Navigating the Black Box: Board Co-option and Environmental Innovation

Abstract

Purpose – This study examines the impact of board co-option on environmental innovation and the moderating effect that firms' industrial context and ESG compensation has on this relationship.

Design/methodology/approach – This study employs the system generalized method of moments (GMM) estimator on a longitudinal panel dataset of the US listed firms, to test the proposed hypothesis. The system GMM findings were also substantiated through the use of propensity score matching (PSM) and difference-in-differences (DiD) estimations, to better establish causality by addressing endogeneity concerns.

Findings – The findings provide evidence that board co-option has a negatively significant relationship with environmental innovation. Further analyses implies that the impact of board co-option on environmental innovation is more pronounced among firms operating in environmentally non-sensitive industries and those not tying executive compensation with ESG performance. Taken together, these results suggest that industrial context and ESG compensation moderates the relationship of board co-option and environmental innovation.

Originality – This study is a novel attempt contributing to debate on board composition and its impact on corporate environmental sustainability. It also complements existing literature on sustainability governance and accounting by providing an understanding of the impact of board co-option on corporate environmental innovation and how industrial context and ESG compensation influence this relationship, offering important insights for academics, senior management, and policymakers.

Keywords: Board co-option; Environmental innovation; ESG compensation; Environmentally sensitive industries.

1. Introduction

Recent environmental scandals, such as the Volkswagen emissions scandal, the Apple product obsolescence case, and the Duke Energy oil spill case have highlighted the critical role that board of directors play in promoting eco-innovation and preventing environmental damage. These scandals have not only resulted in significant financial losses and reputational damage for the companies involved (El Ghoul, Guedhami, Kim, & Park, 2018; Karpoff & Lott Jr, 1993) but have also undermined investors' trust, decreased shareholders' value, misallocated resources, and increased market uncertainty (Baek, Johnson, & Kim, 2009; Cumming, Johan, & Peter, 2018; Cumming & Leung, 2021; Karpoff, Lott, & Wehrly, 2005). Investigations into these incidents have revealed that the board of directors did not fulfill their obligations and breached the trust of society and stakeholders alike, suggesting that effective board governance is essential to prevent such events and promote sustainable business practices. This study therefore investigates whether board co-option, a form of board composition characterized by the appointment of directors after the CEO joins office, help firms protect the environment through eco-innovation.

Our research focuses on the phenomenon of board co-option in corporate governance, driven by the significant influence exerted by the CEOs in appointment of the board members. However, comprehending the intricate dynamics and composition of corporate boards poses challenges as they are often regarded as opaque entities (Baghdadi, Nguyen, & Podolski, 2020; Zaman, Atawnah, Baghdadi, & Liu, 2021). To address this concern, we adopt a measure of board co-option developed by Coles, Daniel, and Naveen (2014), which involves calculating the ratio of directors appointed following the CEO's assumption of office to the board size. This measure serves as a gauge of compromised board independence, as co-opted directors are more likely to associate their fidelities with the appointing CEO rather than exercising independent judgment. This novel approach departs from conventional methods that

predominantly rely on assessing material ties between directors and the company. Recognizing the limitations inherent in conventional measures of board independence, Coles et al. (2014) convincingly argue that co-option may offer greater insights into capturing board impartiality. Consequently, our study aims to investigate the implications of board co-option for various organizational outcomes, including the crucial domain of sustainable business practices such as eco-innovation, thereby contributing to the advancement of scholarly knowledge in this field.

Existing literature on board co-option has largely focused on examining the influence of co-opted directors on various corporate outcomes such as firm investment decision, dividend payout, default risk, and misconduct among others (Chintrakarn, Jiraporn, Sakr, & Lee, 2016; Jiraporn & Lee, 2018; Lim, Do, & Vu, 2020; Zaman, Atawnah, Baghdadi, et al., 2021). However, a little attention has been paid to examine the association between board co-option and corporate sustainability. Few studies in this regard document the significant impact of board co-option on firms climate risk (Ghafoor, Šeho, & Sifat, 2023) and greenhouse gas emissions (Gull, Sarang, Shakri, & Atif, 2023). Our research contributes to corporate governance literature by investigating how board co-option affects eco-innovation—a measure integrating environmental sustainability considerations into innovation processes.

In this study, we put forth two exclusive hypotheses to investigate the impact of co-opted directors on eco-innovation, drawing upon contrasting perspectives known as the dark and bright side view of co-opted directors. The first view raises concerns about compromised monitoring quality, reduced CEO accountability, and a lack of challenge to established practices. Studies aligned with this view have shown higher instances of corporate misconduct, increased climate risk, higher probability of default and lower employee welfare (Baghdadi et al., 2020; Ghafoor et al., 2023; Zaman, Atawnah, Baghdadi, et al., 2021). Based on the dark side view, board co-option is likely to have an adverse impact on eco-innovation. Alternatively,

bright side view proposes that board co-option encourages a positive work environment, fostering uniformity between executives and the Chief Executive Officer (CEO) with regard to work ethics and shared perspectives (Bhuiyan, Sangchan, & D'Costa, 2022; Chintrakarn et al., 2016). Co-opted directors bring expertise, diverse viewpoints, and fresh perspectives to the board, aiding in informed decision-making and identifying risks and opportunities. Studies (e.g., Chintrakarn et al., 2016; Gull et al., 2023; Nguyen, Vu, & Yin, 2021) have shown that co-opted directors perform their fiduciary responsibilities, and that CEOs seek guidance from friendly boards to increase firm value and facilitate long-term initiatives, resulting into alignment of interests which could further promote the eco-innovation.

We employ 3,947 firm-year observations of US firms from the year 2002 to 2018, to examine our hypotheses. Our baseline results, using the system GMM regressions indicate that firms with more co-opted directors are less likely to engage in eco-innovation initiatives. This implies that board co-option negatively affects a company's ability to pursue eco-innovative activities. The findings align with the dark side perspective of board co-option, which posits that these directors take less interest in their monitoring responsibilities and exhibit a greater allegiance to the CEOs who appointed them, rather than prioritizing the interests of stakeholders. This finding remains consistent irrespective of the measure of board co-option. In addition to the system GMM estimations, we use two approaches to address endogeneity concerns. First, we employ propensity score matching (PSM) using nearest neighbor matching with replacement to identify treatment firms which have a high co-option ratio, with a control group, which has a low co-option ratio. This method effectively mitigates selection bias by employing a matching approach wherein firms are paired based on key observable characteristics. By doing so, it ensures that the comparison groups exhibit similarity in terms of these observable characteristics, except eco-innovation. Next, we use a difference in difference (DiD) analysis to examine how the CEO dismissal affected board composition as an

exogenous shock. The results from the endogeneity tests are consistent with our initial findings, reinforcing the robustness and reliability of our baseline analysis. In line with contingency perspective (Donaldson, 2001), the results of further analysis show that industrial context moderates the association between co-opted directors and econ-innovation. Specifically, we find that board co-option positively impacts eco-innovation in environmentally sensitive industries, supporting the arguments of contingency perspective.

Our study substantially contributes to the existing literature. First, it adds to the emerging literature on corporate eco-innovation through the lens of board composition. Prior research demonstrates the impact of board structure on eco-innovation such as board gender diversity (Issa, & Bensalem, 2023; Zaman, Asiaei, Nadeem, Malik, & Arif, 2023), board independence (García-Sánchez, Gallego-Álvarez, & Zafra-Gómez, 2021), age diversity and employee board representation (Galia, Zenou, & Ingham, 2015). Our contribution to the growing literature lies in providing evidence that board co-option is another important determinant of eco-innovation. Second, our study provides a valuable contribution to the existing body of knowledge on the consequences of co-opted directors (Baghdadi et al., 2020; Ghafoor et al., 2023; Zaman, Atawnah, Baghdadi, et al., 2021), by demonstrating that corporations with a large proportion of co-opted directors are less interested in eco-innovation. Finally, we contribute to emerging but inconclusive literature on the effectiveness of co-opted directors (Gull et al., 2023; Lim et al., 2020) by highlighting the underlying mechanisms through which board co-option impacts eco-innovation. Following the contingency perspective of Donaldson (2001) which advocates that association between co-opted boards and eco-innovation may be subject to some other organizational contingencies. Gull et al. (2023) documents that association of board co-option and greenhouse gas emissions depends on whether corporations tie CEO compensation to ESG performance. In this regard, we show that

association between co-opted boards and eco-innovation is subject to industrial context of the firms. Hence, contributing to the literature on board co-option and contingency theory.

