EFP has a significant causal effect only on GHGi2, and ERI has no significant causal effect on any of the performance measures.

To summarize, in terms of the causal effect from the individual EMPs to the three measures of environmental performance, only five out of a total of 30 are significant. Overall, these Granger-causality tests provide compelling evidence that the individual EMPs considered in this paper are ineffective in improving environmental performance. Despite the limited significance of the individual EMPs, the ALL category does have a significant causal influence on GHGi, implying that companies adopting all 10 EMPs have a strong commitment to reduce GHGi. The ALL category also has a significant causal influence on GHGi2 (but not on GHGe). But, as noted earlier in Table 3, such companies form a small proportion of the initial sample, so one should not place too much emphasis on these results.

A very different picture emerges if the tests are reversed. The results show that GHGi Granger causes eight out of 10 EMPs (Table 6, row 1), while GHGi2 and GHGe each Granger causes six EMPs. Thus, whatever measure is used, performance has a significant causal effect on most EMPs. We conclude that we are unable to reject our second hypothesis (H2: There is causation between EMPs and environmental performance). The causation is not from EMPs to environmental performance, however, but from performance to EMPs. The only EMPs which are not Granger caused by any of the performance variables are energy efficiency policy and emissions reduction initiatives. This mirrors the lack of association between the performance measures and EFP and ERI in the association tests (apart from the second lag of ERI). The only instance of bilateral causation with GHGi is green buildings policy.

EFP and ERI form one of only three instances of bilateral causation within the EMPs (WRP/EFP and CCP/BDP are the others), and these results also hold for the other performance measures. These infrequent but robust instances of bilateral causation seem plausible given that each variable pair is closely related in terms of environmental purpose, and these causation relations would form another interesting area for future research.

It is also interesting that the ALL category has a significant causal influence on eight out of the 10 EMPs, the exceptions being emissions reduction initiatives and environmental quality management (these exceptions also hold for GHGi2 and GHGe). But ERI does have a significant causal influence on six of the other nine EMPs, the highest number of causal instances within the individual EMPs (and for GHGi2 as well as GHGe). We speculate that whilst the ALL category is small, its firms have a disproportionate influence on the adoption of EMPs by other firms (mimetic institutional pressure), and where these other firms have adopted ERI, they are more likely to adopt additional EMPs. This hypothesis is supported by the fact that the (second) lag of ERI is the only EMP to have a significant association with all three performance measures.

6 | SUMMARY AND CONCLUSIONS

This study contributes to knowledge and understanding by employing neo-institutional theory to answer a long-standing research question, which is also of interest to policymakers and managers, that is, how and why environmental management practices might affect environmental performance. It uses a large, global data set and rigorous econometric analysis to robustly determine whether our sample firms are greenwashing. It examines the direct relationship between 10 corporate voluntary environmental management practices and operational performance in contrast to prior studies which focus on an indirect relationship mediated by other factors. It uses a panel data set of S&P Global 1200 companies for the years 2009 to 2017. This data set is the largest yet used in this research area, at least in comparison with the related literature in Appendix A. This enables greater generality and rigour in our statistical analysis. The methodology uses statistical tests of both association and Granger causation within a vector autoregressive framework, as well as a consideration of model dynamics via the incorporation of two annual time lags. This contrasts with the focus of prior studies on the associative relationship only. For robustness, our study considers not one but three standardized and objective measures of environmental performance, namely, emissions intensity with respect to total assets (GHGi), emissions intensity with respect to sales revenue (GHGi2) and the amount of emissions (GHGe).

Surprisingly, perhaps remarkably, the main result from our association tests is that nine out of 10 EMPs have no significant association with GHGi, and the same applies to GHGi2 and GHGe. This finding of very limited association is thus highly robust and consistent with the results of Doda et al. (2016).

But tests of association do not provide direct evidence (although they might provide an indicator) of the temporal relationships between EMPs and environmental performance. The main point of interest for environmental policymakers in the business sector and elsewhere is this: do EMPs drive environmental performance, or vice versa, or both? Echoing the results of the association analysis, only one EMP (green buildings policy) has a statistically significant causal impact on GHGi, and this limited influence also applies to GHGi2 and GHGe. The results are very different if we reverse the direction of the causality tests. There is significant causation from GHGi to eight out of 10 EMPs, and GHGi2 and GHGe each Granger causes six out of 10 EMPs. Thus, whichever measure is used, environmental performance has a significant causal influence on most EMPs. Overall, these Granger causality tests strongly support the view that EMPs are used in a reactive manner to symbolically legitimize corporate environmental responsibility rather than proactively to improve environmental performance. This is the key result of our study.

