

Do Green Mergers and Acquisitions Foster Green Innovation?

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Abstract

This study examines how green mergers and acquisitions (M&As) influence green innovation and how ownership structure, environmental preparedness, and governance quality shape this relationship. Using a comprehensive dataset of publicly listed Japanese firms from 2000 to 2021, we find that green M&A activity significantly enhances the acquiring firm's subsequent green innovation performance. Institutional ownership, especially by foreign investors, strengthens the innovation benefits of green M&A activity, while family ownership weakens this effect. Moreover, the positive relationship between green M&A activity and green innovation is weaker in firms with a poor history of green innovation, while it is stronger among firms with an established green orientation. We also find that the positive effect of green M&A activity on green innovation is more pronounced for firms with greater board independence and gender diversity. These findings contribute to the literature on sustainability, corporate governance, and strategic management by identifying key conditions under which green M&A activity leads to effective environmental transformation.

Keywords: Green mergers and acquisitions; Green innovation; Ownership structure; Absorptive capacity

EFM Classification Codes: 160; 150; 380.

1. Introduction

The accelerating urgency of climate change and the global transitions toward a low-carbon economic system have pushed firms to adopt strategies that meaningfully enhance their environmental performance. As environmental regulation intensifies and stakeholders demand credible sustainability actions, corporations increasingly turn to green mergers and acquisitions (M&As) as a mechanism for acquiring environmentally oriented firms, clean technologies, and green capabilities. Unlike conventional M&As, where value creation often hinges on financial or operational synergies, green M&A activity explicitly targets environmental assets, raising important questions about how effectively firms can translate strategic transactions into sustained green innovation.

A large body of research shows that M&As can both foster and hinder innovation, depending on knowledge complementarities, absorptive capacity, and technological relatedness (Ahuja and Katila, 2001; Cassiman et al., 2005; Cloudt et al., 2006). More recent work integrating sustainability and corporate finance perspectives further demonstrates that acquiring firms with strong environmental or corporate social responsibility (CSR) practices can achieve superior post-M&A outcomes when environmental capabilities are effectively absorbed and integrated (Aktas et al., 2011; Deng et al., 2013; Eccles et al., 2014). Despite these insights, systematic empirical evidence on whether green M&A activity enhances acquiring firms' green innovation performance remains limited, and existing findings appear highly context-dependent.

A critical yet underexplored factor shaping the success of green M&A activity is ownership structure, which influences how effectively firms integrate and capitalize on acquired environmental capabilities. Ownership types differ in their monitoring strength, time horizon, risk tolerance, and access to external knowledge, each of which plays a central role in post-M&A innovation performance. For instance, institutional investors are widely shown to promote CSR adoption, long-term strategic investments, and green innovation by aligning managerial incentives and enhancing oversight (Aghion et al., 2013; Dyck et al., 2019). These investors may also help firms navigate the complexities of post-M&A integration, particularly when environmental capabilities are tacit and require strategic

alignment. In contrast, family ownership tends to be characterized by a greater emphasis on control, legacy, and socioemotional wealth preservation, which are factors that often correlate with risk aversion and reluctance toward uncertain, long-term environmental investments (Gómez-Mejía et al., 2007; Chrisman and Patel, 2012). Such firms may pursue symbolic rather than substantive green strategies or underinvest in post-M&A integration processes, thereby limiting green innovation realization.

Existing studies have also largely overlooked how firm heterogeneity conditions the effectiveness of green M&A activity in translating into green innovation outcomes. Two factors that stand out as particularly influential are the acquiring firm's green capabilities and its environmental, social, and governance (ESG) orientation. Firms with strong green capabilities, such as eco-friendly technologies, sustainability-oriented human capital, and robust environmental management systems, are better equipped to absorb, integrate, and leverage environmental knowledge and resources of the target firm, thereby enabling meaningful post-M&A green innovation (Russo and Fouts, 1997; Dangelico and Pujari, 2010). In contrast, green underperforming firms, often characterized by weak environmental records, limited absorptive capacity, and short-term oriented leadership, face structural and organization barriers that hinder the realization of innovation benefits from green M&A activity (Yang and Chi, 2023; Chen et al., 2025; Li et al., 2025). Complementing this capability lens, the acquiring firm's ESG orientation also plays a pivotal role. ESG-committed firms not only display stronger internal systems and stakeholder alignment but also demonstrate greater strategic preparedness in identifying suitable green targets, integrating environmental assets, and structuring transactions effectively (Gordano et al., 2024; Gu et al., 2025).

Japan represents a particularly compelling context in which to examine the effectiveness of green M&A strategies the role of corporate governance. The country combines a technologically sophisticated industrial base and mounting environmental policy pressures. It also has a unique ownership and governance landscape, marked by the strong presence of domestic financial institutions, rising foreign institutional participation, and a persistent prevalence of family-controlled firms.

particularly, in the existing studies, little is known about how ownership structure, green capabilities, and governance orientations condition the innovation outcomes of green M&A activity. The joint influence of institutional versus family ownership, as well as internal environmental preparedness, remains theoretically and empirically underexplored. To fill this gap, this study investigates whether green M&A activity enhances firms' subsequent green innovation performance, and how ownership structure, green capabilities, and ESG orientation condition this relationship. Drawing on a novel hand-collected sample of green M&A events in Japan from 2000 to 2021, combined with detailed patent-based green innovation measures and firm-level characteristics, we provide robust empirical evidence on the governance conditions under which green M&A activity generates meaningful environmental innovation.

The empirical findings offer several important insights. First, green M&A activity is found to significantly enhance firms' subsequent green innovation performance, suggesting that acquiring environmentally oriented assets and capabilities can materially improve firms' technological development. Second, this positive effect is significantly strengthened by institutional ownership, particularly by foreign institutional investors, whose global expertise and monitoring capacity appear to support more effective post-M&A integration and capability development. These results are consistent with prior evidence highlighting the role of institutional investors in fostering innovation-oriented strategies (Bushee, 1998; Kim et al., 2025). In contrast, family ownership dampens the innovation benefits of green M&A activity, echoing behavioral agency theory and empirical evidence on family firms' heightened risk aversion and reluctance to engage in uncertain innovation (Wiseman and Gomez-Mejia, 1998; Sirmon and Hitt, 2003).

Third, firms with historically low green innovation outputs (i.e., green underperformers) derive weaker innovation benefits from green M&A activity, consistent with absorptive capacity theory (Cohen and Levinthal, 1990). Such firms may lack the foundational technological knowledge and organizational preparedness needed to assimilate and exploit newly acquired green assets. Conversely, firms with strong ESG orientation experience enhanced innovation gains from green M&A activity.

ESG-committed firms are not only more likely to initiate green M&A transactions but also possess the complementary managerial systems and stakeholder alignment necessary to translate green M&As into innovation outcomes (Gu et al., 2025). Fourth, the analysis reveals that strong board governance structures, particularly greater board independence and gender diversity facilitate the realization of innovation benefits from green M&A activity. Additional analyses further show that the positive effect of green M&A activity is amplified for firms with higher absorptive capacity and those operating in technology-rich sectors. Meanwhile, we reveal a trade-off that while markets reward green M&A activity, innovation-related integration costs may temporarily reduce profitability, emphasizing the short-term trade-offs inherent in environmental strategic investments.

Overall, the study demonstrates that ownership structure, green capabilities, and governance orientation are decisive factors in determining whether firms can transform green M&A activity into genuine green innovation. By providing new evidence from Japan, this study contributes to a deeper understanding of the institutional and strategic contingencies underlying green transformation through M&A activity.

2. Literature review and hypothesis development

2.1. Green M&A activity and green innovation performance

M&As have long been recognized as strategic instruments for corporate growth, resource acquisition, and capability renewal. Beyond financial motives, M&As facilitate the transfer of technological and organizational knowledge, thereby influencing firms' innovation performance. In recent years, growing attention has been paid to M&As aimed at sustainability objectives, so-called green M&A activity, referring to acquisitions targeting environmentally oriented firms, clean technologies, or green capabilities. A central question is whether and how green M&A activity enhances acquiring firms' green innovation, a topic that intersects corporate finance, strategic management, and environmental economics.

The innovation implications of M&A activity have been extensively explored. Early studies

emphasize knowledge complementarity and absorptive capacity. Ahuja and Katila (2001), using data from the chemical industry, find that technological acquisitions enhance innovation when the absolute size of the acquired knowledge base is large, but that relative size can reduce innovation. They also show that technological relatedness exhibits a nonlinear effect, underscoring the importance of both similarity and complementarity. Bena and Li (2014) extend this idea in a corporate finance context, showing that acquirers with technological linkages to targets experience significantly greater post-acquisition patenting. Cloudt et al. (2006) report that non-technological acquisitions often reduce innovation, while outcomes of technological M&As depend on knowledge base size and relatedness. At a broader industry level, Bertrand and Zuniga (2006) find that M&As have limited aggregate effects on R&D investment across OECD countries, though the impact differs between domestic and cross-border deals. Cassiman et al. (2005) further highlight that technological and market-relatedness between acquirer and target significantly affects both R&D inputs and outputs. Together, these studies suggest that the innovation outcomes of M&A activity hinge on strategic fit, knowledge synergies, and acquisition type.

Building on this foundation, more recent work has explored how M&A activity interacts with CSR and sustainability. Aktas et al. (2011) show that acquiring targets with strong environmental and social practices enhances acquirers' post-M&A CSR profiles. Deng et al. (2013) report that high-CSR acquirers achieve higher announcement returns, superior long-run operating performance, and lower merger failure rates, emphasizing CSR as a strategic asset in M&As. Eccles et al. (2014) provide further evidence that high-sustainability firms develop superior organizational capabilities that translate into long-term performance gains. Within this context, cross-border M&As have emerged as a key vehicle for acquiring green knowledge. For example, Li (2022) finds that technology-oriented cross-border M&As significantly enhance green innovation in Chinese firms, with effects moderated by ownership concentration, political connections, and institutional distance. These findings broadly align with the Porter Hypothesis (Porter and van der Linde, 1995), which posits that well-designed environmental regulation can spur innovation rather than hinder competitiveness.

In summary, the extant literature converges on three key insights: (1) technological M&As enhance innovation when knowledge bases are complementary, though effects vary by scale and relatedness; (2) integrating CSR and sustainability considerations into M&A strategy improves legitimacy and innovation outcomes; and (3) specific forms of M&A activity, such as cross-border and green M&A activity offers access to unique environmental capabilities that support green innovation, particularly under favorable financial, organizational, and institutional conditions. Based on these insights, we propose our baseline hypothesis:

H1: Green M&A activity positively affects the green innovation performance of acquiring firms.

2.2. Ownership structure in the innovation effects of green M&A activity

2.2.1. Institutional ownership

Institutional ownership serves as an important external governance mechanism that can enhance firms' ability to translate green M&A activity into meaningful green innovation. Institutional investors provide governance expertise, monitoring, and long-term capital, which can enhance managerial accountability, mitigate agency problems, and support the integration of environmentally oriented technologies. Through these channels, institutional ownership has the potential to strengthen the innovation benefits derived from green M&As.

