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RESEARCH ARTICLE

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Top-management compensation and environmental innovation strategy

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Abstract

The increasing awareness of global climate change puts more pressure on firms to reduce their environmental externalities. Managers long ignored this responsibility, which may erode business profits, going against their traditional goals. In this study, we examine the effect of top management's extrinsic incentives (i.e., reward-driven motivation) on corporate environmental innovation strategy (i.e., eco-innovation) using a large dataset of S&P1500 non-financial firms for 2000–2020. The results indicate that firms with greater levels of top-management compensation exhibit higher scores of eco-innovation engagement. The effect holds after we address the endogeneity problem through the quasi-natural experiment using the difference-in-differences analysis on the event of the Paris Agreement 2015. Our further investigations reveal that such a positive impact of managerial incentives on eco-innovation is less intensified in the more polluting industries but more pronounced in more innovative ones.

KEYWORDS
eco-innovation, environmental policy, top-management compensation

1 | INTRODUCTION

In the last few decades, business growth and profitability have been significantly spun around overconsumption and overproduction, which expose the world to more and more natural capital risks, including climate change, land degradation, wildfires, and agricultural droughts. The drive to make companies more climate-resilient and sustainable started with institutional investors and equity analysts, long aware of climate risk (Zaman et al., 2021). Consumer awareness, likewise, has grown significantly, as climate change and its impacts become more apparent in their daily lives amid new stories. As a result, many consumers are more conscious than ever, choosing brands whose policies meet their values.[1] The attitude carries over as a factor in evaluating the companies they choose to work for, especially among the millennials (Klimkiewicz & Oltra, 2017). This then motivates firms to incorporate climate action and sustainability, among other environmental, social, and governance (ESG) criteria, to help attract and engage the best talents. Consequently, it is increasingly vital that companies focus on sustainability from a business and economic standpoint.

One of the recent responsibilities of top management within firms is to figure out how sustainability can drive innovation and how to encourage innovation that can improve sustainability through impactful solutions. The purpose of this study is, therefore, to explore the extrinsic incentives for top senior executives via financial compensation (top-management compensation hereafter) and, consequently, the impact of their reward-driven behavior on environmental innovation strategies (hereby eco-innovation).[2] Our extensive analyses are enlightened by theoretical insights drawn from a combination of incentive alignment (Tosi et al., 1997) and stakeholder theory (Freeman, 2010). The former (Tosi et al., 1997) favors incentive over monitoring as a more powerful mechanism, to ensure that top management acts in the best interests of organizations. The latter Freeman (2010) sheds light on the importance of other stakeholders. Operating in a well-connected society, the organization cannot succeed without adequate support from various stakeholders. The environment commitment strategy employed by the top management through a company's eco-innovation score represents a wide range of stakeholders about the firm's sustainability strategy.

From the perspective of executive competence (Arena et al., 2018), we argue that the more competent managers (generally proxied by higher compensation) are aware of the complexity and risks attached to eco-innovation but take them as welcoming challenges that will pay off in the long term, thereby engaging in innovative strategies aimed at reducing negative environmental impacts. Limited research finds the links between eco-innovation and CEO characteristics such as personal traits (Arena et al., 2018) or the significant connections between executive compensation, sustainable compensation policy, and carbon performance (Haque & Ntim, 2020). Our study contributes to this line of work by exploring the associations between top-management compensation and corporate eco-innovation. We employ a sample of 11,814 firm-year observations focusing on non-financial US firms representing up to 90% of the US equity market capitalization over 2000–2020. We find that top-management compensation is significantly and positively associated with the level of eco-innovation. The result holds after we address the endogeneity problem through the quasi-natural experiment using the difference-in-differences (DID) analysis on the event of the Paris Agreement (2015 United Nations Climate Change Conference or COP 21), as well as other advanced endogeneity treatments such as the two-step system generalized method of moments (GMM) and propensity score matching (PSM).

We further complement prior works by investigating the impacts of the sectors (i.e., polluting; innovative) on firms' eco-innovation. This is motivated by recent evidence that firms operating in environment-sensitive industries (e.g., oil and gas, alcohol, or beverage) attempt to mitigate the negative environmental impacts of their business by engaging more actively in corporate social responsibility (CSR) as a means to obtain legitimacy (Cai et al., 2012; Du & Vieira, 2012) or to reduce firms' specific risks (Jo & Na, 2012). Our results reveal that the positive impact of managerial incentives on eco-innovation is less intensified in high polluting industries but more pronounced in highly innovative ones. Furthermore, using the quantile analysis, we find that while the association between top-management compensation and firms' eco-innovation shows no difference between *small* and *large* firms, it is stronger for firms with *lower* leverage as well as firms with *lower* eco-innovation scores.

Our findings have several contributions and implications. First, our study adds to the extant research on the influence of executives' intrinsic characteristics on corporate strategic decisions. Prior studies mainly focus on career horizon (Oh et al., 2016), international background (Piaskowska & Trojanowski, 2014), managers' attitude (Damanpour & Schneider, 2006), CEO personal traits (Arena et al., 2018), CEO risk-taking propensity (Kraiczy et al., 2015), and CEO hometown identity (Ren et al., 2021). However, there is a lack of attention to eco-innovation strategies. We complement this literature by examining the influence of *extrinsic* motivations on top management, in particular the level of their compensation and its relationship with corporate eco-innovation. Second, our research adds to prior studies examining the effect of organizational features (size, visibility, and local slack), stakeholder integration, business environment uncertainty, and complexity (Rueda-Manzanares et al., 2008) on environmental responsiveness (Bowen, 2002) and CEO openness and industrial discretion level (Datta et al., 2003) on general innovation. We provide empirical evidence that factors such as sectors' environmental sensitivity, firms' general openness to innovation, and explicit commitment to sustainability matter concerning corporate eco-innovation. Finally, our study contributes to the ongoing debate on the drivers of CSR, including investor demography (Cheah et al., 2011), firm humanistic culture (Galbreath, 2010), institutional collectivism and power distance or CEO visionary leadership and integrity (Waldman et al., 2006), and CEO political ideologies (Chin et al., 2013). We emphasize the importance of the board's CSR orientation and its reinforcing impact on environmentally responsible actions (Shaukat et al., 2016).

The paper is structured as follows. Section 2 discusses the theoretical framework, literature review, and hypothesis development. Section 3 presents data and methodology. Section 4 discusses the results. Section 5 covers robustness checks, while Section 6 concludes the paper.

2 | LITERATURE REVIEW, THEORETICAL FRAMEWORK, AND HYPOTHESIS DEVELOPMENT

2.1 | Corporate innovation and eco-innovation

According to the United Nations Environment Programme (UNEP), eco-innovation entails a coordinated set of novel solutions to products, processes, market approach, and organizational structure, which improves a company's performance and competitiveness from a life-cycle perspective. Consistent with this definition, Kim et al. (2021) show evidence that the pursuit of green innovation is positively associated with the firm's value in the long run, despite some initial cost disadvantages, as pointed out by Hart and Ahuja (1996). Unlike a short-term outlook that leads to incremental improvements and results in only limited progress and benefits, eco-innovation represents a long-term strategic drive towards sustainability. This approach to eco-innovation requires cooperation with suppliers, customers, and other stakeholders across the value chain. It allows companies to analyze the possibility of significant progress to surpass the significant challenges faced by the industry or even anticipate and avoid future problems.

Thereby, eco-innovative companies create value for the business, the environment, and society in general, resulting in a more flexible company that responds to changing market trends with novel solutions ahead of competitors (Forsman, 2013). In general, innovation is typically driven by a firm's necessity and is fundamental for firm vitality (Schumpeter, 1942). Long-term competitive advantages provided by innovation lead to higher stock returns (Griliches, 1981), lower default risks and, as a result, decreased bond issuance premiums (Hsu et al., 2015). Eco-innovation is a more recent branch of corporate innovation and has attracted increasing research interest (Acebo et al., 2021; Chen et al., 2022). A growing body of literature has shown a positive link between good eco-efficiency and operating performance or market valuation (Eichholtz et al., 2010; Guenster et al., 2011; Klassen & McLaughlin, 1993). Even in the presence of transaction costs at different levels, Derwall et al. (2005) find evidence of incremental benefits of socially responsible investing, suggesting that environmental outperformance is gradually incorporated into firm value over time (Zheng & Iatridis, 2022).

The increasing market environmental pressure can drive eco-innovation efforts; for example, Porter (1996) finds that countries with the most rigorous green regulations often lead to patenting and exporting affected products. Christmann (2004) shows that firms respond to pressure from external corporate stakeholders, including customers and regulatory bodies, to improve the quality of internal corporate environmental management using global standards. Following the introduction of the 2005 European Union Emissions Trading System, Calel and Dechezleprêtre (2016) document a 36% increase in the number of low-carbon technology patent applications in European firms compared with non-European matched peers. Our present study considers the evolution in corporate eco-innovation after the Paris Agreement in 2015 (COP21). This marked the point when the world was wakened by the foreseeable consequences of the rise in the global average temperature, and countries decided to strengthen the ability to adapt to climate change together by aligning all finance flows with a pathway towards low greenhouse gas emissions and climate-resilient development.