Our results fail to support the hypothesis that normative institutional pressure motivates the corporate sector to take proactive measures to reduce the adverse effect of their operations on the natural environment. Our results rather support the cultural–cognitive hypothesis of neo-institutional theory that the corporate sector adopts environmental management practices symbolically to discharge their responsibility towards the natural environment to defend, maintain or repair their organizational legitimacy. This result extends the literature in this area, which tends to investigate a one-way associative relationship, usually from EMPs to environmental performance, employing a natural resource-based view or no explicit theory at all. Employing neo-institutional theory enables a consideration of a potential two-way relationship between corporate voluntary environmental management practices and operational performance. A natural potential extension of this study is to employ the concept of regulatory institutional pressure to explain the association between mandatory environmental management practices and operational performance. In addition, this study reports environmental performance as a significant driver of corporate voluntary environmental management practices. Future studies might consider other potential drivers such as corporate governance.

We acknowledge the following limitations of our study. Our analysis uses dummy variables to measure EMPs which may not capture the full extent of the practices, so that several reasons for the mismatch between reporting efforts and performance may be possible. Indeed, one might argue that the foregoing methodology does not distinguish between firms that are greenwashing and those with genuine commitment to improve environmental performance but nonetheless fail to do so. This may be a valid point in some cases, but the combined results show so little association or causation from EMPs to performance that, given the sample size (over five thousand observations for each performance measure), it is unlikely to hold in most cases. Even if it did, it would still represent a widespread corporate failure to achieve improved environmental performance.

Our study uses a sample of large to very large, listed companies, and future studies might consider extending the analysis to small- and medium-sized companies as well as considering different standardized measures for EMPs and environmental performance, when they become available, to check whether these results hold for other settings and measures. We do not explore the precise nature of the linkages between each EMP and performance or the interlinkages between EMPS, and these links could form an interesting research area. Future research might also consider the effectiveness of third-party assurance, such as reviews by an external audit body, on the relationship between EMPs and environmental performance.

Finally, we reiterate the findings of the Global Financial Stability Report (IMF, 2020) which, inter alia, concluded that the business sector must respond more effectively to climate change in terms of risk analysis, operational performance and environmental disclosure. Our careful empirical investigation finds persuasive evidence that, to this list of climate change shortcomings, we should add the failure of the business sector to implement effective EMPs. This corporate governance failure has two important policy implications. First, the business sector should put an end to greenwashing tactics and focus much more on the effectiveness of their EMPs to align them with societal expectations. Our results demonstrate that the gap between rhetoric and reality is not just perceived, but real. Management could formally intervene to implement environmental management practices effectively (Murphy et al., 2020) and promote a pro-environment corporate culture (Ciocirlan et al., 2020). Management could also consider climate-related whistle-blowing policies to encourage and protect employees who voice environmental concerns at work. Second, while some forms of external monitoring already exist through channels such as consumer organizations, pressure groups and related publications, governments should become more involved with the green claims made by the business sector, probably through the legislature. Most countries have laws preventing firms from making false advertising claims about their products: similar laws could be devised to deter greenwashing. Governments might use "name and shame" practices to denounce companies for their greenwashing tactics. Given the overriding importance of climate change, society has a right to expect higher standards from the business sector.

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No conflicts of interest to declare.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from Bloomberg database. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the author(s) with the permission of Bloomberg database.

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ENDNOTES

[1]This study focuses on voluntary EMPs.

[2]Doda et al. (2016) state their paper is the first large-scale quantitative study to examine the effect of EMPs on GHGe, with a total of 433 observations. The association and causality tests of the current study utilize a total of 5189 observations.

[3]The S&P Global 1200 is a composite index which consists of seven leading indices in their regions, these include the S&P 500 (US), S&P Europe 350, S&P TOPIX 150 (Japan), S&P/TSX 60 (Canada), S&P/ASX All Australian 50, S&P Asia 50 and S&P Latin America 4. It is used to identify the coverage of our sample in terms of the sample companies. For more information, see the following link: https://www.spglobal.com/spdji/en/indices/equity/sp-global-1200/#overview.

[4]The principal component analysis shows that the first two components capture 82% of the variance of these six corporate governance indicators.

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APPENDIX A

A SUMMARY OF RELATED STUDIES

Reference	Study investigation	Environmental management metric	Environmental performance metric	Sample	Data collection and analysis	Results
Alt et al. (2015)	The mechanism of how employees affect environmental performance	Participants' perceptions of employee stakeholder integration and proactive environmental strategies	Managers' and directors' perceptions of their firm's (2008–2009) environmental performance	170 multi-industry and cross-country firms	Online questionnaire; regression analysis	The constructive environmental strategies of companies turned the involvement of employee stakeholders into better environmental performance
Ateş et al. (2012)	The effect of proactive environmental strategy on environmental performance as mediated by environmental investments	Participants' perceptions of proactive environmental strategies	Participants' perceptions of how successful their plant/company is in reducing material use, waste and energy use relative to its rivals	96 Turkish manufacturers	Online questionnaire; partial least squares	Environmental investment serves as a mediating factor between proactive environmental strategy and environmental performance
Chen et al. (2015)	The effect of business strategy on both employees' and firms' performance in protecting the environment	Participants' perceptions of the organization-level variables, such as culture and firm strategy, and individual-level variables, such as employees' involvement	Participants' perceptions of firm environmental performance over a period of 2–3 years	134 sets of matched questionnaires from Chinese firms	On-site interviews; confirmatory factor analysis; common method variance	Market orientation has a positive effect on environmental policy, which in turn impacts both the quality of environmental goods and the environmental engagement of employees. As a result, the latter two variables have positive impacts on environmental performance
Dangelico (2015)	The link between employee green teams and environmental performance and reputation	The existence of green teams where employees voluntarily work together to reduce firm environmental impact and/or improve the natural environment using content analysis	Environmental Impact Score and the Green Policies Score as reported in the US 500 Newsweek's 2010 Green Ranking	500 largest publicly traded US companies	OLS with 1-year time lag to indicate causality	Employee green teams have a positive impact on environmental performance and environmental reputation
Doda et al. (2016)	The effect of corporate carbon management practices on corporate greenhouse gas emissions intensity	23 carbon management practices	Changes in the natural logarithm of greenhouse gas emissions normalized by the operating revenues of the corporation between 2009 and 2010	433 corporations from the Carbon Disclosure Project survey	Cross-sectional OLS	There is no association between any of the 23 corporate carbon management practices and greenhouse gas emissions

(Continues)

APPENDIX A (Continued)

Reference	Study investigation	Environmental management metric	Environmental performance metric	Sample	Data collection and analysis	Results
Haque and Ntim (2022)	The influence of corporate sustainability initiatives on corporate carbon performance	Emission reduction score, environmental innovations score and efficient use of resources score provided by Refinitiv Eikon database	The ratio of a firm's total of Scope 1 and Scope 2 GHG emissions to the net sales revenue, and the ratio of the firm's Scope 1 emission to the net sales revenue	2444 firm-year observations from listed nonfinancial European companies	Three-way fixed-effects model	Corporate sustainability initiatives reduce GHG emission and improve corporate carbon performance
Heggen (2019)	The interrelationships among environmental strategic planning, environmental value systems, and firms' environmental and economic outcomes	Participants' perceptions of firm environmental strategic planning and environmental value systems	Participants' perceptions of firm environmental performance	221 Australian firms	Postal and online questionnaire; SPSS macro-process	Environmental strategic planning has a positive association with better environmental performance, but environmental value systems do not directly affect environmental performance
Henri and Journeault (2010)	The direct and indirect effects of eco-control on economic performance	Participants' perception of eco-control	Participants' perceptions of firm environmental performance, with a higher score indicating better environmental performance	303 large Canadian manufacturing firms	Postal questionnaire	Environmental performance serves as a mediating factor between eco-control and economic performance
Latan et al. (2018)	The mediating effect of environmental management accounting on the relationship between organizational resources and corporate environmental performance	Participants' perceptions of environmental strategies implemented in their firms, top management commitment and environmental management accounting	Participants' perceptions of firm environmental performance	107 responses in ISO 14001 certified companies listed on the Indonesia Stock Exchange	Online survey; partial least squares path modelling analysis	Organizational resources positively affect the use of environmental management accounting, which leads to better environmental performance
Longoni et al. (2018)	The effect of the deployment of environmental management in the human resource and the supply chain functions on environmental and financial performance	Participants' perceptions of the environmental practices adopted in their firms (i.e. green human resource management and green supply chain management)	Environmental performance measured using a composite score of all Kinder, Lydenberg and Domini (KLD) parameters	96 human resource managers and 125 supply chain managers in multiple industries in Italy	Online questionnaire; partial least squares	The deployment of environmental management affects both environmental and financial performance. Also, green supply chain management serves as a mediating factor between green human resources management and environmental performance

APPENDIX A (Continued)

Reference	Study investigation	Environmental management metric	Environmental performance metric	Sample	Data collection and analysis	Results
Sarkis and Dijkshoorn (2007)	The association between the adoption of environmentally supportive practices and environmental performance	Participants' perceptions of environmental policies, the monitoring of waste expenditures, waste auditing, environmental management systems and becoming involved in environmental support groups	Environmental efficiency defined by how well a facility or organization can manage its wastes on a per employee basis using a multifactor environmental productivity model	299 Welsh small- and medium-sized manufacturing enterprises	Questionnaire; non-parametric tests	Environmental management practices are associated with worse environmental performance
Shetty and Kumar (2017)	The effectiveness of voluntary environmental programmes in improving environmental performance	Voluntary environmental programmes measured as the number of voluntary initiatives undertaken by the firm	Environmental performance of a firm measured by its environmental efficiency estimated using a directional distance function approach	49 Indian firms in the steel, cement and power sectors	Truncated regression model with boot-strapped standard errors	There is no association between the adoption of multiple voluntary environmental programmes and environmental performance