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Corporate commitment to climate change: The effect of eco-innovation and climate governance

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ABSTRACT

Climate change represents a significant problem to the planet which raises concerns from stakeholder groups about corporate commitment to climate change issues. In this paper, we explore the effect of eco-innovation and climate governance on corporate commitment to climate change. We develop a unique measure for climate change commitment by considering four components, viz. whether a company supports the Sustainable Development Goal 13 on climate action, whether a company is aware that climate change can represent commercial risks or opportunities, whether a company reports Scope 3 CO_2 emissions and whether a company sets a target for emission reduction. We measure eco-innovation by using a score collected from the Eikon database that reflects a company's capacity to reduce environmental costs, eco-innovation intensity measured as environmental expenditures over revenues. We also create an index computed as a composite score by totalling five eco-innovation proxies collected from the Eikon database that reflect companies' efforts to reduce environmental impact. Concerning climate governance, we focus on three proxies, namely the existence of an environmental committee, climate incentives and the existence of sustainability reports. Based on a sample of companies listed on the London Stock Exchange for the period of 2014–2020, we find that corporate eco-innovation is positively associated with climate change commitment. We argue that firms that adopt innovative approaches to efficiently control pollution and resource use and reduce their environmental impact are more committed to climate change. We also find that climate governance is positively associated with climate change commitment. We claim that companies that integrate climate change issues in governance can help address climate change risks and opportunities. Our empirical evidence provides recommendations for managers and policymakers to promote the adoption of eco-innovative technologies and integrate climate change issues in governance, which can contribute to corporate commitment to climate change.

1. Introduction

In recent years, the issue of climate change has become a trend as a major environmental issue of concern to stakeholders including the global community, managers, consumers, media, suppliers and professionals (Borghesi et al., 2015; Haque et al., 2016; Krieger and Zipperer, 2022). There is also an increasing demand from governments and shareholders for companies to demonstrate their responsibility and accountability to stakeholders by enhancing corporate practices related to climate change commitments (Afrifa et al., 2020; Hollindale et al., 2019). The ambitious UK plan to bring greenhouse gas emissions to net zero by 2050, which was recommended by the Climate Change Committee, requires companies to play a vital role in improving their practices in terms of climate change commitments (Karim et al., 2021).

The UK is one of the first countries that ratified the Kyoto Protocol at a very early stage, participates in the European Emission Trading Scheme (ETS) and implements its own national climate change instruments, e.g. the UK ETS, the Climate Change Act of 2008 and mandatory carbon reporting, which employ from tradeable permits (Baumol and Oates, 1976) and incentive taxes (Weitzman, 1974) instruments, to the more stringent carbon reporting regulation. From the environmental policy perspective, these instruments are all supposed to be powerful mechanisms, which take into account both welfare economics and evolutionary economics, to motivate firms to engage in

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carbon emissions reduction (Cainelli et al., 2020; Costantini and Mazzanti, 2012; Fabrizi et al., 2018; Lee et al., 2011). For instance, taxes are expected to provide stronger long-term incentives and ETSs stimulate innovative activities. However, despite the fact that environmental policies with price incentives perform better than command and control policies (Requate, 2005), more stringent policies have been employed in recent years. Nevertheless, firms are criticized for symbolically conforming to regulative policy and stakeholder pressure without necessarily making any genuine commitment to carbon reduction (Haque and Ntim, 2018).

At firm level, in an era of constraints of natural resources and socio-environmental pressures, corporate commitment to better climate change practices has been increasingly pushed to the forefront of corporate decision-making (Gerged et al., 2021). On the one hand, firms can demonstrate better commitment to climate change by implementing new practices to prevent or reduce environmental damage and facilitate waste recycling and energy saving, which reflect more commitment to climate change (Erdoğan et al., 2020). Eco-innovation can improve energy efficiency and consequently reduce energy consumption and carbon emissions in the production process (Kesidou and Demirel, 2012; Lin and Zhu, 2019). On the other hand, there is a need for transition in corporate governance to a focus on corporate climate governance and to go beyond the general corporate governance mechanisms which do not necessarily capture corporate commitment to climate change issues (Bui et al., 2020).

This study empirically examines the effect of eco-innovation and climate governance on corporate commitment to climate change. We use different proxies for measuring eco-innovation: first by applying the Thomson Reuters Eikon score, which reflects a company's capacity to reduce environmental costs and burdens for its customers, thereby creating new market opportunities through improving existing environmental technologies; second, by creating an index computed as a composite score by totalling five proxies related to corporate eco-innovation collected from the Eikon database which reflect companies' practices to reduce environmental impact and capability to develop new environmental technologies. We also investigate the impact of climate governance on climate change commitment by focusing on three proxies for climate governance, namely environmental committee, climate incentives related to the management of climate change issues, and the existence of sustainability reports.

Building on the resource-based view (RBV) and based on a sample of companies listed on the London Stock Exchange (FTSE-All-Share) over the period of 2014–2020 with a total of 2000 firm-year observations, we show that corporate eco-innovation is positively associated with corporate climate change commitment. Companies with a higher eco-innovation score are more committed to climate change. Firms that adopt innovative approaches to efficiently control pollution and resource use and reduce their environmental impact are more committed to climate change. Further climate governance is positively associated with corporate commitment to climate change, suggesting that companies with a governance system that integrates climate change into corporate strategies can help address climate change issues and improve commitment to climate change. The results regarding the relationship between eco-innovation and commitment to climate change hold for large companies and in firms with a strong financial position, suggesting that highly visible companies face pressures from stakeholders to engage in eco-innovation strategies. The results regarding the effect of climate governance hold regardless of the firm's size and its financial position. Our results are robust to endogeneity concerns, which were addressed by propensity score matching (PSM), Heckman two-step approach, and entropy balancing technique. Finally, we run additional analyses using alternative measures of the dependent variable and the results hold.

This paper contributes to the literature in several ways. First, this paper contributes to the emerging literature on corporate commitment to climate change. Unlike existing studies which use either CO_2 emissions score or carbon disclosure as proxies for climate change practice (e.g. Afrifa et al., 2020; Ben-Amar and McIlkenny, 2015), we develop a unique measure for corporate climate change commitment by considering four components, namely whether a company supports Sustainable Development Goal 13 (SDG 13) on climate action, whether a company is aware that climate change can represent commercial risks or opportunities, whether a company reports Scope 3 CO_2 emissions and whether a company sets a target for emission reduction. Because of the challenges of measuring the overall corporate commitment to climate change, we argue that using a single proxy such as CO_2 emissions or carbon disclosure would not capture the real commitment of firms to climate change, as a single proxy represents an approximate measure of climate change and there are other factors that would contribute (and will need to be factored in) to understanding to what extent companies are committed to climate change. For example, SDG 13 calls for urgent action to combat climate change and its impact. Companies that support SDG 13 on climate action show awareness and commitment to cutting their emissions. Moreover, if a company supports SDG 13 and sets a target for emissions reduction, it shows more commitment to climate change.

Second, to the best of our knowledge, this paper is the first in this domain to examine the effect of corporate eco-innovation on corporate commitment to climate change. As shown, prior studies focused on eco-innovation and environmental outputs such as CO_2 emissions (Albitar et al., 2022; Lin and Zhu, 2019; Mongo et al., 2021). For example, Mongo et al. (2021) use patent data to measure environmental innovations when examining the effects of environmental innovations on CO_2 emissions. Albitar et al. (2022) use a single measure, which is environmental innovation scores provided by the Eikon database, to approximate environmental innovation when exploring the effect of environmental innovation on CO_2 emissions. Lin and Zhu (2019) regard CO_2 emissions as a proxy for climate change when exploring the relationship between renewable energy technological innovation and climate change. We differ from prior studies by taking this further and using alternative measures of eco-innovation and climate change commitment which support the robustness of our findings. We take existing literature further by showing that corporate eco-innovation is positively associated with corporate commitment to climate change. Firms with eco-innovation have more knowledge, experience and other resources to adapt innovative approaches that can help to efficiently control pollution and resource use to reduce their environmental impact, and thus are more committed to climate change.

Third, unlike prior research which is focused on either innovation input proxied by the percentage of R&D expenditure to GDP (Afrifa et al., 2020) or environmental innovation scores (Albitar et al., 2022; Nadeem et al., 2020; Zaman et al., 2021), we move beyond a simple proxy of eco-innovation by creating a measure computed as a composite score by totalling five eco-innovation proxies that reflect companies' efforts to reduce the impact on the environment through responsible use of natural resources, including energy, and developing new products or services that provide a better quality of life for all. We argue that those proxies capture the real effort of companies to devote more resources to environmental innovation activities which are likely to be associated with their commitment to climate change. Further, Krieger and Zipperer (2022) use innovation intensity measured by innovation expenditures over revenues to proxy innovation inputs. Garcés-Ayerbe et al. (2019) use survey questions about firms' innovations to calculate eco-innovation intensity variables. In our paper, we capture the eco-innovation effort of companies by using eco-innovation intensity measured as environmental expenditures over revenues.

Fourth, unlike prior studies that explore the impact of environmental governance on disclosure behaviour (Bui et al., 2020), or that consider the moderating role of environmental governance on the business environmental innovation–CO_2 emissions nexus (Albitar et al., 2022), our paper contributes to the literature by examining the effect of climate governance on corporate commitment to climate change. We provide insights into whether governance mechanisms that are tailored towards the environment are associated with corporate commitment to climate change. Environmental governance is anticipated to be responsive to stakeholder concerns about climate change and has a crucial role to play in helping companies adapt to new climate requirements.

The remainder of the paper is structured as follows. Section 2 discusses the theory and hypothesis development. Section 3 discusses the research design, including data and sample, variable measurement and model specifications. Section 4 reports and discusses the findings. Section 5 concludes the research.