2. Theory and hypotheses development

Our study explores the influence of board co-option on eco-innovation through the lens of stakeholder-agency theory and the resource-based view. By drawing on stakeholder-agency theory, our study acknowledges the presence of contractual associations between the CEO, who serves as the representative of the management, and diverse stakeholders, including shareholders of the firm (Hill & Jones, 1992). Stakeholder-agency theory posits that conflicts of interest between executives and stakeholders can potentially result in opportunistic behavior and the prioritization of self-interest. In the context of eco-innovation, such behaviors can be viewed as deviations from expected norms of stakeholder engagement, thus giving rise to agency problems that stem from the infringement of stakeholder interests (Fama & Jensen, 1983). This tendency is particularly accentuated when co-opted directors join the board. As a result, the association between the CEO and co-opted directors may potentially encourage deviant behavior, which may eventually undermine eco-innovation, particularly without rigorous monitoring.

Scholars recognize this compromised independence of co-opted directors as a dark side view of the board co-option. The dark side perspective expresses apprehension about the compromised quality of monitoring and reduced CEO accountability, as co-opted directors may exhibit greater loyalty towards the appointing CEO and may be less inclined to challenge the established business practices (Coles et al., 2014; Rahman, Malik, Ali, & Iqbal, 2021), including those associated with eco-innovation. Coles et al. (2014) also suggested that co-opted directors shield the CEOs from performance pressures, which subsequently lead to increased CEO power and reduced accountability. In a similar vein, studies show that despite the poor performance and risky investment decisions, co-opted directors may demand for an increase in

CEO's remuneration than asking for resignation (Coles et al., 2014; Harris, Karl, & Lawrence, 2019).

Studies aligned with this view have documented higher instances of corporate misconduct, higher climate risk and lower employee welfare (Ghafoor et al., 2023; Gull et al., 2023; Nishikawa, Hashemi Joo, & Okafor, 2022; Zaman, Atawnah, Baghdadi, et al., 2021). For instance, Zaman, Atawnah, Baghdadi and Liu (2021) document that board co-option leads to a higher involvement of firms in environmental violations. Ghafoor et al. (2023) also documents that co-opted boards increase the firms' exposure to climate risk. Likewise, El Saleh and Jurdi (2021) noted that firms with more co-opted directors exhibit a decline in the extent of involvement in social activities, indicating a potential lack of emphasis on environmental and social responsibility. Additionally, given the long-term nature of eco-innovation and its potential financial impact (Hossain et al., 2022), CEOs may prioritize financial concerns over climate-related issues, thereby reducing the involvement in activities aimed at promoting eco-innovation. Taken together, this stream of literature indicates that co-opted directors may adversely affect corporate sustainability. We, therefore, present the following hypothesis:

H1: *Board co-option is negatively associated with eco-innovation.*

Alternatively, the resource dependence view holds that companies leverage their available resources to maximize economic gains (Warnerfelt, 1984). In this framework, CEOs strategically appoint co-opted directors to capitalize on their specific skills and expertise to facilitate the board's decision-making processes. The empirical literature classifies this as a bright side view of board co-option. Studies in this regard (Wintoki & Xi, 2019) suggest that co-opted boards create a positive and harmonious work environment, facilitating the alignment of management and the CEO in terms of work ethics and shared perspectives.

The studies argue that board co-option mitigates managerial myopia by insulating CEOs from market pressure and encouraging innovative R&D investments with long-term

payoffs (Chintrakarn et al., 2016; Nguyen, Vu, & Yin, 2021). Furthermore, co-opted directors may also be inclined to fulfill their fiduciary duties, notwithstanding their appointed status, due to concerns regarding the perceived board legitimacy and their professional reputation (Cowen & Marcel, 2011; Fich & Shivdasani, 2007). In fact, Adams and Ferreira (2007) posit that CEOs tend to seek guidance from friendly boards as it leads to an increase in firm value without impeding or challenging their decisions, enabling the CEOs to invest in long term initiatives and facilitating long-termism (Chintrakarn et al., 2016). In a recent study, Gull et al. (2023) shows that board co-option reduces the firm's likelihood of emitting greenhouse gases. In line with resource-based view and relevant empirical literature, we argue that board co-option brings convergence of interests between the CEOs and stakeholders which may increase the firm involvement in eco-innovation. Consequently, we put forward the following hypothesis:

H2: *Board co-option is positively associated with eco-innovation.*

3. Research Methods

3.1. Data and sample

Our final sample consists of 3,947 firm-year observations of US companies for the period of 2002–2018. The data period starts from 2002, as this is the initial year for which the sustainability data are available in Thomson Reuters Eikon and ends in 2018 because board co-option data are not available after this year. We collect data from various sources. Eco-innovation and governance variables are sourced from Thomson Reuters Eikon. The data on board co-option and accounting variables are retrieved from the webpage of Lalitha Naveen[1] and WorldScope, respectively.

[1] The public data on coopted board is available at Lalitha Naveen's webpage: https://sites.temple.edu/lnaveen/data/

3.2. Variables

In the existing literature, research and development has been widely used as a measure of innovation, but this approach falls short in capturing eco-innovation. Given the challenges associated with acquiring accurate data on environmental research and development (R&D) expenditures, we employ the Thomson Reuters Eikon eco-innovation score (*ECO_INNO*) to proxy firms eco-innovation which is consistent with recent literature (e.g., Zaman, Atawnah, Haseeb, Nadeem, and Irfan (2021). This metric assesses a company's ability to create new market opportunities through the development of environmental technologies and processes, as well as eco-designed products, by reducing environmental costs and burdens for its customers.

The eco-innovation score (*ECO_INNO*) sourced from the Thomson Reuters Eikon database is a widely recognized and established metric for assessing eco-innovation. It has been employed in recent studies ((Zaman, Atawnah, Baghdadi, et al., 2021). This measure is a composite score on a scale of 0-100. It is a weighted average that considers industry adjustments and is based on twenty factors relating to the organization's eco-products and eco-processes. A higher score indicates a stronger commitment to eco-innovation within the organization. To simplify the interpretations, the eco-innovation score is divided by 100 to get fractions. Our decision to use the eco-innovation score is based on the belief that firms' eco-innovation efforts represent a significant driver of their long-term success and competitiveness, particularly in light of the growing concerns about environmental sustainability.

In measuring board co-option, we adopt the definition provided by Coles et al. (2014) who define board co-option as the proportion of directors who are hired to a company's board following the appointment of an incumbent CEO. In order to comprehensively investigate the influence of co-opted directors on eco-innovation (*ECO_INNO*), we employ four distinct

measures of co-option. The first measure (*COPT*) captures the proportion of co-opted directors by calculating the ratio of co-opted directors to the total number of directors serving on the board. The second measure *(COPT_IND)* accounts for the number of independent co-opted directors as a percentage of the total number of board directors. Our third measure *(COPTW)* takes into consideration the possible effect of co-opted directors tenure by recognizing that longer-serving directors tend to exert greater influence on board decision-making (Gull et al., 2023). The measure of *COPTW* is operationalized by scaling the aggregate tenure of co-opted directors by the aggregate tenure of all board members. Fourth measure denoted as *COPTW_IND*, represents the fraction of independent co-opted directors weighted by their tenure. The computation includes the division of the aggregate tenure of independent co-opted directors by the aggregate tenure of all board members. This measure provides insights into the influence of independent co-opted directors, considering their tenure in relation to the entire board.