A large body of research links institutional ownership to enhanced innovation outcomes. Aghion et al. (2013) show that institutional investors reduce CEOs' career concerns and encourage long-term R&D engagement, while Chemmanur et al. (2014) demonstrate that sophisticated investors (e.g., corporate venture capitalists) improve firms' ability to pursue productive innovation by supplying monitoring and industry expertise. Institutional investors also shape acquisition decisions and outcomes. Fang et al. (2014) highlight that institutional monitoring offsets the innovation-detering effects of stock liquidity, and Kim et al. (2025) find that institutional ownership increases the likelihood of stock-for-stock deals that mitigate information asymmetry and improve post-acquisition

performance. Foreign institutional investors, in particular, enhance cross-border deal quality through governance substitution and lower transaction costs (Chen et al., 2007; Ferreira et al., 2010).

Theoretical mechanisms suggest three ways in which institutional ownership should positively moderate the innovation effects of green M&A activity. First, institutional monitoring enforces strategic alignment and reduces the risk that firms engage in symbolic or greenwashing-oriented acquisitions. Second, institutional investors signal credibility to capital markets, improving financial conditions for post-M&A innovation investments (Aghion et al., 2013; Chemmanur et al., 2014). Third, their long-term orientation supports environmentally oriented strategies whose yield benefits materialize gradually (Fang et al., 2014). Evidence from CSR and sustainability literature reinforces this view. Dyck et al. (2019) document that institutional investors improve firms' global environmental and social performance, and Wang and Li (2024) show that CSR engagement enhances post-merger outcomes.

Additional insights come from the Asian context, especially from China, which provides extensive evidence on how institutional ownership interacts with environmental strategies. Studies find that institutional ownership improves internal control, eases financing constraints, and facilitates the diffusion of green innovation within ownership networks (Ding, 2023). Other work shows that institutional investors amplify the innovation effects of green M&As when supported by complementary policy forces, such as subsidies, environmental pressure, or tax reforms (Liang et al., 2022). Nevertheless, some caution that concentrated institutional ownership may constrain green transformation under certain competitive conditions (Zhou and Chen, 2025). While institutional settings differ across countries, these studies collectively illustrate how institutional investors can affect the innovation outcomes following environmentally oriented acquisitions. Based on these arguments, we propose the following hypothesis:

H2a: Higher institutional ownership strengthens the positive relationship between green M&A activity and firms' subsequent green innovation.

2.2.2. Family Ownership

Family ownership, by contrast, shapes firm behavior and innovation outcomes through internally oriented governance priorities and socioemotional considerations. Unlike nonfamily firms, family-controlled firms pursue both financial returns and the preservation of socioemotional wealth, which includes maintaining family control, legacy, and identity (Gómez-Mejía et al., 2007). Behavioral agency theory posits that this dual objective can lead to both risk aversion and risk-taking, depending on whether strategic actions protect or threaten these non-economic goals. Classic evidence from long-lived family firms shows that family firms carefully balance risk in ways that preserve both performance and control. While this long-term orientation encourages stability, it also fosters cautious investment behavior, often leading family firms to invest less in innovation unless economic and family goals are well aligned (Wiseman & Gómez-Mejía, 1998). Consistent with this view, Chrisman and Patel (2012) show that family-controlled S&P 1500 firms are less willing to engage in high-risk innovative activities, including sustainability-related initiatives.

In the context of green innovation, empirical studies report mixed effects of family ownership. Li (2022) finds that in technology-oriented cross-border M&As, family ownership can facilitate green innovation by enabling long-term strategic commitment and leveraging concentrated control. Similarly, Ding (2023) reports that family firms with supportive institutional investors are more likely to pursue green M&A activity and ultimately achieve higher environmental innovation. However, now all evidence points to positive effects. Yang et al. (2022) document a U-shaped relationship between family ownership and green innovation, indicating that although very low and very high levels of family ownership may be beneficial, moderate levels constrain innovation. This nuanced relationship underscores the importance of ownership concentration and governance structures in shaping innovation outcomes. Moreover, family firms may also encounter structural barriers that constrain innovation. High family ownership often results in greater control concentration, reduced external oversight, and limited managerial diversity, which in turn weakens absorptive capacity and hinders the effective integration of external knowledge (Sirmon and Hitt, 2003). These limitations are especially

salient in the control of green M&A activity, which typically requires integration of unfamiliar technologies, reconfiguration of resources, and greater openness to external change. While M&As have the potential to drive innovation through technology transfer and knowledge recombination (Ahuja and Katila, 2001), family-controlled firms may struggle to fully realize these gains due to their conservative governance style and strong control motives. Based on this reasoning, we propose the following hypothesis:

H2b: Higher family ownership mitigates the positive relationship between green M&A activity and firms' subsequent green innovation.

2.3. Firm heterogeneity in the innovation effects of green M&A activity

2.3.1 Green capabilities of the acquiring firm

The environmental performance of the acquiring firm is a critical determinant of the effectiveness of green M&A activity. Firms with well-developed green capabilities, such as eco-friendly technologies, sustainability-oriented human capital, and established environmental management systems, are better positioned to absorb and integrate the environmental resources, knowledge, and technologies of the target firm to drive subsequent green innovation (Russo and Fouts, 1997; Dangelico and Pujari, 2010). From a resource-based perspective, green M&A activity involves not only tangible assets but also intangible environmental capabilities that must be strategically combined to enhance innovation outcomes. In contrast, firms with poor environmental performance, limited sustainability practices, or weak green reputations (i.e., green underperforming acquirers) often face substantial internal barriers that constrain the realization of innovation benefits from green M&A activity. These green underperformers typically lack the absorptive capacity, managerial attention, and strategic alignment necessary to integrate newly acquired environmental assets.

Recent empirical evidence highlights the conditional nature of green M&A effectiveness for underperforming firms. Li et al. (2025) find that firms with weak prior green performance tend to undertake green M&A activity primarily in response to external pressures, such as retail investor ESG

engagement or government green subsidies, which serve as enabling mechanisms for post-acquisition green innovation. Other studies underscore structural limitations among green underperformers. Yang and Chi (2023) argue that green M&A activity may enhance the legitimacy of polluting firms in the eyes of external stakeholders, but tends to be less effective than internally driven innovation in facilitating authentic green transformation. Managerial traits also play a role. Chen et al. (2025) show that managerial myopia significantly lowers the likelihood of engaging in green M&A activity, especially among underperforming, high-polluting firms, indicating that short-term-oriented leadership undermines strategic environmental decisions. In addition, Hussain and Kumar (2025) demonstrate that acquirers with strong green credentials gain more from acquiring targets with lower information asymmetries, a structural advantage that green underperforming firms often lack due to governance weakness and limited market signaling.

Taken together, these arguments suggest that the relationship between green M&A activity and post-acquisition green innovation is shaped by the acquiring firms' internal capabilities and strategic preparedness. However, green underperformers often face unique challenges that internally limit their ability to absorb and develop the environmental assets of acquired firms. Thus, we propose the following hypothesis:

H3a: The positive effect of green M&A activity on subsequent green innovation is diminished when acquiring firms have historically underperformed in green innovation

2.3.2. ESG orientation of the acquiring firm

A firm's ESG orientation is a key determinant of how effectively green M&A activity translates into innovation outcomes. Acquiring firms with strong ESG profiles typically possess the internal systems, managerial commitment, and stakeholder alignment necessary to integrate environmentally focused assets. As such, ESG orientation influences not only the decision to engage in green M&A activity but also the firm's capacity to achieve meaningful post-acquisition innovation gains.

Recent studies highlight the importance of ESG compatibility between acquirers and targets. Tang

et al. (2024) find that larger ESG distances, where the acquirer's ESG performance is substantially lower than the target's, are associated with lower cumulative abnormal returns and higher long-term crash risk. This indicates that ESG misalignment undermines post-merger value creation and complicates integration. Similarly, Just et al. (2023) show that while high-ESG acquirers may close deals more efficiently, inconsistencies in ESG practices can still compromise performance, limiting the realization of long-term synergies.

Beyond integration challenges, ESG orientation also influences acquisition strategy and deal structuring. Gordano et al. (2024) find that ESG-strong acquirers are more likely to target smaller firms, rely on cash transactions, and complete deals more swiftly. These findings suggest that ESG leaders approach M&As with more strategic intent and greater capability for integration. Strategic reputation effects also matter. Gu et al. (2025) report that ESG-oriented firms are more likely to pursue green M&As when peer firms do so, reflecting a desire to maintain or enhance sustainability standing. These peer effects increase the likelihood of strategic, innovation-focused M&A activity among ESG-leading firms. Financial incentives further intersect with ESG profiles. Ezenwa et al. (2025) find that high-ESG acquirers tend to pay higher premiums for green targets, although their premiums do not consistently lead to superior financial returns. This underscores the importance of post-acquisition ESG capability transfer and integration in achieving innovation benefits.

In summary, these findings suggest that ESG orientation enhances both the strategic execution and post-acquisition innovation potential of green M&As. Accordingly, we propose the following hypothesis:

H3b: The positive effect of green M&A activity on green innovation is strengthened when the acquiring firms are oriented toward ESG.

2.4. Corporate governance in the innovation effects of green M&A activity

The transition toward sustainable development has positioned corporate governance, particularly the characteristics of board members and executive leadership, as a central determinant of firms'

environmental strategies and innovation outcomes.

Among these characteristics, board independence is widely recognized as a key mechanism that strengthens oversight, disciplines managerial decisions, and supports long-term strategic decision-making. Empirical research consistently shows that independent directors promote superior environmental and innovation outcomes by providing objective monitoring and reducing managerial opportunism (Zhao and Jia, 2022). In the context of green M&A activity, independent boards are more likely to ensure that environmental commitments are implemented substantively rather than adopted for symbolic purposes. Evidence across countries further shows that board independence acts not only as a disciplinary tool but also as a strategic facilitator. By leveraging professional expertise and external networks, independent directors improve firms' ability to access relevant information, evaluate technological and operational synergies, and reduce information asymmetry in environmentally focused acquisitions (Hussain and Kumar, 2025).

These findings suggest that board independence strengthens both the initiation and execution phases of green M&A transactions, thereby enhancing their potential to generate meaningful green innovation. Independent boards improve information quality, align managerial incentives, and safeguard environmental objectives during complex transactions, such as green M&As. Moreover, they help moderate the adverse effects of managerial self-interest, ESG ambiguity, and governance instability, ensuring that innovation outcomes derived from green M&A activity are substantive, credible, and sustainable.

In parallel, an emerging literature highlights the role of gender diversity in executive leadership, particularly the presence of female CEOs, in shaping firms' environmental strategies and innovation capacity. Female executives are often associated with stronger ethical orientations, greater stakeholder sensitivity, and more cautious but principled risk-taking. These traits are especially relevant for green M&A activity, which involves complex, long-term environmental commitments and elevated uncertainty. For instance, Rehman et al. (2024) show that female CEOs strengthen the relationship between environmental knowledge management and corporate environmental performance by

fostering learning-oriented organizational cultures. Similarly, Li and Maqsood (2025) find that female CEOs improve post-M&A environmental performance by facilitating more disciplined integration and monitoring of acquired capabilities. Other studies demonstrate that gender-diverse leadership teams are more likely to adopt contractual mechanisms that reduce information asymmetry and post-acquisition opportunism, thereby improving the quality and accountability of M&A governance (Luo and Zhou, 2025). At a broader governance level, Liu et al. (2024) identify an inverted U-shaped relationship between top management team gender diversity and green innovation, suggesting that moderate diversity enhances cognitive balance and problem-solving while minimizing coordination frictions.

These studies suggest that female CEOs and gender-diverse leadership structures strengthen the innovation potential of green M&A activity. By enhancing transparency, promoting stakeholder-aligned decisions, and improving post-M&A integration, gender diversity contributes to transforming green M&As into meaningful environmental outcomes.

Building on these arguments, we posit that the relationship between green M&A activity and green innovation is contingent on the acquirers' corporate governance quality. Firms with greater board independence and gender diversity are more likely to realize the innovation benefits of green M&A activity. We, therefore, propose the following hypothesis:

H4: The positive effect of green M&A activity on green innovation is more pronounced in firms with greater board independence and gender diversity

3. Data, variables, and methodology

3.1. Data

Our initial sample comprises all publicly listed Japanese firms between 2000 and 2021, sourced from the Development Bank of Japan (DBJ) dataset. We begin in 2000, as this period marks the onset of increased environmental awareness in Japan and coincides with improved coverage of firm-level innovation and M&A transactions records in major databases. The sample period ends in 2021 to allow

sufficient time for innovation outcomes to materialize following M&A events.

Following prior studies (e.g., Lawrence et al., 2024; Hussain and Kumar, 2025), we identify M&A transactions from the Thomson Financial SDC Platinum M&A Database. We apply several filters to construct our sample: (1) excluding transactions where the acquiring firm is not a publicly listed Japanese firms; (2) excluding firms in the financial and utility sectors due to their regulated nature; (3) excluding deal types such as leveraged buyout, spin-offs, re-capitalizations, self-tender offers, exchange offers, and privatization; (4) retaining transactions only marked as completed; (5) excluding deals with a transaction value below USD one million; and (6) excluding transactions with missing key information. Applying these criteria yields an initial sample of 6,228 M&A transactions, which we then identify whether they are green M&As and match to the firm-year level sample.

Innovation data are obtained from the Institute of Intellectual Property (IIP) patent database. Fundamental firm-level and accounting information is sourced from the DBJ dataset, while stock market-related data are supplemented using the NEEDS-FinancialQUEST and NPM databases. To maintain consistency, we again exclude firms in the financial and utility sectors at the firm-year level. After removing firm-year observations with missing data, the final dataset consists of 46,518 firm-year observations. All continuous variables are winsorized at the 1% and 99% levels to mitigate the influence of outliers.

3.2. Variables

3.2.1. Green innovation

Following Goto and Motohashi (2007) and Kato et al. (2022), we construct our innovation measures using data from the IIP patent database, which contains all patents filed with the Japan Patent Office since 1964, encompassing over nine million entries in its 2024 edition. In line with recent studies on green innovation (e.g., Han et al., 2024; Block et al., 2025), we identify green innovation by matching International Patent Classification (IPC) codes with two benchmark classification schemes. Specifically, as the primary classification, we adopt the Green Transformation Technologies

Inventory (GXTI) published by the Japan Patent Office, which reflects Japan-specific environmental policy priorities.¹ For robustness, we also use the IPC Green Inventory published by the World Intellectual Property Office (WIPO), which ensures comparability with global standards.

Consistent with standard practice in patent-based innovation research (Griliches et al., 1986), we use the application date rather than the grant date to more accurately capture the timing of the innovation activity. Our main measure, *Green innovation*, is defined as the natural logarithm of one plus the total number of green patent applications filed by a firm in a given year. In all regressions, we lag this measure by one year (i.e., use the $t+1$ value) to reduce reverse causality concerns.

3.2.2. Green M&A activity

To identify green M&A activity, we adopt a text analysis to analyze the M&A announcements of listed firms, consistent with Li et al. (2025) and Wang et al. (2025). We conduct a comprehensive analysis of the disclosed purpose and background of the deal, as well as the business scope of the target firms. An M&A is classified as “green” if the text contains environmental-related keywords such as “clean”, “emission reduction”, “recycling”, or “sustainability”.²

We construct three variables to capture the intensity of green M&A activity. First, *Green M&A dummy* is a dummy variable equal to one if the firm engaged in at least one green M&A transaction in a given year, and zero otherwise. Second, *Green M&A count* measures the number of green M&A transactions per firm-year and is defined as the natural logarithm of one plus the count. Third, *Green M&A value* represents the total value (in USD) of green M&A transactions per firm-year, again transformed using the natural logarithm of one plus the aggregate value.

¹ The GXTI provides a comprehensive classification of technologies related to green transformation. It covers five major technology domains (i.e., energy supply, energy demand, energy storage, CO₂ reduction in non-energy sectors, and the capture, storage, utilization, and removal of greenhouse gas) and four transversal perspectives (i.e., control, measuring, business, and ICT). For details, see: <https://www.jpo.go.jp/e/resources/statistics/gxti-gaiyo.html>.

² To classify green M&A transactions, we searched for environmental-related keywords in M&A announcement texts. The keywords include: “carbon”, “circulation”, “clean”, “dust removal”, “ecological”, “ecology”, “emission reduction”, “energy”, “environment”, “flue gas”, “garbage”, “green”, “new materials”, “pollution”, “protection”, “pulp and paper”, “recycling”, “regeneration”, “resource conservation”, “saving”, “sewage”, “sustainability”, “sustainable”, “transformation”, and “waste”.

3.3. Methodology

To empirically examine the relationship between green M&A activity and green innovation, we estimate the following baseline regression model:

$$\begin{aligned} & \text{Green innnovation}_{i,t+1} \\ &= \alpha_0 + \beta_1 \text{Green M\&A}_{i,t} + \sum \beta_j \text{Controls}_{i,t} + \text{Industry FE} + \text{Year FE} + \varepsilon_{i,t}, \end{aligned} \quad (1)$$

where the dependent variable, $\text{Green innnovation}_{i,t+1}$, denotes the number of green patent applications filed by firm i in year $t+1$, capturing green innovation outcomes in the period following green M&A activity. The key explanatory variable, $\text{Green M\&A}_{i,t}$ reflects green M&A activity and is alternatively measured using a binary indicator (*Green M&A dummy*), the count (*Green M&A count*), and the total value (*Green M&A value*). $\text{Controls}_{i,t-1}$ is a vector of firm-level control variables. *Industry FE* and *Year FE* represent industry and year fixed effects, respectively. The error term is denoted by $\varepsilon_{i,t}$.

We include a comprehensive set of firm-level control variables, consistent with prior research, to account for firm characteristics that may influence green innovation outcomes. *Firm size* is measured as the natural logarithm of total assets, and *Firm age* is defined as the natural logarithm of one plus the number of years since the firm's founding (Tawiah et al., 2024). *Leverage*, calculated as the ratio of total debt to total assets, is included to capture financial constraints (Hu et al., 2024). *Slack*, measured by the ratio of current assets to current liabilities, proxy for internal flexibility and the firm's ability to undertake exploratory innovation (Wadhwa et al., 2016). *Cash holdings* is measured as the ratio of cash and cash equivalents to total assets, capturing liquidity (Bai et al., 2024). We control for reinvestment intensity using *Capital expenditure*, calculated as the sum of annual changes in fixed assets plus depreciation, scaled by total assets (Mobbs et al., 2021). To proxy for growth opportunities and profitability, we include sales growth, Tobin's Q , and ROA (Han et al., 2024). Sales growth is the percentage change in sales. *Tobin's Q* is computed as the sum of the market value of equity and the book value of liabilities, divided by the book value of total assets. *ROA* is calculated as net income

divided by total assets. To account for knowledge-based capabilities, we include *R&D expenditure*, measured by the ratio of R&D expenses to total assets. Following Koh and Reed (2015), we also include an *R&D dummy* to indicate non-missing R&D values, mitigating potential biases from missing R&D disclosures. All regressions include industry and year fixed effects to unobservable time-invariant and macro-level influences. Standard errors are clustered at the firm level to correct for within-firm serial correlation. Detailed definitions of all variables used are provided in Appendix A.

4. Results

4.1. Descriptive statistics

Table 1 presents the temporal distribution of green innovation and green M&A activity. In Panel A, we observe that, at the firm-year level, a total of 425,398 green innovations were filed during the sample period, accounting for 12.1% of the 3,527,297 total innovations. The share of green innovation relative to total innovation has remained broadly stable between 11% and 13% since 2005. A similar trend is visible in Figure 1a, where the share of green innovations remains consistently high after 2004, despite a declining trend in the absolute number of green innovations. Panel B of Table 1 presents the deal-level distribution of M&A transactions. Among the 6,228 M&A transactions conducted by sample firms, 1,170 (or 18.8%) are classified as green. However, the total deal value of these green M&As (USD 22,415.1 million) accounts for just 6.8% of the total M&A transaction value (USD 330,327.9 million). This discrepancy suggests that, while green M&As are relatively common in number, they represent a smaller proportion of the overall M&A market in terms of size. This observation is further illustrated in Figures 1b and 1c, which show the annual trends in the count and deal value of green M&As, as well as their respective proportions of total M&A activity.

Insert Table 1 and Figure 1 about here

Table 2 presents descriptive statistics for the main variables used in the regression analyses. On average, firms file 3.416 green innovations in the year following the observation year. For green M&A-related variables, the mean values of *Green M&A dummy*, *Green M&A count*, and *Green M&A value*

are 0.021, 0.025, and 5.791, respectively. In terms of firm characteristics, the average *Firm size* amounts to 147.433 billion yen, and the average *Firm age* is 53 years. The mean *Leverage* ratio is 0.483, the *Slack* ratio is 2.088, the *Cash holdings* ratio is 0.127, and *Capital expenditure* accounts for 8.7% of total assets. Firms report an average *Sales growth* of 2.6%, a *Tobin's Q* of 0.817, and an *ROA* of 0.022. Regarding R&D, the average *R&D expenditure* ratio is 0.006, and the mean of the *R&D dummy* is 0.019. We report the Pearson correlation coefficients for key variables in Appendix B. No correlation coefficient among control variables exceeds 0.5, indicating that multicollinearity is unlikely to be a major concern in our empirical model.

To further explore sample heterogeneity, we divide the sample into two subsamples based on green M&A activity. The green M&A subsample includes 969 observations, while the non-green M&A subsample comprises 45,549 observations. The mean number of green innovations is substantially higher in the green M&A subsample (16.825) compared to the non-green M&A subsample (3.131). Statistically significant differences are also observed across most control variables (except the R&D dummy). Specifically, firms engaging in green M&As tend to have larger size, be older, show higher leverage, capital expenditures, sales growth, Tobin's Q, ROA, and R&D intensity. In contrast, the non-green M&A subsample reports significantly higher levels of slack and cash holding.

Insert Table 2 about here

4.2. Baseline results

Table 3 presents the results from Eq. (1), which examines the relationship between green M&A activity and subsequent green innovation. To ensure robustness, we first present the models without control variables in Columns (1) to (3), followed by the full specification including all control variables in Columns (4) to (6). Across all columns, the coefficients on green M&A variables are positive and statistically significant at the 1% level, providing consistent evidence that green M&As are positively associated with green innovation. In Column (4), the coefficient on the *Green M&A dummy* is 0.241, suggesting that firms conducting green M&A transactions experience significantly more green

innovation in the following year. Economically, this corresponds to approximately 24.1% higher green innovation output (in natural logarithm) relative to comparable firms without green M&A activity. This magnitude represents roughly 27.5% of the sample standard deviation ($0.241/0.876$), implying a meaningful economic effect. Columns (5) and (6) extend the analysis using the *Green M&A count* and *Green M&A value* as continuous measures of green M&A activity. The coefficients are 0.348 and 0.090, respectively, and both are significant at the 1% level. These results imply that firms engaging in more frequent or larger green M&A transactions generate higher levels of green innovation in the following year. Specifically, a one standard deviation increase in the green M&A count leads to a 3.5% ($\exp(0.348 \times 0.099) - 1$) increase in green innovation output (in natural logarithm), accounting for 17.2% of the sample mean. Similarly, a one standard deviation increase in the green M&A value corresponds to a 3.7% ($\exp(0.090 \times 0.407) - 1$) increase in green innovations (in natural logarithm), equivalent to approximately 18.3% of the sample mean. Collectively, these findings support H1, indicating that green M&A activity has a positive influence on the acquiring firm's subsequent green innovation performance.

Insert Table 3 about here

4.3. Robustness tests

4.3.1. Endogeneity concerns

4.3.1.1. Propensity score matching. To address potential endogeneity arising from selection bias, we first employ a propensity score matching (PSM) procedure. This approach allows us to mitigate differences in observable characteristics between firms that conduct green M&As (treatment group) and those that do not (control group). Specifically, we define the treatment group as firm-year observations in which at least one green M&A transaction is conducted, and the control group as observations with no green M&A activity. We estimate propensity scores using a logit model that includes all control variables from Table 3. Firms in the treatment group are matched to those in the control group using the one-to-one nearest-neighbor matching with replacement. The results of the

first-stage logit model are presented in Column (1) of Appendix C. This procedure yields 969 matched pairs.

Panel A of Table 4 compares the mean differences in variables between the treatment and control groups after matching. The lack of statistically significant differences across covariates confirms the matching procedure achieves balance between the two groups. We then re-estimate Eq. (1) using the matched sample and report the results in Columns (1) to (3) of Panel C. The coefficients on all three green M&A variables remain positive and statistically significant, reinforcing the validity of our baseline findings.

4.3.1.2. Entropy balancing. As an additional robustness check, we employ entropy balancing, a reweighting technique that achieves covariate balance by adjusting the weights of control observations to match the treatment group on the first three moments (i.e., mean, variance, and skewness) of each covariate (Hainmueller, 2012). This method offers improved balance while minimizing sample loss. In our context, we use entropy balancing to ensure covariate comparability between firms engaging in green M&As (treated group) and those that do not (control group) based on all control variables.

Panel B of Table 4 presents the moments of the covariates before and after balancing. The reweighted sample is then used to re-estimate Eq. (1) with the results reported in Columns (4) to (6) of Panel C. The estimated coefficients on three green M&A variables continue to be positive and statistically significant, confirming the robustness of the main results to alternative matching techniques.

4.3.1.3. Heckman two-stage regression. We further employ Heckman's (1979) two-stage regression model to examine whether the observed effect of green M&A activity on green innovation may be driven by sample selection bias. Specifically, we address the concern that firms engaging in green M&As may systematically differ from others, particularly if firms with prior M&A experience are typically more capable of undertaking subsequent M&As, including green ones. In the first-stage

probit regression, the development variable is the *Green M&A dummy*, capturing the likelihood of a firm engaging in green M&A activity in a given year. In addition to the full set of control variables from the baseline regression, we include an instrumental variable that is correlated with the green M&A participation but uncorrelated with post-transaction green innovation output, except through its influence on the treatment. As our instrument, we use *Prior non-green M&A experience*, a dummy variable equal to one if a firm has engaged in at least one non-green M&A transaction in the past, and zero otherwise. This variable captures a firm's prior M&A capability and experience, which is expected to influence green M&A participation but not directly affect green innovation unless through the green M&A itself.

The first-stage regression results are reported in Column (2) of Appendix C. As expected, the coefficient on *Prior non-green M&A experience* is positive and statistically significant, supporting its relevance as an instrument. We then re-estimate Eq. (1) in the second stage, including the Inverse Mills Ratio (*IMR*) calculated from the first stage, and present the results in Columns (7) to (9) of Table 4, Panel C. The coefficients on all three green M&A variables remain positive and statistically significant, consistent with our baseline findings. *IMR* term is positive and significant at the 10% level in the models using *Green M&A dummy* and *Green M&A count*, suggesting the presence of selection bias. Nonetheless, the continued significance of the green M&A effect even after correcting for selection bias reinforces the robustness of our main findings.

4.3.1.4. Event-study analysis: Dynamic effect. To further address the potential endogeneity and explore the timing of the effects, we conduct an event-study of the dynamic treatment effect of green M&As on green innovation. We begin with a baseline difference-in-differences (DiD) framework using a static treatment indicator. Specifically, we defined *Treated* as an indicator variable equal to one in all years from (and including) the year of a firm's first green M&A onward, and zero otherwise. As shown in Column (10) of Table 4, Panel C, the coefficient on *Treated* is positive and statistically significant at the 1% level, suggesting that firms exhibit higher levels of green innovation following

their initial green M&A transaction.

To examine the dynamic effect more precisely, we construct a set of event-time indicators covering the period from four years before to four years after a firm's first green M&A transaction. The year immediately preceding the transaction ($\tau = -1$) is omitted and serves as the reference period. Figure 2a plots the estimated coefficients and 95% confidence intervals. The estimates show no significant differences in green innovation trends prior to the green M&A, suggesting the absence of pre-trend bias. In contrast, post-treatment coefficients become significantly positive, supporting a sustained increase in green innovation following green M&A activity. The insignificant estimate for the treatment year ($\tau = 0$) may reflect the time lag required for green innovation output to materialize.

Given that firms may conduct green M&A transactions at different times, our empirical setting constitutes a staggered DiD framework. Recent econometric research has raised concerns that traditional two-way fixed effects regression models may yield biased estimates in such settings, especially when treatment effects vary over time or across samples (Sun and Abraham, 2021; Borusyak et al., 2024). To address this concern, we adopt the estimator developed by Sun and Abraham (2021), which retains only effective controls, including those from never-treated and late-treated firms. Figure 2b presents the results using Sun and Abraham's (2021) model, which closely mirrors the dynamic treatment patterns in Figure 2a, except that the estimate for year four post-treatment ($\tau = +4$) becomes statistically insignificant. Overall, both event-study estimators consistently support the finding that green M&A activity exerts a persistent and positive effect on subsequent green innovation.

Insert Table 4 and Figure 2 about here

4.3.2. Alternative measurements and model specifications

To further validate the robustness of our baseline findings, we perform a series of tests using alternative measurements of green innovation and different model specifications. First, in addition to our baseline development variable, *Green innovation*_{*t+1*}, we use three alternative metrics of the number of citations received by green patent applications (as a proxy for innovation quality), the number of

green patents granted, and number of green innovations classified using the WIPO taxonomy. Each of these variables is transformed using the natural logarithm of one plus the respective value. The results, reported in Panel A of Table 5, indicate that all coefficients on the green M&A variables remain positive and statistically significant across specification, with the sole exception of *Green M&A value* losing significance when WIPO-based green innovation is used as the outcome.

Second, we introduce ratio-based measures of green innovation. Specifically, we construct *Green share*, defined as the ratio of a firm's green patents to its total patents in a given year. To account for truncation bias in innovation counts, as discussed by Lerner and Seru (2022), we also construct two normalized indicators. *Adjusted green innovation*, calculated as a firm's green patents scaled by the total number of green patents filed across all firms in the same year (Farida et al., 2026), and *Average adjusted green innovation*, which scales firm-level green patents by the industry-wide average (He and Qiu, 2025). The regression results in Panel B show that the green M&A variables remain positively and significantly associated with all three ratio-based proxies.

Third, to examine the persistence of the green M&A effect, we extend the outcome window and re-estimate our regression using green innovation in years $t+2$ through $t+4$. As shown in Panel C, the coefficients on the green M&A variables remain positive and statistically significant throughout the extended periods, suggesting that the effect of green M&A activity persists for at least four years following the transaction.

Finally, we address unobserved heterogeneity by re-estimating Eq. (1) with firm fixed effects. Columns (1) to (3) of Panel D show that the coefficients on all three green M&A variables continue to be positive and significant, consistent with the baseline results. To complement this, we estimate a negative binomial regression model using the count of green patents (rather than log-transformed values) as the development variable. The results in the remaining columns confirm the positive and statistically significant relationship between green M&A activity and green innovation output.

Insert Table 5 about here

4.3.3. Additional robustness tests: Comparative analyses

To further contextualize our main findings, we conduct a set of comparative and falsification analyses. First, we replicate our baseline regression by replacing the green M&A variables with their corresponding general M&A counterparts. Panel A of Table 6 presents the results, which show that general M&A variables are positively associated with green innovation at the 5% significance level. However, the magnitude and the significance of these effects are considerably smaller than those of green M&As, as reported in Table 3.

Second, we conduct a falsification test by introducing three non-green M&A variables alongside the green M&A variables. If the observed increase in green innovation were coincidental or driven by general M&A activity, we would expect to see similar positive effects for non-green M&As. However, as shown in the remaining columns of Panel A, the coefficients on non-green M&A variables are either statistically significant or even negative (especially for the count and value measures). In contrast, the coefficients on green M&A variables remain consistently positive and significant across all relevant model specifications.

Lastly, we examine whether the effect of green M&A activity extends beyond green innovation by replacing the development variable with *Overall innovation* (i.e., total patent applications). The results, shown in Panel B of Table 6, indicate that all green M&A variables are positively and significantly associated with overall innovation. This finding suggests that green M&A activity not only promote environmentally focused innovation but also stimulate broader innovation performance.

Insert Table 6 about here

4.4. Ownership structure and the green M&A-innovation relationship

4.4.1. Institutional ownership

In this section, we examine how ownership structure moderates the relationship between green M&A activity and subsequent green innovation. We begin by analyzing the effect of institutional ownership and present the results in Panel A of Table 7. The coefficients on the interaction terms

between the three green M&A variables and institutional ownership are all positive and statistically significant at the 1% or 5% levels. These results suggest that institutional ownership amplifies the positive effect of green M&As on subsequent green innovation, thereby supporting H2a. This finding is consistent with the view that institutional investors, through their monitoring, information advantages, and resource-provision roles, can curb managerial myopia and support long-term investments. Consequently, they facilitate the more effective allocation of resources toward green innovation and improve the firms' ability to integrate newly acquired green technologies (He et al., 2025). Figure 3 visualizes the interaction effects of institutional ownership on the impact of (a) the presence of green M&A activity and (b) the number of green M&A transactions on green innovation. A corresponding visualization for green M&A value is presented in Appendix D (a).

Given the heterogeneous nature of institutional ownership, we further explore whether the moderating effect depends on the type of institutional investors. One important category is financial institutions (e.g., banks and insurance companies), which are often considered passive investors and tend to be more economically and short-term oriented. Prior research suggests that such investors may be inclined to support long-term, uncertain innovation projects such as green innovation (García-Sánchez et al., 2020). Therefore, we do not expect financial institutions to strengthen the positive relationship between green M&As and green innovation. In contrast, foreign institutional investors are typically more active, better able to access specialized knowledge and networks, and are more capable of facilitating technology transfer at a lower cost (Deng et al., 2025). Thus, it is reasonable to expect that foreign investors amplify the positive effect of green M&As on green innovation. The results in Panel B support this view. In Columns (1) to (3), the coefficients on the interaction terms between green M&A variables and financial institution ownership are positive but statistically insignificant. By contrast, in Columns (4) to (6), the interaction terms between green M&A variables and foreign investor ownership are consistently positive and statistically significant at the 5% level. These findings suggest that, among institutional investors, foreign investors significantly amplify the positive impact of green M&A activity on green innovation, whereas financial institutions do not.

Insert Table 7 and Figure 3 about here

4.4.1. Family ownership

We next examine how family ownership moderates the positive effect of green M&A activity on subsequent green innovation. Table 8 presents the results. The coefficients on the interaction terms between the three green M&A variables and family ownership are all negative and statistically significant at the 1% level. These results indicate that family ownership attenuates the positive relationship between green M&As and green innovation, thus supporting H2b. This finding is consistent with the notion that family owners, due to their non-economic objectives, long-term orientation, and risk aversion, are often reluctant to engage in disruptive activities such as M&As and to integrate unfamiliar technologies (Gómez-Mejía et al., 2011). As a result, firms with higher levels of family ownership are more reluctant or less effective in leveraging acquired green technologies for innovation purposes, thereby dampening the benefits of green M&A activity. Figure 4 visually illustrates the interaction effects of family ownership on the impact of (a) the presence of green M&A activity and (b) the number of green M&A transactions on green innovation. A corresponding figure for green M&A value is presented in Appendix D (b).

In summary, our findings suggest that while institutional ownership, especially foreign investors, enhances the positive innovation effect of green M&A activity, family ownership mitigates this effect.

Insert Table 8 and Figure 4 about here

4.5. Firm heterogeneity and the green M&A-innovation relationship

4.5.1. Green capabilities of acquiring firm

In this section, we explore whether the effect of green M&A activity on green innovation depends on firms' existing green capabilities and strategic orientation. We begin by examining whether the positive effect is diminished when firms have historically underperformed in green innovation. To proxy for such relative weakness, we identify green underperforming firms based on their historical

green innovation intensity compared to industry peers in a given year. Specifically, we calculate each firm's green innovation share as the ratio of the cumulative number of green innovations to total innovations over the previous three years:

$$Green\ innovation\ share_{i,t-1:t-3} = \frac{Green\ innov_{i,t-1} + Green\ innov_{i,t-2} + Green\ innov_{i,t-3}}{Total\ innov_{i,t-1} + Total\ innov_{i,t-2} + Total\ innov_{i,t-3}}. \quad (2)$$

We define *Green underperformer* as an indicator variable equal to one if the firm's green innovation share is below the sample industry-year median, and zero otherwise. We interact this proxy with all three green M&A variables and present the results in Table 9.

We first run a probit model to assess the likelihood of green underperforming firms engaging in green M&A activity. As shown in Column (1), the coefficient on *Green underperformer* is negative and statistically significant at the 1% level, indicating that firms with weaker green capabilities are less likely to undertake green M&A transactions. In the remaining columns, the coefficients on the interaction terms between green M&A variables and green underperforming firms are all negative and statistically significant at the 1% level. These results suggest that the positive effect of green M&As on green innovation is weakened among firms with historically low green innovation performance, thereby supporting H3a.³ This finding aligns with the view that firms must possess a minimum threshold of technological knowledge (i.e., absorptive capacity) to recognize, integrate, and exploit newly acquired external knowledge (Cohen and Levinthal, 1990; Yu et al., 2019). Firms with poor prior green innovation capabilities may lack such absorptive capacity. Consequently, their green M&A activity may be more symbolic or reputational (e.g., greenwashing) rather than functional, and they may struggle to effectively translate acquired green technologies into actual innovation output. As such, green underperforming firms dilute the positive effect of green M&A activity on green innovation.

Insert Table 9 about here

³ For robustness, we also define *Green underperformer* using the sample industry-year mean or based solely on the immediate past year. The unreported results remain qualitatively the same.

4.5.2. ESG orientation of acquiring firm

We next examine whether the positive effect of green M&A activity on green innovation is amplified among firms with an ESG orientation (i.e., higher ESG performance). We use the firms' lagged ESG scores as a proxy for ESG orientation and interact this measure with all three green M&A variables. The results are reported in Table 10.

In Column (1), we estimate a probit model to assess whether acquiring firms with superior ESG performance are more likely to undertake green M&A transactions. The coefficient on the *ESG score* is positive and statistically significant at the 1% level, indicating that firms with stronger ESG orientation are more inclined to engage in green M&A activity. In the subsequent regressions, the interaction terms between the three green M&A variables and ESG-oriented firms are consistently positive and statistically significant at the 10% level. These results indicate that the positive effect of green M&As on green innovation is enhanced when firms exhibit superior ESG performance. Our findings thus support H3b, suggesting that ESG-oriented firms are better positioned to leverage green M&As to stimulate green innovation. This is economically consistent with the notion that firms already committed to ESG practices are not only more likely to participate in green M&A activity, but also possess the complementary capabilities necessary to exploit newly acquired green technologies and generate greater innovation outcomes (Gu et al., 2025).

Overall, our findings suggest that the innovation benefits of green M&A activity are constrained when firms lack prior green capabilities (i.e., green underperforming firms), but are enhanced when firms are already ESG-oriented (i.e., acquiring firms with higher ESG performance).

Insert Table 10 about here

4.6. Corporate governance and the green M&A-innovation relationship

We examine whether corporate governance matters in the relationship between green M&A activity and green innovation. We use two proxies to capture governance quality. *Board independence* is the ratio of independent directors to the total number of directors, and *Board gender diversity* is an

indicator variable equal to one if at least one female director is present, and zero otherwise. A firm is classified as having *high* governance quality if its board independence exceeds the sample mean or if it has at least one female director. We divided the sample into six subsamples, with two assigned to each proxy.

We present the results in Table 11. Across all columns, the coefficients on the three green M&A variables are positive and statistically significant at the 1% or 5% levels. Notably, the magnitude of the coefficients is larger in the subsamples with superior governance compared to those with weaker governance, providing support for our H4. These findings are consistent with our main findings and confirm that board independence is associated with improved environmental performance, as independent directors provide oversight, strategic guidance, and access to valuable external resources (Arora and Aliani, 2024). Similarly, board gender diversity positively influences green innovation, as female directors are more attuned to stakeholder sustainability concerns and help promote environmentally responsible behavior (Vicente-Molina et al., 2018). Overall, a strong governance framework may enhance the effectiveness of green M&A activity by facilitating its alignment with long-term sustainability goals and enabling the strategic development of acquired green capabilities for fostering green innovation.

Insert Table 11 about here

4.7. Additional analysis

4.7.1. Innovation capacity and external opportunity

As an additional analysis, we examine whether the innovation effect of green M&A activity is stronger when firms possess established innovation capacities and operate in environments characterized by greater technological opportunities. As discussed earlier, absorptive capacity enables firms to more effectively recognize, assimilate, and exploit newly acquired external knowledge (Cohen and Levinthal, 1990; Yu et al., 2019), thereby enhancing green innovation outcomes. Similarly, technological opportunities provide pathways for innovation by offering access to diverse external

knowledge flows, facilitating knowledge spillovers and recombination that enhance the integration of newly acquired and existing knowledge (Ahuja and Katila, 2001; Apa et al., 2018). As such, firms exposed to richer technological environments may more successfully translate external knowledge into green innovations. Accordingly, we expect that the positive innovation effect of green M&As will be stronger for firms with higher absorptive capacity and those operating in sectors with richer technological opportunities.

To proxy absorptive capacity, we use the stock of prior green patents, which captures past innovation efforts and reflects the firm's ability to absorb external knowledge. Compared to R&D expenditure, this proxy avoids concerns over resource substitution between internal and external R&D and instead aligns with the complementarity view (Dushnitsky and Lenox, 2005). Following their approach, we calculate *Absorptive capacity* as the depreciated sum of all green patent applications from the start of the database to a given year, applying a depreciation rate (δ) of 5%:

$$Absorptive\ capacity_{i,t} = Green\ innovation_{i,t} + (1 - \delta)XGreen\ innovation_{i,t-1}. \quad (3)$$

Firms with an *Absorptive capacity* above the sample annual mean are classified as *high* absorptive capacity. To proxy *Technological opportunity*, we compute the natural logarithm of one plus the average number of green patent applications in a given IPC sector per year, following Dushnitsky and Lenox (2006). Firms with a *Technological opportunity* above the sample annual mean are defined as operating in *high* opportunity environments. We divide the sample into four subsamples based on these two proxies.

We report the results in Table 12. Across all columns, the coefficients on the three green M&A variables remain positive and statistically significant at the 1% or 5% levels for the subsamples with high absorptive capacity or high technological opportunity. In contrast, the coefficients become statistically insignificant in the subsamples with low absorptive capacity or technological opportunity. These results support our conjecture that the green M&As yield stronger green innovation effects when firms are more internally capable or externally supported.

Insert Table 12 about here

4.7.2. Market and accounting performance following green M&A activity

As a final analysis, we examine whether green M&A activity affects firms' subsequent market and accounting performance. Specifically, we assess the effect on Tobin's Q as a proxy for market valuation and ROA as a measure of profitability, using the lead variables to capture outcomes one, two, and three years after the green M&A activity. In addition to the full set of control variables used in the previous model, we include *Green innovation* as an additional control to account for its potential role in shaping post-M&A performance.

We present the results in Table 13. Panel A reports the results for market valuation. The coefficients on the three green M&A variables are positive and statistically significant across all three post-M&A periods, indicating that green M&A activity contributes positively to firm market value beyond its effect on green innovation. This finding supports the notion that the market perceives such environmental practices as value-enhancing initiatives, potentially improving firms' growth prospects and environmental competitiveness (Tampakoudis and Anagnostopoulou, 2020). Consistently, green innovation itself also shows a positive and significant association with market value across all three periods. In contrast, Panel B presents results for profitability. Here, both the coefficients on the three green M&A variables and the green innovation are negative and statistically significant for each of the three years following the M&A. These results imply that while green M&As and innovation enhance firms' market valuation, they come at the cost of reduced profitability. This finding may suggest that environmental strategies, such as investing in green businesses and pursuing innovation in sustainability, entail considerable implementation costs (e.g., R&D and integration efforts), which can weigh on accounting performance.

Overall, our results suggest a trade-off that while green M&A activity may depress profitability, they are rewarded by the market.

Insert Table 13 about here

5. Conclusion

This study examines how green M&A activity influences subsequent green innovation performance in Japan, a context characterized by strong environmental policy initiatives, distinctive corporate governance structures, and substantial heterogeneity in firm ownership. Motivated by the growing strategic importance of green M&As in the transition toward low-carbon development, the study integrates resource-based perspectives with agency theory and socioemotional wealth theory to explain why and how ownership structure, firm heterogeneity, and corporate governance affect the extent to which green M&A activity leads to meaningful green innovation outputs.

Using a large panel dataset of publicly listed Japanese firms, green innovation is identified through patent-based indicators primarily derived from the GXTI classification of the Japan Patent Office, while green M&A activity is captured via text analysis of M&A announcement documents. The results consistently indicate that green M&A activity has a positive and statistically significant effect on subsequent green innovation. This relationship holds across multiple robustness checks and even when controlling for endogeneity. Firms engaging in green M&As appear better positioned to absorb environmental knowledge, strengthen technological capabilities, and generate novel green inventions.

A central contribution of this study lies in uncovering the moderating effect of ownership structure. We find that institutional ownership significantly strengthens the positive effect of green M&A activity on green innovation, supporting the view that sophisticated investors provide critical monitoring, long-term orientation, and resource access that facilitate post-acquisition knowledge integration. The effect is particularly pronounced for foreign institutional investors, likely reflecting tighter oversight and cross-border knowledge spillovers. In contrast, family ownership weakens the innovation benefits of green M&A activity. This finding is consistent with the socioemotional wealth theory that family-controlled firms tend to avoid high-risk, uncertain environmental investments, thereby limiting the realization of green synergies. The study further explores heterogeneities in firm capabilities and governance quality. We show that the innovation-enhancing effect of green M&A

activity is weaker for green underperforming firms but stronger for those with pre-existing ESG orientations. Similarly, firms with greater board independence and gender diversity are more likely to translate green M&As into substantive innovation outcomes. These results underscore the importance of internal capabilities and governance systems in realizing the full potential of environmentally oriented M&A activity. Moreover, we show that the positive effect of green M&A activity is amplified for firms with greater absorptive capacity and for those operating in sectors with richer technological opportunities. Meanwhile, the findings reveal a trade-off that while green M&As and green innovation contribute positively to firms' market valuation, they exert a negative impact on short-term profitability.

Overall, the paper contributes to the literature on sustainability, strategic management, and corporate governance by offering robust empirical evidence that green M&A activity can serve as a catalyst for green innovation. However, the effectiveness of such activity depends critically on who owns the firm and how it is governed. These findings carry important implications for managers, investors, and policymakers seeking to promote sustainability-oriented corporate strategies. Managers must recognize that while green M&As offer long-term innovative benefits, their success require supportive governance systems and strategic alignment. Policymakers and institutional investors should pay closer attention to firm ownership, internal capacity, and governance conditions when designing frameworks to encourage green-related investments and innovation.

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Appendix A.

Data descriptions and sources

Variables	Descriptions	Sources
<i>Dependent and Independent variables</i>		
Green innovation	The natural logarithm of one plus the total number of green patent applications filed by a firm in a given year. Green patents are classified based on the Green Transformation Technologies Inventory (GXTI) provided by the Japan Patent Office.	Institute of Intellectual Property
Green M&A dummy	A dummy variable equal to one if a firm engaged in at least one green M&A transaction in a given year, and zero otherwise.	Refinitiv Eikon
Green M&A count	The natural logarithm of one plus the total number of green M&A transactions conducted by a firm in a given year.	Refinitiv Eikon
Green M&A value	The natural logarithm of one plus the total deal value of green M&A transactions conducted by a firm in a given year.	Refinitiv Eikon
<i>Control Variables</i>		
Firm size	The natural logarithm of total assets.	Development Bank of Japan
Firm age	The natural logarithm of one plus the number of years between the founding year and the observation year.	Development Bank of Japan
Leverage	The ratio of total debt to total assets.	Development Bank of Japan
Slack	The ratio of current assets to current liabilities.	Development Bank of Japan
Cash holdings	The ratio of cash and cash equivalents to total assets.	Development Bank of Japan
Capital expenditure	[Fixed assets (t) – Fixed assets (t–1) + Depreciation] / Book value of total sales.	Development Bank of Japan
Sales growth	The percentage change in sales.	Development Bank of Japan
Tobin's Q	[Market value of equity + Book value of liabilities] / [Book value of equity + Book value of liabilities].	Development Bank of Japan; NEEDS-FinancialQUEST
ROA	The ratio of net income to total assets.	Development Bank of Japan
R&D expenditure	The ratio of research and development (R&D) expenditure to total assets.	Development Bank of Japan
R&D dummy	A dummy variable equal to one if a firm reports positive R&D expenditure in a given year, and zero otherwise. Missing R&D values are treated as zero.	Development Bank of Japan
<i>Other Variables of Interest</i>		
Green innovation quality	The natural logarithm of one plus the total number of citations received by each green patent application in the subsequent years.	Institute of Intellectual Property
Granted green innovation	The natural logarithm of one plus the total number of green patent applications that were eventually granted.	Institute of Intellectual Property
Green innovation (WIPO)	The natural logarithm of one plus the total number of green patent applications classified according to the World Intellectual Property Organization (WIPO) green patent taxonomy.	Institute of Intellectual Property
Green share	The ratio of green patent applications to the total number of overall innovation applications filed by the firm in a given year.	Institute of Intellectual Property
Adjusted green innovation	The number of green patent applications filed by the acquiring firm in a given year, normalized by the total number of green patents filed by all firms in the same year.	Institute of Intellectual Property
Average adjusted green innovation	The number of green patent applications filed by the acquiring firm in a given year, scaled by the annual industry average of green patent filings across all firms in the same industry.	Institute of Intellectual Property
M&A dummy	A dummy variable equal to one if the firm conducted at least one M&A transaction in a given year, and zero otherwise.	Refinitiv Eikon
M&A count/value	The natural logarithm of one plus the total number/deal value of M&A transactions conducted by a firm in a given year.	Refinitiv Eikon

(continued on next page)

Appendix A. (continued)

Variables	Descriptions	Sources
<i>Other Variables of Interest</i>		
Non-green M&A dummy	A dummy variable equal to one if the firm conducted at least one non-green M&A transaction in a given year, and zero otherwise.	Refinitiv Eikon
Non-green M&A count/value	The natural logarithm of one plus the total number/deal value of M&A transactions conducted by a firm in a given year.	Refinitiv Eikon
Overall innovation	The natural logarithm of one plus the total number of overall patent applications filed by the firm in a given year.	Institute of Intellectual Property
Institutional ownership	The percentage of total shares held by all institutional investors.	Development Bank of Japan
Financial institutions	The percentage of shares held by financial institutions.	Development Bank of Japan
Foreign investors	The percentage of shares held by foreign investors.	Development Bank of Japan
Family ownership	The percentage of shares held by the founding family, including direct holdings and those through family-owned asset management firms.	Development Bank of Japan; Toyo Keizai Database
Green underperformer	A dummy variable equal to one if the firm's average green innovation output over the three years preceding a green M&A is below the sample median; zero otherwise.	Institute of Intellectual Property
ESG score	The corporate environmental, social, and governance (ESG) score reported by the LSEG Data & Analytics.	Refinitiv Eikon
Board independence	The ratio of the independent directors to the total number of directors on the board.	Toyo Keizai Database
Board gender diversity	A dummy variable equal to one if the board includes at least one female director, and zero otherwise.	Toyo Keizai Database
Absorptive capacity	The natural logarithm of the depreciated cumulative stock of patents filed by the firm from the beginning of the database period up to the current year.	Institute of Intellectual Property
Technological opportunity	The natural logarithm of the average number of forward citations per patent within the firm's sector in a given year.	Institute of Intellectual Property

Appendix A contains definitions for variables used in this study.

Appendix B.

Correlation matrix

Variables		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Green innovation _{it+1}	(1)	1.000														
Green M&A dummy	(2)	0.101***	1.000													
Green M&A count	(3)	0.107***	0.909***	1.000												
Green M&A value	(4)	0.052***	0.140***	0.186***	1.000											
Firm size	(5)	0.255***	0.223***	0.244***	0.100***	1.000										
Firm age	(6)	0.093***	0.037***	0.033***	-0.005	0.161***	1.000									
Leverage	(7)	0.023***	0.030***	0.031***	0.008*	0.135***	0.170***	1.000								
Slack	(8)	-0.037***	-0.028***	-0.026***	-0.007	-0.096***	-0.186***	-0.628***	1.000							
Cash holdings	(9)	-0.070***	-0.046***	-0.043***	-0.007	-0.179***	-0.336***	-0.362***	0.459***	1.000						
Capital expenditure	(10)	0.010**	0.036***	0.032***	0.036***	0.092***	-0.085***	-0.060***	0.010**	-0.048***	1.000					
Sales growth	(11)	-0.007	0.009*	0.008*	-0.002	-0.021***	-0.179***	-0.028***	0.011**	0.107***	0.037***	1.000				
Tobin's Q	(12)	0.034***	0.016***	0.019***	0.011**	-0.003	-0.327***	-0.348***	0.273***	0.403***	0.122***	0.254***	1.000			
ROA	(13)	-0.000	0.008*	0.004	0.006	0.003	-0.132***	-0.309***	0.148***	0.233***	0.113***	0.321***	0.385***	1.000		
R&D expenditure	(14)	0.024***	0.008*	0.010**	-0.001	0.008	0.005	0.022***	-0.017***	-0.023***	-0.016***	-0.010**	-0.015***	-0.034***	1.000	
R&D dummy	(15)	0.019***	0.006	0.008*	-0.001	0.001	0.004	0.030***	-0.020***	-0.027***	-0.015***	-0.011**	-0.017***	-0.042***	0.911***	1.000

Appendix B contains the correlations between the main variables used in this study. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Appendix C.

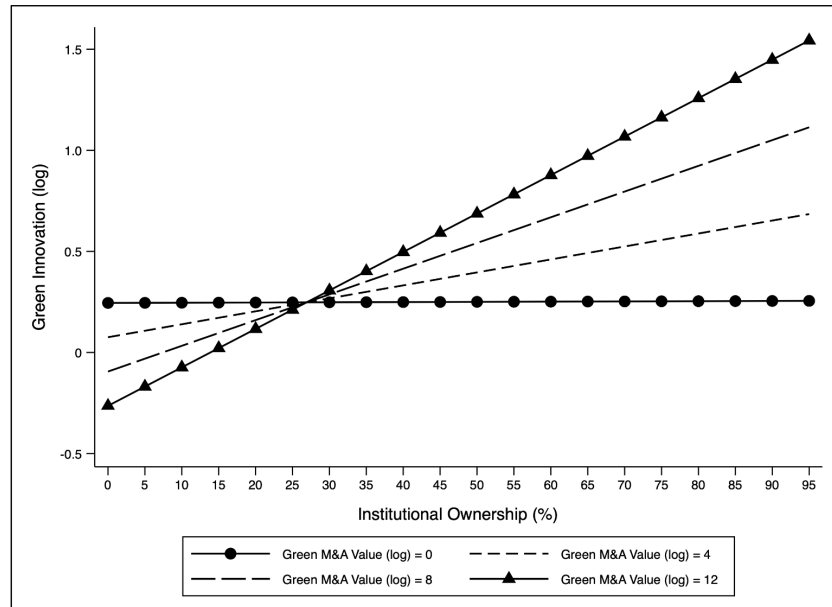
Propensity score matching and Heckman two-stage regression (First-stage)

Variables	PSM (1 st -stage)	Heckman (1 st -stage)
	Green M&A dummy	Green M&A dummy
	(1)	(2)
Prior non-green M&A experience		0.098** (0.046)
(ln) Firm size	0.662*** (0.023)	0.275*** (0.011)
(ln) Firm age	-0.093 (0.062)	-0.058** (0.029)
Leverage	0.371 (0.230)	0.211** (0.100)
Slack	-0.050* (0.030)	-0.014 (0.012)
Cash holdings	0.262 (0.405)	0.168 (0.173)
Capital expenditure	0.456*** (0.107)	0.220*** (0.050)
Sales growth	0.280 (0.188)	0.151* (0.084)
Tobin's Q	0.223*** (0.042)	0.101*** (0.019)
ROA	0.476 (0.857)	0.087 (0.360)
R&D expenditure	-0.012 (1.688)	-0.106 (0.730)
R&D dummy	0.153 (0.627)	0.153 (0.267)
Industry FE	Yes	Yes
Year FE	Yes	Yes
N	47399	44445
Pseudo R ²	0.135	0.132

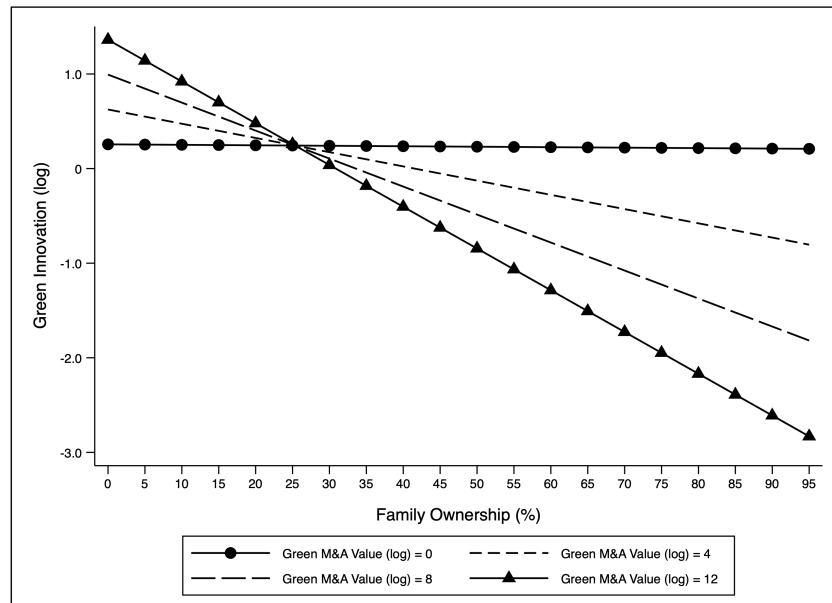
Appendix C contains the first-stage regression results of propensity score matching and Heckman two-stage selection model in Table 4.

Appendix D.

Interaction effects of ownership structure and green M&A value



(a)



(b)

Appendix D illustrates how (a) institutional ownership and (b) family ownership moderate the relationship between green M&A value and green innovation. The results are based on Column (3) of Table 7, Panel A, and Column (3) of Table 8, respectively. The vertical axis in both figures represents the natural logarithm of one plus green innovation, while the horizontal axis reflects the respective levels of institutional and family ownership.

Table 1

Temporal frequency distributions

Panel A. Sample distribution by green innovation			
Year	Overall Innovations	Green Innovations	Green Innovations/Overall Innovations (%)
2000	205,237	18,058	8.8
2001	208,123	27,291	13.1
2002	199,709	20,536	10.3
2003	196,960	29,230	14.8
2004	195,807	13,839	7.1
2005	193,615	21,916	11.3
2006	185,331	21,321	11.5
2007	178,732	24,338	13.6
2008	180,229	22,052	12.2
2009	160,033	19,788	12.4
2010	156,183	20,887	13.4
2011	157,262	19,434	12.4
2012	157,475	18,239	11.6
2013	147,388	16,693	11.3
2014	142,101	17,829	12.5
2015	137,257	16,161	11.8
2016	134,152	16,580	12.4
2017	132,415	19,885	15.0
2018	129,008	15,813	12.3
2019	122,561	14,738	12.0
2020	109,025	17,029	15.6
2021	98,694	13,741	13.9
Total	3,527,297	425,398	12.1

Panel B. Sample distribution by green M&As						
Year	Number of M&As			Volume of M&As (USD, million)		
	M&As	Green M&As	Green M&As/M&As (%)	M&As	Green M&As	Green M&As/M&As (%)
2000	273	42	15.4	13,517.0	767.6	5.7
2001	234	43	18.4	10,701.6	694.6	6.5
2002	247	54	21.9	9,763.8	986.8	10.1
2003	269	55	20.4	11,462.5	946.8	8.3
2004	321	54	16.8	13,416.7	922.1	6.9
2005	400	67	16.8	19,333.9	1,285.7	6.7
2006	397	79	19.9	18,036.8	1,451.6	8.0
2007	413	64	15.5	19,425.0	1,236.0	6.4
2008	354	70	19.8	16,714.1	1,144.8	6.8
2009	331	62	18.7	15,596.9	1,280.6	8.2
2010	265	56	21.1	13,570.0	955.4	7.0
2011	287	58	20.2	17,389.2	1,161.3	6.7
2012	302	59	19.5	20,504.0	1,204.0	5.9
2013	263	47	17.9	14,859.1	926.6	6.2
2014	238	62	26.1	12,944.0	1,173.9	9.1
2015	266	48	18.0	15,320.6	942.7	6.2
2016	253	52	20.6	16,977.2	1,046.3	6.2
2017	257	42	16.3	15,969.5	920.9	5.8
2018	262	49	18.7	16,414.3	1,103.4	6.7
2019	228	39	17.1	15,987.9	841.3	5.3
2020	168	28	16.7	9,901.9	590.3	6.0
2021	200	40	20.0	12,521.9	832.3	6.6
Total	6,228	1,170	18.8	330,327.9	22,415.1	6.8

This table presents temporal distributions for the sample firms. Panel A reports annual figures for total innovations, green innovations, and the proportion of green to total innovations. Panel B presents the annual distribution of total and green M&A activity, measured by both deal count and aggregate deal value (in USD millions), as well as the proportion of green M&As relative to total M&As.

Table 2

Descriptive and summary statistics

Variables	Full Sample			Green M&As		Non-Green M&As		Difference in Mean
	N	Mean	Std. Dev.	N	Mean	N	Mean	
Green innovation _{t+1}	46518	3.416	19.375	969	16.825	45549	3.131	13.694***
Green M&A dummy	46518	0.021	0.143	969	1.000	45549	0.000	1.000
Green M&A count	46518	0.025	0.186	969	1.186	45549	0.000	1.186***
Green M&A value	46518	5.791	282.829	969	278.016	45549	0.000	278.016***
Firm size	46518	147.433	368.749	969	711.085	45549	135.442	575.643***
Firm age	46518	53.014	23.766	969	59.037	45549	52.886	6.151***
Leverage	46518	0.483	0.214	969	0.527	45549	0.482	0.045***
Slack	46518	2.088	1.969	969	1.707	45549	2.096	-0.388***
Cash holdings	46518	0.136	0.127	969	0.096	45549	0.137	-0.041***
Capital expenditure	46518	0.087	0.252	969	0.149	45549	0.085	0.063***
Sales growth	46518	0.026	0.183	969	0.037	45549	0.026	0.011*
Tobin's Q	46518	0.822	1.015	969	0.932	45549	0.820	0.112***
ROA	46518	0.022	0.056	969	0.025	45549	0.022	0.003*
R&D expenditure	46518	0.006	0.048	969	0.009	45549	0.006	0.003*
R&D dummy	46518	0.019	0.137	969	0.025	45549	0.019	0.006

This table presents descriptive statistics for the main variables, along with t-tests comparing firms engaged in green M&A versus those with no green M&A activity. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3**Green M&A activity and green innovation**

Variables	Green Innovation _{t+1}			Green Innovation _{t+1}		
	(1)	(2)	(3)	(4)	(5)	(6)
Green M&A dummy	0.479*** (0.067)			0.241*** (0.060)		
(ln) Green M&A count		0.692*** (0.097)			0.348*** (0.087)	
(ln) Green M&A value			0.180*** (0.025)			0.090*** (0.023)
(ln) Firm size				0.144*** (0.010)	0.144*** (0.010)	0.143*** (0.010)
(ln) Firm age				-0.010 (0.018)	-0.010 (0.018)	-0.010 (0.018)
Leverage				0.107** (0.047)	0.107** (0.047)	0.107** (0.047)
Slack				-0.008** (0.004)	-0.008** (0.004)	-0.008** (0.004)
Cash holdings				0.193*** (0.062)	0.193*** (0.062)	0.192*** (0.062)
Capital expenditure				-0.045*** (0.017)	-0.045*** (0.017)	-0.045*** (0.017)
Sales growth				-0.032 (0.021)	-0.032 (0.021)	-0.032 (0.021)
Tobin's Q				0.056*** (0.010)	0.056*** (0.010)	0.056*** (0.010)
ROA				-0.345*** (0.105)	-0.345*** (0.105)	-0.345*** (0.105)
R&D expenditure				0.252 (0.289)	0.252 (0.289)	0.252 (0.289)
R&D dummy				-0.076 (0.078)	-0.076 (0.078)	-0.076 (0.078)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	46518	46518	46518	46518	46518	46518
Adjusted R ²	0.039	0.039	0.039	0.091	0.091	0.091

This table presents the regression results on the effect of green M&A activity on green innovation. All models include industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4**Robustness tests: Endogeneity concerns**

Panel A. Matching efficiency of the propensity score matching (PSM)										
Variables	Treatment			Control			t	p -value		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(ln) Firm size	19.208			19.194			0.180			0.860
(ln) Firm age	3.951			3.948			0.110			0.909
Leverage	0.527			0.516			1.200			0.229
Slack	1.707			1.715			-0.110			0.911
Cash holdings	0.096			0.098			-0.350			0.730
Capital expenditure	0.149			0.155			-0.400			0.691
Sales growth	0.037			0.037			0.070			0.942
Tobin's Q	0.932			0.961			-0.630			0.530
ROA	0.025			0.026			-0.330			0.743
R&D expenditure	0.009			0.008			0.310			0.757
R&D dummy	0.025			0.021			0.610			0.542

Panel B. Matching efficiency of the entropy balancing method										
Variables	Treatment			Control Before Balancing			Control After Balancing			
	Mean	Variance	Skewness	Mean	Variance	Skewness	Mean	Variance	Skewness	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(ln) Firm size	19.190	3.182	-0.255	17.520	2.087	0.413	19.190	3.182	-0.253	
(ln) Firm age	3.949	0.398	-1.724	3.844	0.376	-1.527	3.949	0.398	-1.722	
Leverage	0.528	0.040	-0.149	0.483	0.046	0.028	0.528	0.040	-0.148	
Slack	1.699	2.269	5.012	2.092	3.902	3.574	1.699	2.269	5.012	
Cash holdings	0.096	0.010	2.252	0.137	0.016	1.715	0.096	0.010	2.252	
Capital expenditure	0.150	0.116	3.085	0.085	0.062	3.644	0.150	0.116	3.085	
Sales growth	0.037	0.041	1.449	0.025	0.033	1.201	0.037	0.041	1.449	
Tobin's Q	0.923	0.905	3.118	0.815	1.022	3.565	0.923	0.905	3.118	
ROA	0.025	0.002	-1.227	0.021	0.003	-1.626	0.025	0.002	-1.227	
R&D expenditure	0.009	0.003	6.686	0.006	0.002	8.143	0.009	0.003	6.687	
R&D dummy	0.025	0.025	6.055	0.019	0.019	7.054	0.025	0.025	6.053	

Panel C. Regression results										
Variables	PSM (2 nd stage)			Entropy Balancing			Heckman (2 nd stage)			DiD Model
	Green Innovation _{t+1}			Green Innovation _{t+1}			Green Innovation _{t+1}			Green Innovation _{t+1}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Green M&A dummy	0.202*** (0.076)			0.175*** (0.057)			0.222*** (0.061)			
(ln) Green M&A count		0.291*** (0.109)			0.253*** (0.082)			0.320*** (0.088)		
(ln) Green M&A value			0.070** (0.028)			0.064*** (0.021)			0.083*** (0.024)	
IMR							0.513* (0.309)	0.513* (0.309)	0.496 (0.309)	
Treated										0.220*** (0.037)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1874	1874	1874	46518	46518	46518	43601	43601	43601	44821
Adjusted R ²	0.122	0.122	0.122	0.126	0.126	0.127	0.092	0.092	0.092	0.095

This table presents robustness tests addressing endogeneity. Panel A shows pre- and post-matching covariate differences using the propensity score matching (PSM) approach. Panel B compares the covariate balance before and after the entropy balancing method. Panel C reports regression results using the matched and reweighted samples, the second-stage regression result from the Heckman two-stage selection model, and regression results from the event-study DiD model. All regressions include the full set of control variables used in Table 3 (not reported for brevity), as well as industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5**Robustness tests: Alternative measurements and model specifications**

Panel A. Alternative measurements of green innovation (1)									
Variables	Green Innovation Quality _{t+1}			Green-Granted Innovation _{t+1}			WIPO-Based Green Innovation _{t+1}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Green M&A dummy	0.183*** (0.056)			0.080*** (0.028)			0.031* (0.016)		
(ln) Green M&A count		0.263*** (0.081)			0.115*** (0.040)			0.045* (0.023)	
(ln) Green M&A value			0.068*** (0.021)			0.029*** (0.011)			0.009 (0.005)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry and Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	46518	46518	46518	46518	46518	46518	46518	46518	46518
Adjusted R ²	0.083	0.083	0.083	0.046	0.046	0.046	0.016	0.016	0.016
Panel B. Alternative measurements of green innovation (2)									
Variables	Green Share _{t+1}			Adjusted Green Innovation _{t+1}			Average Adjusted Green Innovation _{t+1}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Green M&A dummy	0.019** (0.009)			0.045*** (0.010)			1.119*** (0.257)		
(ln) Green M&A count		0.027** (0.013)			0.064*** (0.015)			1.614*** (0.371)	
(ln) Green M&A value			0.007** (0.003)			0.017*** (0.004)			0.424*** (0.099)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry and Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	46518	46518	46518	46518	46518	46518	46518	46518	46518
Adjusted R ²	0.035	0.035	0.035	0.091	0.091	0.092	0.091	0.091	0.092
Panel C. Green innovation (from t+2 to t+4)									
Variables	Green Innovation _{t+2}			Green Innovation _{t+3}			Green Innovation _{t+4}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Green M&A dummy	0.185*** (0.057)			0.186*** (0.055)			0.204*** (0.058)		
(ln) Green M&A count		0.267*** (0.082)			0.268*** (0.080)			0.295*** (0.084)	
(ln) Green M&A value			0.062*** (0.021)			0.059*** (0.021)			0.071*** (0.022)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry and Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	44035	44035	44035	41606	41606	41606	39260	39260	39260
Adjusted R ²	0.091	0.091	0.091	0.093	0.093	0.093	0.092	0.092	0.092
Panel D. Firm fixed effect and negative binomial model									
Variables	Green Innovation _{t+1}			Green Innovation _{t+1}					
	(1)	(2)	(3)	(4)	(5)	(6)			
Green M&A dummy	0.077*** (0.025)				0.240*** (0.091)				
(ln) Green M&A count		0.111*** (0.036)				0.346*** (0.131)			
(ln) Green M&A value			0.033*** (0.009)				0.085*** (0.031)		
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	No	No	No		
Industry FE	No	No	No	No	Yes	Yes	Yes		
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
N	46518	46518	46518	46518	46518	46518	46518		
Adjusted R ² /Pseudo R ²	0.002	0.002	0.002	0.002	0.035	0.035	0.035		

This table presents robustness checks using alternative measures of green innovation and model specifications. Panel A uses the WIPO-based classification, green-granted innovations, and green innovation quality. Panel B adopts green share and firm- and industry-adjusted green innovation. Panel C evaluates green innovation from year t+2 to t+4. Panel D applies alternative estimation strategies, including OLS with firm fixed effects and the negative binomial regression. All regressions include the full set of control variables used in Table 3 (not reported for brevity), as well as industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6**Robustness tests: Comparative analyses**

Panel A. General, green, and non-green M&As and green innovation						
Variables	Green Innovation _{t+1}		Green Innovation _{t+1}		Green Innovation _{t+1}	
	(1)	(2)	(3)	(4)	(5)	(6)
M&A dummy	0.059** (0.024)					
Green M&A dummy		0.242*** (0.061)				
Non-green M&A dummy		0.004 (0.022)				
(ln) M&A count			0.064** (0.033)			
(ln) Green M&A count				0.350*** (0.085)		
(ln) Non-green M&A count				-0.013 (0.033)		
(ln) M&A value					0.019** (0.009)	
(ln) Green M&A value						0.091*** (0.022)
(ln) Non-green M&A value						-0.004 (0.009)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	46518	46518	46518	46518	46518	46518
Adjusted R ²	0.090	0.091	0.090	0.091	0.090	0.091
Panel B. Green M&As and overall innovation						
Variables	Overall Innovation _{t+1}		Overall Innovation _{t+1}		Overall Innovation _{t+1}	
	(1)	(2)	(3)			
Green M&A dummy	0.286*** (0.100)					
(ln) Green M&A count		0.413*** (0.145)				
(ln) Green M&A value				0.086** (0.038)		
Controls	Yes	Yes		Yes		
Industry FE	Yes	Yes		Yes		
Year FE	Yes	Yes		Yes		
N	46518	46518		46518		
Adjusted R ²	0.494	0.494		0.494		

This table presents comparison analyses of innovation outcomes across different types of M&A activity. Panel A compares the effects of general, green, and non-green M&A activity on green innovation, while Panel B examines the effect of green M&A activity on overall innovation. All regressions include the full set of control variables used in Table 3 (not reported for brevity), as well as industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7**Ownership structure: Institutional ownership**

Panel A. Institutional ownership			
Variables	Green Innovation _{t+1}		
	(1)	(2)	(3)
Institutional ownership	0.000 (0.864)	0.000 (0.864)	0.000 (0.848)
Green M&A dummy	-0.226* (0.099)		
Green M&A dummy $\times$ Institutional ownership	0.007*** (0.004)		
(ln) Green M&A count		-0.327* (0.099)	
(ln) Green M&A count $\times$ Institutional ownership		0.010*** (0.004)	
(ln) Green M&A value			-0.076 (0.229)
(ln) Green M&A value $\times$ Institutional ownership			0.002** (0.018)
(ln) Firm size	0.142*** (0.000)	0.142*** (0.000)	0.142*** (0.000)
(ln) Firm age	-0.010 (0.570)	-0.010 (0.570)	-0.010 (0.577)
Leverage	0.108** (0.022)	0.108** (0.022)	0.107** (0.022)
Slack	-0.008** (0.039)	-0.008** (0.039)	-0.008** (0.038)
Cash holdings	0.196*** (0.001)	0.196*** (0.001)	0.196*** (0.002)
Capital expenditure	-0.043** (0.013)	-0.043** (0.013)	-0.043** (0.012)
Sales growth	-0.031 (0.143)	-0.031 (0.143)	-0.031 (0.151)
Tobin's Q	0.056*** (0.000)	0.056*** (0.000)	0.056*** (0.000)
ROA	-0.351*** (0.001)	-0.351*** (0.001)	-0.350*** (0.001)
R&D expenditure	0.287 (0.321)	0.287 (0.321)	0.288 (0.320)
R&D dummy	-0.092 (0.239)	-0.092 (0.239)	-0.091 (0.240)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	46297	46297	46297
Adjusted R ²	0.092	0.092	0.092

Panel B. Financial institutions and foreign investors

Variables	Financial Institutions			Foreign Investors		
	Green Innovation _{t+1}			Green Innovation _{t+1}		
	(1)	(2)	(3)	(4)	(5)	(6)
X	0.001 (0.497)	0.001 (0.497)	0.001 (0.453)	0.002* (0.098)	0.002* (0.098)	0.002* (0.091)
Green M&A dummy	0.142 (0.172)			0.023 (0.738)		
Green M&A dummy $\times$ X	0.003 (0.410)			0.012** (0.013)		
(ln) Green M&A count		0.205 (0.172)			0.034 (0.738)	
(ln) Green M&A count $\times$ X		0.005 (0.410)			0.017** (0.013)	
(ln) Green M&A value			0.075* (0.097)			0.017 (0.569)
(ln) Green M&A value $\times$ X			0.000 (0.760)			0.004** (0.037)

(continued on next page)

Table 7 (continued)**Panel B. Financial institutions and foreign investors**

Variables	Financial Institutions			Foreign Investors		
	Green Innovation _{t+1}			Green Innovation _{t+1}		
	(1)	(2)	(3)	(4)	(5)	(6)
(ln) Firm size	0.140*** (0.000)	0.140*** (0.000)	0.140*** (0.000)	0.134*** (0.000)	0.134*** (0.000)	0.134*** (0.000)
(ln) