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The Impact of Firm-Level Political Risk on Eco-Innovation: The Moderating Effect of CEO Power

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ABSTRACT

This study examines the impact of firm-level political risk on eco-innovation at the firm level, particularly emphasizing the moderating role of CEO power in this relationship. Using a dataset from 33 countries from 2006 to 2022, we employ two-step dynamic panel data estimations to address endogeneity concerns. The findings highlight a positive impact of political risk on eco-innovation, which is further strengthened in the presence of a powerful CEO. This evidence implies that effective leadership from CEOs can assist firms in navigating political risks and advancing sustainable initiatives. The results remain robust across various specifications, including alternative measurements for firm-level political risk. The study highlights the crucial role of CEOs in managing political risks and facilitating eco-innovative practices within firms.

1 | Introduction

There are increasing concerns about environmental sustainability because of the continuous and rapid expansion of the global economy. The rise of urgent ecological issues, such as natural resource depletion, environmental degradation, and climate change, has attracted significant attention. Therefore, many firms contributing to this environmental degradation face immense pressure from stakeholders, interest groups, and policymakers to implement eco-innovative and sustainable business practices. In response, these firms are increasingly exploring viable ways to ensure sustainable environmental and economic practices (Zaman et al. 2021). However, the growing global ecological concerns and awareness have made it more challenging for businesses to adhere to environmental standards (Wagner 2015). Despite these challenges, many executives are already integrating practices to make their firms more economically friendly, increasing eco-innovation.

Eco-innovation involves the development of novel or adapted systems, products, procedures, and processes that lead to sustainable environmental benefits (Liao et al. 2018). It encompasses a variety of innovations, ranging from the advancement of new technological solutions to the restructuring of existing systems, all with the primary objective of achieving sustainable environmental benefits. Eco-innovation has a positive impact on the environment during the process of production of a good or its after-sale use (Tsai and Liao 2017). As an innovation that prioritizes environmental sustainability, eco-innovation positively impacts the environment by reducing waste, eliminating pollution, enhancing corporate profitability through efficient resource utilization, and incorporating creativity in the production process. Firms can modify their products, production processes, and organizational practices through eco-innovative initiatives to reduce waste and minimize negative environmental impacts. According to previous literature, engaging in eco-innovative practices can lead to improved firm performance (He et al. 2015), especially regarding increased labor productivity, higher profitability, and stimulating growth-enhancing effects (Lanoie, Laurent-Lucchetti, and Johnstone 2011).

Despite the available evidence, it is essential to note that the positive benefits of engaging in eco-innovative practices are typically realized in the long run. However, immediate favorable

environmental impacts, such as reduced emissions and waste, can be achieved immediately. Additionally, although the ecological improvements associated with eco-innovative practices are generally cost-saving, various barriers can impede firms from engaging in eco-innovative practices (Maxwell, Lyon, and Hackett 2000). These obstacles are complex and range from the costs of implementing eco-innovative systems, processes, and practices to the availability of skilled personnel and a firm's market position. More importantly, because eco-innovation is often directly associated with policy, government regulations or interventions also form a significant barrier. Policies addressing environmental concerns, natural resources, and energy can directly or indirectly affect the integration of eco-innovative practices into a firm's operations (Marin, Marzucchi, and Zoboli 2015). Moreover, uncertainty in environmental policies, regulations, and other government interventions may pose an additional political risk for firms implementing eco-innovation methods.

Political risk refers to the potential for unfavorable events that can result from adverse policy changes, which can impact a firm's operations and performance (Fitzpatrick 1983; Kobrin 1979). This risk is often rooted in uncertainty about the probability and consequences of these adverse political changes, especially in situations where a change in the stance of political actors leads to alterations in existing policies.

Political risk is critical as it often affects various aspects of an organization, including growth, investment decisions, capital and governance structures, and the firm's overall performance. As noted in prior literature, political risk typically causes uncertainty for firms in both micro and macro forms, influencing corporate decisions. These uncertainties directly impact the financial performance of firms. For example, Pastor and Veronesi (2012) highlighted how political risk significantly impacts firms' stock prices. Additionally, firms facing greater political risks tend to significantly decrease their investment in intellectual capital (Huynh, Le, and Tran 2024).

Apart from affecting the financial performance of firms, political risk, because of its complex nature, also impacts environmental intent and eco-innovative practices in various ways. A recent study suggests climate policy uncertainty intensifies the adverse effect of climate risk on green total factor productivity in agriculture (Wang, Song, and Zhang 2024). Moreover, political uncertainty and struggles stemming from political tensions can hinder economic activities, infrastructural expansion, and attracting foreign capital investments (Nguyen et al. 2023; Khan, Khurshid, and Cifuentes-Faura 2023). Additionally, political risk can exacerbate environmental deterioration and hinder the successful incorporation of sustainable environmental practices like eco-innovation (Ma, Yu, and Jiang 2023; Zhang et al. 2023). Political uncertainty and instability can also lead to unsustainable exploitation of the environment (Wang et al. 2023) and reduce a firm's engagement in innovative practices such as eco-innovation (Bhattacharya et al. 2017). This implies that the effectiveness of sustainability measures largely relies on policy and regulatory uncertainties.

Political risk can vary depending on the country or firm under study. It is considered firm-specific when a governmental policy intentionally aims to interfere in the operational activities of a specific organization or when governmental decisions target specific organizations or businesses (Kobrin 1979). Conversely, political risk is regarded as country-level or country-specific when governmental decisions or policies generally affect all firms or organizations operating within a country.

Unlike country-level political risk, which is challenging to manage, firm-level political risk is typically more manageable as it often impacts decision-making and the ability of firms to pursue innovative strategies (Choi, Chung, and Wang 2022), such as eco-innovation. The correlation between firm-level political risk and innovative practices is quite apparent, at least judging from the prevailing literature mentioned earlier; however, what is not clear is the role of CEOs and their power in this relationship. Generally, CEOs are considered powerful because of their position as the most senior executives within a firm and the nature of the responsibilities and duties they are required to undertake. Existing literature documents a substantial connection between the power of the CEO and the strategic choices organizations make (Chikh and Filbien 2011). It has also been demonstrated that CEO power influences organizational performance and corporate strategy. Considering the documented role of CEO power in corporate strategy, this study seeks to ascertain the moderating effect of CEO power on the connection between firm-level political risk and eco-innovation.

Given the critical environmental degradation instigated by the excessive use of fossil fuels and the intensifying impact of climate change, many nations have increasingly turned toward the implementation of eco-innovative practices to reduce emissions and promote sustainable development (e.g., Wang, Wang, and Chang 2022; Yang et al. 2021). However, as Pidgeon, Lorenzoni, and Poortinga (2008) argued, these eco-innovative transitions require significant risk–risk trade-offs, wherein resolving one environmental risk may worsen another. This makes managing eco-innovations in an uncertain political climate challenging for firms and policymakers. The successful and sustainable implementation of eco-innovative practices largely depends on both a stable political environment and sustainable economic investments. Yet, these practices are often subject to significant political risks, particularly at the firm level, which can profoundly impact implementing eco-innovative practices. Although a significant body of literature has examined the factors influencing eco-innovation, more research is needed on the connection between firm-level political risk and eco-innovation. There is also a notable gap in understanding the role of CEO power in this context, specifically its moderating effect on the relationship between political risk and eco-innovation.