2.2 | Top-management compensation and eco-innovation

Top senior executives have a crucial role in setting and implementing operation strategies for organizations, including investment decisions regarding short-term activities and long-term development (Nielsen, 2010). If the executive pays more attention to short-term achievement, investment in the long-term activities (i.e., research and development, and innovation) may be conducted less (Scuotto et al., 2017). As a result, compensation has been used as an effective tool to harmonize the interest of executives and organizations (Berrone & Gomez-Mejia, 2009). In addition, researchers have explored the impact of top-management compensation on capital structure (John & John, 1993), shareholder return (Kerr & Bettis, 1987), and survival likelihood of organizations (Trinh & Seetaram, 2022). These studies argue that the top-management compensation package significantly influences organizations' risk of bankruptcy and is closely linked with firm performance.

Since innovation is recognized as one of the key drivers for organizations to maintain their competitive advantage (Forsman, 2013), more studies have explored the relationship between executive compensation and corporate innovation (Holthausen et al., 1995; Tsang et al., 2021; Zhou et al., 2021). However, there is a lack of study examining the direct impact of executive compensation on eco-innovation.

Recently, firms have been under pressure from various stakeholders (e.g., regulators, policymakers, climate scientists, and communities) to reduce the negative impacts of business operations on the environment and achieve the "Sustainable Development Goals" defined by the United Nations (Adu et al., 2021; Choi & Luo, 2021). This consequently pushes the top management to act and operate their strategic plans with a serious consideration of environmental impact. Prior studies find that the top-management team characteristics (i.e., age, gender, and experience) have a significant influence on the implementation of environmental policies and the budget spent on innovation activities (Bantel & Jackson, 1989). In addition, Haque and Ntim (2020) argue that the market reacts positively to the firm's carbon performance; therefore, compensation can be used as an incentive-based mechanism to motivate the executive management to get more involved in the process of reducing carbon emissions.

However, in comparison to other types of innovation, investments in environmental activities are less profitable, and their return may not be able to be realized in a short time (Arena et al., 2018; Oh et al., 2016). In some cases, environmental investments may generate extra costs, require more capital, and decrease the productivity of companies due to limited financial and human resources (Palmer et al., 1995). Furthermore, the riskiness of innovation investment leads to a hesitancy among executives, who are risk-averse and prefer short-term incentives to devote resources to those projects (Steinbach et al., 2017). In many situations, managerial risk aversion can motivate value protection at the expense of value maximization, thereby misaligning interests (Jensen & Meckling, 1976). Therefore, understanding the rationale of the executive decision concerning eco-innovation is crucial. While Arena et al. (2018) examine the influence of executives' intrinsic characteristics (i.e., CEO personal traits) on eco-innovation, Ren et al. (2021) suggest that CEO hometown identity has a positive impact on a firm's green innovation performance. Haque and Ntim (2020) find a positive effect of executive compensation on process-oriented carbon performance but a dissimilar impact on actual carbon performance. The scarce findings of prior studies regarding the direct effect of top-management compensation on eco-innovation motivate us to deepen our examination of this issue.

2.3 | Theoretical framework and hypothesis development

In this study, we suggest a combination of overarching theories (i.e., stakeholder theory and incentive alignment theory) in understanding the decisions made by the executive concerning eco-innovation investment. While the stakeholder theory proposes that the executives are expected to consider the interests of a wide range of stakeholders (beyond shareholders) to ensure the firm's long-term development as firms operate in an interactive relationship with broad-ranging stakeholders (Edmans, 2012; Freeman, 2010; Tsang et al., 2021), the incentive alignment theory argues that compensation is a means to align the interests of executives, shareholders, and stakeholders (Tosi et al., 1997) and, hence, it should incentivize executives to work hard for the shareholders and stakeholders (Bebchuk & Fried, 2003; Zhou et al., 2021).

Advocates of the stakeholder theory find evidence that involvements in environmental and social activities (as a part of CSR) help firms demonstrate their responsibilities to broader society and the ecosystem (Sen & Cowley, 2013). In particular, firms are recently facing more substantial pressure from environmentalists, a critical environmental stakeholder (Neubaum et al., 2012). Therefore, the commitment to and engagement with environmental activities have been taken into the contract with executives besides the financial condition to ensure the top management have appropriate strategies and actions (Radu & Smaili, 2021; Tsang et al., 2021) rather than symbolic strategy (Okhmatovskiy & David, 2011).

Likewise, advocates of the incentive alignment theory show that executive compensation stimulates investment for the firms' long-term development. Typically, Zhou et al. (2021) find that executive salary can effectively promote the input level of corporate innovation within Chinese-listed companies. Previously, Tosi et al. (1997) consider incentive alignment as "a more powerful mechanism than monitoring for ensuring that agents act in the interest of owners." Steinbach et al. (2017) argue that the executives make long-term investment decisions (for example, investment in innovation projects) not because of the monitoring pressure from shareholders but because of the incentive alignment between the executives and other stakeholders. Alignment of interests between agents and principals can be achieved through compensation contracts, which link with organizations' outcomes that are desired by the stakeholders. Accordingly, executive decisions about resource utility, research, and development investment are influenced by how these choices affect their pay, based on organization compensation policies (Gomez-mejia et al., 1987; Tosi et al., 1997). We, therefore, contend that incentive alignment theory is more appropriate in explaining the impact of executive compensation on long-term investments like eco-innovation, especially when we consider that corporates operate under the influence of a wide range of stakeholders beyond shareholders (Edmans, 2012; Tsang et al., 2021).

Relatedly, Luo et al. (2021) find that carbon transparency is higher when a firm's executive compensation contract is aligned with stakeholders' interests, although transparent carbon reporting requires significant long-term investment, and the disclosure of unfavorable carbon information is sensitive to reputation loss. Holthausen et al. (1995) find evidence that there is a positive association between a division executive's long-term compensation and its future innovation, suggesting that executives find the incentive alignment between themselves and stakeholders and are, therefore, willing to undertake the long-term investment decision over their short-term incentive orientation. Similarly, CEOs commit to participating in environmental activities by enhancing voluntary carbon disclosure when a firm's executive compensation contracts are aligned with stakeholders' interests. Tsang et al. (2021) further find that the integration of CSR criteria into executive compensation positively impacts firm innovation. However, Tsang et al. (2021) did not consider the specific type of innovation integrated by the organizations. While Ren et al. (2021) suggest that a CEO's hometown identity positively impacts a firm's green innovation performance, Arena et al. (2018) argue that CEO's traits affect firm eco-innovation.

Taken together, underlying incentive alignment theory (Tosi et al., 1997) and stakeholder theory (Freeman, 2010) as well as prior empirical evidence, we hypothesize that top-management compensation is significantly and positively related to eco-innovation. Thus, our hypothesis is stated as follows:

> **H1.** Top-management compensation is significantly and positively related to eco-innovation.

3 | METHODOLOGY

3.1 | Data and sample

We collect data on all the common stocks for the US listed in the S&P 1500 composite equity index for the period 2000–2020. The index covers the three leading equity indexes for the US, including the S&P 500, the S&P Midcap 400, and the S&P SmallCap 600, which represent up to 90% of the US equity market capitalization.[3] While the data on corporate eco-innovation are extracted from Thompson Reuters's Refinitiv Eikon (formerly ASSET 4), the accounting data on top-management compensation, corporate governance determinants, and other firm-year accounting data are collected from Thompson Reuters's DataStream.

Our study excludes financial firms from our sample which feature the standard industrial classification (SIC) codes between 6,000 and 6,999. Following the previous literature (Brogaard et al., 2017; Trinh et al., 2021), if the firm accounting data are missing for the current year (t_0), the study replaces them with the previous non-missing values ($t-1$). To mitigate the potential effects of outliers, the study winsorizes all the variables at the 1st and 99th percentiles, except corporate eco-innovation. Our ultimate sample includes 1,154 listed non-financial firms with a total of 11,814 firm-year observations for all the selected variables.

3.2 | Empirical model

To examine the relation and effects of top-management compensation on corporate eco-innovation, the study proposes the following baseline regression model.

$$Eco-innovation_{i,t} = \alpha + \beta_1 SEComp/TA_{it-1} + \beta_k \sum_{i=0}^{n} controls_{i,t-1} + Year\ dummies + Industry\ dummies + \varepsilon. \quad (1)$$

The left-hand side of Equation (1) presents the corporate eco-innovation (*Eco-innovation*) as our main dependent variable.

Distinguished from the literature on CSR/ESG where scholars use the overall ESG scores to capture firms' social responsibility, see Gillan et al. (2021)[4]; we employ the Refinitiv ESG innovation score that captures the capability of firms in decreasing their environmental burdens and associated costs for customers through the application of new eco-friendly technologies, processes, environment-oriented products, and services which consequently create new market opportunities for firms.[5] The firms' eco-innovation score has been employed in the recent studies by Nadeem et al. (2020) and Zaman et al. (2021). The right-hand side of the equation presents the total senior executive (*SE*) compensation scaled by a firm's total assets, *SE-Comp/TA*, as our main independent variable. Controls include governance and firm-specific factors. To mitigate the potential problem of reverse causality, the study lags all the independent variables by 1 year (or only main independent variables or only *SE-Comp/TA*), while the results without lag fashion are also reported to see the differences if any. The variable definitions are presented in Table A1.

Table 1 reports the descriptive statistics of all the employed variables in our sample. For instance, the eco-innovation scores range from 0 to 94.74 with an average of 21.63. Our main independent variable *SE-Comp/TA* ratio presents a mean value of 5.6%, ranging from 0.229% to 44.248%, with a standard deviation of 7.193%. We find no serious multicollinearity issues given low significant coefficients of pairs of independent factors (much lower than 0.8) (Table 2).

4 | EMPIRICAL FINDINGS

We estimate various ordinary least square (OLS) regression models of eco-innovation (*Eco-Innovation*) as a function of firms' top-management compensation (*SE-Comp/TA*) and several corporate governance and firm-level characteristics control variables. Panel A of Table 3 contains our baseline regression model that lagged all independent variables by 1 year ($t-1$). Doing this can reduce the potential effect of endogeneity problems caused by governance factors. Panels B and C report regression results of models that lagged either all corporate governance variables or only our main independent variable (*SE-Comp/TA*), respectively. These tests aim to check whether the result in Panel A remains qualitatively the same when we alter lagging approaches. Panel D, finally, shows the regression findings when we do not use the lag function of any independent variables, i.e., all our variables are observed in year t but not year $t-1$. Besides controlling for year-fixed effect, we also include industry dummies in our models because some industries may tend to invest more in eco-innovation than others and are more likely to differentially offer compensation packages to top-management.

Across all models in all panels A–D, we consistently find that firms with higher top-management compensation exhibit significantly superior levels of eco-innovation. This effect is economically significant: for every 1% (100 bps) increase in the top-management compensation compared to total assets in year $t-1$ (or year t), the eco-innovation is

TABLE 1 Summary statistics

Variable	N	Mean	SD	Min	p25	p50	p75	Max
Eco-innovation	11,814	21.635	29.486	0	0	0	42.860	94.740
SE-comp/TA	11,656	5.640	7.193	0.229	1.494	3.236	6.740	44.248
LnBSize	11,806	2.273	0.225	1.609	2.079	2.303	2.398	2.708
%female	11,782	17.913	10.692	0	11.110	16.670	25	50
%skills	11,580	57.166	21.067	6.250	42.860	55.560	71.430	100
Re-election [1–2]	11,535	1.579	0.494	1	1	2	2	2
Board tenure	11,792	9.071	3.641	1.350	6.670	8.720	11.050	20.470
Ln(B-meeting)	11,708	1.984	0.375	1.386	1.792	1.946	2.197	2.996
B-meeting attendance	11,123	79.522	8.744	75	75	75	75	100
P-board Independence [1–2]	11,537	1.914	0.280	1	2	2	2	2
Audit committee [1–2]	11,535	1.992	0.090	1	2	2	2	2
CSR-Committee [1–2]	11,537	1.381	0.486	1	1	1	2	2
CEO comp-TSR [1–2]	11,537	1.643	0.479	1	1	2	2	2
CEO-chairman duality [1–2]	11,537	1.675	0.468	1	1	2	2	2
Chair-ex-CEO [1–2]	11,537	1.554	0.497	1	1	2	2	2
Debt/equity	21,474	72.960	209.308	−886.720	5.880	45.640	99.220	1282.830
M/B	20,064	3.403	5.496	−19.940	1.560	2.430	4.020	34.400
Ln (TA)	21,583	14.553	1.795	9.880	13.335	14.497	15.773	18.803
PPE/TA	21,413	0.272	0.228	0.011	0.092	0.198	0.394	0.878
R&D/TA	15,908	0.040	0.064	0	0	0.014	0.052	0.359
ROA	21,237	5.853	11.153	−51.910	3.340	6.560	10.590	34.370

Note: This table reports the summary statistics of all variables employed in this study. See Table A1 for variable definitions and measurements.

TABLE 2 Correlation matrix

	1	2	3	4	5	6	7	8	9	10
1. SE-comp/TA	1									
2. LnBSize	−0.39*	1								
3. %female	−0.05*	0.17*	1							
4. %skills	0.07*	−0.20*	−0.09*	1						
5. Re-election	−0.15*	0.13*	0.11*	−0.02*	1					
6. Board tenure	0.01	−0.04*	−0.11*	0.01	0.00	1				
7. Ln(B-meeting)	−0.06*	0.07*	0.05*	0.03*	0.06*	−0.17*	1			
8. B-meeting attendance	−0.06*	0.00	0.00	−0.01	0.03*	0.00	−0.02*	1		
9. P-board Independence	−0.04*	0.08*	0.13*	−0.00	−0.00	−0.04*	0.05*	−0.01	1	
10. Audit committee	0.02*	0.01*	0.04*	−0.09*	0.01	−0.01	−0.02*	−0.02*	0.05*	1
11. CSR-Committee	−0.27*	0.33*	0.25*	−0.10*	0.17*	−0.08*	0.08*	0.08*	0.14*	0.02*
12. CEO comp-TSR	−0.13*	0.19*	0.20*	−0.06*	0.08*	−0.07*	0.09*	0.07*	0.16*	0.02*
13. CEO-chairman duality	−0.12*	0.09*	−0.02*	−0.03*	−0.00	0.19*	−0.06*	0.03*	0.01	0.02*
14. Chair-ex-CEO	−0.05*	0.03*	0.04*	−0.01	0.02*	0.21*	−0.04*	0.04*	0.01	0.03*
15. Debt/equity	−0.11*	0.09*	0.04*	−0.03*	0.03*	−0.07*	0.05*	0.00	0.01	−0.01
16. M/B	0.11*	−0.00	0.04*	−0.02*	−0.00	−0.00	−0.05*	0.00	−0.01	0.00
17. Ln (TA)	−0.68*	0.56*	0.15*	−0.14*	0.25*	−0.10*	0.13*	0.09*	0.12*	−0.00
18. PPE/TA	−0.21*	0.10*	0.01	−0.04*	0.04*	−0.00	0.02*	0.06*	0.02*	−0.02
19. R&D/TA	0.38*	−0.20*	−0.08*	0.10*	−0.08*	−0.01	0.01	−0.06*	−0.01	0.01
20. ROA	−0.00	0.01*	0.01	−0.03*	0.03*	0.11*	−0.15*	−0.00	−0.01	−0.00

Note: This table reports the correlation matrix of all independent variables employed in this study. See Table A1 for variable definitions and measurements.
*Significance level of 5%.

TABLE 2 (Continued)

	11	12	13	14	15	16	17	18	19	20
1. SE-comp/TA										
2. LnBSize										
3. %female										
4. %skills										
5. Re-election										
6. Board tenure										
7. Ln(B-meeting)										
8. B-meeting attendance										
9. P-board Independence										
10. Audit committee										
11. CSR-Committee	1									
12. CEO comp-TSR	0.28*	1								
13. CEO-chairman duality	0.02	−0.01	1							
14. Chair-ex-CEO	0.02*	0.02*	0.77*	1						
15. Debt/equity	0.08*	0.06*	−0.01	−0.01	1					
16. M/B	0.02	−0.01	0.00	0.01	0.57*	1				
17. Ln (TA)	0.46*	0.25*	0.13*	0.04*	0.17*	0.01*	1			
18. PPE/TA	0.14*	0.11*	0.08*	0.01	0.10*	−0.08*	0.22*	1		
19. R&D/TA	−0.10*	−0.08*	−0.14*	−0.10*	−0.09*	0.13*	−0.30*	−0.30*	1	
20. ROA	0.02*	−0.03*	0.06*	0.03*	−0.03*	0.12*	0.13*	−0.00	−0.31*	1

Note: This table reports the correlation matrix of all independent variables employed in this study. See Table A1 for variable definitions and measurements.
*Significance level of 5%.