2. Theory and hypothesis development

2.1. Resource-based view

A company is a bundle of resources and capabilities, with capabilities referring to a firm's ability to efficiently deploy relevant resources (input) to achieve desirable goals (output) (Amit and Schoemaker, 1993). According to the RBV, there is a direct link between a firm's sustained competitive advantage and its valuable, rare, imperfectly imitable and non-sustainable resources and capabilities, such as management skills, organizational processes and governance, and the information and knowledge it controls (Barney, 2001). To establish corporate capability, the business must adapt to changing strategic needs by establishing internal structures and processes to build its specific competences (Ulrich and Lake, 1991).

RBV suggests that firm-specific resources and capabilities are crucial to explain firm performance (Amit and Schoemaker, 1993). Existing climate change studies that take an RBV perspective are largely based on the premise that environmental engagement entails significant costs, which more profitable firms should be better able to incur (Qiu et al., 2016). However, in a longitudinal study of the five largest European oil and gas firms (BP, Total, Shell, BG Group and Eni), Dragomir (2012) finds these firms have unexplained carbon emission figures and methodological inconsistencies in their corporate reports. Moreover, firms' environmental disclosure is found to be decoupled from their actual environmental performance (Bowen, 2014); firms symbolically conform to regulative institutional policy and stakeholder pressure without substantively improving their actual environmental performance (Haque and Ntim, 2018), and employ selective disclosure techniques to produce a decoupling of carbon disclosure between the traditional communication channels and the Carbon Disclosure Project (CDP) channel (Depoers et al., 2016). We could summarize that not all firms with superior resources are competent to turn the resources they own into competitive advantage.

It is therefore important to think beyond the premise of owning and controlling superior assets and resources of RBV, and consider managerial intention and a firm's capability to effectively and continuously reconfigure and upgrade critical resources to address the fast-changing environment, which is usually referred to as dynamic capability (Huang and Li, 2017; Zahra et al., 2022). In other words, it is the capability to convert the resources a firm controls into its core competence and competitive advantage. Extant literature highlights the organizational factors that could make dynamic capability more actionable. Entrepreneurial scholars assert that innovative centres provide a strong foundation for conceiving novel ways to identify and seize opportunities, reallocate resources and reconfigure organizational processes (Zahra et al., 2022). Eco-innovation needs to be driven by both internal and external knowledge and resources (Chang, 2011; Marzucchi and Montresor, 2017), and is connected to the production, marketing and other operational centres that could further help in articulating and building green competence. Another factor is the corporate governance mechanism led by the top-management team. Executives play an important role in setting priorities that stimulate the process of capability deployment. The corporate governance system not only shapes and monitors the operation of the business, but also pays attention to the underlying business processes to make the business capabilities strategically focused, actionable and contemporary (Zahra et al., 2022).

Taking the RBV, we expect that firms with strong climate change governance and eco-innovation strategies are capable of identifying and adapting to the fast-changing needs of climate change ahead of their competitors. On the one hand, eco-innovation and climate change governance are the outcome of a firm's endeavour to construct its green competence, which is embedded in all aspects of the business processes. On the other hand, they are also the input that makes corporate climate engagement actionable. Firms with climate governance and eco-innovation strategies could better utilize their existing resources and know-how to make a genuine commitment to climate change ahead of their competitors. In contrast, firms without such an established governance system and eco-innovative background would find it challenging to respond to the climate change pressure and could only react symbolically.

2.2. Eco-innovation and climate change commitment

Eco-innovation is the technical advance by which firms implement new practices, processes and products to prevent or reduce environmental damage and facilitate waste recycling and energy saving (Cainelli et al., 2020; Chen et al., 2006; Krieger and Zipperer, 2022; Rennings, 2000). Differing from general innovation, eco-innovation places emphasis on sustainability development and is motivated by concerns about environmental issues. The primary objective of eco-innovation is to improve environmental sustainability, such as reducing environmental burdens or meeting ecologically specified sustainability targets. Consequently, from the environmental policy and economic perspective, firms are not always motivated to engage in eco-innovation due to its double externality (Baumol and Oates, 1976; Rennings, 2000), greater uncertainty and market failure (Horbach et al., 2012; Weitzman, 2007). So, most of the existing studies on eco-innovation focus on the determinant of eco-innovation (Cainelli et al., 2015; Horbach, 2008; Krieger and Zipperer, 2022) and environmental policy instruments (Borghesi et al., 2015; Costantini and Mazzanti, 2012; Kemp and Pontoglio, 2011; Rennings, 1998; Requate, 2005).

Compared with the determinant studies of eco-innovation, studies on the implications of eco-innovation, especially on climate change, are limited at both macro and micro level and achieve contradictory results (Afrifa et al., 2020; Chen et al., 2006; Erdoğan et al., 2020; Ge et al., 2018; Lin and Zhu, 2019; Mongo et al., 2021). For instance, Lin and Zhu (2019) suggest that innovation can improve energy efficiency and consequently reduce energy consumption and carbon emissions in the production process. However, through a study of the most developed European countries over 23 years, Mongo et al. (2021) find such an effect can only be observed in the long term and, in the short term, the effect is the opposite. Du et al. (2019) observe that the mitigation effect of green innovation only exists in economies with a high income level, using a panel data of 71 economies from 1996 to 2012. Erdoğan et al. (2020) also suggest the emission reduction effect varies between sectors, e.g. no significant effect is found in the energy and transport sectors, while a negative effect is found in the industrial sector and a positive effect is found in the construction sector. Most of the extant studies on the carbon emission mitigation effect of eco-innovation are at macro level and the research at micro level remains scarce.

At micro level, innovation scholars find that eco-innovation helps firms gain sustainable competitive advantage (Ge et al., 2018) and firms use eco-innovation to enhance environmental management performance to satisfy the requirements of environmental protection (Chen et al., 2006). The way in which eco-innovation influences corporate climate change engagement is under-studied, even though there are significant implications – not least for the corporate social and environmental responsibility literature. Different from traditional innovation, eco-innovation has a higher capital cost and greater uncertainty, a delayed payback period and a high failure-to-success ratio (Zaman et al., 2021). Moreover, in contrast to start-ups dedicating themselves to a green focus and green mission, finding a match between green technology opportunities and internal competences and diversifying into green markets is challenging and complex for most established companies (Wicki and Hansen, 2019). Therefore, eco-innovation requires more input from top managers and managerial environmental awareness (Peng and Liu, 2016), organizational internal capabilities (Salim et al., 2019) and more diversified knowledge resources (Conti et al., 2018; Martínez-Ros and Kunapatarawong, 2019).

General innovation theory emphasizes firms' technological capabilities, which comprise the physical and knowledge capital stock of a firm to develop new products and processes (Baumol, 2002; Horbach, 2008; Rennings, 1998). Baumol (2002) also suggests that the technological capabilities (e.g. accumulation of human capital, available knowledge) induces further innovation. In a similar vein, we suggest that eco-innovation is the outcome of resource orchestration and represents a firm's capability and competence to deal with environmental affairs such as climate change. From a legitimacy perspective, many existing climate change studies indicate that firms engage in climate change disclosures and carbon reductions to manage the legitimacy gap as a result of increased public concern about climate change (Talbot and Boiral, 2018) and to avoid economic penalties (Matsumura et al., 2014). Firms also symbolically conform to regulative policy and stakeholder pressure without necessarily making any genuine commitment to carbon reduction (Haque and Ntim, 2018). We argue that this may be due to the timescale involved in eco-innovation and the transition to a low-emission economy involves major changes in crucial economic and social sub-systems and may take centuries to achieve.

From the RBV, firms with eco-innovation have more internal and external knowledge, experience and other resources to adapt to environmental change flexibly and easily, and even commit to carbon reduction at a lower cost. Based on the above discussion, we posit the following hypothesis:

H1. : Corporate eco-innovation is positively associated with corporate commitment to climate change.

2.3. Climate governance and climate change commitment

Corporate governance is defined as the distribution of rights and responsibilities within the firm, which involves the allocation of power and resources to different corporate actors and managing the inevitable tension among these actors (Aguilera et al., 2021). Existing studies find corporate governance plays an important role in carbon disclosure and carbon emission performance (Ben-Amar et al., 2017; Bui et al., 2020; Haque and Deegan, 2010; Haque et al., 2016; Liao et al., 2015; Moussa et al., 2019; Post et al., 2011). Haque and Ntim (2018) evidence that executive management and independent boards tend to respond to the enactment of the Climate Change Act by symbolically undertaking climate protection initiatives without demonstrating substantive improvement in actual carbon performance. Prior research into corporate governance has not captured the extent to which a firm's board is committed to climate issues (Bui et al., 2020).

From the RBV perspective, we contend that even though independent directors may have inadequate power and remit to compel powerful executives for long-term financial and other resources in carbon reduction, the environmental committee would constantly push for environmental strategy and practice within the business and eventually institutionalize climate change governance, which forms part of a firm's ability to tackle climate change issues. In addition to the environmental committee, the board also employs climate-based compensation packages in the hope of incentivizing self-interested executives to engage in carbon reduction. Existing literature finds that environmental, social and governance-based compensation policy has a positive effect on symbolic carbon reduction initiatives, but no similar effect on the actual carbon emissions (Haque, 2017; Haque and Ntim, 2020). Nevertheless, corporate social responsibility (CSR) scholars argue that social and environmental-based compensation is likely to promote good social and environmental performance (Campbell et al., 2007), in addition to steering executives to adopt longer time horizons and strengthening the relationship with firms' stakeholders (Flammer et al., 2019). Moreover, the compilation and publication of standalone CSR reports also signifies a firm's special effort and commitment to improving transparency regarding their long-term performance (Dhaliwal et al., 2011). Firms issuing standalone CSR reports or integrated reports provide higher-quality information than firms that include their CSR information within the annual financial reports. CSR reports are more comprehensive and contain better-quality information than integrated reports (Romero et al., 2019) which demonstrate a firm's resources and capability to commit to climate change issues.

Corporate carbon reduction is a political project since it entails a change in the structures of corporate governance in a way that shifts attention towards environmental objectives and engagement of environmental non-governmental organizations in governance processes (Kolk et al., 2008). Such transition often requires substantial investments with long-term strategic implications and significant multi-level co-ordination among various parties who compete for firm resources (Aguilera et al., 2021). Khanna et al. (2009) evidence that senior management commitment, teamwork, empowerment of employees at all levels and all other techniques involved in environmental management can enable firms to become aware of inefficiencies and find new ways to increase efficiency and reduce the costs of emission control.