Despite increasing evidence of the influence of CEO power on organizational performance and decision-making, its specific impact on a firm's innovative practices remains unclear (Sariol and Abebe 2017). Specifically, when examining firm-level political risk, this research explores the moderating influence of CEO power on the nexus between firm-level political risk and eco-innovation. By doing so, it aims to provide a better understanding of how organizations can effectively implement eco-innovative strategies amidst political uncertainties, thus advancing the body of literature on corporate innovation and political risk. The analysis shows a direct connection between firm-level political risk and eco-innovation using the two-step

dynamic generalized method of moments (GMM) regression, which addresses endogeneity concerns. To ensure robustness, we incorporate political sentiment, another element of firm-level political risk, and employ the two-step panel GMM regression, producing consistent findings.

This research contributes to the literature in several ways. First, it emphasizes a notable gap by exploring the influence of firm-level political risk on eco-innovation, a topic that has not been extensively explored. Second, it contributes to the growing body of literature investigating the association between uncertainty and sustainability, providing new insights into how external uncertainties can drive sustainable initiatives. Third, this research highlights the role of a powerful CEO in leveraging political risk to enhance eco-innovation within firms, presenting a strategic path for firms to turn potential risks into innovative opportunities.

The remainder of this study is organized as follows. Section 2 provides a review of the literature and presents the hypotheses' development. Section 3 gives an overview of our data collection and empirical methodology. Section 4 presents the results and provides a discussion of the findings. It then reports robustness tests. Section 5 concludes the paper.

2 | Literature Review and Hypothesis Development

2.1 | Determinants of Eco-Innovation

The increased emphasis on ecological innovation has been driven by the social and political recognition of its crucial role in promoting economic progress and the growing understanding of environmental concerns. Recently, eco-innovation has become an essential strategy for businesses to achieve balanced, sustainable environmental and economic benefits. This shift has contributed to transforming economic growth toward continuous sustainability. Because of its critical importance in advancing sustainability, numerous studies (e.g., Horbach, Rammer, and Rennings 2012; Jové-Llopis and Segarra-Blasco 2020) have focused on eco-innovation, particularly identifying its determinants. These studies have recognized that several determinants can potentially affect eco-innovation, often depending on various environmental conditions and industry sectors. For example, Jové-Llopis and Segarra-Blasco (2020) identified key drivers of eco-innovation in manufacturing and service sectors. Their findings suggest that technological factors, such as internal R&D and firm size, are persistent drivers across sectors. However, market-driven factors and public environmental regulations impact different subgroups of service firms to varying degrees.

Horbach, Rammer, and Rennings (2012) classified eco-innovation determinants into four categories: regulatory or institutional determinants, market factors, technological determinants, and firm-specific characteristics. Among these, institutional or regulatory determinants have received more attention (Khanna, Deltas, and Harrington 2009; Lanoie, Laurent-Lucchetti, and Johnstone 2011), which is a central focus of this research. The role of institutional or regulatory determinants of eco-innovation is particularly relevant to this study because of the manifestation of firm-level political risk through policy changes and instability (Ahmad et al. 2024). The substantial impact of institutional and regulatory pressures on firms' adoption of eco-innovative practices and investments is well-documented (Guo et al. 2020). These pressures often create a conducive environment for firms to participate in innovative plans aligned with sustainability principles, encouraging them to pursue eco-innovations. In this regard, Demirel and Kesidou (2019) highlighted that a firm's ability to detect environmental market shifts and adopt new regulations significantly determines its propensity to embrace eco-innovation.

In response to these pressures, firms often integrate CSR and ESG initiatives into their eco-innovation strategies. CSR, especially in environmental sustainability, has been shown to enhance a firm's capacity for innovation while improving shareholder concerns (Guerrero-Villegas, Sierra-García, and Palacios-Florencio 2018). In addition, higher ESG scores motivate firms to adopt sustainable production methods, thereby fostering the development of eco-innovative solutions and increasing the issuance of green patents.

Consequently, CSR and ESG initiatives become more favorable to investors, reducing the cost of external financing and supporting sustainable business growth (Zhou, Liu, and Luo 2022). The authors demonstrated that CSR facilitates innovation by leveraging social, environmental, and sustainability factors to create new business models, markets, goods, services, and procedures (Guoyou et al. 2013). However, despite these benefits, firms may hesitate to invest in eco-innovation because of the difference between private and social returns, especially concerning environmental impact. This hesitation is often attributed to the double externality problem associated with eco-innovation, which generates two favorable externalities: knowledge and positive environmental impact (Arranz et al. 2020). Many governments have implemented policy instruments to incentivize firms to invest in eco-innovation and ensure continuous sustainability to address this challenge. Consequently, the double externality problem has established institutional pressure as a robust determinant of eco-innovation (Rennings 2000). The prevailing literature on environmental and eco-innovation determinants has extensively investigated their significance.

Eco-innovation often requires adequate institutional supervision and policy support (Liao and Tsai 2019), making institutional effectiveness a crucial element in determining firms' efforts to pursue eco-innovation. Considering this, unplanned modifications and unstable institutional policies driven by political changes pose significant risks to firms aiming to eco-innovate. The connection between firm-level political risk and eco-innovation is further discussed in the subsection below.

2.2 | Firm-Level Political Risk and Eco-Innovation

Like economic instability, political instability involves large-scale external market disruptions that affect firms' ability to manage, leverage, and capitalize on political tensions stemming from regulations and institutional factors (Boah and Ujah 2024). These political pressures are often analytically

combined with firms' political risk in the prevailing literature. Insights from the literature demonstrate that these political tensions often influence firms' behavior and decision-making (Boah and Ujah 2024; Jensen 2008; Keillor, Wilkinson, and Owens 2005). As a popular construct in the literature, political risk involves both firm- and country-specific features, each carrying different implications for firms. Firm-level political risk primarily occurs when there is an intentional institutional intervention in specific firms or industries (Kobrin 1979), typically through institutional policies that directly influence operational activities, strategic direction, and profitability of affected firms or industries.

Various actions can significantly influence a country's business and investment climates, though these are not always directed at specific firms or industries (Góes and Bekkers 2022). It is crucial to distinguish between firm- and country-specific political risks to understand how firms develop risk management strategies. Firm-specific political risk can often be addressed through targeted measures such as lobbying, engaging with investors, or diversifying operations. In contrast, country-specific political risk presents broader and more complex challenges that may be beyond the control of individual firms. Firms operational in countries with higher country-specific political risks face heightened uncertainty. They may need to implement comprehensive global risk management processes or consider acquiring political risk insurance.