Drawing upon prior research on eco-innovation (Issa & Bensalem, 2023; Kuzey, Fritz, Uyar, & Karaman, 2022; Nadeem, Bahadar, Gull, & Iqbal, 2020), we include several variables that could potentially affect our baseline results. In terms of governance variables, we include board size (*BOARD_SIZE*), board independence (*BOARD_IND*) and board gender diversity (*FEMALE%*). Furthermore, we account for the influence of CSR committee (*CSR_COM*), CSR assurance (*CSR_AUD*), and sustainable compensation (*ESG_COMPEN*). We also include several firm-specific variables in our analysis. These variables include research and development intensity (*FIRM_R&D*), capital intensity (*FIRM_CAPX*), cash holdings (*FIRM_CASH*), return on assets (*FIRM_ROA*), tobin's q (*FIRM_TQ*), financial leverage (*FIRM_LEV*) and firm size (*FIRM_SIZE*). All variables are defined in Table 1.

[Insert Table 1]

3.3. Empirical equation

It is important to consider the dynamic nature of the relationship while examining the impact of board co-option on eco-innovation, because it is tempting to assume that the current year's board co-option has a direct impact on eco-innovation, it is plausible that the impact may be driven by the previous years' board co-option. To address this issue, we follow existing sustainability literature (Gull et al., 2023; Nadeem et al., 2020; Shahab et al., 2022) and employ the system Generalized Method of Moments (GMM) as a baseline regression technique. By using lagged values of the dependent variable as instruments, the system GMM approach allows us to control endogenous nature of the relationships and capture any dynamic effects that may influence our results.

The following equation is employed to investigate the impact of board co-option on eco-innovation:

$$ECO\_INNO_{i,t} = \beta_0 + \beta_1 ECO\_INNO_{i,t-1} + \beta_2 B\_COP_{i,t} + \beta_Z Controls_{i,t} + \varepsilon_{i,} \quad (1)$$

ECO_INNO represents eco-innovation, $ECO\_INNO_{i,t-1}$ represents the one-year lag of eco-innovation, *B_COP* represents different board co-option measures and *Controls* represents control variables as named in section 3.2. To account for industry and time effects, all regressions include fixed effects for industry and year.

4. Results

4.1. Descriptive results

Table 2 shows that the mean value of *ECO_INNO* is 0.219 with a standard deviation of 0.305. Among the four measures of board co-option, the highest mean value of 0.429 is observed for *COPT* with a standard deviation of 0.280. The board size has an average value of 2.378, and non-executive directors make up 86.1% of board members. On average, gender diversity in our sample is 16.6%. Additionally, nearly half of the firms in our sample (48.2%) have CSR

committees, while 22.4% of the firms receive third-party assurance on their CSR reports and sustainable compensation policies for executives are present in 25% of the sample firms. Concerning other variables, the mean of research and development intensity, capital intensity, cash holdings, return on assets, Tobin's q, firm leverage, and size is 0.039, 0.075, 0.126, 6.865, 2.021, 0.250, and 16.398, respectively.

[Insert Table 2]

We present the results of correlation analysis in Table 3. The results show that all proxies of board co-option have a negative correlation with eco-innovation. These findings provide an initial indication that board co-option is associated with a reduction in eco-innovation.

[Insert Table 3]

4.2. Hypotheses testing

To test our hypotheses, we employ four different Models, each specifying a distinct measure of board co-option. In Table 4, Model 1-4 specifically utilize the following measures: proportion of co-opted directors (*COPT*), tenure-weighted proportion of co-opted directors (*COPTW*), proportion of independent co-opted directors (*COPT_IND*), and tenure-weighted proportion of co-opted independent directors (*COPTW_IND*). The findings indicate that the effect of all proxies of board co-option and eco-innovation remains negative and statistically significant across Model 1-4 (coefficients= -0.034, $p<0.05$; -0.081, $p<0.05$; -0.043, $p<0.01$; -0.130, $p<0.01$). In particular, the results indicate that a one percentage point increase in *COPT, COPTW, COPT_IND,* and *COPTW_IND* is associated with a corresponding decrease in eco-innovation by 0.034, 0.081, 0.043, and 0.130 percentage points, respectively. The impact is also economically significant. For instance, considering an increase in *COPT, COPTW, COPT_IND,* and *COPTW_IND* by one standard deviation (as shown in Table 2), it corresponds

to a reduction in eco-innovation by approximately 4.3% [*COPT* (0.280) × −0.034/*ECO_INNO*(0.219)=−0.043], 9.1% [*COPTW*(0.246) × −0.081/*ECO_INNO* (0.219) = − 0.091], 5.2% [*COPT_IND* (0.268) × −0.043/*ECO_INNO* (0.219) = − 0.052], and 12.8% [*COPTW_IND* (0.216) × −0.130/*ECO_INNO* (0.219) = − 0.128], respectively. In nutshell, results suggest that board co-option hinders a firm's ability to engage in eco-innovative activities. The results are consistent with the dominant literature on dark side view of board co-option and imply that co-opted directors are not able to perform their monitoring role effectively and show their loyalties to the appointing CEOs (Zaman, Atawnah, Baghdadi, et al., 2021). Hence, H1 is accepted.

Other than board co-option, we observe a positively significant impact of *BOARD_SIZE, CSR_COM, ESG_COMPEN, FIRM_ROA,* and *FIRM_SIZE on ECO_INNO.* However, *BOARD_IND* is negatively and significantly associated with *ECO_INNO* in Model 1. The rest of the variables show no significant association with eco-innovation. The findings pertaining to the control variables are broadly consistent with previous research on eco-innovation (Javed, Wang, Usman, Gull, & Zaman, 2023; Nadeem et al., 2020).

[Insert Table 4]

4.3. Identification strategies

4.3.1. Propensity score matching (PSM)

To address potential issues related to selection bias and functional misspecification (Rosenbaum & Rubin, 1983), we employ a Propensity Score Matching (PSM) approach in this section to repeat the main analysis. To perform the PSM analysis, we first assign the firms to treatment and control group based on the level of board co-option. We classify the treatment group as firms with a proportion of board co-option above the sample median. Conversely, the control group comprises of firms with a proportion of board co-option below the sample

median. To ensure comparability and minimize differences in observable firm characteristics, we employ nearest neighbor matching with replacement, adjusting the caliper distance at 1%. This approach allows us to create balanced treatment and control groups, ensuring that the firms selected for analysis have similar characteristics. The PSM was performed using the same control variables included in equation (1).

Table 5, Panel A presents the mean comparisons and t-statistics between treatment and control firms' characteristics. The results show no significant difference between the treatment and control group based on the observable characteristics (i.e., control variables), suggesting that PSM procedures have effectively addressed the issue of selection bias. Finally, we have a sample that includes firms similar based on all firm-level characteristics except eco-innovation. Panel B exhibits the results of system GMM estimations using the PSM sample, the coefficients for all board co-option proxies remain negatively significant at 1 percent level. Hence, ruling out the possibility of selection bias.

[Insert Table 5]

4.3.2 Difference-in-differences (DiD)

In order to establish a causal relationship between board co-option and eco-innovation, we exploit the events of CEO dismissal as a natural experiment to examine the impact of changes in board co-option on eco-innovation. Following related literature (e.g., Zaman, Atawnah, Baghdadi, et al. (2021), we analyze the impact of board co-option on eco-innovation after the CEO dismissal. Coles et al. (2014) assert that co-opted directors often prioritize the interests of their appointer (i.e., the CEO). We therefore argue that CEO turnover may lead to changes in the board composition including the board co-option.

To assess the causal effect of board co-option on eco-innovation following the CEO dismissal, we first measure the co-option ratio before and after the CEO dismissal.

Subsequently, we evaluate the effect of changes in the co-option ratio on eco-innovation. If the relationship between board co-option and eco-innovation is causal, we must observe an increase in eco-innovation subsequent to a decrease in the board co-option ratio because of the CEO dismissal. This approach allows us to examine the relationship while mitigating potential endogeneity concerns.

To conduct this analysis, we form a treatment group consisting of firms that have experienced a reduction in the co-option ratio subsequent to CEO dismissal. In contrast, the control group comprises firms that have not undergone such a reduction. To ensure that treatment and control group is homogeneous, we employ PSM as explained in section 4.3.1 using the same control variables. Table 6, Panel A, presents the results of post-matched sample univariate analysis for treatment and control firms. The results confirm that both groups are identical based on the firm specific characteristics. Panel B of Table 6 presents the results of DiD estimator. Following Zaman, Atawnah, Baghdadi, et al. (2021), we measure the change in eco-innovation for the pre-dismissal period (i.e., three years before the CEO dismissal) to the post-dismissal period (i.e., three years following the CEO dismissal) for treatment and control firms. Subsequently, we calculate the difference between the two periods by averaging the changes over the treatment and control groups. These differences are reported in Columns 1 (Pre-dismissal) and 2 (Post-dismissal), respectively. Our difference-in-differences (DiD) estimator captures the difference in the differences between the treatment and control groups, as reported in Column 3 (Post-dismissal - Pre-dismissal). The results reveal that a decrease in the co-option ratio following the CEO dismissal is linked to an increase in eco-innovation, establishing a causal relationship between board co-option and eco-innovation. The treatment group experiences an average change of 0.085 in eco-innovation, while the control group shows a change of -0.020. The DiD estimator for eco-innovation is 0.105 and is statistically significant at the 5% level, confirming the positive association between an exogenous reduction

in the co-option ratio and eco-innovation. These findings provide compelling evidence that the relationship between board co-option and eco-innovation is indeed causal.

[Insert Table 6]

4.4. Board co-option, industrial context and eco-innovation

Our findings have established a notable relation between board co-option and eco-innovation. However, it is important to acknowledge that contingency theory (Donaldson, 2001) suggests that the relationship between co-opted directors and eco-innovation may be influenced by organizational contingencies. These contingencies can play a crucial role in shaping the nature and extent of the impact of co-opted directors on eco-innovation within an organization. In this regard, corporate governance literature demonstrates that the impact of board composition on firms' sustainable outcomes is contingent on their industrial context (Gull et al., 2023; Li et al., 2017; Lemma, Tavakolifar, Mihret, & Samkin, 2022). More importantly, Huang and Li (2017) suggests that industry nature is an important determinant of firms likelihood of adopting eco-innovation. We therefore argue that it is important to investigate the contingency perspective (i.e., industrial context) that potentially drives the association among board co-option and eco-innovation.

The industrial context is likely to impact the nexus of board co-option and eco-innovation because of two reasons. First, the stakeholders' demand for eco-innovation vary widely depending on the sector to which firms belong (Bansal & Roth, 2000), because the impact of firms on climate vary depending on their industry nature (Lemma et al., 2022). Companies operating in industries with high environmental sensitivity are more prone to have a negative impact on the climate compared to firms in industries that are less environmentally sensitive (Addison, 2018; Nadeem et al., 2020). Second, the environmentally sensitive firms are under higher pressure and scrutiny from regulators and the public to reduce the impact of their operations on climate (Li et al., 2017; Lemma et al., 2022), and corporate board serves as

the primary policy and decision-making entity within firms, with stakeholders placing their trust in the board to safeguard their interests, including those related to the climate (Gull et al., 2023; Nadeem et al., 2020). Furthermore, the CEOs implement environmentally friendly initiatives to seek legitimacy and support from stakeholders, to address their career concerns (Al-Shaer, Albitar, & Liu, 2022), suggesting that co-opted boards may have the opportunity to simultaneously address the stakeholders demand of being environment friendly and their appointers' (i.e., the CEO) career concerns by promoting eco-innovation in environmentally sensitive industries. Based on these conjectures, we expect co-opted boards to be positively (negatively) associated with eco-innovation in environmentally sensitive (non-sensitive) firms.

To examine the association between co-opted directors and eco-innovation, we conducted a cross-sectional analysis, considering the potential influence of industry context as a contingency factor. In doing that, we split the sample into environmentally sensitive and non-sensitive industries. Following Gull et al. (2023) and Nadeem et al. (2020), environmental sensitivity is determined based on the magnitude of the impact that the firms operations have on the environment. Specifically, we classify firms operating in industries such as chemical, agricultural, fishing, forestry, mining, metal, petroleum, and construction as environmentally sensitive while firms operating in rest of the industrial sectors are classified as environmentally non-sensitive. The findings presented in Table 7 highlight that coefficients on all measures of board co-option are positively (negatively) significant for environmentally sensitive (non-sensitive) firms, suggesting that co-opted boards in environmentally sensitive firms are more likely to adopt environment friendly policies (e.g., eco-innovation) because of the stakeholders and regulatory pressure to reduce the impact of their operations on climate as well as to mitigate the CEOs career concerns. Thus, our findings confirm that the industrial context serves as a crucial contingency factor that influences the relationship between board co-option and eco-innovation.

[Insert Table 7]

4.5. Board co-option, ESG-compensation and eco-innovation

The association between board co-option and eco-innovation is many fold and may be influenced by various factors. Studies have shown that executives prioritize short-term financial gains over environmental concerns, which can compromise eco-innovation efforts. For instance, Cordeiro and Sarkis (2008) document that executives tend to compromise on environmental issues to pursue short-term financial gains. This short-term focus is often driven by managerial incentives that reward immediate financial performance, making executives less interested in pursuing long-term investments aimed at eco-innovation.

As managerial incentives are predominantly linked with short-term financial performance, their inclination towards long-term investments for environmental sustainability is relatively low. Hence, the willingness of boards to address the concerns of stakeholders regarding eco-innovation is highly contingent on the incentives given to them by the firm, such as ESG compensation. Berrone and Gomez-Mejia (2009) corroborate this and suggest that ESG-based compensation tends to enhance firms' environmental performance. In a recent study, Gull et al. (2023) reports that firms with gender-diverse boards tend to manage waste responsibly by tying executives' compensation with ESG performance. In another study, Gull et al. (2023) show that influence of co-opted directors on GHG emissions is more pronounced for firms that tie executives' compensation with ESG performance. Particularly, they suggest that co-opted boards offer higher environmental performance in firms that tie executives' compensation with ESG performance.

We therefore argue that ESG-compensation should positively moderate the effect of board co-option on eco-innovation. By reducing the potential for executives to prioritize short-term gains over environmental concerns, ESG-compensation can help promote eco-innovation and advance sustainable business practices. Specifically, we propose that firms with ESG-

compensation for their boards may be better able to mitigate the negative impact of board co-option on eco-innovation by aligning incentives with sustainability objectives. We perform a cross-sectional analysis that considers the role of ESG performance-based compensation. Particularly, we divided the sample into firms with and without ESG compensation policies.

We present the regression results in Table 8 where all measures of board co-option show statistically significant and negative association with eco-innovation for the sample of firms without ESG performance-based compensation (Models 1-4), suggesting that co-opted directors in such firms have limited drive to promote eco-innovation. Conversely, in firms with ESG-compensation (Models 5-8), we find a positive effect of board co-option on eco-innovation, indicating that co-opted directors in these firms promote eco-innovation initiatives—supporting the incentive alignment view of ESG-compensation policies. Overall, our findings highlight the significant role of ESG-compensation policies in determining the effectiveness of board co-option for environmental innovation.

5. Conclusion

This study examines the impact of board co-option on eco-innovation and moderating effect of firms' industrial context (i.e., environmentally sensitive industries vs. environmentally non-sensitive industries) on this relationship. Using a sample of the US firms from 2002-2018, our findings suggest that board co-option has a negative impact on eco-innovation activities. Our findings are in line with the dark side perspective of having co-opted directors on the board (Ghafoor et al., 2023; Zaman, Atawnah, Baghdadi, et al., 2021), which posits that co-opted directors are lax monitors and more likely to show their allegiance to the CEO than protecting the interests of stakeholders. In line with the contingency perspective (Donaldson, 2001), we also consider the firms' industrial context as an important contingency factor which is likely to impact the boards' inclination towards eco-innovation. We observe that board co-option in environmentally (non-)sensitive firms promote(reduce) eco-innovation. These findings are in

line with prior studies (Gull et al., 2023; Javed et al., 2023; Nadeem et al., 2020), documenting that board of directors and executives of companies operating in environmentally sensitive industries face heightened scrutiny and pressure from regulators and stakeholders to ensure the sustainability of their operations. Consequently, co-opted directors find it easy to promote eco-innovation in environmentally sensitive firms while ensuring the interests of stakeholders as well as their appointer (i.e., the CEO). We also show that ESG-compensation positively moderates the effect of board co-option on eco-innovation. By reducing the potential for executives to prioritize short-term gains over environmental concerns, ESG-compensation helps promote eco-innovation and advance sustainable business practices.

The results have important theoretical and practical implications for scholars, policymakers, and other stakeholders. In the backdrop of stakeholders' growing awareness of firms' climate impact, our findings provide some interesting insights for policymakers which can help them make informed decisions aimed at ensuring environmental sustainability of firms. Considering our findings which empirically substantiate the dark side view of board co-option, we warn the firms with a higher proportion of co-opted directors on their boards of consequences, because of the lax monitoring and less accountability of the CEOs by such boards. This study also enhances our understanding of the relationship between board co-option and eco-innovation by examining the impact of firms' industrial context, aligned with the contingency perspective. Based on these, findings we recommend firms to have co-opted boards if they operate in environmentally sensitive industries, As, such boards help firms reduce the negative impact of their operation on climate by adopting co-innovation in environmentally sensitive industries.

Despite the significant implications, the study has some limitations too. For instance, the findings may not be applicable to contexts other than the US such as EU or emerging markets. We have used an eco-innovation index provided by the EIKON to proxy for firms'

level of eco-innovation while some recent studies have used environment related patents count to proxy for environmental innovation. Future studies may employ patents count as a more direct proxy for eco-innovation. Although we have employed several sophisticated econometric techniques to address potential endogeneity issues, we acknowledge that it might not be possible to completely rule out such concerns.

References

Baek, H. Y., Johnson, D. R., & Kim, J. W. (2009). Managerial ownership, corporate governance, and voluntary disclosure. *Journal of Business and Economic Studies, 15*(2), 44.

Baghdadi, G. A., Nguyen, L. H., & Podolski, E. J. (2020). Board co-option and default risk. *Journal of Corporate Finance, 64*, 101703.

Bansal, P., & Roth, K. (2000). Why companies go green: A model of ecological responsiveness. *Academy of Management Journal, 43*(4), 717-736.

Bhuiyan, M. B. U., Sangchan, P., & D'Costa, M. (2022). Do Co-opted boards affect the cost of equity capital? *Finance Research Letters, 46*, 102491. doi:10.1016/j.frl.2021.102491

Chintrakarn, P., Jiraporn, P., Sakr, S., & Lee, S. M. (2016). Do co-opted directors mitigate managerial myopia? Evidence from R&D investments. *Finance Research Letters, 17*, 285-289.

Coles, J. L., Daniel, N. D., & Naveen, L. (2014). Co-opted boards. *The Review of Financial Studies, 27*(6), 1751-1796.

Cowen, A. P., & Marcel, J. J. (2011). Damaged goods: Board decisions to dismiss reputationally compromised directors. *Academy of Management Journal, 54*(3), 509-527.

Cumming, D., Johan, S., & Peter, R. (2018). Developments in financial institutions, governance, agency costs, and misconduct. *Journal of International Financial Markets, Institutions and Money, 54*, 1-14.

Cumming, D., & Leung, T. Y. (2021). Board diversity and corporate innovation: Regional demographics and industry context. *Corporate Governance: An International Review, 29*(3), 277-296.

El Ghoul, S., Guedhami, O., Kim, H., & Park, K. (2018). Corporate environmental responsibility and the cost of capital: International evidence. *Journal of Business Ethics, 149*(2), 335-361.

Fama, E. F., & Jensen, M. C. (1983). Separation of ownership and control. *The journal of law and Economics, 26*(2), 301-325.

Fich, E. M., & Shivdasani, A. (2007). Financial fraud, director reputation, and shareholder wealth. *Journal of financial Economics, 86*(2), 306-336.

Ghafoor, A., Šeho, M., & Sifat, I. (2023). Co-opted board and firm climate change risk. *Finance Research Letters, 52*, 103508.

Gull, A. A., Sarang, A. A. A., Shakri, I. H., & Atif, M. (2023). Co-opted directors and greenhouse gas emissions: Does ESG compensation matter? *Journal of Cleaner Production*, 137192.

Issa, A., & Bensalem, N. (2023). Are gender-diverse boards eco-innovative? The mediating role of corporate social responsibility strategy. *Corporate Social Responsibility and Environmental Management*, *30*(2), 742-754.

Javed, M., Wang, F., Usman, M., Gull, A. A., & Zaman, Q. U. (2023). Female CEOs and green innovation. *Journal of Business Research, 157*, 113515.

Jiraporn, P., & Lee, S. M. (2018). Do co-opted directors influence dividend policy? *Financial Management, 47*(2), 349-381.

Karpoff, J. M., Lott, J., John R, & Wehrly, E. W. (2005). The reputational penalties for environmental violations: Empirical evidence. *The Journal of Law and Economics, 48*(2), 653-675.

Karpoff, J. M., & Lott Jr, J. R. (1993). The reputational penalty firms bear from committing criminal fraud. *The Journal of Law and Economics, 36*(2), 757-802.

Kuzey, C., Fritz, M. M., Uyar, A., & Karaman, A. S. (2022). Board gender diversity, CSR strategy, and eco-friendly initiatives in the transportation and logistics sector. *International Journal of Production Economics, 247*, 108436.

Lim, J., Do, V., & Vu, T. (2020). Co-opted directors, covenant intensity, and covenant violations. *Journal of Corporate Finance, 64*, 101628. doi:https://doi.org/10.1016/j.jcorpfin.2020.101628

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.

Nguyen, L., Vu, L., & Yin, X. (2021). The bright side of co-opted boards: Evidence from firm innovation. *Financial Review, 56*(1), 29-53.

Nishikawa, Y., Hashemi Joo, M., & Okafor, C. E. (2022). Board co-option and employee welfare. *Managerial Finance, 48*(8), 1174-1185.

Rahman, D., Malik, I., Ali, S., & Iqbal, J. (2021). Do co-opted boards increase insider profitability? *Journal of Contemporary Accounting & Economics, 17*(3), 100265.

Wintoki, M. B., & Xi, Y. (2019). Friendly directors and the cost of regulatory compliance. *Journal of Corporate Finance, 58*, 112-141.

Zaman, R., Atawnah, N., Baghdadi, G. A., & Liu, J. (2021). Fiduciary duty or loyalty? Evidence from co-opted boards and corporate misconduct. *Journal of Corporate Finance, 70*, 102066.

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.

Table 1: Definitions of variables

Variables	Symbol	Definition	Source
Eco-innovation	*ECO_INNO*	Eco-innovation score takes values from 0 to 100 with the highest values correspond to more eco-innovation activities in a firm.	Eikon
Proportion of co-opted directors	*COPT*	The proportion of co-opted directors to the total number of directors on a board.	Coles et al. (2014)
Tenure weighted proportion of co-opted directors	*COPTW*	The tenure weighted measure of co-option, defined as the sum of the tenure of co-opted directors divided by the sum of all directors' tenures.	Same
Proportion of independent co-opted directors	*COPT_IND*	The number of co-opted independent directors divided by the total number of directors on a board.	Same
Tenure weighted proportion of independent co-opted directors	*COPTW_IND*	The tenure weighted measure of independent co-opted directors, defined as the sum of the tenure of independent co-opted directors divided by the sum of all directors' tenures.	Same
Board size	*BOARD_SIZE*	Natural log of the number of directors on the board.	Eikon
Board independence	*BOARD_IND*	The proportion of independent directors on the board.	Same
Board gender diversity	*FEMALE%*	The proportion of female directors on the board.	Same
CSR committee	*CSR_COM*	Dummy variable coded 1 if the company has a CSR committee and 0 otherwise.	Same
CSR assurance	*CSR_AUD*	Dummy variable coded 1 if the CSR report was assured by third party auditor and 0 otherwise.	Same
Sustainable compensation	*ESG_COMPEN*	Dummy variable coded 1 if the firm has a sustainable compensation policy for executives and 0 otherwise.	Same
Research and development intensity	*FIRM_R&D*	The ratio of research and development expenditures to sales.	WorldScope
Capital intensity	*FIRM_CAPX*	The ratio of capital expenditures to sales.	Same
Cash holdings	*FIRM_CASH*	The ratio of cash to total assets.	Same
Return on assets	*FIRM_ROA*	Net profit/loss divided by total assets.	Same
Tobin's Q	*FIRM_TQ*	The ratio of the sum of market capitalization and total assets minus the book value of shareholders' equity divided by total assets.	Same
Financial leverage	*FIRM_LEV*	The ratio of a firm's total debt to total assets.	Same
Firm size	*FIRM_SIZE*	Natural log of total assets.	Same

All continuous variables are winsorized at bottom 1% and top 99% levels.

Table 2: Descriptive statistics

Variables	Observations	Mean	Standard deviation	Minimum	1st quartile	Median	3rd quartile	Maximum
ECO_INNO	3,947	0.219	0.305	0.000	0.000	0.000	0.447	0.993
COPT	3,947	0.429	0.280	0.000	0.200	0.400	0.636	1.000
COPTW	3,947	0.360	0.246	0.000	0.167	0.333	0.545	1.000
COPT_IND	3,947	0.247	0.268	0.000	0.046	0.146	0.358	1.000
COPTW_IND	3,947	0.200	0.216	0.000	0.035	0.120	0.298	1.000
BOARD_SIZE	3,947	2.378	0.218	1.609	2.303	2.398	2.485	2.833
BOARD_IND	3,947	0.861	0.074	0.556	0.833	0.889	0.917	0.941
FEMALE%	3,947	0.166	0.093	0.000	0.100	0.167	0.222	0.444
CSR_COM	3,947	0.482	0.500	0.000	0.000	0.000	1.000	1.000
CSR_AUD	3,947	0.224	0.417	0.000	0.000	0.000	0.000	1.000
ESG_COMPEN	3,947	0.250	0.433	0.000	0.000	0.000	1.000	1.000
FIRM_R&D	3,947	0.039	0.110	0.000	0.000	0.000	0.033	2.942
FIRM_CAPX	3,947	0.075	0.112	0.000	0.022	0.039	0.077	2.011
FIRM_CASH	3,947	0.126	0.144	0.001	0.026	0.073	0.174	0.906
FIRM_ROA	3,947	6.865	8.286	-84.010	3.450	6.500	10.930	33.620
FIRM_TQ	3,947	2.021	1.216	0.758	1.204	1.621	2.403	9.621
FIRM_LEV	3,947	0.250	0.163	0.000	0.132	0.241	0.351	1.058
FIRM_SIZE	3,947	16.398	1.405	12.949	15.277	16.299	17.355	19.233

All variables are defined in Table 1.

Table 3: Correlation matrix

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1.	*ECO_INNO*	1.000																	
2.	*COPT*	-0.050*	1.000																
3.	*COPTW*	-0.001	0.945*	1.000															
4.	*COPT_IND*	-0.064*	0.925*	0.854*	1.000														
5.	*COPTW_IND*	-0.030	0.894*	0.916*	0.942*	1.000													
6.	*BOARD_SIZE*	0.160*	-0.108*	-0.077*	-0.156*	-0.119*	1.000												
7.	*BOARD_IND*	0.172*	-0.061*	0.033*	-0.057*	0.006	0.247*	1.000											
8.	*FEMALE%*	0.243*	-0.045*	0.008	-0.067*	-0.019	0.209*	0.179*	1.000										
9.	*CSR_COM*	0.477*	-0.044*	0.014	-0.049*	-0.007	0.231*	0.220*	0.345*	1.000									
10.	*CSR_AUD*	0.330*	-0.010	0.023	-0.008	0.017	0.179*	0.116*	0.280*	0.478*	1.000								
11.	*ESG_COMPEN*	0.312*	-0.003	0.036*	-0.021	0.010	0.162*	0.165*	0.172*	0.440*	0.319*	1.000							
12.	*FIRM_R&D*	-0.033*	0.091*	0.083*	0.096*	0.093*	-0.170*	-0.027	-0.070*	-0.061*	-0.003	-0.066*	1.000						
13.	*FIRM_CAPX*	-0.004	0.004	0.011	-0.007	0.006	-0.009	0.003	-0.023	0.096*	0.060*	0.186*	-0.015	1.000					
14.	*FIRM_CASH*	-0.024	0.103*	0.086*	0.112*	0.101*	-0.295*	-0.129*	-0.105*	-0.083*	-0.019	-0.096*	0.519*	-0.157*	1.000				
15.	*FIRM_ROA*	0.020	-0.002	-0.001	0.014	0.012	-0.074*	-0.032*	0.028	0.041*	0.047*	-0.028	-0.234*	-0.101*	0.124*	1.000			
16.	*FIRM_TQ*	-0.060*	0.076*	0.050*	0.097*	0.075*	-0.237*	-0.131*	0.001	-0.077*	0.026	-0.149*	0.245*	-0.125*	0.482*	0.485*	1.000		
17.	*FIRM_LEV*	0.102*	-0.040*	-0.019	-0.045*	-0.020	0.117*	0.114*	0.142*	0.165*	0.116*	0.106*	-0.126*	0.166*	-0.293*	-0.082*	-0.139*	1.000	
18.	*FIRM_SIZE*	0.247*	-0.056*	-0.007	-0.082*	-0.031*	0.494*	0.202*	0.218*	0.342*	0.313*	0.268*	-0.187*	0.083*	-0.314*	-0.131*	-0.354*	0.110*	1.000

* shows significance at the 0.05 level.

All variables are as defined in Table 1.

Table 4: Co-opted directors and eco-innovation

	(1)	(2)	(3)	(4)
VARIABLES		***ECO_INNO***		
ECO_INNO$_{i,t-1}$	0.854***	0.851***	0.857***	0.853***
	(107.27)	(78.21)	(107.82)	(78.81)
COPT	-0.034**			
	(-2.21)			
COPTW		-0.081**		
		(-2.00)		
COPT_IND			-0.043***	
			(-2.69)	
COPTW_IND				-0.130***
				(-3.18)
BOARD_SIZE	0.027***	0.022	0.020*	0.017
	(2.68)	(1.61)	(1.81)	(1.18)
BOARD_IND	-0.039*	-0.000	-0.021	-0.003
	(-1.65)	(-0.00)	(-0.83)	(-0.11)
FEMALE%	0.008	-0.002	0.017	0.001
	(0.38)	(-0.06)	(0.75)	(0.04)
CSR_COM	0.034***	0.028***	0.036***	0.025***
	(5.33)	(3.08)	(5.54)	(2.74)
CSR_AUD	0.003	0.007	0.004	0.006
	(0.49)	(0.97)	(0.81)	(0.76)
ESG_COMPEN	0.011**	0.012*	0.011**	0.014**
	(2.10)	(1.90)	(2.13)	(2.19)
FIRM_R&D	0.014	0.033	0.012	0.031
	(0.83)	(1.42)	(0.66)	(1.31)
FIRM_CAPX	-0.020	-0.027	-0.021	-0.026
	(-1.31)	(-1.39)	(-1.33)	(-1.33)
FIRM_CASH	0.005	-0.005	-0.006	0.004
	(0.29)	(-0.22)	(-0.35)	(0.21)
FIRM_ROA	0.001***	0.001**	0.001***	0.001**
	(3.15)	(2.43)	(3.14)	(2.37)
FIRM_TQ	-0.003	-0.001	-0.001	-0.000
	(-1.26)	(-0.23)	(-0.60)	(-0.13)
FIRM_LEV	-0.012	-0.007	-0.009	-0.005
	(-0.87)	(-0.42)	(-0.71)	(-0.27)
FIRM_SIZE	0.005**	0.005**	0.004**	0.005**
	(2.44)	(2.14)	(2.09)	(2.07)
Intercept	-0.043	0.017	-0.009	-0.020
	(-0.86)	(0.57)	(-0.17)	(-0.37)
Obs.	2,914	2,914	2,914	2,914
Year & Industry	Yes	Yes	Yes	Yes
AR (1) p-value	0.000	0.000	0.000	0.000
AR (2) p-value	0.411	0.446	0.427	0.471
Sargan p-value	0.098	0.030	0.031	0.014
Hansen p-value	0.297	0.247	0.332	0.424

Z statistics are given in parenthesis.
*, **, *** Represent significance at 0.1, 0.05 and 0.01 levels, respectively.
The definitions of all variables are as defined in Table1.