TABLE 3 Top-management compensation and eco-innovation

Dependent variable: Eco-innovation	Panel A: All independent variables $_{t-1}$ (1)	Panel B: All governance variables $_{t-1}$ (2)	Panel C: SE-comp/TA $_{t-1}$ (3)	Panel D: All independent variables $_{t}$ (4)
SE-comp/TA	0.203*** (0.000)	0.169*** (0.001)	0.155*** (0.002)	0.179*** (0.002)
LnBSize	6.332*** (0.000)	6.686*** (0.000)	5.970*** (0.000)	5.719*** (0.001)
%female	0.076** (0.017)	0.081** (0.012)	0.050 (0.115)	0.047 (0.137)
%skills	−0.002 (0.877)	−0.000 (0.974)	−0.008 (0.613)	−0.008 (0.572)
Re-election	0.290 (0.679)	0.425 (0.543)	0.224 (0.745)	0.234 (0.715)
Board tenure	−0.001 (0.993)	0.014 (0.876)	0.024 (0.788)	0.048 (0.585)
Ln(B-meeting)	2.010** (0.017)	2.035** (0.015)	1.371* (0.099)	1.376* (0.082)
B-meeting attendance	−0.036 (0.325)	−0.034 (0.362)	−0.007 (0.846)	−0.010 (0.770)
P-board Independence	0.474 (0.684)	0.835 (0.470)	1.280 (0.284)	1.055 (0.386)
Audit committee	5.158 (0.233)	5.436 (0.208)	8.364** (0.026)	7.778 (0.119)
CSR-Committee	9.448*** (0.000)	9.705*** (0.000)	9.857*** (0.000)	10.188*** (0.000)
CEO comp-TSR	−0.420 (0.529)	−0.248 (0.710)	−0.293 (0.663)	0.087 (0.893)
CEO-chairman duality	0.855 (0.470)	0.934 (0.430)	−0.920 (0.443)	−0.386 (0.735)
Chair-ex-CEO	−1.565 (0.163)	−1.628 (0.146)	0.013 (0.991)	−0.314 (0.767)
Debt/equity	−0.008*** (0.000)	−0.006*** (0.000)	−0.007*** (0.000)	−0.007*** (0.000)
M/B	0.074 (0.209)	0.067 (0.252)	0.059 (0.318)	0.060 (0.340)
Ln (TA)	7.237*** (0.000)	7.044*** (0.000)	7.035*** (0.000)	6.851*** (0.000)
PPE/TA	5.059* (0.051)	5.127** (0.047)	5.498** (0.033)	5.148** (0.032)
R&D/TA	32.788*** (0.000)	30.077*** (0.000)	30.697*** (0.000)	31.837*** (0.000)
ROA	0.046 (0.143)	0.037 (0.241)	0.022 (0.478)	0.022 (0.502)
Constant	−161.800*** (0.000)	−163.090*** (0.000)	−163.736*** (0.000)	−163.078*** (0.000)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	7,278	7,320	7,330	7,949
Adjusted *R*-squared	0.396	0.394	0.394	0.394
Wald chi 2	81.94***	89.67***	82.99***	37.08***

Note: This table reports the OLS regression results on the association between top-management compensation and eco-innovation (or environmental innovation). The dependent variable is the eco-innovation score (*Eco-Innovation*). The main independent variable is top-management compensation (*SE-Comp/TA*). See Table A1 for variable definitions and measurements.
*Significance level of 10%.
**Significance level of 5%.
***Significance level of 1%.

increased by about 0.00155 (15.5 bps) to 0.00203 (20.3 bps). Our results support the hypothesis and are in line with incentive alignment as well as stakeholder theories, consistent with previous literature such as Freeman (2010); Holthausen et al. (1995); Luo et al. (2021); Tsang et al. (2021). High top-management compensation can promote long-term investment decisions like investment in innovation projects because of the incentive alignment between the executives and the stakeholders (Steinbach et al., 2017). From the perspective of stakeholder theory, involvement in environmental and social activities helps organizations manifest their responsibilities to the wider society and ecosystem (Sen & Cowley, 2013), and the commitment to environmental activities has been taken into the contract with executives besides the financial criteria to secure top management's appropriate strategies and actions (Okhmatovskiy & David, 2011; Radu & Smaili, 2021; Tsang et al., 2021).

Turning to the control variables, as predicted, we find that generally, board size (*LnBSize*), board gender diversity (*%Female*), board meeting (*Ln*[*B-meeting*]), CSR committee (*CSR-Committee*), firm size (*Ln* [*TA*]), PPE (*PPE/TA*), and R&D investment (*R&D/TA*) are all positively and significantly associated with a higher level of eco-innovation. This suggests that firms with larger boards, more females on boards, higher board meeting frequency, which have a CSR committee, are bigger and, which place more investment on PPE and R&D, tend to pursue greener policies, particularly as demonstrated by their superior investment in eco-innovation. However, we also find that firms with higher financial leverage are likely to perform worse in terms of innovation in environmental issues. This is sensible because both leverage and eco-innovation are risky activities; thereby, higher levered firms might have less incentive to take additional risk from the costly eco-innovation investment.

5 | ROBUSTNESS AND SENSITIVITY CHECKS

5.1 | Quasi-natural experiments: Difference-in-differences analysis

In this subsection, we retest our predictions by conducting quasi-natural experiments using *difference-in-differences* (DID) analysis. Specifically, we examine the effect of the top-management compensation on eco-innovation following the exogenous shock, i.e., the Paris Agreement 2015, United Nations Climate Change Conference (UNCCC-2015 or COP 21). This event is considered a legally binding international treaty on climate change, which was adopted by 96 parties at COP 21 in Paris on 12 December 2015. We create two dummies: (1) a top-management compensation dummy (*SE-Comp Dummy*), which takes the value of 1 if SE-Comp/TA is equal or higher than its median of 3.236 and zero otherwise, and (2) a *Post-2015* dummy variable, which denotes the value of 1 if the observed year is in the post-2015 period and zero otherwise. We then interact these two binary variables (i.e., *SE-Comp Dummy*Post-2015*) to test whether the positive effect of compensation holds following the exogenous shock. Our DID model is specified as follows:

$$\begin{aligned} Eco-innovation_{i,t} = \alpha + \beta_1 SEComp\ Dummy_{it-1} * Post2015 \\ + \beta_2 SEComp\ Dummy_{it-1} + \beta_3 Post2015 \\ + \beta_k \sum_{i=0}^{n} controls_{t-1} + Year\ dummies \\ + Industry\ dummies + \varepsilon. \end{aligned} \quad (2)$$

Table 4 reports the multivariate analysis results for the eco-innovation. In Panels A–B and C–D, we use different model specifications which include the 1-year lag fashion of all independent variables and the 1-year lag fashion of all corporate governance variables, respectively. Panels A and C control for year-fixed effects, while Panels B and D capture both year- and industry-fixed effects. Across all models, the results indicate that the coefficients of the interaction term *SE-Comp Dummy*Post-2015* are positive (ranging from 2.176 to 2.364) and statistically significant (at a 10% significance level). This implies that firms with high top-management compensation exhibit higher eco-innovation investment following the UNCCC-2015 event. The effect of UNCCC-2015 on the eco-innovation of US firms is also positive and economically meaningful. In sum, DID results consistently show that an increase in top-management compensation leads to a higher eco-innovation score following the UNCCC-2015. Therefore, our findings are free of endogeneity problems and survive when going through the exogenous shock

5.2 | Firm size, leverage, and eco-innovation

Our study next extends its empirical works by investigating the association between top-management compensation and firms' eco-innovation levels by firm size (*small* vs. *large* firms), financial leverage

TABLE 4 Differences-in-differences analyses

Dependent variable: Eco-innovation				
	Panel A: All independent variables $_{t-1}$ (1)	Panel B: All independent variables $_{t-1}$ (2)	Panel C: All governance variables $_{t-1}$ (3)	Panel D: All governance variables $_{t-1}$ (4)
SE-comp dummy * Post-2015	2.364* (0.094)	2.176* (0.080)	2.339* (0.097)	2.250* (0.070)
SE-comp dummy	2.649** (0.016)	1.503 (0.126)	1.839* (0.093)	0.952 (0.329)
Post-2015	22.137*** (0.000)	27.967*** (0.000)	22.349*** (0.000)	28.013*** (0.000)
Controls included	Yes	Yes	Yes	Yes
Constant	−116.381*** (0.000)	−158.415*** (0.000)	−115.612*** (0.000)	−159.417*** (0.000)
Year FE	Yes	Yes	Yes	Yes
Industry FE	No	Yes	No	Yes
Observations	7,326	7,326	7,369	7,369
Adjusted R-squared	0.193	0.396	0.190	0.395
Wald chi 2	55.33***	90.45***	54.51***	91.02***

Note: This table reports the difference-in-differences regression results on the association between top-management compensation and eco-innovation, using the event of the Paris Agreement 2015 as an important exogenous shock. See Table A1 for variable definitions and measurements.
*Significance level of 10%.
**Significance level of 5%.
***Significance level of 1%.