Similarly, studies show that increased political risk typically adversely affects firms' corporate investment (Alam, Houston, and Farjana 2023; Gulen and Ion 2016; King, Loncan, and Khan 2021; Le and Tran 2021). With its long-term and potentially significant influence on corporate decisions, political risk negatively affects firms' innovation ability (Gulen and Ion 2016; Julio and Yook 2012). A recent study underlines the paradoxical nexus between policy uncertainty and investment in sustainability-related efforts. For example, Zhou et al. (2024) found that although uncertainty can discourage investment in renewable energy technologies, it can also, paradoxically, lead firms to reallocate budgets toward eco-innovation to hedge themselves against future regulatory changes. Furthermore, Zheng et al. (2024) showed how geopolitical risks shape budget allocation for renewable energy technologies, highlighting the comprehensive interplay between global political risk, social media narratives, and strategic investment choices required for sustainable energy advancement. These findings are consistent with more general idea that political risks, especially those related to environmental regulations, present a strategic trade-off for firms. Uncertainty deters substantial investments because of concerns about abrupt changes in legislation, but it also encourages firms to innovate in advance to be competitive when new rules are implemented (Zhou et al. 2024). This risk paradox aligns with the strategic growth option perspective (Kogut and Kulatilaka 2001), where companies concerned about the future may opt to innovate to mitigate long-term risk and take advantage of regulatory shifts.

Most previous studies assumed that macrolevel political risks uniformly influence various segments of businesses in an economy. However, as Huynh, Le, and Tran (2024) claim, a particular political event does not always affect the entire economy uniformly in the same way. Similarly, Song et al. (2024) observed that increased economic policy uncertainty could constrict investments in renewable energy processes and eco-innovations, causing environmental harm. These findings emphasize that political risks are not homogeneously distributed across firms. Considering this, recent studies have increasingly focused on firm-level political risks, recognizing the necessity for more in-depth analysis. Higher policy or political risk can alter firms' financing decisions (Chen, Jiang, and Tong 2017), firm investment decisions (Choi, Chung, and Wang 2022), and firm innovation decisions (Bhattacharya et al. 2017; Xu 2020). For instance, Chatjuthamard et al. (2021) demonstrated that firms strategically enhance their CSR activities because of firm-level political risk and sentiment, emphasizing the importance of political factors in shaping CSR initiatives and stakeholder engagement. In support of this, Hasan and Jiang (2023) found that the positive relationship between political sentiment and CSR is influenced by environmental practices, community engagement, staff engagement, and diversity. Additionally, Boah and Ujah (2024) examined firms' research and development investment decisions during periods of political uncertainty, using data from US firms from 2005 to 2021. Their results show that firms tend to increase research and development investments during periods of heightened political risk, with an average injection of about ten million six hundred thousand dollars. This effect is particularly prominent for firms in politically sensitive industries, firms with high growth potential, and those with significant liquid holdings.

Despite the positive connection between firm-level political risk and certain firm activities found in some studies, other studies have identified adverse impacts. For example, Huang et al. (2015) discovered that firms might reduce their financial commitments during political uncertainty by cutting dividend payouts or share buybacks. Bhattacharya et al. (2017) suggested that political unpredictability can hinder innovation, leading to declines in research and development (R&D) expenditures and inventive endeavors. Similarly, Udeagha and Muchapondwa (2023) noted that firm-level political risks can bring about economic policy uncertainty that causes a reduction in the quality of the environment through the investment channel by hindering industrial development and invention as well as reducing R&D investments. Gyimah et al. (2022) linked company-specific political risk profiles to leverage decisions, indicating that political factors influence capital structure choices. Similarly, Saffar, Wang, and Wei (2024) highlighted the adverse influence of political instability at the firm level on the cost of bank loans, suggesting that political uncertainties can affect firms' access to external financing and capital structure decisions. Lastly, Hassan et al. (2024) found that firms exposed to higher firm-level political risk tend to maintain more significant cash holdings. This positive association persists across various firm characteristics, such as financial constraints, growth opportunities, industry competition, and economic cycles, highlighting the strategic importance of cash reserves in mitigating the effects of political instability.

Previous literature has consistently reported that political risk has significant implications for firms' outcomes. Habib and Zurawicki (2002) highlighted the detrimental effects of political risk on firm performance, especially regarding reduced profitability, increased costs, and weakened investors'

confidence. In addition, studies suggest that a rise in political risk can lead firms to implement more cautious strategies, like intensifying cash management (Duong et al. 2020) and reducing financing (Çolak, Durnev, and Qian 2017; Dai and Ngo 2020; Lee et al. 2018). These actions eventually affect firms' financial performance (Keillor, Wilkinson, and Owens 2005) and their ability to execute corporate innovation (Ellis, Smith, and White 2020).

Because political risk tends to have a long-term, contextual, and potentially significant effect on corporate decisions, firm-level political risk is expected to influence corporate innovative drives, such as eco-innovation. Political risk is vital for corporate innovation because of the substantial investment in intangible capital associated with innovation (Khan et al. 2020; Wang, Wei, and Song 2017). Regulatory and policy changes can change the economic climate in which a firm operates (Bhattacharya et al. 2017). In the absence of policy shifts or changes, the commitment of institutional actors to enforcing existing policies is often not specific.

However, there remains a notable gap in the literature concerning the relationship between firm-level political risk and eco-innovation. Although substantial research has focused on political risks and general corporate strategies, the specific influence of firm-level political risk on eco-innovation activities is less understood. Understanding how political risks impact eco-innovation is crucial, given the increasing importance of sustainability and environmental responsibility in business practices. This area warrants further investigation to determine whether firms' strategies to manage political risk also promote or hinder eco-innovation efforts. Addressing this gap could provide key insights into the interplay between political risk management and sustainable innovation strategies in firms.

2.3 | Theoretical Framework: A Strategic Growth Option Perspective

The impact of political risk on global economic dynamics is a critical concern with substantial implications for financial markets, the management of natural resources, and the development of eco-innovative systems and practices. As discussed earlier, political risks can significantly reduce corporate investment and innovation. Firms may decrease their total investment during periods of intense uncertainty to avoid disruptions in investment expenditures, a phenomenon often attributed to nonrecoverable investments (Gulen and Ion 2016), as the real options theory proposes. The real options theory perspective focuses on the notion that intensified risk can reduce corporate investment because of investment irreversibility (Myers 1977). The core tenet of this perspective lies in the premise that a firm controls all investment decisions. In contrast, strategic growth theory suggests that uncertainty may motivate companies to invest in growth-oriented opportunities under imperfect competition. This view assumes that uncertainty can create strategic growth paths or options for firms. Therefore, as suggested by real options theory, deferring investments can result in firms losing investment opportunities to competitors. At the same time, instant actions might dampen entrants' confidence in the market (Kulatilaka and Perotti 1998), allowing firms that innovate in periods of uncertainty to intensify their competitive edge.