Integrating climate change issues at the board level is a strong indicator of a company's commitment to addressing climate change (Bui et al., 2020). The board provides the necessary governance support for this configuration and facilitates access to resources to improve firm performance since it is formed to calibrate the firm's management structure on behalf of shareholders (Jain and Zaman, 2020; Kim et al., 2009). Ignoring the need for such transition in corporate governance could threaten the firm's competitive advantage and ultimately jeopardize its financial performance (Ben-Amar and McIlkenny, 2015; Haque et al., 2016). Extant studies largely focus on the general corporate governance mechanisms and do not capture corporate boards' commitment to climate change issues (Bui et al., 2020), and Jain and Zaman (2020) argue that specific boards' characteristics may have a dissimilar impact on different environmental sustainability outcomes. Focusing on corporate climate governance specifically, we posit that environmental-oriented corporate governance forms a firm's resource and capability which enables the firm to commit to carbon reduction and other climate change matters. Based on the above discussion, we hypothesize that:

H2. : Corporate climate governance is positively associated with corporate commitment to climate change.

3. Research method

3.1. Sample selection

Our study is based on an initial sample of companies listed on the London Stock Exchange (FTSE-All-Share) over a seven-year period of 2014–2020. The chosen period is appropriate for our study as it allows us to investigate the recent policies and updates related to climate change, including the initiation of the mandatory disclosure of greenhouse gas (GHG) emissions (Scope 1 and Scope 2) in 2013. Companies that report their Scope 3 GHG emissions show better commitment to climate change because it is still a voluntary act, and it was not included in the mandatory disclosure requirements. We use two databases to collect our variables: the Eikon database to collect eco-innovation data, financial variables and industry affiliations, and the Bloomberg database to collect climate governance and board variables. We merge the two datasets collected from Eikon and Bloomberg. As a result, we lose observations due to the merge and have missing data on the board and

Table 1
Variable definitions.

Climate_*commit*	Corporate climate commitment index computed as a composite score by totalling the four climate commitment components: (i) An indicator variable takes a value of 1 if the company supports SDG 13 on climate action, 0 otherwise; (ii) Climate change commercial risk opportunities: an indicator variable takes a value of 1 if the company is aware that climate change can represent commercial risks or opportunities, 0 otherwise; (iii) Scope 3 CO_2 emissions: an indicator variable takes a value of 1 if the company discloses its Scope 3 emissions, 0 otherwise; and (iv) Emission reduction target: an indicator variable takes a value of 1 if a firm sets a target for emission reduction, 0 otherwise.
Eco-innovation_*score*	A score that reflects a company's capacity to reduce the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies; it ranges from 0 to 100.
Eco-innovation_*index*	Eco-innovation index computed as a composite score by totalling five eco-innovation proxies: (i) Environmental product: an indicator variable takes a value of 1 if the company reports on at least one product line or service that is designed to have a positive effect on the environment, 0 otherwise; (ii) Environmental asset under management: an indicator variable takes a value of 1 if the company reports on assets under management which employ environmental screening in the investment selection process, 0 otherwise; (iii) Product environmentally responsible use: an indicator variable takes a value of 1 if the company reports on product features or services that will promote responsible, efficient, cost-effective and environmentally preferable use, 0 otherwise; (iv) Renewable/clean energy product: an indicator variable takes a value of 1 if the company develops products or technologies for use in the clean renewable energy sector, 0 otherwise; and (v) Eco-design product: an indicator variable takes a value of 1 if the company reports on specific products which are designed for reuse and recycling, 0 otherwise.
Eco-innovation intensity	Environmental expenditure divided by total sales.
ENV_*committee*	An indicator variable that equals 1 if a board-level environmental committee exists, 0 otherwise.
Climate_*incentive*	An indicator variable that equals 1 if the company provides incentives for individual management of climate change issues, 0 otherwise.
SUS_*report*	An indicator variable that equals 1 if a firm publishes sustainability reports, 0 otherwise.
Climate_*gov*	Strength of climate governance of a firm, computed as a composite score by totalling the three environmental governance components (i.e. ENV_*committee* (0–1), Climate_*incentive* (0–1) and SUS_*report* (0–1)). Hence, the composite score ranges from 0 to 3.
BODSIZE	Number of board members.
BODIND	Proportion of independent directors on the board.
BODMEET	Number of board meetings.
SIZE	Natural log of total assets.
ROA	Return on assets measured by net income to total assets.
Liquidity	Current assets over current liabilities ratio.
MTB	Company market value divided by book value of equity.
INTANG_*intensity*	Intangible asset intensity measured by total intangible assets divided by total assets.
FCF	Free cash flow measured by cash flow from operations divided by sales.
CAP_*intensity*	Capital intensity measured by firm's capital divided by total sales.
ENV_*train*	An indicator variable takes a value of 1 if the company sets an environmental training programme, 0 otherwise.

financial variables. Our final dataset corresponds to an unbalanced panel covering the reference years 2014–2020. There are 298 unique firms in 2014; 299 firms in 2015; 286 firms in 2016; 286 firms in 2017; 281 firms in 2018; 280 firms in 2019; and 270 firms in 2020. We have a final sample of 2000 firm-year observations.

Table 2
Descriptive statistics.

Variable	Mean	SD	Max	Min
Climate_*commit*	1.269	1.063	3.000	0.000
Eco-innovation_*score*	22.392	30.141	99.752	0.000
Eco-innovation_*index*	1.629	1.986	4.000	0.000
Eco-innovation_*intensity*	6.534	11.757	71.657	7.051
ENV_*committee*	0.476	0.500	1.000	0.000
Climate_*incentive*	0.217	0.412	1.000	0.000
SUS_*report*	0.642	0.480	1.000	0.000
Climate_*gov*	1.335	1.109	3.000	0.000
BODSIZE	8.608	2.121	16.000	1.000
BODIND	0.235	0.116	0.600	0.000
BODMEET	8.857	3.736	48.000	0.000
SIZE	20.870	1.568	26.410	10.820
ROA	0.051	0.102	0.687	−1.730
Liquidity	1.862	1.783	11.694	0.242
MTB	3.043	5.392	33.300	−21.380
INTANG_*intensity*	0.394	0.660	9.302	0.000
FCF	0.113	0.980	1.603	−36.157
CAP_*intensity*	7.088	1.405	12.188	0.789
ENV_*train*	0.547	0.497	1.000	0.000

Variables winsorized to adjust for outliers. Variables are as defined in Table 1.

3.2. Variables definitions and measurement

3.2.1. Corporate commitment to climate change

Our dependent variable is the corporate commitment to climate change. This study provides a unique measurement for corporate climate commitment by developing an index computed as a composite score by totalling four climate commitment components:

(i) SDG 13 on climate action: this indicator variable was constructed from Thomson Reuters and takes a value of 1 if the company supports SDG 13 on climate action, 0 otherwise. The key purpose of SDG 13 is to encourage companies to take urgent action to combat climate change and its impacts by reducing emissions and developing practices that help to increase climate change mitigation by integrating climate change measures into policy and planning. Companies that support SDG 13 take urgent action to combat climate change and its impact. We consider that firms that support SDG 13 are likely to be committed to climate change.[1]

(ii) Climate change commercial risk opportunities: an indicator variable takes a value of 1 if the company is aware that climate change can represent commercial risks or opportunities, 0 otherwise. This indicator was constructed from Thomson Reuters and as described in the database, companies take climate change as a business opportunity and develop new products and services. Companies that are aware of climate risks and opportunities may develop new products and services to overcome the threats of climate change to the existing business model of the company and consider climate change a business opportunity. Therefore, those companies may have better commitment to climate change.

(iii) Scope 3 CO_2 emission: an indicator variable takes a value of 1 if the company discloses its Scope 3 emissions, 0 otherwise. This indicator was constructed based on the data available on Thomson Reuters. Thomson Reuters follows GHG protocol for all emission classifications. Scope 3 emissions include emissions from contractor-owned vehicles, employee business travel, waste disposal, emissions from product use by customers and emissions from the production of purchased materials, so Scope 3 emissions can be described as the outcome of activities of assets not owned or controlled by the company, but that the company indirectly impacts in its value chain. Following the mandatory carbon reporting requirement that came into force in October 2013 in the UK,

[1] The UN General Assembly proposed a document containing 17 goals in 2014 to be put forward for the General Assembly's approval in 2015. This document set the ground for the SDGs and the global development agenda spanning from 2015 to 2030.

Table 3
Correlation matrix.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Climate_commit	1.000															
Eco_innovation_score	0.3539*	1.000														
ENV_committee	0.4012*	0.1504*	1.000													
Climate_incentive	0.1967*	0.1026*	0.2998*	1.000												
SUS_report	0.2589*	0.0812*	0.6477*	0.3316*	1.000											
BODSIZE	0.3346*	0.1313*	0.2142*	0.0733*	0.1230*	1.000										
BODIND	0.2963*	0.2030*	0.1001*	0.1066*	0.1464*	0.0606*	1.000									
BODMEET	−0.002	−0.0471*	0.002	0.013	0.034	−0.0789*	0.040	1.000								
SIZE	0.4172*	0.2643*	0.4982*	0.2607*	0.4976*	0.5564*	0.1848*	−0.0622*	1.000							
ROA	−0.0469*	−0.007	−0.0405*	−0.017	0.013	−0.014	0.001	−0.1394*	−0.0975*	1.000						
Liquidity	−0.007	0.0538*	−0.0488*	−0.028	−0.0665*	−0.0756*	0.0723*	−0.0493*	−0.021	0.025	1.000					
MTB	0.009	−0.042	−0.031	−0.016	−0.011	0.007	0.0497*	0.020	−0.0436*	0.1168*	−0.027	1.000				
INTANG_intensity	0.008	−0.0974*	0.034	−0.004	0.038	0.1207*	0.0500*	0.018	0.1311*	−0.1913*	−0.045*	0.016	1.000			
FCF	0.017	0.0588*	0.034	0.024	0.033	0.021	−0.023	−0.0684*	0.0466*	0.1642*	0.026	−0.005	−0.067*	1.000		
CAP_intensity	0.049*	0.071*	−0.051*	−0.126*	−0.111*	0.079*	−0.087*	−0.053*	0.107*	−0.174*	0.101*	−0.188*	0.118*	−0.041*	1.000	
ENV_train	0.293*	0.141*	0.335*	0.143*	0.246*	0.184*	0.060*	−0.037	0.276*	−0.065*	−0.025	−0.029	−0.034	0.028	−0.042	1.000

This table reports the Pearson correlation matrix between the variables used in the analyses (two-tailed test). We use the command: pwcorr varlist, star (0.05) where the star (0.05) option requests that an asterisk be printed for correlation coefficients with *p*-values of 0.05 or lower. Variables are as defined in Table 1.

companies are required to report their Scope 1 and Scope 2 GHG emissions as part of their annual report (Tang and Demeritt, 2018). Reporting of Scope 3 is still voluntary as it is hard to monitor, whereas Scopes 1 and 2 are mandatory. We argue that firms that report Scope 3 emissions are more committed to climate change.

(iv) Emission reduction target: an indicator variable takes a value of 1 if a firm sets a target for emission reduction, 0 otherwise. We constructed this variable from Thomson Reuters which provides data about the target emission reduction percentage until a specific future year. We used a dummy variable to identify whether a firm sets a target for emission reduction or not. Firms setting a target to reduce carbon emissions reflect a commitment to climate change.

3.2.2. *Corporate eco-innovation*

The study uses eco-innovation score constructed from Thomson Reuters as the first independent variable. The Thomson Reuters Eikon eco-innovation score reflects a company's capacity to reduce environmental costs and burdens for its customers, and thereby creates new market opportunities through improvement in existing environmental technologies and processes or eco-designed products or processes. The eco-innovation score ranges from 0 to 100 and this score has been used in recent research (e.g. Nadeem et al., 2020; Zaman et al., 2021).[2]

As an alternative measure to eco-innovation, we created an index computed as a composite score by totalling five eco-innovation proxies collected from the Eikon database that reflect companies' efforts to reduce the impact on the environment through responsible use of natural resources, including energy, and developing new products or services that provide a better quality of life for all. These proxies are: (i) Environmental product: an indicator variable takes a value of 1 if the company reports on at least one product line or service that is designed to have a positive effect on the environment, 0 otherwise; (ii) Environmental asset under management: an indicator variable takes a value of 1 if the company reports on assets under management which employ environmental screening in the investment selection process, 0 otherwise; (iii) Product environmentally responsible use: an indicator variable takes a value of 1 if the company reports on product features or services that will promote responsible, efficient, cost-effective and environmentally preferable use, 0 otherwise; (iv) Renewable/clean energy product: an indicator variable takes a value of 1 if the company develops products or technologies for use in the clean renewable energy sector, 0 otherwise; and (v) Eco-design product: an indicator variable takes a value of 1 if the company reports on specific products which are designed for reuse and recycling, 0 otherwise. Hence, the composite score ranges from 0 to 5.

Further to that, Krieger and Zipperer (2022) use innovation intensity measured by innovation expenditures over revenues to proxy innovation inputs. Garcés-Ayerbe et al. (2019) use survey questions about firms' innovations to calculate eco-innovation intensity variables. In our paper, we capture the eco-innovation effort of companies by using eco-innovation intensity measured as environmental expenditures over revenues.

3.2.3. *Climate governance*

Climate governance is our second independent variable. We follow Bui et al. (2020) to construct this variable by using the following indicators to assess the climate governance of a company. We examine whether the company has a board-level environmental committee that

[2] Following the methodology described in Supplementary material S1 of Zaman et al. (2021), “Thomson Reuters Eikon uses the percentile rank scoring method to calculate the eco-innovation score that is based on three factors, namely: i) numbers of companies that worse than the current one; ii) number of companies that have the same value; and iii) number of companies that have a value at all. This is by using the Thomson Reuters Business Classification industry group as a benchmark” (Zaman et al., 2021).

Table 4
The impact of the corporate eco-innovation score and climate governance on climate change commitment.

Variable	Climate_*commit*	Climate_*commit*	Climate_*commit*	Climate_*commit*
	Model 4.1	*Model 4.2*	*Model 4.3*	*Model 4.4*
Eco_innovation_*score*	0.0108***		0.0106***	0.0104***
	[3.51]		[3.46]	[3.42]
ENV_committee		0.6481***	0.6518***	
		[3.81]	[3.87]	
Climate_incentive		0.2731**	0.2388*	
		[2.10]	[1.83]	
SUS_report		0.3508**	0.3449**	
		[2.24]	[2.20]	
Climate_*gov*				0.4459***
				[4.38]
BODSIZE	0.0823**	0.0810**	0.0791**	0.0808**
	[2.11]	[2.05]	[1.97]	[2.06]
BODIND	1.9613***	2.0773***	1.8466***	1.8447***
	[2.92]	[2.98]	[2.64]	[2.65]
BODMEET	0.0005	0.002	0.0012	0.0019
	[0.03]	[0.10]	[0.06]	[0.10]
SIZE	0.1114*	0.0866**	0.0476**	0.0593*
	[2.36]	[2.11]	[2.57]	[1.71]
ROA	−0.1183	0.2145	0.0903	0.0938
	[−0.15]	[0.28]	[0.12]	[0.12]
Liquidity	0.0693*	0.0716**	0.0679**	0.0715*
	[1.59]	[2.54]	[2.49]	[1.89]
MTB	0.008	0.0081	0.0112	0.0122
	[0.68]	[0.71]	[0.94]	[1.01]
INTANG_*intensity*	0.3637**	0.2652*	0.3409**	0.3500**
	[2.32]	[1.75]	[2.17]	[2.22]
FCF	−0.1017	−0.0932	−0.1142	−0.1158
	[−0.99]	[−0.79]	[−0.97]	[−0.98]
CAP_*intensity*	−0.106	−0.0322	−0.0656	−0.0576
	[−1.19]	[−0.35]	[−0.74]	[−0.65]
ENV_*train*	0.3216**	0.1502	0.136	0.159
	[2.00]	[0.91]	[0.81]	[0.97]
Industry	Included	Included	Included	Included
Year	Included	Included	Included	Included
Intercept	−1.8897	−2.4931	−1.6436	−1.9623
	[−1.03]	[−1.41]	[−0.88]	[−1.07]
R-squared	0.223	0.251	0.251	0.25
N	2000	2000	2000	2000

Variables are as defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

discusses and promotes environmental issues. ENV_*committee* is a binary variable that takes a value of 1 if an environmental committee exists, 0 otherwise. We also investigate whether, for executives, there is some form of incentive related to environmental issues. Climate_*incentive* is an indicator variable that equals 1 if the company provides incentives for individual management of climate change issues, 0 otherwise. Finally, we check whether a company publishes a sustainability report (SUS_*report*), using an indicator variable that equals 1 if a firm publishes a sustainability report, 0 otherwise. All these indicators were constructed from Thomson Reuters and our composite measure of the climate governance strength of a firm is computed by totalling the three components discussed above. Hence, the composite score ranges from 0 to 3.

3.2.4. Control variables

In testing our model, we control for board of directors and firm-specific variables identified from prior studies as potential determinants of corporate commitment to climate change (e.g. Backman et al., 2017; Marquis and Qian, 2014; Tavakolifar et al., 2021). We control for board size (BODSIZE), measured by the total number of directors serving on the board; board independence (BODIND), measured by the proportion of independent directors to the total number of directors on the board; and board meeting (BODMEET), measured by the frequency of board meetings. Finally, we control for firm-specific variables. These are: firm size (SIZE), measured by the natural logarithm of total assets; firm profitability (ROA), measured by net income before extraordinary items divided by total assets; liquidity ratio, measured by current assets over current liabilities; market to book ratio (*MTB*), measured by the company's market value scaled by its book value; intangible asset intensity (*INTANG_intensity*), measured by the company's total intangible assets scaled by its total assets; free cash flow (FCF), measured by the company's cash flow from operations divided by its total assets; capital intensity, measured by the firm's capital divided by total sales (Krieger and Zipperer, 2022; Nadeem et al., 2020); and environmental training initiative, as environmental training may encourage firms to enhance their environmental innovation (Antonioli et al., 2013). We use a dummy variable which takes a value of 1 if the company sets an environmental training programme, 0 otherwise. Finally, we control for industry and year dummies.

3.3. Empirical model

To examine the impact of eco-innovation and climate governance on corporate commitment to climate change, we use the empirical models below. Eq. (1) includes the individual components of climate governance, and Eq. (2) replaces them with the climate governance composite

Table 5
The impact of the corporate eco-innovation index and climate governance on climate change commitment.