(*low* vs. *high* leverage firms), and eco-innovation (*high* vs. *low* eco-innovation). This examination is conducted by classifying those firm-specific characteristics by their top and bottom quantiles using Equation (1). The rationale for these investigations is the potential differences in the top-management compensation package, the eco-innovation investment, and the connection of these two factors between *small* and *large* firms, as well as between *low*- and *high-levered* firms. For example, larger firms are likely to pay their top

TABLE 5 The relationship between top-management compensation and eco-innovation by firm size, leverage and eco-innovation

	Panel A: Firm size		Panel B: Financial leverage		Panel C: Eco-innovation	
	(1) Small firms	(2) Large firms	(3) Low leverage	(4) High leverage	(5) Low eco-innovation	(6) High eco-innovation
SE-comp/TA $_{t-1}$	0.018 (0.797)	−0.029 (0.836)	0.245*** (0.001)	0.109 (0.348)	0.154** (0.050)	0.033 (0.698)
Controls included	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−63.950*** (0.002)	−176.379*** (0.000)	−149.329*** (0.000)	−163.919*** (0.000)	12.859 (0.516)	−47.075*** (0.000)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,789	5,489	3,119	4,159	1,558	2,295
R-squared	0.325	0.406	0.396	0.419	0.350	0.494
Wald chi 2	8.18***	29.19***	16.58***	23.07***	8.98***	19.67***

Note: This table reports the OLS regression results on the association between top-management compensation and eco-innovation by firm size (Panel A: small versus large firms), leverage (Panel B: low versus high levered firms), and eco-innovation (Panel C: low versus high eco-innovation scored firms) using the median values of *Ln (TA)*, *Debt/Equity* and *Eco-Innovation* as the cut-offs. See Table A1 for variable definitions and measurements.
*Significance level of 10%.
**Significance level of 5%.
***Significance level of 1%.

TABLE 6 Effects of top-management compensation on eco-innovation by polluting and innovative sectors

	Panel A: Polluting sector				Panel B: Innovative sector			
VARIABLES	(1) All independent variables $_{t-1}$	(2) All governance variables $_{t-1}$	(3) SE-comp/TA $_{t-1}$	(4) All independent variables $_t$	(5) All independent variables $_{t-1}$	(6) All governance variables $_{t-1}$	(7) SE-comp/TA $_{t-1}$	(8) All independent variables $_t$
*SE-comp/TA * polluting sector*	−0.645*** (0.001)	−0.630*** (0.001)	−0.683*** (0.001)	−0.640*** (0.003)				
Polluting sector	33.925*** (0.000)	33.716*** (0.000)	34.693*** (0.000)	33.863*** (0.000)				
*SE-comp/TA * innovative sector*					0.258*** (0.000)	0.256*** (0.000)	0.231*** (0.001)	0.266*** (0.002)
Innovative sector					−34.284*** (0.000)	−34.085*** (0.000)	−34.808*** (0.000)	−34.164*** (0.000)
SE-comp/TA	0.219*** (0.000)	0.183*** (0.000)	0.170*** (0.001)	0.193*** (0.001)	0.110* (0.079)	0.073 (0.234)	0.066 (0.282)	0.083 (0.198)
Controls included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−162.151*** (0.000)	−163.184*** (0.000)	−164.081*** (0.000)	−163.394*** (0.000)	−127.399*** (0.000)	−128.639*** (0.000)	−128.494*** (0.000)	−128.866*** (0.000)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,278	7,320	7,330	7,949	7,278	7,320	7,330	7,949
R-squared	0.408	0.407	0.407	0.394	0.408	0.407	0.406	0.394
Wald chi 2	81.32***	89.76***	82.46***	36.92***	80.05***	90.10***	81.80***	36.93***

Note: This table reports the OLS regression results on the association between top-management compensation and eco-innovation (or environmental innovation) by Polluting (Panel A) and Innovative sectors (Panel B). See Table A1 for variable definitions and measurements.
*Significance level of 10%.
**Significance level of 5%.
***Significance level of 1%.

senior executives more compared to their smaller peers (but possibly relatively less when the compensation is scaled by assets), and they may have better financial conditions to invest in costly projects like eco-innovation. *High-levered* firms have used more external debts as their financing instruments for operations and investments, and therefore, they tend to be better monitored by outsiders (e.g., creditors). As such, the top-management compensation may be lower, and the environmental activity could be higher, possibly to maintain their reputation in the eyes of creditors and outsiders.

The results are reported in Table 5, Panels A–C. We find no significant difference between *small* and *large* firms, yet the positive link between top-management compensation and eco-innovation is significantly driven by *low-levered* firms. These firms are less risky and have more opportunities to use leverage as a tool to raise external funds; higher pay for their top managers encourages them to invest in costly eco-innovation projects using available funds. In other words, given that eco-innovation is likely to improve the firms' reputation and value, these managers can participate in eco-innovation activities without exceeding the firm's overall risk limit, aligning their incentive with other stakeholders. Results in Panel C further reveal that the top-management compensation tends to increase the eco-innovation investment in *low eco-innovative* firms more than in their *high eco-innovative* counterparts. Possibly, low eco-innovative firms have more space for managers to invest in such activities, and paying high for top management in those firms encourages them to improve the eco-innovation and in turn, their value.

5.3 | Environmental-sensitive industries

As the eco-innovation levels might be dissimilar across *high* and *low-polluting* industries, we examine whether top-management compensation explains such difference. We follow Nguyen (2017) to define high-polluting industries as those with the highest "carbon intensity," "greatest greenhouse gas," or highly-consuming energy firms based on the GICS.[6] We then match the GICS with the TRBC[7] to obtain the list of high-polluting sectors (Appendix S2). We argue that eco-innovation should be already more of a concern to managers and boards of directors within those highly polluting firms. Hence, the higher top-management compensation may be *less* likely to encourage them to invest more in eco-innovation. Heavy regulations imposed on the operations of those polluting industries may require them to invest in certain activities relevant to eco-innovation that not only helps firms respond to local government policies on environmental protection but also reduces their future costs to address related environmental problems. Furthermore, due to their inherent business models, it is challenging to improve their negative impacts on the environment beyond regulatory requirements.

We test our prediction and report the results in Table 6 (Panel A). Across all different model specifications (1–4), we find that the positive impact of top-management compensation on eco-innovation is less intensified in high-polluting industries.

5.4 | Effects of top-management compensation on eco-innovation by innovative sectors

We further investigate the relationship between top-management compensation and eco-innovation across *high* and *low-innovative* industries. Following the report of OECD (2011), we classify highly innovative industries as ones with the highest industry R&D intensities, matching with the industry names provided by the TRBC (Appendix S3). As innovative industries often invest in innovation activities irrelevant to environmental issues, we anticipate a more important role of top-management payment in eco-innovation investment. Results in Table 6 (Panel B) reveal significant and positive coefficients on the interaction term, i.e., *SE-Comp/TA*Innovative sector*, which suggests that the positive effect of top-management compensation on eco-innovation is more pronounced in more innovative firms than their low innovative peers.

5.5 | Dynamic panel-data estimation: Two-step system GMM estimations

Although we have used the 1-year lagged fashion of all independent variables in our empirical models, the endogeneity problem may still exist due to reverse causality. While firms with high top-management compensation exhibit higher eco-innovation, firms with high levels of eco-innovation can offer a more attractive compensation package to top management. We address such endogeneity bias by employing the two-step system generalized method of moments (GMM) (Ullah et al. (2018). The method captures endogeneity through the internal

TABLE 7 Dynamic panel-data estimation: Two-step system GMM estimations

	(1) eco-innovation $_t$	(2) eco-innovation $_t$
Eco-innovation $_{t-1}$	0.709*** (0.000)	0.707*** (0.000)
SE-comp/TA	0.124** (0.039)	0.116** (0.044)
Controls included	*Yes*	*Yes*
Constant	−37.414*** (0.000)	−37.039*** (0.000)
Year FE	No	Yes
Observations	7,374	7,374
Number of groups	852	852
AR(1)	0.000	0.000
AR(2)	0.484	0.621
Overidentification Sargan test (*p* value)	0.124	0.198
Overidentification Hansen test (*p* value)	0.262	0.293
Wald chi 2	12408***	13543***

Note: This table reports the GMM estimations results on the association between top-management compensation and eco-innovation. See Table A1 for variable definitions and measurements.
*Significance level of 10%.
**Significance level of 5%.
***Significance level of 1%.

transformation of data and the use of the lagged value of the dependent variable (i.e., *Eco-innovation* $_{t-1}$) (Khan et al., 2021; Ullah et al., 2018).

We report our GMM results in Table 7 (Model 1: *without* year-fixed effect and Model 2: *with* year-fixed effect). Our main findings remain relatively unchanged. Post-estimation tests of GMM models satisfy all conditions. We, therefore, conclude that after controlling for three issues, i.e., the unobserved heterogeneity, simultaneity, and dynamic endogeneity, our main results are still robustly grounded.

5.6 | Propensity score matching estimation

We finally address the endogeneity as well as the sample selection bias by employing the propensity score matching (PSM) technique. These problems can occur in three possible cases: (i) when the high top-management compensation is not randomly distributed across firms; (ii) when some variables are related to both eco-innovation and top-management compensation; and (iii) when there exists a reverse-causal relationship between top-management compensation and eco-innovation as mentioned earlier. We follow the previous studies of Trinh et al. (2020), Chakravarty and Rutherford (2017), Rosenbaum and Rubin (1983), and Trinh et al. (2021) to conduct a three-step process (see more details in in the supporting information). Table 8 shows the PSM results which are consistent with our main findings.