It is imperative to note that although real options theory presumes firms have exclusive control over investment opportunities and that these investment opportunities do not readily affect their market structure or product prices, in contrast, the strategic growth option theory often evaluates investment within the context of imperfect competition (Kulatilaka and Perotti 1998). Specifically, this perspective holds that in nonmonopolistic markets, early investment can be advantageous for capturing expansion opportunities. Therefore, in these types of markets, firms acknowledge that early-stage investments, specifically in corporate innovations, are often linked to promising expansion prospects (Kulatilaka and Perotti 1998).

Previous studies have revealed a positive connection between political instability and investment and innovation. Firms tend to strengthen their investment in R&D under higher uncertainty, especially in more competitive industries, as Van Vo and Le (2017) noted. Similarly, Paunov (2012) showed that with increased uncertainty, firms must invest more in producing viable innovations if they do not want to lose market share in foreign and local markets.

Drawing insights from the strategic growth option perspective, it can be asserted that even though firm-level political risk poses challenges to firms' growth and expansion, firms can also exploit opportunities within such situations to invest and drive growth strategically. Essentially, by exploiting strategic, innovative efforts despite the uncertainty associated with firm-level political risks, firms can maintain their market share and standing, enhancing their market power and establishing strong foundations for future profitability and expansion (Guan et al. 2021). Considering this, rather than deferring investment opportunities during firm-level political risks and uncertainties, firms may engage in corporate investments and innovations, such as eco-innovation, to ensure continuous growth and strategic expansion.

Based on this perspective, the first hypothesis for the study is formulated as follows:

Hypothesis 1. *Firm-level political risk exhibits a significant positive impact on eco-innovation.*

2.4 | Moderating Effect of CEO Power on the Relation Between Firm-Level Political Risk and Eco-Innovation

As top executives in organizations, CEOs hold a prestigious position within a firm's upper management, allowing them to play an essential role in shaping and directing strategic decisions (Crossland et al. 2014). They are usually expected to be actively involved in strategy formulation, and research has shown that CEOs directly impact critical organizational outcomes (Finkelstein, Hambrick, and Cannella 2009). Occupying a unique position, CEOs often influence organizational processes and outcomes in ways that affect firm performance (Combs

et al. 2007). Therefore, differences in organizational outcomes are often seen as the direct result of CEOs' strategic choices (Finkelstein, Hambrick, and Cannella 2009).

CEO power, which reflects their ability to pursue their objectives and exert influence (Finkelstein 1992), plays a substantial role in strategic decision-making. CEO power is usually obtained from different sources. As proposed by Finkelstein (1992), the four primary sources of CEO power are prestige, ownership, expertise, and structural factors. These sources, such as performance and innovation, are often exercised across various strategic choices and decision-making processes, differentially influencing outcomes (Adams, Almeida, and Ferreira 2005).

Previous literature has documented the impact of CEO power on firm performance (Cheng 2008; Javeed et al. 2021; Sheikh 2019). Similarly, various studies have reported that CEO power influences firms' innovation (Sariol and Abebe 2017) and environmental innovation efforts. However, because political risks involve several factors, such as regulatory and policy shifts, as well as institutional uncertainty, which can affect firms' operational activities and profitability, the importance and impact of CEOs—especially in terms of using their power to manage and mitigate these risks—have raised concerns. The World Economic Forum (2019) reported that political risks ranked among the top concerns for CEOs globally. CEO power is crucial when CEOs lead organizations' responses to political risks (Hillman and Hitt 1999). Effective CEOs use their power to manage operational activities and influence a firm's resilience to political instability and risk, which is why it is reported that CEO power moderates the association between political risk and firm performance (Denis and McConnell 2003; Li, Liu, and Zhao 2017). Consequently, because CEOs are usually seen as the significant architects of their firm's innovation drive, CEO power is expected to moderate the link between firm-level political risk and innovation. Although extensive research has explored the link between CEO power and firm performance, a notable gap exists in examining the moderating role of CEO power on the relationship between political risk and eco-innovation. Drawing on the behavioral agency theory, this study analyses the potential moderating role of CEO power on the relationship between firm-level political risk and eco-innovation.

2.5 | Theoretical Framework: Behavioural Agency Theory Perspective

Initially hypothesized by Wiseman and Gomez-Mejia (1998), the behavioral agency theory has been widely utilized to clarify how executive risk preferences are related to business outcomes (Martin, Gomez-Mejia, and Wiseman 2013). This perspective emphasizes that the risk preferences of executives vary substantially based on the supervisory, regulatory, or institutional context in which they operate. In contrast to the classic agency theory (Eisenhardt 1989), the behavioral agency perspective views executive decision-makers as risk-averse and risk-seeking, depending on their perceptions, as predicted by prospect theory (Kahneman and Tversky 1979). It posits that a firm's performance history significantly affects how executives perceive organizational problems or challenges, affecting their risk-taking attitudes or decisions. When organizational issues are positively framed, less risky decisions are made, whereas negatively framed issues tend to prompt more aggressive risk-taking decisions (Sariol and Abebe 2017).

Essentially, the behavioral agency perspective extends the classic agency perspective by considering executives as risk-averse when faced with organizational issues framed in a positive light, which involve apparent significant losses, and as risk-takers when faced with organizational issues framed in a negative light (Sariol and Abebe 2017). Considering this, the behavioral agency theory is highly relevant because eco-innovation typically carries a higher risk as an exploratory innovation (Uotila et al. 2009). It indicates that a CEO's decision to invest in such innovation will be influenced by their evaluation of the comparative risk associated with the innovation and their risk-bearing responsibilities for such a decision (Sariol and Abebe 2017).

When confronted with adverse political risks, CEOs can use their power to implement a more aggressive risk-taking approach, leveraging their power to steer and moderate the potential adverse effect of political risk on their firms' performance and innovative activities (Shabir et al. 2023). The behavioral agency perspective provides valuable insights into how CEO power can moderate organizational responses to ecological constraints and enhance eco-innovative activities. A CEO's encouragement and prioritization of eco-innovative practices enable them to leverage their power to position such activities as viable prospects for firms' reputation, competitive edge, and long-term sustainability. CEO power is often associated with enhanced information processing capacity, improved authority, and decision-making autonomy, allowing CEOs to effectively lead their firms' innovation endeavors. Based on this perspective, this study expects CEO power to moderate the positive connection between firm-level political risk and eco-innovation. Therefore, the second hypothesis for the study is formulated as follows:

Hypothesis 2. *Powerful CEOs can positively influence eco-innovation, even with increased political risk within the firm.*

3 | Data and Methodology

This section outlines the data collection and sample selection processes. It also describes the key variables and empirical models used to test our hypotheses.

3.1 | Data

Our analytical approach requires the use of multiple databases to gather relevant information. The data required for computing the eco-innovation score and CEO Power Index, as well as data for control variables, are sourced from the London Stock Exchange (LSEG). The Global Innovation Index score is sourced from the World Intellectual Property Organisation (WIPO) (2024). GDP growth data are attained from the World Bank (2024), and data on firm-level political risk are attained from Hassan et al. (2019). For additional analyses and robustness

tests, we use the measure of firm-level political sentiment from Hassan et al. (2019). Because Hassan et al. (2019) presented a quarterly dataset, we calculated yearly measures of political risk and political sentiment by averaging all quarterly figures within a particular financial year.

We begin our data collection process by collating data from publicly traded global firms on LSEG from 2006 to 2022. The selection of 2006 as the starting year is based on the availability of eco-innovation data from that year onward. Initially, our sample includes 34,650 firm-year observations. Subsequently, we combine all datasets and exclude firm-years with omitted data for our explanatory, dependent, and financial variables. The final dataset comprises 29,729 firm-year observations across 33 countries. Descriptions of all variables are provided in Table 1.

3.2 | Variables

3.2.1 | Dependent Variable

In this study, our dependent variable is eco-innovation. Previous studies have primarily measured eco-innovation using surveys (Peng and Liu 2016), which can be subject to biases because of personal beliefs and assumptions, potentially declining the reliability of results (Arena, Michelon, and Trojanowski 2018). To address this issue, Arena, Michelon, and Trojanowski (2018) developed a custom environmental innovation index, scoring firms from zero to six based on their disclosure of specific indicators. The efficacy of such self-developed indices has faced criticism in existing literature (Zaman et al. 2021) because of the inherent selection bias they may introduce. Zaman et al. (2021) used the eco-innovation scores of firms to evaluate the degree of eco-innovation within companies. This score assesses a company's capacity to mitigate environmental costs, lower consumer burdens, and identify new market opportunities by developing innovative environmental technologies or eco-friendly practices. The LSEG eco-innovation score is a sector-adjusted combined score computed using a weighted mean of 20 factors associated with sustainable products and processes. Scores range from 0 to 100, with a perfect score of 100 indicating a strong dedication to eco-innovation (Zaman et al. 2021; Zaman et al. 2024).

3.2.2 | Independent Variable

The firm-level political risk (*PRisk*) is used as the leading independent variable of our study. Hassan et al. (2019) employed an innovative methodology of analyzing firm quarterly earnings conference call transcripts to identify bigrams indicative of political risk. Their research sought to quantify the prevalence of such bigrams as a proxy for assessing the extent of political risk faced by firms. They found a positive association between the aggregated occurrence of these identified bigrams and risk levels, which exhibited positive correlations with return volatility and negative correlations with various firm-level metrics such as investments, capital expenditure, and hiring growth. Notably, this measure represents a pioneering effort in systematically capturing firm-specific political risk, characterized by its temporal variability and nonbinary nature, unlike previous studies, which primarily relied on country- or state-level policy or political risk metrics, such as policy uncertainty and partisan differences. Hassan et al. (2019) offer a granular examination of political risk at the individual firm level. Subsequently, we annualized the political risk values by averaging the mean and applying the log of the political risk.

TABLE 1 | Summary statistics.

Variable	Mean	Std. dev	Minimum	Maximum
Eco-innovation	24.27	31.1	0.0	173.2
Firm-level political risk	122.41	166.0	0.0	508.4
CEO Power Index	0.00	0.7	−0.8	2.2
Board size	9.75	3.5	1.0	138.0
Leverage	0.20	0.7	0.0	169.1
Size	20.74	2.2	2.3	27.6
Cashflow	0.65	4.4	−3.3	9.6
Dividend	1.61	4.5	0.0	3.3
GII score	53.19	10.3	16.9	82.9
ROA	0.49	0.3	−7.2	105.1
GDP growth	3.12	3.8	−11.3	26.2
CEO tenure	0.08	0.3	0.0	1.0
CHAIRMAN is ex-CEO	0.30	0.5	0.0	1.0
CEO duality	0.35	0.5	0.0	1.0
CEO board member	0.85	0.4	0.0	1.0

3.2.3 | Moderating Variable: CEO Power

We construct a CEO Power Index using the principal component analysis (PCA) data reduction technique, combining four normalized variables representing the CEO's decision-making autonomy level. These variables include CEO duality, CEO tenure, the board chairperson being a former CEO, and the CEO serving as a current board member, consistent with previous research (e.g., Sheikh 2019; Veprauskaitė and Adams 2013).

CEO duality, a binary variable set to 1 if the CEO also holds the position of board chairperson and 0 otherwise, can enhance decision-making efficiency and reduce conflicts among board members, thereby increasing the CEO's influence within the company. CEO tenure is the second source of CEO power, coded as one if the CEO's tenure is above the sample median and 0 if it is not. Combs et al. (2007) suggest that CEOs with longer tenures have greater power because of increased autonomy in decision-making. Brookman and Thistle (2009) indicate that lengthy CEO tenure can improve financial performance by enabling CEOs to use firm-specific expertise to influence board choices positively.

Another source of CEO power is when the board chairperson is a former CEO. It is a binary variable coded as 1 if the board's chairperson is a former CEO and 0 otherwise. Firms often retain ex-CEOs as board chairpersons to benefit from their counsel, experience, expertise, and networks. When the previous CEO serves as the board's chairperson, they may be motivated to supervise managers and board members more closely (Pucheta-Martínez and Gallego-Álvarez 2024). Typically, a former CEO promoted to the Chair position within the same company holds significant authority on the board and can influence the current CEO's actions. This often results in the chairperson having a level of control and influence comparable with that of the CEO, enabling them to align board members' perspectives.

The final variable captures whether the CEO is also a board member. It is coded as 1 if the CEO is a board member and 0 otherwise. CEOs on the board often hold significant privileges, including voting rights, substantial credibility, and considerable power within the organization. These factors can potentially lead to conflicts with other board members. CEOs serving on boards are more inclined to impose their criteria and preferences on organizations, which can enhance their authority and influence.

3.2.4 | Control Variables

To bolster the robustness of our findings, we account for several control variables that may influence innovation outcomes. We incorporate firm size (SIZE), determined as the natural log of total assets. Azar and Drogendijk (2016) proposed that this measure accounts for the scale of operations and organizational resources available to the firm. We incorporate return on assets (ROA) as another control variable, calculated as the ratio of preinterest earnings (EBIT) to total assets (Pucheta-Martínez and Gallego-Álvarez 2024). This metric provides insights into a firm's profitability and operational efficiency, which could influence its propensity for innovation.

We also account for firms' leverage, calculated as total debts divided by total assets. This measure accounts for firms' reliance on debt financing, mitigating potential confounding effects on innovation outcomes. Furthermore, we include board size (Boardsize) as a control variable, denoting the number of board directors within the firm. This variable reflects the governance structure and board's composition, which may affect firms' strategic choices and innovation initiatives. In addition, following Van Vo and Le's (2017) approach, we include dividend pay-outs as a control variable.

Regarding the country-specific control variables, we control for GDP Growth, defined as the yearly GDP growth rate (World Bank 2024); GII SCORE, the "Global Innovation Index," released by Cornell University, INSEAD, and WIPO (2024), provides essential worldwide statistics on innovation to help economies measure their performance in this area. The overall GII score, which ranges from 0 to 100, is the average of 80 indicators covering all aspects of innovation. A higher GII score indicates that a country is more inclined to innovate.

By incorporating these control variables into our analysis, we aim to isolate the specific effect of our focal variables on eco-innovation outcomes while accounting for other factors that could potentially influence the results. This approach enhances the validity and reliability of our findings, enabling a more nuanced understanding of the determinants of eco-innovation within organizations.

3.3 | Empirical Model

To evaluate how firm-level political risk affects eco-innovation, we perform regression using the dynamic GMM, a two-step panel estimation (Arellano and Bond 1991). This estimation allows us to account for both unobservable heterogeneity and endogeneity. An additional advantage of utilizing the GMM is that it minimizes estimate bias. In each regression, we present the estimated coefficients, the results of the AR (1) and AR (2) autocorrelation tests, and the Hansen test.

The empirical model detailed below is used to test the first hypothesis (H_1):

$$Eco-innovation_{i,t} = \beta_0 + \beta_1 PRisk_{k_{i,t}} + \beta_2 CEOPowerIndex_{i,t} + \beta_3 IND_i + \beta_4 YEAR_i + \sum_{j=1}^{k} \beta_j Controls_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $Eco-innovation_{i,t i,t}$ represents eco-innovation, which reflects the eco-innovation score of firm i at year t; $PRisk_{\text{yearly}k_{i,t}}$ refers to the firm-level political risk measure by Hassan et al. (2019) for firm i at time t; $Controls_{i,t}$ is the vector of control variables for firm i at year t; $CEO\ Power\ Index_t$ is the index used to measure CEO power; IND_i is the industry sector for the firm i; and $YEAR_i$ is the year of firms i. To test the second hypothesis (H_2), the following model is used:

$$Eco-innovation_{i,t} = \beta_0 + \beta_1 PRisk_{k_{i,t}} + \beta_2 CEOPowerIndex_{t,t} + \beta_3 PRisk_{k_{i,t}} \times CEOPowerIndex_{i,t} + \beta_4 IND_i + \beta_5 Year_i + \sum_{j=1}^{k} \beta_j Controls_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $PRisk_t \times CEOPower\ Index_t$ is an interaction term between firm-level political risk and the CEO Power Index.

4 | Empirical Findings and Discussion

4.1 | Descriptive Statistics

Table 1 presents the descriptive statistics. The average eco-innovation score is 24.27, with a standard deviation of 31.08. This implies that the sample firms, on average, have a moderate eco-innovation level, with considerable variability in scores across the dataset. The mean firm-level political risk is 122.4, with a standard deviation of 165.9, indicating a wide range of political risk exposures among the sampled firms. The mean CEO Power Index is zero, with a standard deviation of 0.657. This variable represents the degree of CEO Power within the sampled firms, with values ranging from −0.819 to 2.171. Furthermore, Table 1 provides summary statistics for the firm characteristics.

4.2 | PCA Results

As previously stated, this research uses PCA to determine the CEO Power Index, our moderating factor. PCA simplifies the dataset by reducing its dimensionality, particularly among correlated variables related to CEO Power, while preserving most of the variance. The data are transformed into a different set of independent and arranged variables (principal components) so that the first few components capture most of the original variables' variance, highlighting essential features of CEO power (Veprauskaitė and Adams 2013). In this study, PCA reduces the four variables depicting features of CEO power into a single dimension, which we define as the CEO Power Index.

The CEO Power Index is defined by factors such as CEO duality, board membership, tenure, and whether the chairperson is a former CEO, as these variables have loadings greater than 0.5. This suggests that increases in CEO duality, board membership, tenure, and having a former chairperson contribute to increased CEO power, as indicated by the CEO Power Index. Table 2 presents the correlation matrix of the four CEO power variables contributing to the CEO Power Index. Additionally, Table 1 provides the key descriptive statistics for the proxies of the *CEO Power Index*.

4.3 | Firm-Level Political Risk and Eco-Innovation

Model (1) in Table 3 shows the results for Hypothesis 1. The findings from the panel GMM regression in Model (1) suggest that the coefficient of firm-level political risk (*PRisk*) is 0.104 and statistically significant at the 5% level ($p < 0.05$). This indicates that firm-level political risk positively affects a firm's eco-innovation. Therefore, Hypothesis 1 is supported, suggesting that firm-level political risk positively impacts eco-innovation. The coefficient of the CEO Power Index is 0.0774 and significant at the 5% level ($p < 0.05$). This result indicates that firms with more powerful

TABLE 2 | Correlation matrix.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Eco-innovation	1												
(2) Firm-level political risk	−0.004	1											
(3) CEO Power Index	0.110**	−0.01	1										
(4) Chairman is ex-CEO	0.035**	0.002	0.751**	1									
(5) CEO tenure	0.127**	−0.008	0.585**	−0.014**	1								
(6) CEO board member	−0.060**	−0.005	0.140**	0.159**	−0.282**	1							
(7) CEO duality	0.031**	−0.011**	0.759**	0.878**	−0.014**	0.200**	1						
(8) Board size	0.247**	−0.029**	0.167**	0.032**	0.161**	0.045**	0.066**	1					
(9) Leverage	0.020**	0.013**	0.032**	0.066**	−0.005	−0.006	0.056**	0.079**	1				
(10) Size	0.258**	−0.008	0.154**	0.062**	0.097**	0.030**	0.100**	0.512**	0.027**	1			
(11) Cashflow	0.134**	−0.007	0.056**	0.015**	0.048**	0.003	0.032**	0.206**	0.005	0.211**	1		
(12) Dividend paid	0.191**	−0.008	0.065**	0.025**	0.061**	0.007	0.034**	0.260**	0.089**	0.495**	0.353**	1	
(13) GDP growth	−0.077	−0.013	−0.011	−0.05	−0.046	−0.035	−0.098	−0.14	−0.03	−0.044	−0.344	−0.001	1

**$p < 0.05$.

TABLE 3 | Baseline estimations.

Variable	(1)	(2)
Eco Innovation$_{t-1}$	0.897***	0.915***
	(0.02)	(0.01)
PRisk	0.125**	0.0299*
	(0.05)	(0.02)
CEO Power Index	0.0774**	0.0437**
	(0.04)	(0.02)
PRisk × *CEO Power Index*		0.230***
		(0.09)
Board size	−0.027	0.0333*
	(0.03)	(0.02)
Leverage	−0.0256	−0.0033
	(0.02)	(0.01)
Size	0.0434	0.0338
	(0.03)	(0.07)
Cashflows	0.0010	0.0133
	(0.02)	(0.02)
Dividend paid	0.0253	0.00608
	(0.02)	(0.01)
ROA	0.0495	0.287*
	(0.04)	(0.17)
GIISCORE	−0.193	0.0229*
	(0.12)	(0.01)
GDPGRWTH	−1.310	−0.000985
	(0.56)	(0.02)
Constant	1.209***	0.322***
	(0.37)	(0.06)
Industry FE	Yes	Yes
Year FE	Yes	Yes
AR (1)	[0.000]	[0.000]
AR (2)	[0.115]	[0.808]
Hansen test	[0.805]	[0.239]

Note: Standard errors are in parentheses, and probability values are in brackets.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.10$.