Table 5

Panel A: Quality of Matching

VARIABLES	*N*	*Treated*	*N*	*Control*	*Mean Difference*	*t-statistics*
BOARD_SIZE	1,705	2.377	1,705	2.372	0.005	0.650
BOARD_IND	1,705	0.860	1,705	0.859	0.001	0.730
FEMALE%	1,705	0.166	1,705	0.165	0.001	0.270
CSR_COM	1,705	0.478	1,705	0.476	0.002	0.100
CSR_AUD	1,705	0.223	1,705	0.219	0.004	0.250
ESG_COMPEN	1,705	0.257	1,705	0.250	0.007	0.430
FIRM_R&D	1,705	0.036	1,705	0.037	-0.001	-0.400
FIRM_CAPX	1,705	0.076	1,705	0.073	0.003	0.670
FIRM_CASH	1,705	0.124	1,705	0.128	-0.004	-0.900
FIRM_ROA	1,705	6.820	1,705	7.129	-0.309	-1.170
FIRM_TQ	1,705	2.002	1,705	2.019	-0.017	-0.430
FIRM_LEV	1,705	0.252	1,705	0.249	0.003	0.470
FIRM_SIZE	1,705	16.401	1,705	16.365	0.036	0.760

Panel B: Co-opted directors and eco-innovation using PSM sample

	(1)	**(2)**	**(3)**	**(4)**
VARIABLES		***ECO_INNO***		
$ECO\_INNO_{i,t-1}$	0.855***	0.855***	0.854***	0.852***
	(204.82)	(222.96)	(194.56)	(211.39)
COPT	-0.014***			
	(-2.66)			
COPTW		-0.025***		
		(-4.31)		
COPT_IND			-0.057***	
			(-9.63)	
COPTW_IND				-0.059***
				(-9.13)
BOARD_SIZE	0.031***	0.030***	0.022***	0.025***
	(5.10)	(5.05)	(3.42)	(4.19)
BOARD_IND	-0.036**	-0.013	-0.031*	-0.023
	(-2.18)	(-0.78)	(-1.88)	(-1.34)
FEMALE%	0.005	0.009	-0.004	0.002
	(0.40)	(0.64)	(-0.31)	(0.15)
CSR_COM	0.029***	0.028***	0.027***	0.028***
	(6.37)	(6.30)	(6.02)	(6.76)
CSR_AUD	0.000	-0.001	-0.002	-0.003
	(0.04)	(-0.36)	(-0.73)	(-1.17)
ESG_COMPEN	0.012***	0.012***	0.010***	0.009***
	(4.00)	(4.05)	(3.29)	(2.93)
FIRM_R&D	-0.020	0.005	-0.019	-0.005
	(-0.74)	(0.19)	(-0.72)	(-0.19)
FIRM_CAPX	-0.025*	-0.015	-0.023*	-0.017
	(-1.75)	(-1.09)	(-1.85)	(-1.25)
FIRM_CASH	0.033***	0.031***	0.033***	0.033***
	(2.82)	(2.71)	(2.90)	(2.89)
FIRM_ROA	0.001***	0.001***	0.001***	0.001***
	(5.99)	(7.40)	(5.86)	(6.86)
FIRM_TQ	-0.003**	-0.003**	-0.002	-0.003*
	(-1.98)	(-2.30)	(-1.22)	(-1.72)
FIRM_LEV	-0.008	-0.009	-0.016*	-0.014*
	(-0.89)	(-1.18)	(-1.89)	(-1.66)
FIRM_SIZE	0.008***	0.008***	0.008***	0.009***
	(6.90)	(6.56)	(6.25)	(6.84)

Intercept	-0.172*** (-6.86)	-0.181*** (-6.95)	-0.150*** (-5.25)	-0.177*** (-6.37)
Obs.	2,533	2,533	2,533	2,533
Year & Industry	Yes	Yes	Yes	Yes
AR (1) p-value	0.000	0.000	0.000	0.000
AR (2) p-value	0.275	0.281	0.266	0.277
Sargan p-value	0.007	0.008	0.008	0.004
Hansen p-value	0.129	0.121	0.193	0.144

Z statistics are given in parenthesis.
*, **, *** Represent significance at 0.1, 0.05 and 0.01 levels, respectively.
The definitions of all variables are as defined in Table1.

Table 6: Difference-in-Differences analysis
Panel A: Post-matched sample univariate analysis

VARIABLES	*N*	*Treated*	*N*	*Control*	*Mean Difference*	*t-statistics*
BOARD_SIZE	70	2.382	70	2.380	0.002	0.050
BOARD_IND	70	0.843	70	0.842	0.001	0.100
FEMALE%	70	0.159	70	0.175	-0.016	-1.020
CSR_COM	70	0.333	70	0.347	-0.014	-0.170
CSR_AUD	70	0.194	70	0.181	0.014	0.210
ESG_COMPEN	70	0.181	70	0.139	0.042	0.680
FIRM_R&D	70	0.030	70	0.033	-0.003	-0.290
FIRM_CAPX	70	0.061	70	0.061	0.001	0.050
FIRM_CASH	70	0.108	70	0.118	-0.009	-0.350
FIRM_ROA	70	4.904	70	5.856	-0.952	-0.870
FIRM_TQ	70	1.569	70	1.583	-0.014	-0.120
FIRM_LEV	70	0.269	70	0.269	0.000	0.010
FIRM_SIZE	70	16.617	70	16.511	0.106	0.480

Panel B: Difference-in-differences estimators

VARIABLES	*Pre-dismissal*	*Post-dismissal*	*Post-dismissal - Pre-dismissal*
Control Firms	-1.014	-1.034	-0.020
Treated Firms	-1.061	-0.976	0.085
Treated - Control Firms	-0.047	0.058*	-
Difference-in-differences	-	-	0.105** (2.42)

Note: This table presents the results of a difference-in-differences (DiD) regression analysis on board co-option following CEO dismissals from 2003 to 2018. The treatment group consists of firms that experienced a reduction in board co-option after the CEO's dismissal, while the control group comprises firms that did not experience such a reduction. Control firms are matched using propensity score matching (nearest neighbor option) with the same control variables as in the main analysis. Panel A shows the results of the post-matched sample univariate analysis, and Panel B presents the DiD estimators for board co-option. T-statistics are reported in parentheses. *, **, *** Represent significance at 0.1, 0.05 and 0.01 levels, respectively.
All variables are defined in Table 1.