6 | DISCUSSION AND CONCLUDING REMARKS

The top senior executives have an important role in responding to how businesses survive and thrive to meet their long-term sustainable

TABLE 8 Propensity-score matching estimators

		Unmatched sample			Matched sample		
	# of observations	Mean	Difference (*high SE-comp/TA* – *Low SE-comp/TA*)	*T* value of difference	Mean	Difference (*high SE-comp/TA* – *Low SE-comp/TA*)	*T* value of difference
With replacement ($n = 1$)							
Eco-innovation (high SE-comp/TA)	3,823	21.305	−11.965***	−16.63	22.553	**4.845******	2.03
Eco-innovation (low SE-comp/TA)	3,503	33.270			17.708		
With replacement ($n = 2$)							
Eco-innovation (high SE-comp/TA)	3,823	21.305	−11.965***	−16.63	22.553	**4.652******	2.07
Eco-innovation (low SE-comp/TA)	3,503	33.270			17.901		
With replacement ($n = 3$)							
Eco-innovation (high SE-comp/TA)	3,823	21.305	−11.965***	−16.63	22.553	**3.857****	1.76
Eco-innovation (low SE-comp/TA)	3,503	33.270			18.695		

Regressions results on matched sample	With replacement ($n = 1$)	With replacement ($n = 2$)	With replacement ($n = 3$)
SE-comp dummy	3.238*** (0.000)	2.724*** (0.000)	2.724*** (0.000)
Controls included ($t-1$)	Yes	Yes	Yes
Intercept	−115.632*** (0.000)	−109.266*** (0.000)	−109.266*** (0.000)
Observations	4,332	4,680	4,680
R-square	0.157	0.152	0.152
Wald chi 2 (*p* value)	43.59***	45.10***	45.10***

Note: This table reports the results for the propensity score matching estimation. Table A1 presents the definitions and measurements of all variables.
*Significance level of 10%.
**Significance level of 5%.
***Significance level of 1%.

development strategy, which benefits various stakeholders. In this study, to understand their role in corporate innovation, we examine the impact of managerial incentives proxied by the top-management compensation on eco-innovation activities. Prior studies argue that top-management intrinsic characteristics (i.e., attitude, nationality, personal traits, or risk-taking propensity) have a significant impact on the commitment to innovation investment projects (Arena et al., 2018; Boone et al., 2019; Damanpour & Schneider, 2006; Kraiczy et al., 2015). Our study complements the literature by exploring the extrinsic incentives, which potentially influence the strategic behavior of the top management. Under the overarching theoretical frameworks of stakeholder and incentive alignment theories, we find that firms with high top-management compensation exhibit higher scores of eco-innovation engagement. This result supports the stakeholder-incentive alignment view that compensation is an effective mechanism to align the interest of management and stakeholders for sustainable development.

Our results remain consistent after alternative tests are conducted to address the endogeneity problem (i.e., the difference-in-differences analysis on the event of the Paris Agreement 2015, the two-step system generalized method of moments, and propensity score matching). The results also suggest that the compensation is less well linked with eco-innovation in the polluting industries. This finding implies the inherent low environmental scores of those industries and the difficulties of improving the environmental reputation out of their business nature, for which increasing top-management compensation may not be a solution. Our results also suggest that the positive impact of top-management compensation on eco-innovation is driven by the low eco-innovative firms. These findings indicate that stakeholders in low eco-innovative sectors may exhibit their concerns with firms' sustainability strategies. Hence, compensation is a useful tool to align their interests with managers. Although eco-innovation investments are unconventional, they are highly visible and have a wide societal impact on various stakeholders (Arena et al., 2018).

Our study offers some important implications. Firms should design a suitable compensation policy to encourage the top management to pursue greener investment strategies such as eco-innovation. Besides the intrinsic characteristics of the top managers, for instance, executive hubris (Arena et al., 2018), the extrinsic incentives via their compensation package play a significant role in enhancing eco-innovation. In particular, when the firms belong to the low eco-innovation rate cluster, top-management compensation could be used as an effective way to boost the environmental performance. Furthermore, while applying executive compensation incentives to promote eco-innovation, the stakeholders should consider the impact of other external factors, such as environment-sensitive industries.

Our study employs a sample of a single country (the US), similar to Arena et al. (2018) using a UK sample, which may limit the generalization of our results and implications for other less developed markets. Future studies can extend our investigation across countries to capture the impact of social and cultural factors. Due to the lack of details related to top-management compensation contracts, our study is unable to capture the impact of compensation elements such as CSR and innovation-linked incentives on eco-innovation. As such, our findings are generalized for the whole compensation package.

CONFLICT OF INTEREST

There is no conflict of interest to declare and the project did not receive any funding.

AUTHOR CONTRIBUTIONS

Giang Phung contributed to the research idea discussion, introduction/literature review, and writing and editing. Hai Hong Trinh contributed to the research idea discussion, data and sample, and writing and editing. Tam Nguyen contributed to the research idea discussion, literature review/hypothesis, and writing and editing. Vu Quang Trinh contributed to the research idea discussion, all data analysis, and writing and editing. All authors have contributed equally to the project administration.

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ENDNOTES

[1] According to a 2017 survey by Cone Communications, 92% of consumers will have a more positive image of it, and 87% will be more likely to trust and be more loyal to a company that supports social or environmental issues.

[2] It is the strategy of development of new ideas, that of the promotion of new operations, products and processes to protect the environment, and, in turn, ultimately to obtain environmental sustainability (Arena et al., 2018; Zaman et al., 2021).

[3] https://www.spglobal.com/spdji/en/indices/equity/sp-composite-1500/

[4] See the recent articles in which authors use ESG scores for capturing corporate sustainability by Drempetic et al. (2020) and van Duuren et al. (2016).

[5] https://www.refinitiv.com/en/sustainable-finance/esg-scores and https://refini.tv/3sKBYxh.

[6] For more details on the Global Industry Classification Standard (GICS), please visit the report of S&P Global Market Intelligence (2018).

[7] For more details on the Refinitiv Business Classifications (TRBC) Sector Classification, please visit https://www.refinitiv.com/en/financial-data/indices/trbc-business-classification

REFERENCES

Acebo, E., Miguel-Dávila, J.-Á., & Nieto, M. (2021). External stakeholder engagement: Complementary and substitutive effects on firms' eco-innovation. *Business Strategy and the Environment*, *30*(5), 2671–2687. https://doi.org/10.1002/bse.2770

Adu, D. A., Flynn, A., & Grey, C. (2021). Executive compensation and sustainable business practices: The moderating role of sustainability-based compensation. *Business Strategy and the Environment*, *31*, 698–736. https://doi.org/10.1002/bse.2913

Arena, C., Michelon, G., & Trojanowski, G. (2018). Big egos can be green: A study of CEO hubris and environmental innovation. *British Journal of Management*, *29*(2), 316–336. https://doi.org/10.1111/1467-8551.12250

Bantel, K. A., & Jackson, S. E. (1989). Top management and innovations in banking: Does the composition of the top team make a difference? *Strategic Management Journal*, *10*(S1), 107–124. https://doi.org/10.1002/smj.4250100709

Bebchuk, L. A., & Fried, J. M. (2003). Executive compensation as an agency problem. *Journal of Economic Perspectives*, *17*(3), 71–92. https://doi.org/10.1257/089533003769204362

Berrone, P., & Gomez-Mejia, L. R. (2009). Environmental performance and executive compensation: An integrated agency-institutional perspective. *Academy of Management Journal*, *52*(1), 103–126. https://doi.org/10.5465/amj.2009.36461950

Boone, C., Lokshin, B., Guenter, H., & Belderbos, R. (2019). Top management team nationality diversity, corporate entrepreneurship, and innovation in multinational firms. *Strategic Management Journal*, *40*(2), 277–302. https://doi.org/10.1002/smj.2976

Bowen, F. E. (2002). Organizational slack and corporate greening: Broadening the debate. *British Journal of Management*, *13*(4), 305–316. https://doi.org/10.1111/1467-8551.00248

Brogaard, J., Li, D., & Xia, Y. (2017). Stock liquidity and default risk. *Journal of Financial Economics*, *124*(3), 486–502. https://doi.org/10.1016/j.jfineco.2017.03.003

Cai, Y., Jo, H., & Pan, C. (2012). Doing well while doing bad? CSR in controversial industry sectors. *Journal of Business Ethics*, *108*(4), 467–480. https://doi.org/10.1007/s10551-011-1103-7

Calel, R., & Dechezleprêtre, A. (2016). Environmental policy and directed technological change: Evidence from the European carbon market. *The Review of Economics and Statistics*, *98*(1), 173–191. https://doi.org/10.1162/REST_a_00470

Chakravarty, S., & Rutherford, L. G. (2017). Do busy directors influence the cost of debt? An examination through the lens of takeover vulnerability. *Journal of Corporate Finance*, *43*, 429–443. https://doi.org/10.1016/j.jcorpfin.2017.02.001

Cheah, E.-T., Jamali, D., Johnson, J. E. V., & Sung, M.-C. (2011). Drivers of corporate social responsibility attitudes: The demography of socially responsible investors. *British Journal of Management*, *22*(2), 305–323. https://doi.org/10.1111/j.1467-8551.2011.00744.x

Chen, X., Pan, X., & Sinha, P. (2022). What to green: Family involvement and different types of eco-innovation. *Business Strategy and the Environment*. 1–15. https://doi.org/10.1002/bse.3045

Chin, M. K., Hambrick, D. C., & Treviño, L. K. (2013). Political ideologies of CEOs: The influence of Executives' values on corporate social responsibility. *Administrative Science Quarterly*, *58*(2), 197–232. https://doi.org/10.1177/0001839213486984

Choi, B., & Luo, L. (2021). Does the market value greenhouse gas emissions? Evidence from multi-country firm data. *The British Accounting Review*, *53*(1), 100909. https://doi.org/10.1016/j.bar.2020.100909

Christmann, P. (2004). Multinational companies and the natural environment: Determinants of global environmental policy. *Academy of Management Journal*, *47*(5), 747–760. https://doi.org/10.5465/20159616

Damanpour, F., & Schneider, M. (2006). Phases of the adoption of innovation in organizations: Effects of environment, organization and top Managers1. *British Journal of Management*, *17*(3), 215–236. https://doi.org/10.1111/j.1467-8551.2006.00498.x

Datta, D. K., Rajagopalan, N., & Zhang, Y. (2003). New CEO openness to change and strategic persistence: The moderating role of industry characteristics. *British Journal of Management*, *14*(2), 101–114. https://doi.org/10.1111/1467-8551.00268

Derwall, J., Guenster, N., Bauer, R., & Koedijk, K. (2005). The eco-efficiency premium puzzle. *Financial Analysts Journal*, *61*(2), 51–63. https://doi.org/10.2469/faj.v61.n2.2716

Drempetic, S., Klein, C., & Zwergel, B. (2020). The influence of firm size on the ESG score: Corporate sustainability ratings under review. *Journal of Business Ethics*, *167*(2), 333–360. https://doi.org/10.1007/s10551-019-04164-1

Du, S., & Vieira, E. T. (2012). Striving for legitimacy through corporate social responsibility: Insights from oil companies. *Journal of Business Ethics*, *110*(4), 413–427. https://doi.org/10.1007/s10551-012-1490-4

Edmans, A. (2012). The link between job satisfaction and firm value, with implications for corporate social responsibility. *Academy of Management Perspectives*, *26*(4), 1–19. https://doi.org/10.5465/amp.2012.0046

Eichholtz, P., Kok, N., & Quigley, J. M. (2010). Doing well by doing good? Green office buildings. *American Economic Review*, *100*(5), 2492–2509. https://doi.org/10.1257/aer.100.5.2492

Forsman, H. (2013). Environmental innovations as a source of competitive advantage or vice versa? *Business Strategy and the Environment*, *22*(5), 306–320. https://doi.org/10.1002/bse.1742

Freeman, R. E. (2010). *Strategic management: A stakeholder approach*. Cambridge University Press. https://doi.org/10.1017/CBO9781139192675

Galbreath, J. (2010). Drivers of corporate social responsibility: The role of formal strategic planning and firm culture. *British Journal of Management*, *21*(2), 511–525. https://doi.org/10.1111/j.1467-8551.2009.00633.x

Gillan, S. L., Koch, A., & Starks, L. T. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*, *66*, 101889. https://doi.org/10.1016/j.jcorpfin.2021.101889

Gomez-mejia, L. R., Tosi, H., & Hinkin, T. (1987). Managerial control, performance, and executive compensation. *Academy of Management Journal*, *30*(1), 51–70. https://doi.org/10.5465/255895

Griliches, Z. (1981). Market value, R&D, and patents. *Economics Letters*, *7*(2), 183–187. https://doi.org/10.1016/0165-1765(87)90114-5

Guenster, N., Bauer, R., Derwall, J., & Koedijk, K. (2011). The economic value of corporate eco-efficiency. *European Financial Management*, *17*(4), 679–704. https://doi.org/10.1111/j.1468-036X.2009.00532.x

Haque, F., & Ntim, C. G. (2020). Executive compensation, sustainable compensation policy, carbon performance and market value. *British Journal of Management*, *31*(3), 525–546. https://doi.org/10.1111/1467-8551.12395

Hart, S. L., & Ahuja, G. (1996). Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. *Business Strategy and the Environment*, *5*(1), 30–37. https://doi.org/10.1002/(SICI)1099-0836(199603)5:1<30::AID-BSE38>3.0.CO;2-Q

Holthausen, R. W., Larcker, D. F., & Sloan, R. G. (1995). Business unit innovation and the structure of executive compensation. *Journal of Accounting and Economics*, *19*(2), 279–313. https://doi.org/10.1016/0165-4101(94)00385-I

Hsu, P.-H., Lee, H.-H., Liu, A. Z., & Zhang, Z. (2015). Corporate innovation, default risk, and bond pricing. *Journal of Corporate Finance*, *35*, 329–344. https://doi.org/10.1016/j.jcorpfin.2015.09.005

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X

Jo, H., & Na, H. (2012). Does CSR reduce firm risk? Evidence from controversial industry sectors. *Journal of Business Ethics*, *110*(4), 441–456. https://doi.org/10.1007/s10551-012-1492-2

John, T. A., & John, K. (1993). Top-management compensation and capital structure. *The Journal of Finance*, *48*(3), 949–974. https://doi.org/10.1111/j.1540-6261.1993.tb04026.x

Kerr, J., & Bettis, R. A. (1987). Boards of directors, top management compensation, and shareholder returns. *Academy of Management Journal*, *30*(4), 645–664. https://doi.org/10.5465/256153

Khan, M. K., Trinh, H. H., Khan, I. U., & Ullah, S. (2021). Sustainable economic activities, climate change, and carbon risk: An international evidence. *Environment, Development and Sustainability*, *24*, 9642–9664. https://doi.org/10.1007/s10668-021-01842-x

Kim, I., Pantzalis, C., & Zhang, Z. (2021). Multinationality and the value of green innovation. *Journal of Corporate Finance*, *69*, 101996. https://doi.org/10.1016/j.jcorpfin.2021.101996

Klassen, R. D., & McLaughlin, C. P. (1993). TQM and environmental excellence in manufacturing. *Industrial Management & Data Systems*, *93*(6), 14–22. https://doi.org/10.1108/02635579310040924

Klimkiewicz, K., & Oltra, V. (2017). Does CSR enhance employer attractiveness? The role of millennial job seekers' attitudes. *Corporate Social Responsibility and Environmental Management*, *24*(5), 449–463. https://doi.org/10.1002/csr.1419

Kraiczy, N. D., Hack, A., & Kellermanns, F. W. (2015). What makes a family firm innovative? CEO risk-taking propensity and the organizational context of family firms. *Journal of Product Innovation Management*, *32*(3), 334–348. https://doi.org/10.1111/jpim.12203

Luo, L., Wu, H., & Zhang, C. (2021). CEO compensation, incentive alignment, and carbon transparency. *Journal of International Accounting Research*, *20*(2), 111–132. https://doi.org/10.2308/JIAR-2020-032

Nadeem, M., Bahadar, S., Gull, A. A., & Iqbal, U. (2020). Are women eco-friendly? Board gender diversity and environmental innovation. *Business Strategy and the Environment*, *29*(8), 3146–3161. https://doi.org/10.1002/bse.2563

Neubaum, D. O., Dibrell, C., & Craig, J. B. (2012). Balancing natural environmental concerns of internal and external stakeholders in family and non-family businesses. *Journal of Family Business Strategy*, *3*(1), 28–37. https://doi.org/10.1016/j.jfbs.2012.01.003

Nguyen, J. H. (2017). Carbon risk and firm performance: Evidence from a quasi-natural experiment. *Australian Journal of Management*, *43*(1), 65–90. https://doi.org/10.1177/0312896217709328

Nielsen, S. (2010). Top management team diversity: A review of theories and methodologies. *International Journal of Management Reviews*, *12*(3), 301–316. https://doi.org/10.1111/j.1468-2370.2009.00263.x

OECD. (2011). Innovative sectors. *In OECD science, technology and industry scoreboard 2011*. OECD Publishing. https://doi.org/10.1787/sti_scoreboard-2011-66-en

Oh, W.-Y., Chang, Y. K., & Cheng, Z. (2016). When CEO career horizon problems matter for corporate social responsibility: The moderating roles of industry-level discretion and Blockholder ownership. *Journal of Business Ethics*, *133*(2), 279–291. https://doi.org/10.1007/s10551-014-2397-z

Okhmatovskiy, I., & David, R. J. (2011). Setting your own standards: Internal corporate governance codes as a response to institutional pressure. *Organization Science*, *23*(1), 155–176. https://doi.org/10.1287/orsc.1100.0642

Palmer, K., Oates, W. E., & Portney, P. R. (1995). Tightening environmental standards: The benefit-cost or the no-cost paradigm? *Journal of Economic Perspectives*, *9*(4), 119–132. https://doi.org/10.1257/jep.9.4.119

Piaskowska, D., & Trojanowski, G. (2014). Twice as smart? The importance of managers formative-years international experience for their international orientation and foreign acquisition decisions. *British Journal of Management*, *25*(1), 40–57. https://doi.org/10.1111/j.1467-8551.2012.00831.x

Porter, M. (1996). Americas green strategy. *Business and the Environment: A Reader*, *33*, 1072.

Radu, C., & Smaili, N. (2021). Alignment versus monitoring: An examination of the effect of the CSR Committee and CSR-linked executive compensation on CSR performance. *Journal of Business Ethics*. 1–19. https://doi.org/10.1007/s10551-021-04904-2

Ren, S., Wang, Y., Hu, Y., & Yan, J. (2021). CEO hometown identity and firm green innovation. *Business Strategy and the Environment*, *30*(2), 756–774. https://doi.org/10.1002/bse.2652

Rosenbaum, P. R., & Rubin, D. B. (1983). Assessing sensitivity to an unobserved binary covariate in an observational study with binary outcome. *Journal of the Royal Statistical Society: Series B: Methodological*, *45*(2), 212–218. https://doi.org/10.1111/j.2517-6161.1983.tb01242.x

Rueda-Manzanares, A., Aragón-Correa, J. A., & Sharma, S. (2008). The influence of stakeholders on the environmental strategy of service firms: The moderating effects of complexity, uncertainty and munificence*. *British Journal of Management*, *19*(2), 185–203. https://doi.org/10.1111/j.1467-8551.2007.00538.x

S&P Global Market Intelligence. (2018). The Global Industry Classification Standard (GICS®). Retrieved from https://bit.ly/3KGzAii

Schumpeter, J. A. (1942). *Socialism, capitalism and democracy*. Harper and Brothers.

Scuotto, V., del Giudice, M., & Carayannis, E. G. (2017). The effect of social networking sites and absorptive capacity on SMES innovation performance. *The Journal of Technology Transfer*, *42*(2), 409–424. https://doi.org/10.1007/s10961-016-9517-0

Sen, S., & Cowley, J. (2013). The relevance of stakeholder theory and social capital theory in the context of CSR in SMEs: An Australian perspective. *Journal of Business Ethics*, *118*(2), 413–427. https://doi.org/10.1007/s10551-012-1598-6

Shaukat, A., Qiu, Y., & Trojanowski, G. (2016). Board attributes, corporate social responsibility strategy, and corporate environmental and social performance. *Journal of Business Ethics*, *135*(3), 569–585. https://doi.org/10.1007/s10551-014-2460-9

Steinbach, A. L., Holcomb, T. R., Holmes, R. M. Jr., Devers, C. E., & Cannella, A. A. Jr. (2017). Top management team incentive heterogeneity, strategic investment behavior, and performance: A contingency theory of incentive alignment. *Strategic Management Journal*, *38*(8), 1701–1720. https://doi.org/10.1002/smj.2628

Tosi, H. L., Katz, J. P., & Gomez-Mejia, L. R. (1997). Disaggregating the agency contract: The effects of monitoring, incentive alignment, and term in office on agent decision making. *Academy of Management Journal*, *40*(3), 584–602. https://doi.org/10.5465/257054

Trinh, H. H., Nguyen, C. P., Hao, W., & Wongchoti, U. (2021). Does stock liquidity affect bankruptcy risk? DID analysis from Vietnam. *Pacific-Basin Finance Journal*, *69*, 101634. https://doi.org/10.1016/j.pacfin.2021.101634

Trinh, V. Q., Elnahass, M., Salama, A., & Izzeldin, M. (2020). Board busyness, performance and financial stability: Does bank type matter? *The European Journal of Finance*, *26*(7–8), 774–801. https://doi.org/10.1080/1351847X.2019.1636842

Trinh, V. Q., & Seetaram, N. (2022). Top-management compensation and survival likelihood: The case of tourism and leisure firms in the US. *Annals of Tourism Research*, *92*, 103323. https://doi.org/10.1016/j.annals.2021.103323

Tsang, A., Wang, K. T., Liu, S., & Yu, L. (2021). Integrating corporate social responsibility criteria into executive compensation and firm innovation: International evidence. *Journal of Corporate Finance*, *70*, 102070. https://doi.org/10.1016/j.jcorpfin.2021.102070

Ullah, S., Akhtar, P., & Zaefarian, G. (2018). Dealing with endogeneity bias: The generalized method of moments (GMM) for panel data. *Industrial Marketing Management*, *71*, 69–78. https://doi.org/10.1016/j.indmarman.2017.11.010

van Duuren, E., Plantinga, A., & Scholtens, B. (2016). ESG integration and the investment management process: Fundamental investing reinvented. *Journal of Business Ethics*, *138*(3), 525–533. https://doi.org/10.1007/s10551-015-2610-8

Waldman, D. A., Sully de Luque, M., Washburn, N., House, R. J., Adetoun, B., Barrasa, A., Bobina, M., Bodur, M., Chen, Y. J., Debbarma, S., Dorfman, P., Dzuvichu, R. R., Evcimen, I., Fu, P., Grachev, M., Gonzalez Duarte, R., Gupta, V., den Hartog, D. N., de Hoogh, A. H. B., … Wilderom, C. P. M. (2006). Cultural and leadership predictors of corporate social responsibility values of top management: A GLOBE study of 15 countries. *Journal of International Business*

Studies, *37*(6), 823–837. https://doi.org/10.1057/palgrave.jibs.8400230

Zaman, R., Atawnah, N., Haseeb, M., Nadeem, M., & Irfan, S. (2021). Does corporate eco-innovation affect stock price crash risk? *The British Accounting Review*, *53*(5), 101031. https://doi.org/10.1016/j.bar.2021.101031

Zheng, L., & Iatridis, K. (2022). Friends or foes? A systematic literature review and meta-analysis of the relationship between eco-innovation and firm performance. *Business Strategy and the Environment*, *31*(4), 1838–1855. https://doi.org/10.1002/bse.2986

Zhou, B., Li, Y. M., Sun, F. C., & Zhou, Z. G. (2021). Executive compensation incentives, risk level and corporate innovation. *Emerging Markets Review*, *47*, 100798. https://doi.org/10.1016/j.ememar.2021.100798

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A.

TABLE A1 Variable definitions

Variable – Abbreviation	Definition
Firm eco-innovation	
Eco-innovation	The environmental innovation scores of a company reflecting its capacity to mitigate the expenses and burdens that are associated with environmental issues for customers.
Top-management compensation	
SE-comp/TA	The total compensation paid to all senior executives scaled by the total assets.
Board-related variables	
LnBSize	The natural logarithm of the total number of board members.
%female	The percentage of females on the board.
%skills	The percentage of board members who acquire either an industry-oriented background or a strong financial background.
Re-election [1–2]	Dummy, taking a value of 2 if all board members subject to re-election individually (either no classified or staggered board structure and 1 otherwise).
Board tenure	The average number of years for each member on the board.
Ln(B-meeting)	The natural logarithm of the number of board meetings per year.
B-meeting attendance	The percentage of board meeting attendance.
P-board Independence	Dummy, taking a value of 2 if the company has a policy regarding its board independence and 1 otherwise.
Audit committee	Dummy, taking a value of 2 if the company owns an audit board committee and 1 otherwise.
CSR sustainability committee (*CSR-Committee*)	Dummy, taking a value of 2 if the company has a CSR committee and 1 otherwise.
CEO-related variables	
CEO comp-TSR	Dummy, taking a value of 2 if CEOs compensation is associated with its total shareholder return (TSR) and 1 otherwise.
CEO-chairman duality	Dummy, taking a value of 2 if CEO simultaneously chairs the board and 1 otherwise.
Chair-ex-CEO	Dummy, taking a value of 2 if the chairman has held the CEO position before becoming the company's chairman and 1 otherwise.
Firm-level control variables	
Debt/equity	The leverage ratio: (long-term debt + Short Term Debt & Current Portion of long-term debt) /common equity * 100.
M/B	The ratio of the market value of the common equity and its balance sheet value of the ordinary equity.
Ln (*TA*)	The natural logarithm of the total debt and its shareholders equity.
PPE/TA	The ratio of PPE (gross property, plant and equipment less its accumulated reserves for depreciation, depletion and amortization) and the total assets.
R&D/TA	The ratio of research and development spending and the total assets.
ROA	The return on assets

Note: The table presents the variable definitions and measurements.