Variable	Climate_commit	Climate_commit	Climate_commit	Climate_commit
	Model 5.1	Model 5.2	Model 5.3	Model 5.4
Eco_innovation_index	0.1888***		0.1745***	0.1700***
	[4.36]		[3.95]	[3.87]
ENV_committee		0.6481***	0.6437***	
		[6.36]	[6.29]	
Climate_incentive		0.2731***	0.2428**	
		[2.60]	[2.29]	
SUS_report		0.3508*	0.3418*	
		[1.90]	[1.85]	
Climate_gov				0.4430***
				[6.45]
BODSIZE	0.0924***	0.0810***	0.0874***	0.0886***
	[3.58]	[3.14]	[3.33]	[3.41]
BODIND	1.9975***	2.0773***	1.8823***	1.8866***
	[4.60]	[4.65]	[4.15]	[4.15]
BODMEET	−0.0001	0.002	0.0008	0.0016
	[−0.01]	[0.16]	[0.07]	[0.14]
SIZE	0.1277***	0.0866**	0.0664	0.0778*
	[2.94]	[2.03]	[1.51]	[1.76]
ROA	−0.1231	0.2145	0.0867	0.0896
	[−0.23]	[0.38]	[0.16]	[0.16]
Liquidity	0.0633**	0.0716**	0.0637**	0.0673**
	[2.38]	[2.49]	[2.31]	[2.43]
MTB	0.0076	0.0081	0.0107	0.0116
	[0.83]	[0.85]	[1.14]	[1.23]
INTANG_intensity	0.3423***	0.2652***	0.3185***	0.3273***
	[3.30]	[2.62]	[3.03]	[3.11]
FCF	−0.0873	−0.0932	−0.0988	−0.1001
	[−1.34]	[−1.16]	[−1.29]	[−1.32]
CAP_intensity	−0.0953*	−0.0322	−0.0551	−0.0473
	[−1.72]	[−0.55]	[−0.95]	[−0.82]
ENV_train	0.3208***	0.1502	0.1378	0.1614*
	[3.47]	[1.57]	[1.42]	[1.68]
Industry	Included	Included	Included	Included
Year	Included	Included	Included	Included
Intercept	−2.4847**	−2.4931**	−2.2548**	−2.5633**
	[−2.49]	[−2.51]	[−2.22]	[−2.55]
R-squared	0.219	0.25	0.251	0.249
N	2000	2000	2000	2000

Variables are as defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

index. Table 1 provides a complete definition of the study variables. Since our dependent variable is a 0–5 ascending scale variable, we employ an ordered probit specification.[3,4]

$$\begin{aligned} Climate_{commit} = {} & \beta_0 + \beta_1 Eco_{innovation} + \beta_2 ENV_{committee} + \beta_3 Climate_{incentive} \\ & + \beta_4 SUS_{report} + \beta_5 BODSIZE + \beta_6 BODIND + \beta_7 BODMEET \\ & + \beta_8 SIZE + \beta_9 ROA + \beta_{10} Liquidity + \beta_{11} MTB \\ & + \beta_{12} INTANG_{intensity} + \beta_{13} FCF + \beta_{14} CAP_{intensity} \\ & + \beta_{15} ENV\_train + \beta_{16} Industry\ dummies + \beta_{16} Year\ dummies + \epsilon \end{aligned} \tag{1}$$

$$\begin{aligned} Climate_{commit} = {} & \beta_0 + \beta_1 Eco_{innovation} + \beta_2 Climate\_gov + \beta_3 BODSIZE \\ & + \beta_4 BODIND + \beta_5 BODMEET + \beta_6 SIZE + \beta_7 ROA \\ & + \beta_8 Liquidity + \beta_9 MTB + \beta_{10} INTANG_{intensity} + \beta_{11} FCF \\ & + \beta_{12} CAP_{intensity} + \beta_{13} ENV\_train + \beta_{14} Industry\ dummies \\ & + \beta_{15} Year\ dummies + \epsilon \end{aligned} \tag{2}$$

4. Findings

4.1. Descriptive statistics

Table 2 provides descriptive statistics of variables used in the study. The mean value of the climate commitment composite index is 1.27 and it ranges between 0 and 3. The mean value of the eco-innovation score is 22.392 and it ranges between 0 and 99.752, and the mean value of the eco-innovation index is 1.629 and it ranges between 0 and 4. The mean value of eco-innovation intensity is 6.534 measured using environmental expenditure scaled by total sales. On average, 47.6 % of companies have an environmental committee at the board level, 21.7 % of companies provide executive incentives for managing climate change issues and 64.2 % of companies publish stand-alone sustainability reports; the mean value of the climate governance index is 1.335 and it ranges between 0 and 3. We find the mean value of board size is 8.608,

[3] We use the command 'xtoprobit' in Stata. It is noteworthy that the statistic for computing an ordered probit model with fixed effects is extremely complex where estimator is not consistent, and the most appealing alternative is random effects ordered probit.

[4] We employ the Breusch-Pagan test using the 'hettest' command in Stata to test for homoscedasticity. The test shows that the *p*-value is insignificant. Hence, we conclude that heteroscedasticity is not present. We would like to note that despite the absence of heteroscedasticity, all tests use standard errors clustered at the firm level. We also winsorize some of the continuous variables at the 1 % level to adjust for outliers. Winsorized regressors are generally more robust to outliers, and variables are less skewed after winsorizing.

Table 6
The impact of corporate eco-innovation intensity and climate governance on climate commitment.

Variable	Climate_*commit*	Climate_*commit*	Climate_*commit*	Climate_*commit*
	Model 6.1	*Model 6.2*	*Model 6.3*	*Model 6.4*
Eco-innovation_*intensity*	0.0624**		0.0473*	0.0621**
	[2.13]		[1.76]	[2.00]
ENV_*committee*		0.6481***	−0.0064	
		[6.36]	[−0.02]	
Climate_*incentive*		0.2731***	0.7507**	
		[2.60]	[2.06]	
SUS_*report*		0.3508*	0.4585**	
		[1.90]	[2.49]	
Climate_*gov*				0.4407*
				[1.69]
BODSIZE	0.1433	0.0810***	0.1566	0.161
	[1.33]	[3.14]	[1.39]	[1.42]
BODIND	−3.2428*	2.0773***	−4.1732*	−3.7645*
	[−1.73]	[4.65]	[−1.87]	[−1.86]
BODMEET	−0.0442	0.002	−0.0593	−0.0489
	[−1.03]	[0.16]	[−1.39]	[−1.20]
SIZE	0.3424***	0.0866**	0.3589***	0.2915***
	[3.31]	[2.03]	[3.09]	[2.85]
ROA	2.7532	0.2145	3.1782	3.3683
	[1.20]	[0.38]	[1.44]	[1.50]
Liquidity	−0.106	0.0716**	−0.0656	−0.053
	[−1.17]	[2.49]	[−0.72]	[−0.58]
MTB	0.1074	0.0081	0.1421	0.1104
	[1.04]	[0.85]	[1.30]	[1.09]
INTANG_*intensity*	0.3751	0.2652***	−0.4148	−0.2999
	[−1.09]	[2.62]	[−1.13]	[−0.83]
FCF	0.6492	−0.0932	−0.1104	−0.3437
	[0.44]	[−1.16]	[−0.07]	[−0.22]
CAP_*intensity*	−0.1436	−0.0322	−0.0279	−0.0549
	[−0.66]	[−0.55]	[−0.13]	[−0.25]
ENV_*train*	0.7460**	0.1502	0.504	0.5924*
	[2.41]	[1.57]	[1.40]	[1.75]
Industry	Included	Included	Included	Included
Year	Included	Included	Included	Included
Intercept	−7.0924***	−2.4931**	−7.3408**	−7.4885**
	[−2.61]	[−2.51]	[−2.54]	[−2.56]
R-squared	0.219	0.25	0.251	0.249
N	2000	2000	2000	2000

Variables are as defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

the mean value of board independence is 0.235 and the mean value of board meetings is 8.857. Regarding firm-specific variables, we find the mean firm size is 20.870, measured by the natural log of total assets, the mean value of ROA is 0.051, the mean value of liquidity is 1.862, the mean value of market to book ratio is 3.043, the mean value of intangible intensity ratio is 0.394, the mean value of free cash flow ratio is 0.113, the mean value of capital intensity is 7.088 and the mean value of environmental training is 0.547.

Table 3 provides the Pearson correlation between variables included in our empirical model. There is significant and positive association between eco-innovation and corporate climate commitment. This is consistent with hypothesis H1. In other words, companies that adopt eco-innovative strategies are more committed to climate change issues. We also find that climate governance variables including ENV_*committee*, Climate_*incentive* and SUS_*report* are significant and positively associated with Climate_*commit*. This is consistent with hypothesis H2 that companies with strong climate governance are more committed to climate change. Among other variables, we find BODSIZE, BODIND, BODMEET, SIZE and INTANG_*intensity*, CAP_*intensity* and ENV_*train* are significant and positively associated with Climate_*commit*. Variance inflation factor tests show that multicollinearity is not an issue.

4.2. Multivariate analysis

We report the findings of our regression tests in this section. Since Climate_*commit* is a categorical variable that ranges between 0 and 4, we thus use ordinal probit regression. Table 4 tests the effect of eco-innovation and climate governance on climate commitment. We use the stepwise regression approach where, in Model 4.1, we test the impact of Eco-innovation_*score* and other board and firm-specific variables on Climate_*commit*. Model 4.2 tests the impact of climate governance variables and other board and firm-specific variables on Climate_*commit*. Model 4.3 tests the impact of both Eco-innovation_*score* and climate governance variables on Climate_*commit*, and Model 4.4 replaces climate governance individual variables with the composite index, Climate_*gov*. Results show that Eco-innovation_*score* is significant ($p < 0.01$ in Models 4.1, 4.3 and 4.4) and positively associated with Climate_*commit*, thus supporting our first hypothesis that eco-innovation companies are more committed to climate change issues. This finding is consistent with prior research that found investment in innovation reduces corporate carbon emissions and thus shows greater commitment to climate change (Abdelzaher et al., 2020; Afrifa et al., 2020; Lin and Zhu, 2019). Firms that adopt innovative approaches to efficiently control pollution and resource use and reduce their environmental impact are more committed to climate change. Thus, we find support of the first hypothesis.

Table 7
Big size firms vs. small size firms.

Variable	Big size firms		Small size firms	
	Climate_*commit*	Climate_*commit*	Climate_*commit*	Climate_*commit*
	Model 7.1	*Model 7.2*	*Model 7.3*	*Model 7.4*
Eco_innovation_*score*	0.0037***	0.0038***	−0.0078	−0.0036
	[3.20]	[3.28]	[−1.05]	[−0.49]
ENV_*committee*	0.3079***		1.1767***	
	[5.05]		[3.27]	
Climate_*incentive*	0.0819*		0.4879	
	[1.91]		[1.48]	
SUS_*report*	0.1644*		2.6635*	
	[1.68]		[2.28]	
Climate_*gov*		0.1601***		0.8075***
		[4.90]		[3.45]
BODSIZE	0.0043	0.0057	−0.1711**	−0.1286*
	[0.29]	[0.38]	[−2.50]	[−1.95]
BODIND	0.6623***	0.6982***	−2.5771*	−2.3791
	[2.99]	[3.15]	[−1.72]	[−1.55]
BODMEET	0.0028	0.002	−0.0802***	−0.0892***
	[0.53]	[0.36]	[−2.62]	[−2.87]
SIZE	0.2121***	0.2175***	0.4722	0.5251
	[5.77]	[5.91]	[1.33]	[1.51]
ROA	0.3958	0.399	0.6395	−0.4656
	[1.50]	[1.51]	[0.31]	[−0.22]
Liquidity	0.0007	0.0007	−0.0328	−0.0098
	[0.49]	[0.50]	[−0.72]	[−0.22]
MTB	−0.0041	−0.0042	0.0283	−0.4239
	[−1.06]	[−1.07]	[0.05]	[−0.76]
INTANG_*intensity*	−0.0008	−0.0033	−0.0935	−0.4179
	[−0.02]	[−0.07]	[−0.14]	[−0.63]
FCF	0.0303	0.0376	0.0025	−0.1089
	[0.45]	[0.56]	[0.01]	[−0.52]
CAP_*intensity*	−0.1074**	−0.1000**	−0.2999	−0.3354
	[−2.49]	[−2.31]	[−1.05]	[−1.23]
ENV_*train*	0.1074*	0.1273**	−1.0674***	−0.7090**
	[1.90]	[2.26]	[−2.87]	[−2.04]
Industry	Included	Included	Included	Included
Year	Included	Included	Included	Included
Intercept	−2.8319***	−2.9128***	−3.5692	−3.5692
	[−3.16]	[−3.23]	[−0.55]	[−0.55]
R-squared	0.322	0.315	0.272	0.266
N	1760	1760	240	240

Variables are as defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

We find ENV_*committee* is significant ($p < 0.01$ in Models 4.2 and 4.3) and positively associated with Climate_*commit*, Climate_*incentive* is significant ($p < 0.05$ in Model 4.2 and $p < 0.10$ in Model 4.3) and positively associated with Climate_*commit*, and SUS_*report* is significant ($p < 0.05$ in Models 4.2 and 4.3) and positively associated with Climate_*commit*. Model 4.4 shows that the composite index of climate governance variable (Climate_*gov*) is significant ($p < 0.01$) and positively associated with Climate_*commit*. This finding supports the second hypothesis that companies that integrate climate change issues into governance can have a positive effect on corporate commitment to climate change. Firms show a higher commitment to climate change when they have board-level environmental committees that review and discuss environmental matters associated with firms' activities and provide incentives to directors and management for climate change alleviation (Bui et al., 2020). Moreover, companies committed to climate change are likely to use sustainability reports as a channel to communicate with relevant stakeholders.

The results are also economically significant, where economic significance is computed following Huang et al. (2018). For example, Model 4.4 shows that the coefficient of 0.0104 for Eco-innovation_*score* indicates that moving from the first quartile (0.075) to the third quartile (39.32) of Eco-innovation_*score* can increase a firm's commitment to climate change by 40.89 %. Similarly, the coefficient of 0.4459 for Climate_*gov* indicates that moving from the first quartile (0.00) to the third quartile (2.00) of Climate_*gov* can increase a firm's commitment to climate change by 89.18 %.

Among corporate board variables, we find BODIND is significant ($p < 0.01$) and BODSIZE is significant ($p < 0.05$) in all models and positively associated with Climate_*commit*, indicating that companies with larger boards and more independent directors on the board are more likely to be committed to climate change issues. Among firm-specific variables, we find firm size, liquidity and intangible intensity are significant and positively associated with Climate_*commit*. Results suggest that large and financially healthy firms with intangible resources are more committed to climate change. Overall, findings confirm our hypotheses and support the RBV perspective that firms with climate governance and eco-innovation could better utilize their existing resources and respond to the climate change pressure by making genuine commitment to climate change compared to their peers.

Table 5 and Table 6 use alternative measures of corporate eco-innovation. In Table 5, we use our eco-innovation composite index as our independent variable, which is measured by totalling five indicators that reflect the level of environmental eco-innovation in a company. Results are consistent with the main findings, showing that the Eco-innovation_*index* score is significant and positively associated with Climate_*commit* and climate governance variables are significant and

Table 8
High-performing firms vs. low-performing firms.

Variable	Profit-making firms		Loss-making firms	
	Climate_*commit*	Climate_*commit*	Climate_*commit*	Climate_*commit*
	Model 8.1	*Model 8.2*	*Model 8.3*	*Model 8.4*
Eco_innovation	0.1197***	0.1238***	0.1492*	0.1455*
	[3.13]	[3.21]	[1.96]	[1.93]
ENV_*committee*	0.4495***		0.329	
	[5.31]		[1.62]	
Climate_*incentive*	0.0844		0.1749	
	[1.48]		[1.22]	
SUS_*report*	0.2707		0.1766	
	[1.23]		[0.44]	
Climate_*gov*		0.2053***		0.2247**
		[4.46]		[2.25]
BODSIZE	0.0335*	0.0364*	0.0598	0.0589
	[1.66]	[1.80]	[1.56]	[1.60]
BODIND	1.3453***	1.3892***	0.2902	0.2356
	[4.43]	[4.54]	[0.41]	[0.34]
BODMEET	0.0079	0.0072	0.0093	0.0091
	[0.80]	[0.72]	[0.82]	[0.85]
SIZE	0.0851**	0.0929**	0.059	0.0713
	[2.15]	[2.34]	[0.89]	[1.16]
ROA	−0.0106	−0.0102	−0.02	−0.0215
	[−0.37]	[−0.36]	[−0.30]	[−0.33]
Liquidity	−0.0009	−0.0007	0.0045	0.0048
	[−0.18]	[−0.12]	[0.46]	[0.50]
MTB	−0.0369	−0.0378	−0.0603	−0.0639
	[−0.49]	[−0.50]	[−0.75]	[−0.81]
INTANG_*intensity*	−0.0052	−0.0043	0.0227	0.022
	[−0.07]	[−0.06]	[0.12]	[0.13]
FCF	0.0034	0.0106	0.093	0.1024
	[0.06]	[0.19]	[0.89]	[1.01]
CAP_*intensity*	0.1186	0.1576**	0.0191	0.0195
	[1.57]	[2.10]	[0.13]	[0.14]
ENV_*train*	−0.107	−0.2152	−0.0169	−0.0845
	[−0.19]	[−0.38]	[−0.02]	[−0.10]
Industry	Included	Included	Included	Included
Year	Included	Included	Included	Included
Intercept	−0.5751	−0.523	−0.1809	−0.258
	[−0.75]	[−0.70]	[−0.16]	[−0.24]
R-squared	0.3	0.3	0.308	0.307
N	1420	1420	580	580

Variables are as defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

positively associated with Climate_*commit*. In Table 6, we use eco-innovation intensity as a proxy for eco-innovation and show that Eco-innovation_*intensity* is significant and positively associated with Climate_*commit* and climate governance variables are significant and positively associated with Climate_*commit*. Thus, results are generally consistent with the expected impact on relationships and support our hypotheses on the impact of eco-innovation and climate governance on corporate climate commitment.

In a supplementary analysis presented in Table 7 and Table 8, we run the same regression tests after dividing the study's sample based on size and profitability. Large companies with superior financial performance are highly visible and could be subject to intense scrutiny from stakeholders, thus are more likely to be committed to climate change. In Table 7 we divide the sample based on firm size. Companies that employ 250 employees or more are considered large companies, whereas companies below this threshold are considered small companies (Krieger and Zipperer, 2022). Results show that the eco-innovation score is significant and positively associated with Climate_*commit* in large size firms, while it has no impact on small firms. This suggests that highly visible firms face pressures from stakeholders such as environmental groups, regulators and policymakers to engage in eco-innovation strategies that aim to demonstrate progress towards sustainable development. On the other hand, our results show that climate governance, in particular the presence of an environmental committee, is a strong driver of a firm's commitment to climate change regardless of the size of the firm. Climate_*incentive* and SUS_*report* are more likely to affect corporate commitment to climate change in large size firms only.

In Table 8, we divide the sample into firms with strong financial performance and firms with weak financial performance, based on the average ROA. We find that eco-innovation is more likely to play a role in firms with a strong financial position because they have the required resources to adopt eco-innovation practices that help reduce emissions and waste. On the other hand, firms with strong climate governance are more likely to monitor climate change issues regardless of the level of their financial position.

4.3. Endogeneity tests

In this section, we address endogeneity using various techniques. First, we use a firm and year fixed-effects regression model to reduce the risk of potential time-invariant endogeneity threat (Rjiba et al., 2020; Schons and Steinmeier, 2016). The application of the fixed-effect analysis helps lower the potential risk of multicollinearity and estimation bias, and control the omitted variable bias (Wooldridge, 2020) Table 9 replicates the regression tests in Table 4 using the fixed-effect estimation. The results are largely compatible with the baseline analysis for

Table 9
Replicating the regression tests in Table 4 using the fixed-effect estimation.

Variable	Climate_*commit*	Climate_*commit*	Climate_*commit*	Climate_*commit*
	Model 9.1	*Model 9.2*	*Model 9.3*	*Model 9.4*
Eco_innovation_*score*	0.0032**		0.0030**	0.0031**
	[2.32]		[2.13]	[2.28]
ENV_*committee*		0.2939***	0.2835***	
		[4.31]	[4.16]	
Climate_*incentive*		0.0704	0.0709	
		[1.58]	[1.59]	
SUS_*report*		0.1471	0.1604	
		[1.32]	[1.44]	
Climate_*gov*				0.1399***
				[3.98]
BODSIZE	−0.0239	−0.0297*	−0.0277*	−0.026
	[−1.42]	[−1.78]	[−1.67]	[−1.56]
BODIND	0.5463**	0.4933**	0.4478*	0.4870**
	[2.23]	[2.03]	[1.84]	[2.00]
BODMEET	−0.0007	0.0001	0.0003	−0.0005
	[−0.13]	[0.01]	[0.06]	[−0.09]
SIZE	0.2317***	0.2178**	0.1937**	0.1974**
	[2.74]	[2.56]	[2.26]	[2.34]
ROA	−0.1587	−0.1721	−0.1284	−0.1273
	[−0.58]	[−0.63]	[−0.47]	[−0.47]
Liquidity	0.0002	0.0004	0.0004	0.0004
	[0.13]	[0.27]	[0.26]	[0.26]
MTB	−0.0039	−0.0032	−0.0035	−0.0034
	[−0.90]	[−0.75]	[−0.81]	[−0.81]
INTANG_*intensity*	−0.0704	−0.0513	−0.0495	−0.0557
	[−1.22]	[−0.89]	[−0.86]	[−0.97]
FCF	0.004	0.009	0.0053	0.0044
	[0.05]	[0.11]	[0.07]	[0.06]
CAP_*intensity*	−0.1378**	−0.1439**	−0.1442**	−0.1336*
	[−1.97]	[−2.07]	[−2.07]	[−1.92]
ENV_*train*	0.1239*	0.0961	0.0887	0.1019
	[1.93]	[1.50]	[1.39]	[1.59]
Industry	Included	Included	Included	Included
Year	Included	Included	Included	Included
Intercept	−2.2354	−2.1631	−1.7276	−1.8058
	[−1.32]	[−1.28]	[−1.02]	[−1.07]
R-squared	0.2692	0.2833	0.2869	0.2815
N	2000	2000	2000	2000

Variables are as defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

which corporate eco-innovation and climate governance variables are significant and positively associated with climate commitment.[5]

We further address endogeneity that may result from model misspecification, and we test the main findings on a matched sample using the PSM approach. We compute the industry averages of the eco-innovation and climate governance scores and create a dummy for each predictor based on the cut-off value of the industry average. We first run the first stage of the PSM approach by employing a probit model that uses eco-innovation and climate governance indicators as the dependent variables and board and firm-specific variables as controls. We estimate the propensity score and match based on it for each year-industry group (Tavakolifar et al., 2021), utilising the nearest neighbour matching technique with a 1 % radius matching approach (Shipman et al., 2017). We then re-assess our model for the matched sample and report our results in Table 10, Models 10.1 and 10.2.

We also use the Heckman two-step approach to control for potential sample selection biases. In the first stage, we run a probit model that uses eco-innovation and climate governance indicators as the dependent variables and board and firm-specific variables as controls. The estimated parameters are used to compute the inverse Mills ratio (IMR), which is then included as an additional explanatory variable in the second-stage estimation. Models 10.3 and 10.4 in Table 10 report the result from the second-stage regressions.

Finally, we use entropy balancing to generate an alternative sample and address endogeneity concern (Hainmueller and Xu, 2013). The entropy balancing method helps to reduce model dependence for the subsequent estimation of treatment effects (Hainmueller, 2012). To apply entropy balancing, we generate binary variables that include the treatment and control groups – the control group can be reweighted to match the covariate moments in the treatment group (Hainmueller, 2012). Our variables of interest are corporate eco-innovation and climate governance. The treatment group is created by using the top quartile values of Eco-innovation_*score* and Climate_*gov* by assigning a value of 1. The control group is created using the rest of these two variables by assigning a value of 0. The baseline research model is tested (Table 10, Models 10.5 and 10.6). The results are in line with the main analysis and show a positive association of eco-innovation and climate governance with corporate commitment to climate change. Thus, we find support for our hypotheses of the positive effect of eco-innovation and climate governance on corporate commitment to climate change.

[5] We further explore the semiparametric models using Robinson's partially linear regression (the semipar command in Stata). This estimator was introduced to deal with heterogeneity, non-linearity, serial correlation and endogeneity. We then use Hardle and Mammen's (1993) test to compare the nonparametric and parametric regression fits using squared deviations between them. We reject the null hypothesis and prove that the polynomial adjustment is not suitable.

Table 10
Endogeneity test.

Variable	PSM		Heckman		Entropy balancing	
	Climate_*commit*	Climate_*commit*	Climate_*commit*	Climate_*commit*	Climate_*commit*	Climate_*commit*
	Model 10.1	*Model 10.2*	*Model 10.3*	*Model 10.4*	*Model 10.5*	*Model 10.6*
Eco_innovation_*score*	0.3995***		0.3647***		0.3371***	
	[4.50]		[6.38]		[6.55]	
Climate_*gov*		0.6261***		0.4194***		0.7589***
		[5.10]		[6.49]		[15.51]
BODSIZE	0.0308	0.0162	0.0573***	0.0567***	0.0589***	0.0590***
	[1.10]	[0.43]	[3.28]	[3.78]	[3.94]	[3.99]
BODIND	2.1391***	1.7477***	1.7746***	1.7485***	2.1407***	2.0975***
	[5.04]	[3.35]	[3.66]	[7.10]	[9.28]	[9.18]
BODMEET	0.0044	−0.0203	−0.0012	−0.0004	0.0059	0.0081
	[0.33]	[−1.00]	[−0.17]	[−0.06]	[0.83]	[1.11]
SIZE	0.1209**	0.0793	0.1702***	0.1701***	0.2211***	0.1821***
	[2.49]	[1.04]	[7.16]	[7.17]	[10.37]	[7.46]
ROA	−0.4453	−0.4155	0.3282	0.4929	0.0156	0.4085
	[−0.69]	[−0.42]	[1.04]	[1.57]	[0.04]	[1.13]
Liquidity	0.0759**	−0.0111	0.0018	0.0022	−0.0015	0.0532***
	[2.16]	[−0.24]	[0.87]	[1.05]	[−0.80]	[4.25]
MTB	0.0122	0.0365*	−0.0005	−0.0011	0.0034	0.0096*
	[1.26]	[1.87]	[−0.10]	[−0.21]	[0.55]	[1.65]
INTANG_*intensity*	0.0882	−0.1345	0.0515	0.0049	−0.1321**	−0.0927**
	[0.82]	[−1.14]	[1.20]	[0.12]	[−2.33]	[−2.50]
FCF	1.7651***	−0.0127	−0.0024	0.0061	0.207	−0.0731
	[3.75]	[−0.06]	[−0.05]	[0.12]	[1.47]	[−0.98]
CAP_*intensity*	−0.1210**	0.0926*	−0.0574*	−0.0236	0.0178	0.0327
	[−2.55]	[1.80]	[−1.95]	[−0.81]	[0.83]	[1.57]
ENV_*train*	0.2969***	0.3183***	0.3020***	0.2414***	0.4165***	0.2744***
	[3.27]	[2.64]	[5.74]	[4.48]	[7.49]	[5.20]
MILLS			0.1063	0.3002		
			[0.04]	[0.10]		
Industry	Included	Included	Included	Included	Included	Included
Year	Included	Included	Included	Included	Included	Included
Intercept	−1.6923*	−2.2104	−3.1137***	−4.4227***	−4.9510***	−4.7527***
	[−1.74]	[−1.45]	[−4.61]	[−3.03]	[−11.42]	[−9.79]
R-squared	0.2635	0.2485	0.3839	0.3846	0.3173	0.3213
N	433	433	2000	1838	1190	1190

Variables are defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

4.4. Additional analysis

In an additional analysis, we examine the impact of corporate eco-innovation and climate governance on environmental performance. We use environmental pillars collected from the Thomson Reuters ASSET 4 database as a proxy for environmental performance (e.g. Ioannou and Serafeim, 2012; Lys et al., 2015). We also use the GHG emission level of a firm as a proxy for environmental performance (Haque, 2017). We report the results in Table 11. Models 11.1 and 11.2 use ENV_*pillar* as a proxy for environmental performance and Models 11.3 and 11.4 use GHG emissions. Our findings show that corporate eco-innovation is significant ($p < 0.01$) and positively associated with ENV_*pillar* (Models 11.1 and 11.2), and significant ($p < 0.05$) and negatively associated with GHG emissions, indicating that companies that adopt innovative approaches to efficiently control pollution and reduce their environmental impact have lower GHG emission levels. We also find that Climate_*gov* is significant ($p < 0.01$) and positively associated with ENV_*pillar* (Models 11.1 and 11.2) but not significant in Models 11.3 and 11.4, indicating that climate governance mechanisms do not influence the carbon emission levels of a firm.

We further investigate the impact of eco-innovation and climate governance on the individual components of climate change commitment index developed in this study and report the result in Table 12. These components are: if the company supports SDG 13 on climate action (SDG13), if the company is aware that climate change can represent commercial risks or opportunities (Climate_*risks*), if the company discloses its Scope 3 emissions (Scope3_*emission*), and if the company sets a target for emission reduction (Emission_*target*). The individual proxies are used as a dependent variable within the main estimations to provide a comparison of the broad proxy of climate change practices with the "more restrictive" proxies. The result shows that corporate eco-innovation is significant ($p < 0.01$) and positively associated with Climate_*risks* and Target_*emission* (Models 12.2 and 12.4), and significant ($p < 0.05$) and positively associated with SDG13 (Model 12.1). Corporate eco-innovation is insignificant and positively associated with Scope3_*emission* (Model 12.3). We also find that Climate_*gov* is significant ($p < 0.01$) and positively associated with Climate_*risks* and Emission_*target* (Models 12.2 and 12.4), and significant ($p < 0.05$) and positively associated with Scope 3_*emission* (Model 12.3). Climate governance is insignificant for SDG13 (Model 12.1). Results are generally consistent with the expected impact on relationships and support our hypotheses on the impact of eco-innovation and climate governance on corporate climate commitment. When we compare the results for the individual components of climate change commitment and the results for climate_*commit* index, we find that our results are more economically significant for the latter. For example, Table 4 shows that a 1 %-point increase in eco-innovation score, would increase Climate_*commit* index by 0.011 %, whereas the effect size of eco-innovation on the individual components of firms' climate commitment is smaller as evident in the coefficient values of Eco_innovation_*score* in Table 12. Moreover, Table 4 shows that 1 %-point increase in Climate_*gov*, would increase Climate_*commit* index by 0.446 %, whereas the effect size of climate

Table 11
The impact of corporate eco-innovation score and climate governance on environmental performance.

Variable	ENV_*pillar*	ENV_*pillar*	GHG_*emission*	GHG_*emission*
	Model 11.1	*Model 11.2*	*Model 11.3*	*Model 11.4*
Eco_innovation_*score*	0.2628***		−0.0020*	
	[9.93]		[−1.70]	
Eco_innovation_*index*		4.5958***		−0.0791**
		[8.24]		[−2.01]
Climate_gov	2.0258***	2.0488***	0.0444	0.0452
	[3.68]	[3.56]	[1.72]	[1.25]
BODSIZE	−0.1469	−0.0841	0.012	0.0103
	[−0.62]	[−0.33]	[0.86]	[0.76]
BODIND	13.1640***	16.7035***	−0.0676	−0.1019
	[3.58]	[4.25]	[−0.42]	[−0.63]
BODMEET	0.0481	0.0276	−0.001	−0.0011
	[0.47]	[0.26]	[−0.26]	[−0.28]
SIZE	5.8472***	6.4814***	0.7005***	0.7049***
	[8.44]	[9.00]	[8.06]	[8.14]
ROA	0.9853	−1.0198	0.0226	0.0215
	[0.24]	[−0.25]	[0.13]	[0.13]
Liquidity	−0.0283***	−0.0306***	−0.0004*	−0.0004*
	[−7.07]	[−7.25]	[−1.84]	[−1.82]
MTB	−0.0436	−0.0408	−0.0014	−0.0015
	[−0.92]	[−1.00]	[−0.76]	[−0.79]
INTANG_intensity	−1.0681	−1.3114*	−0.0739*	−0.0726*
	[−1.24]	[−1.67]	[−1.72]	[−1.70]
FCF	−0.0815	0.0289	0.0552	0.0558
	[−0.11]	[0.03]	[1.26]	[1.28]
CAP_intensity	−0.3667	−0.0721	−0.2119***	−0.2143***
	[−0.42]	[−0.08]	[−3.34]	[−3.38]
ENV_train	5.0696***	5.3368***	−0.03	−0.028
	[4.44]	[4.50]	[−0.63]	[−0.58]
Industry	Included	Included	Included	Included
Year	Included	Included	Included	Included
Intercept	−97.2477***	−117.5230***	0.203	0.2772
	[−5.85]	[−6.96]	[0.10]	[0.14]
R-squared	0.645	0.586	0.688	0.687
N	2000	2000	2000	2000

Variables are as defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

governance on the individual components of climate commitment is smaller as evident in the coefficient values of Climate_*gov* in Table 12. This suggests that our comprehensive measure of corporate climate commitment helps better understand to what extent corporate eco-innovation and climate governance can contribute to corporate commitment to climate change.

5. Conclusion

Firms with climate governance and eco-innovation could better utilize their existing resources and know-how to make a genuine commitment to climate change ahead of their competitors, which can be considered as a source of competitive advantage. Based on a sample of companies listed on the London Stock Exchange (FTSE-All-Share) for the period of 2014–2020, this study aims to examine the effect of eco-innovation and climate governance on corporate commitment to climate change. We developed a unique measure for corporate climate change commitment by including three components, namely whether a company supports SDG 13 on climate action, whether a company is aware that climate change can represent commercial risks or opportunities and whether a company reports Scope 3 CO_2 emissions. With regard to the eco-innovation measure, we applied the Thomson Reuters Eikon score and developed an index computed as a composite score by totalling five eco-innovation proxies collected from the Eikon database. Concerning climate governance, we applied three proxies for climate governance, namely environmental committee, climate incentives and the existence of sustainability reports.

Drawing on the RBV, our findings suggest that corporate eco-innovation is significant and positively associated with corporate commitment to climate change. Firms with eco-innovation have more knowledge, experience and other resources to adapt innovative approaches that can help to efficiently control pollution and resource use to reduce their environmental impact, and thus are more committed to climate change. Our findings also show that firms with better climate governance are more committed to climate change. All three components of climate governance, viz. environmental committee, climate incentive and sustainability reporting are positively associated with corporate commitment to climate change. Our results suggest that there is a need for integrating climate issues into governance, which leads to better commitment to climate change. We further run additional analyses and divide the sample into subsamples based on firm size and profitability. Our findings show that the eco-innovation score is significant and positively associated with corporate climate change commitment when focusing on the large-firm sample, while it shows no impact for small firms. Our findings also show that the presence of an environmental committee can be considered as a strong driver of a firm's commitment to climate change regardless of the size of the firm. The relationship between eco-innovation and corporate commitment to climate change holds in firms with a strong financial position. Findings regarding the climate governance–climate change nexus hold regardless of the firm's financial position. We control for endogeneity by using PSM, Heckman two-step, and entropy balancing techniques, and results remain consistent. Finally, we run additional analyses using alternative measures of the dependent variable and the results hold.

This study offers a number of important implications for policy-makers, investors and corporate managers. Managers can take a positive

Table 12
The impact of corporate eco-innovation score and climate governance on firms' climate commitment components.

Variable	SDG 13	Climate_*risks*	Scope3_*emission*	Emission_*target*
	Model 12.1	*Model 12.2*	*Model 12.3*	*Model 12.4*
Eco_innovation_*score*	0.0052**	0.0042***	0.0037	0.0101***
	[2.27]	[2.87]	[1.27]	[4.01]
Climate_*gov*	0.1422	0.3742***	0.2354**	0.3363***
	[1.14]	[3.93]	[2.41]	[3.53]
BODSIZE	0.0471	−0.0271	0.1072***	0.0795**
	[0.93]	[−0.62]	[2.61]	[2.03]
BODIND	1.169	2.0939***	0.7514	2.2184***
	[1.39]	[3.28]	[1.11]	[3.39]
BODMEET	0.0148	0.0111	0.0058	−0.0118
	[0.90]	[0.75]	[0.36]	[−0.82]
SIZE	0.1307*	0.3390***	0.0628	0.1192*
	[1.72]	[4.44]	[0.76]	[1.71]
ROA	0.1958	0.5236	0.9613	−0.1815
	[0.21]	[0.64]	[1.28]	[−0.27]
Liquidity	0.0101***	0.0779*	0.0581	−0.0001
	[3.32]	[1.70]	[0.98]	[−0.04]
MTB	−0.0268*	−0.0197**	0.0159	0.001
	[−1.65]	[−2.10]	[1.44]	[0.09]
INTANG_*intensity*	0.0783	−0.0385	0.2552**	0.0752
	[0.74]	[−0.29]	[2.25]	[0.73]
FCF	0.0483	0.4976	−0.0921	−0.1168**
	[0.57]	[1.16]	[−0.79]	[−2.43]
CAP_*intensity*	0.0028	−0.0096	−0.084	−0.0495
	[0.03]	[−0.12]	[−0.88]	[−0.65]
ENV_*train*	0.4311**	0.4043***	−0.1876	0.4452***
	[2.57]	[2.64]	[−1.22]	[3.02]
Industry	Included	Included	Included	Included
Year	Included	Included	Included	Included
Intercept	−2.7546*	−7.1840***	−2.8812	−4.5483***
	[−1.76]	[−4.25]	[−1.58]	[−2.92]
R-squared	0.342	0.354	0.211	0.261
N	2000	2000	2000	2000

Variables are as defined in Table 1.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

view of opportunities to adopt eco-innovative technologies which appear to be value enhancing and will help them to be more committed to climate change. The board of directors should consider climate change matters to be part of their obligations as directors. The integration of climate change into strategic and oversight duties can help them better address climate change risks and opportunities. The findings of this study offer meaningful insights to regulators, investors and other stakeholders in evaluating the accountability of companies in relation to strategies for managing climate change. Also, the evidence that eco-innovation is associated with corporate commitment to climate change should encourage managers to invest more in eco-innovation, which may enhance firm environmental performance, reduce CO_2 emissions and thus be positively associated with firms' commitment to climate change. Policymakers need to encourage companies to invest more in eco-innovation by providing them subsidies to lower their environmental costs at the early stages. This would encourage companies to be more committed to climate change, which is in line with government strategy and the plan towards net zero carbon emissions.

The study's findings should be evaluated considering the following limitations which open fruitful avenues for future research. First, although we have addressed the endogeneity issue by applying different endogeneity tests including: (i) the fixed-effect analysis; (ii) the PSM approach; (iii) the Heckman two-step approach; and (iv) the entropy balancing method, we acknowledge that there is still the possibility of reverse causality and omitted variable bias, therefore future research may use the difference-in-difference (DID) test by identifying an exogenous shock, such as regulation or policy such as the Paris Agreement, or other regulations promulgated by the government that may affect corporate commitment to climate change. Future research may also consider other variables that could be used to control the relationship between eco-innovation, environmental governance and corporate commitment to climate change; these variables include the environmental penalties, (green) knowledge stock, or corporate competitive environment, and so on. Second, we also acknowledge that the results may not be generalized to some other countries. In presenting this first detailed analysis of how eco-innovation and climate governance is linked with corporate commitment to climate change in the UK, we lay a solid foundation for future researchers interested in the topic. Future research could investigate other international contexts such as China, the US and other European countries, together with unlisted companies and other small enterprises. It would be interesting to explore how other factors such as national culture, laws, politics and market forces can affect corporate commitment to climate change in both developed and developing countries.

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CRediT authorship contribution statement

Khaldoon Albitar: Conceptualization, Methodology, Writing- Original draft preparation, Writing- Reviewing and Editing.

Habiba Al-Shaer: Conceptualization, Methodology, Writing- Original draft preparation, Writing- Reviewing and Editing.

Yang Stephanie Liu: Conceptualization, Theoretical framework, Writing- Original draft preparation, Writing- Reviewing and Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data are available from the authors upon reasonable request.

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