Table 7: Co-opted directors and eco-innovation: role of industrial context

	Non-sensitive industries				Sensitive industries			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	***ECO_INNO***							
ECO_INNO$_{i,t-1}$	0.848***	0.855***	0.853***	0.861***	0.804***	0.808***	0.805***	0.807***
	(237.52)	(123.49)	(117.38)	(83.51)	(454.01)	(357.91)	(576.00)	(428.52)
COPT	-0.102***				0.069***			
	(-35.29)				(30.19)			
COPTW		-0.113***				0.058***		
		(-10.84)				(20.37)		
COPT_IND			-0.159***				0.071***	
			(-14.52)				(39.01)	
COPTW_IND				-0.129***				0.085***
				(-6.19)				(30.28)
BOARD_SIZE	0.032***	0.015*	0.006	0.009	0.017***	0.023***	0.030***	0.028***
	(5.84)	(1.68)	(0.57)	(0.72)	(4.55)	(6.14)	(8.95)	(6.02)
BOARD_IND	-0.073***	-0.020	-0.038	0.001	0.008	-0.011	-0.021**	-0.025***
	(-4.94)	(-0.80)	(-1.35)	(0.03)	(0.70)	(-0.85)	(-2.26)	(-2.95)
FEMALE%	0.020	0.035	0.006	0.027	-0.003	0.006	-0.004	-0.010*
	(1.46)	(1.62)	(0.28)	(1.00)	(-0.40)	(0.65)	(-0.49)	(-1.83)
CSR_COM	0.044***	0.046***	0.045***	0.033***	0.014***	0.017***	0.015***	0.016***
	(12.56)	(7.26)	(7.12)	(3.71)	(6.69)	(9.00)	(7.43)	(8.30)
CSR_AUD	-0.002	-0.002	-0.001	-0.001	0.009***	0.010***	0.011***	0.011***
	(-0.85)	(-0.45)	(-0.19)	(-0.19)	(9.70)	(9.17)	(8.86)	(10.47)
ESG_COMPEN	0.016***	0.015***	0.010**	0.014**	0.004***	0.005***	0.007***	0.005***
	(8.19)	(3.48)	(2.44)	(2.28)	(3.32)	(4.16)	(5.35)	(4.33)
FIRM_R&D	0.090**	0.014	0.079	-0.032	0.011**	0.019***	0.012***	0.009*
	(2.43)	(0.23)	(1.23)	(-0.45)	(2.02)	(4.01)	(2.87)	(1.89)
FIRM_CAPX	0.012	0.020	0.000	-0.001	0.011**	-0.001	0.019***	0.005
	(0.83)	(1.02)	(0.01)	(-0.04)	(1.99)	(-0.18)	(2.87)	(0.61)
FIRM_CASH	0.003	0.006	-0.014	0.004	-0.057***	-0.067***	-0.052***	-0.062***
	(0.25)	(0.33)	(-0.63)	(0.18)	(-5.65)	(-9.38)	(-6.35)	(-7.16)
FIRM_ROA	0.000*	0.000	0.000	0.000	0.001***	0.002***	0.001***	0.001***
	(1.87)	(0.21)	(1.12)	(0.35)	(13.02)	(17.20)	(16.30)	(10.87)
FIRM_TQ	0.002	0.004**	0.005**	0.004*	-0.009***	-0.009***	-0.008***	-0.009***
	(1.49)	(2.00)	(2.38)	(1.73)	(-11.89)	(-15.48)	(-9.84)	(-15.85)
FIRM_LEV	-0.016**	-0.036***	-0.019	-0.025*	-0.065***	-0.061***	-0.058***	-0.059***
	(-2.36)	(-2.96)	(-1.47)	(-1.75)	(-10.85)	(-10.32)	(-11.93)	(-11.39)
FIRM_SIZE	0.007***	0.009***	0.008***	0.010***	-0.007***	-0.007***	-0.005***	-0.006***
	(6.06)	(4.74)	(4.22)	(4.53)	(-8.84)	(-12.06)	(-5.59)	(-6.56)
Intercept	0.004	-0.066	-0.077*	-0.070	0.126***	0.126***	0.079***	0.029***
	(0.17)	(-1.26)	(-1.89)	(-1.42)	(3.74)	(8.01)	(5.07)	(3.38)
Obs.	1,907	1,907	1,907	1,907	1,007	1,007	1,007	1,007
Yea r& Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR (1) p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) p-value	0.103	0.104	0.103	0.102	0.354	0.377	0.390	0.396
Sargan p-value	0.045	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Hansen p-value	0.320	0.208	0.179	0.402	0.862	0.835	0.919	0.877

Z statistics are given in parenthesis.
*, **, *** Represent significance at 0.1, 0.05 and 0.01 levels, respectively.
The definitions of all variables are as defined in Table1.

Table 8: Co-opted directors and eco-innovation: role of ESG performance-based compensation

	Without ESG compensation				With ESG compensation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES				*ECO_INNO*				
LAG_ECO_INNO	0.853***	0.858***	0.852***	0.859***	0.833***	0.842***	0.831***	0.846***
	(132.05)	(90.29)	(96.10)	(102.00)	(293.10)	(131.79)	(711.89)	(147.62)
PRO_ COP	-0.051***				0.054***			
	(-6.20)				(7.18)			
TWPRO_ COP		-0.050***				0.057***		
		(-3.36)				(5.30)		
PRO_INDCOP			-0.072***				0.017***	
			(-5.30)				(9.26)	
TWPRO_INDCOP				-0.029**				0.044***
				(-2.06)				(3.77)
B_SIZE	0.004	0.006	-0.001	0.008	0.063***	0.060***	0.058***	0.061***
	(0.47)	(0.57)	(-0.06)	(0.75)	(7.15)	(4.15)	(17.19)	(4.21)
B_IND	-0.014	0.009	-0.016	0.008	0.025	-0.034	-0.034***	-0.023
	(-0.65)	(0.35)	(-0.59)	(0.33)	(1.17)	(-1.02)	(-3.55)	(-0.56)
F_PRO	-0.023	-0.026	-0.018	-0.019	0.048***	0.041	0.055***	0.017
	(-1.23)	(-1.19)	(-0.80)	(-0.89)	(2.60)	(1.46)	(8.01)	(0.71)
CSR_COM	0.026***	0.026***	0.028***	0.028***	0.037***	0.049***	0.041***	0.042***
	(4.07)	(3.65)	(3.94)	(3.98)	(5.63)	(5.27)	(28.83)	(4.61)
CSR_AUD	0.003	0.001	-0.004	-0.004	0.009**	0.007	0.012***	0.010**
	(0.56)	(0.17)	(-0.58)	(-0.66)	(2.44)	(1.41)	(7.25)	(1.99)
ESG_COMP	0.015***	0.011*	0.021***	0.011*	0.023***	0.007	0.003***	0.005
	(3.57)	(1.86)	(3.11)	(1.86)	(7.97)	(0.88)	(2.67)	(0.77)
RD_INT	0.030***	0.021	0.026*	0.019	-0.258***	-0.239***	-0.250***	-0.216***
	(3.11)	(1.61)	(1.94)	(1.46)	(-6.81)	(-4.92)	(-13.50)	(-4.42)
CAP_INT	-0.007	-0.021	-0.019	-0.015	-0.024	-0.027	-0.011***	-0.027
	(-0.43)	(-1.33)	(-1.10)	(-0.94)	(-1.59)	(-1.32)	(-2.70)	(-1.40)
CASH	-0.013	-0.012	-0.025	-0.016	0.078***	0.074***	0.083***	0.058**
	(-1.12)	(-0.73)	(-1.42)	(-0.98)	(5.83)	(2.84)	(15.36)	(2.25)
ROA	0.001***	0.001***	0.001***	0.001***	0.000	0.000	-0.000*	-0.000
	(4.02)	(2.77)	(3.13)	(2.90)	(0.60)	(0.66)	(-1.94)	(-0.07)
TQ	-0.001	-0.002	-0.000	-0.000	-0.007***	-0.005*	-0.003***	-0.005*
	(-0.49)	(-1.21)	(-0.12)	(-0.21)	(-4.61)	(-1.69)	(-4.71)	(-1.65)
LEVERAGE	-0.012	-0.004	-0.004	0.000	-0.028**	-0.035**	-0.021***	-0.025
	(-1.26)	(-0.40)	(-0.37)	(0.00)	(-2.47)	(-2.03)	(-4.07)	(-1.40)
SIZE	0.009***	0.005**	0.004*	0.005**	0.000	0.001	0.002***	0.003
	(4.92)	(2.12)	(1.93)	(2.51)	(0.16)	(0.58)	(3.89)	(1.33)
Intercept	-0.063	-0.072*	0.042	-0.036	-0.309***	-0.164***	-0.146***	-0.115***
	(-1.14)	(-.1.95)	(0.92)	(-0.86)	(-8.66)	(-10.28)	(-6.85)	(-7.31)
Observations	2,119	2,119	2,119	2,119	795	795	795	795
Industry & Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(1) p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) p-value	0.466	0.494	0.514	0.474	0.996	0.918	0.906	0.848
Sargan p-value	0.003	0.042	0.057	0.053	0.013	0.002	0.000	0.000
Hansen p-value	0.235	0.286	0.113	0.305	0.255	0.224	0.194	0.311

*, **, *** Represent significance at 0.1, 0.05 and 0.01 levels, respectively.

Z statistics are given in parenthesis.

All variables are as defined in Table1.