CEOs tend to engage more in eco-innovation activities, which aligns with our expectations.

4.4 | Moderating Effect of CEO Power

In Model (2) of Table 3, the coefficient of firm-level political risk (*PRisk*) is positive (0.0299) and significant at the 10% level ($p < 0.10$). This implies that higher levels of firm-level political risk are positively linked to eco-innovation. The coefficient of the CEO Power Index is 0.0437, which is significantly positive, suggesting that more significant CEO influence contributes to higher levels of eco-innovation, holding all other variables constant. The interaction term between firm-level political risk and CEO power (*PRisk* × *CEO Power Index*) is positive and significant at the 1% level ($p < 0.01$). This supports Hypothesis 2, which posits that as CEO power increases, the effect of firm-level political risk on eco-innovation is amplified. We therefore argue that high CEO power may enable CEOs to make strategic decisions that mitigate the influence of firm-level political risks and capitalize on the opportunities they present for eco-innovation.

The coefficient for the GII score is 0.022, which is significantly positive. This suggests that a country's innovation environment continues to exert a strong influence on firms' eco-innovation activities. Firms operating in countries with robust innovation ecosystems are more strategically positioned to pursue eco-innovation despite political uncertainties. Hence, creating an environment conducive to national innovation remains critical in fostering eco-innovation and sustainability among firms, even in the face of external political challenges.

ROA has a coefficient of 0.287, which is positive and statistically significant, demonstrating that firms with higher ROA are better positioned to drive eco-innovation initiatives. Additionally, the coefficient of board size is 0.033, which is positive and significant, implying that a larger board provides a more diverse range of perspectives and expertise, helping firms to address political uncertainties and encourage eco-innovation effectively.

4.5 | Components of Political Risk

Further analysis was conducted on the individual elements of firm-level political risk, which include eight elements: economic (*PRiskT_economic*), environment (*PRiskT_environment*), trade (*PRiskT_trade*), institutions (*PRiskT_institutions*), health (*PRiskT_health*), security (*PRiskT_security*), tax (*PRiskT_tax*), and technology (*PRiskT_technology*). These individual elements were standardized, following the methodology of Hassan et al. (2019), and subsequently annualized each element by averaging the means.

The results, presented in Models (1–8) of Table 4, show that each element of political risk significantly positively affects eco-innovation. Additionally, the coefficient for the CEO Power Index remains positive and significant. These findings are consistent with the results in Model (1) of Table 3.

4.6 | Robustness Tests

This section uses alternative proxies for firm-level political risk and eco-innovation in the analysis. First, we substitute firm-level political risk with standardized political sentiment (*PSentiment*) (Hassan et al. 2019). The findings in Model (1) of Table 5 show that the parameter for *PSentiment* is 0.027 and

TABLE 4 | Firm-level political risk components and eco-innovation.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Eco Innovation$_{t-1}$	0.895***	0.895***	0.888***	0.896***	0.895***	0.894***	0.891***	0.894***
	(0.0119)	(0.0123)	(0.014)	(0.0121)	(0.012)	(0.0119)	(0.0118)	(0.0116)
Firm-level *PRisk* economic	0.161**							
	(0.078)							
Firm-level *PRisk* trade		0.169*						
		(0.0898)						
Firm-level *PRisk* health					0.164**			
					(0.0798)			
Firm-level *PRisk* security						0.158**		
						(0.0803)		
Firm-level *PRisk* tax							0.156**	
							(0.0753)	
Firm-level *PRisk* technology								0.135*
								(0.0694)
Firm-level *PRisk* environment			0.0546*					
			(0.033)					
Firm-level *PRisk* institutions				0.161**				
				(0.0749)				
CEO Power Index	0.0191**	0.0209**	0.0233*	0.0177*	0.0201**	0.0197**	0.0173*	0.0201**
	(0.00916)	(0.00955)	(0.013)	(0.00922)	(0.00928	(0.00914)	(0.0092	(0.00924)
Board size	−0.125	−0.142*	−0.177	−0.126	−0.139*	−0.136*	−0.106	−0.142*
	(0.0821)	(0.0859)	(0.128)	(0.0814)	(0.0831)	(0.0818)	(0.0832)	(0.0826)
Leverage	−0.0133**	−0.0143**	−0.000833	−0.0136***	−0.0137**	−0.0134**	−0.0134***	−0.0133***
	(0.0052)	(0.00558)	(0.0173)	(0.00528)	(0.00533)	(0.00521)	(0.00515)	(0.00511)
Size	0.121**	0.128**	−0.0183	0.120**	0.128**	0.126**	0.113**	0.131***
	(0.0502)	(0.0526)	(0.195)	(0.050)	(0.0509)	(0.0501)	(0.0503)	(0.0505)
Cashflow	0.0102	0.0125	−0.0366	0.00939	0.00881	0.00863	0.00861	0.00807
	(0.00767)	(0.00868)	(0.106)	(0.00745)	(0.0074)	(0.00736)	(0.00706)	(0.00723)
Dividend paid	0.0023	0.00299	0.189	0.00342	0.00393	0.00497	0.00264	0.00513
	(0.00748)	(0.00789)	(0.128)	(0.00718)	(0.00725)	(0.00704)	(0.00719)	(0.00704)
GIISCORE	−0.0136	−0.0145	−0.0361	−0.0131	−0.0158	−0.0153	−0.00823	−0.0163
	(0.0155)	(0.0165)	(0.0271)	(0.0155)	(0.0157)	(0.0156)	(0.016)	(0.0158)
ROA	0.0250**	0.0279**	−0.0399	0.0260**	0.0265**	0.0266**	0.0260**	0.0247**
	(0.0124)	(0.013)	(0.0647)	(0.0125)	(0.0126)	(0.0125)	(0.0119)	(0.0117)
GDPGRWTH	−0.00281	−0.00261	−0.0167	−0.00254	−0.004	−0.00542	−0.0014	−0.00448
	(0.0123)	(0.0128)	(0.0177)	(0.0123)	(0.0125)	(0.0123)	(0.0121)	(0.0122)
Constant	−1.247**	−1.218*	0.122	−1.155**	−1.236**	−1.195*	−1.181**	−0.987*
	(0.614)	(0.658)	(0.119)	(0.545)	(0.611)	(0.618)	(0.58)	(0.515)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(Continues)

TABLE 4 | (Continued)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AR (1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR (2)	[0.277]	[0.378]	[0.361]	[0.212]	[0.549]	[0.272]	[0.334]	[0.277]
Hansen test	[0.991]	[0.995]	[0.949]	[0.997]	[0.997]	[0.992]	[0.992]	[0.990]

Note: Standard errors are in parentheses, and probability values are in brackets.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.10$.

TABLE 5 | Robustness Checks-I.

Variable	Eco-innovation
Eco Innovation$_{t-1}$	0.926***
	(0.01)
Firm-level political sentiment	0.0015**
	(0.00)
CEO power index	0.648*
	(0.35)
Board size	−2.318
	(1.84)
Leverage	−0.192
	(0.23)
Size	0.96
	(2.02)
Cashflow	1.661
	(1.36)
Dividend paid	−0.632
	(1.29)
GIISCORE	−0.165
	(0.41)
ROA	−0.136
	(0.89)
GDPGRWTH	−0.20
	(0.34)
Constant	2.387
	(1.48)
Industry FE	Yes
Year FE	Yes
AR (1)	[0.000]
AR (2)	[0.555]
Hansen test	[0.101]

Note: Standard errors are in parentheses, and probability values are in brackets.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.10$.

TABLE 6 | Robustness Checks-II.

Variable	RD intensity
RD Intensity$_{t-1}$	0.0296***
	(0.01)
Firm-level political risk	0.00871*
	(0.00)
CEO Power Index	0.0113**
	(0.01)
Board size	−0.0440**
	(0.02)
Leverage	−0.0169*
	(0.01)
Size	0.0259**
	(0.01)
Cashflow	−0.002
	(0.00)
Dividend paid	0.004
	(0.01)
GIISCORE	−0.002
	(0.01)
ROA	−0.0217***
	(0.01)
GDPGRWTH	−0.009
	(0.01)
Constant	−0.020
	(0.03)
Industry FE	Yes
Year FE	Yes
AR (1)	[0.017]
AR (2)	[0.164]
Hansen test	[0.944]

Note: Standard errors are in parentheses, and probability values are in brackets.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.10$.

is marginally significant ($p < 0.10$). This suggests a positive relationship between political sentiment and eco-innovation. In addition, the coefficient of the CEO Power Index (0.039) is positive and significant ($p < 0.05$), indicating that firms with greater CEO power tend to exhibit higher levels of eco-innovation. These results are in line with those in Model (1) of Table 3.

Next, we use R&D intensity as an alternative proxy for eco-innovation. The findings in Table 6 show that the parameter for *PRisk* is significant and positive, suggesting that firm-level political risk is strongly related to R&D intensity. The result implies that firms increase their R&D investments to manage or adapt to firm-level political risks. Furthermore, the CEO Power Index shows a positive and significant coefficient, indicating that higher CEO power is linked to higher R&D intensity. These results support the main findings presented in Table 3.

5 | Conclusion

This study investigates the relationship between firm-level political risk, CEO power, and eco-innovation, contributing to a deeper understanding of how organizations navigate environmental challenges amidst political uncertainty. By addressing the gaps in the existing literature and employing advanced econometric techniques, we have uncovered valuable insights into the mechanisms through which firms manage sustainability initiatives in politically uncertain environments. This research highlights the importance of integrating political risk considerations into the eco-innovation discourse and emphasizes the critical role of CEO power in driving sustainable business practices. By shedding light on these complex interrelationships, we hope to empower businesses and policymakers with the knowledge to navigate environmental challenges and foster a more sustainable and resilient future for organizations and societies.

Our findings reveal the significance of considering firm-level political risk in understanding eco-innovation activities. Despite the growing recognition of the importance of sustainability in business operations, limited attention has been paid to the implications of political risk at the microeconomic level. Firms operating in politically unstable regions must factor political risk into their sustainability strategies to effectively mitigate the negative impacts of such risks. This finding is relevant for any firm that seeks to sustain its operations against political disruptions and climate-related challenges innovatively. Moreover, this highlights the leadership dynamics that drive firms toward sustainable practices, particularly in politically volatile contexts. Understanding how influential CEOs strategically manage such risks may empower firms to forge more potent sustainability strategies.

Furthermore, our findings reveal the moderating influence of CEO power in shaping the relationship between firm-level political risk and eco-innovation, addressing a significant gap in leadership and sustainability literature. Although previous literature has acknowledged the impact of CEO qualities on firm behavior, empirical evidence on the specific moderating effect of CEO power in the context of political risk and eco-innovation has been scarce.

The implications of our research extend beyond theoretical insights to practical considerations for business leaders and policymakers. Strategically, companies need to develop proactive risk management frameworks that incorporate environmental factors alongside political dynamics, particularly in countries where political stability is uncertain. Eco-innovation should be embraced not merely as a reaction to environmental challenges but as a strategic tool to mitigate political risk and achieve sustainable competitive advantage over time. Organizations pursuing sustainability-driven innovation create growth opportunities out of likely risks, aligning their business objectives with societal demands for sustainability.

From a policy perspective, our research highlights that policymakers must intersect political risks with sustainability in developing regulatory frameworks. Policymakers need to make policies that support eco-innovation and mitigate political uncertainty. Governments can offer tax credits for eco-innovative R&D, reduce regulatory uncertainties, and facilitate public–private partnerships to scale eco-innovation activities. These measures will encourage firms to make sustainability a focal area in their strategies.

This study has implications for further research in leadership dynamics, political risks, and sustainability. Future research could also focus on the impact of CEO characteristics, such as diversity or networks, on eco-innovation outcomes. Comparative studies in varied institutional and regulatory contexts can further determine whether these results have global relevance. Additionally, regional factors mediating firm-level political risk and eco-innovation could be explored as crucial determinants in influencing this relationship.

Although this study provides valuable insights, it has some limitations. This paper focuses on firm-level analysis, excluding regional or industry differences. Future research should explore how external institutional factors, such as institutional qualities and cultural differences, influence the relationship between political risk and eco-innovation, along with longitudinal research to understand changes over time in rapidly evolving political contexts.

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Appendix A

Overview of Variables

Variable	Definition	Source
Dependent variable		
Eco-innovation score	An industry-adjusted composite score calculated using a weighted average method (0–100) assesses a firm's ability to mitigate environmental costs and innovate in eco-products.	LSEG
Main variable of interest		
Firm-level political risk	Quantified prevalence of bigrams indicative of political risk in corporate earnings call transcripts, annualized and logged.	Hassan et al. (2019)
Moderating variables		
CEO Power Index	Constructed using PCA, incorporating four variables related to CEO power: CEO duality, CEO tenure, CEO directorship, and the presence of an ex-CEO as board chairperson	LSEG
CEO tenure	The binary variable is coded as 1 if the CEO's tenure is above the sample median, and 0 if it is not.	LSEG
Ex-CEO as board chairperson	The binary variable is coded as 1 if the board's chairperson is a former CEO and 0 otherwise.	LSEG
CEO duality	The binary variable is coded as one if the CEO also holds the position of board chair and 0 if they do not.	LSEG
CEO as a board member	The binary variable is coded as a value of 1 if the CEO is a board member, and 0 if it is not.	LSEG
Control variables		
SIZE	The natural log of total assets	LSEG
ROA	EBIT divided by total assets	LSEG
Leverage	The ratio of total debts to total assets	LSEG
Board size	Total count of board directors	LSEG
Dividend payouts	Cash is distributed as dividends to shareholders.	LSEG
Cashflow	Cash from business operations and investments to total assets	LSEG
Gross domestic product growth	Yearly growth rate of GDP	World Bank (2024)
Global Innovation Index (GII) score	Overall score (0–100) based on 80 indicators covering all areas of innovation	World Intellectual Property Organisation (2024)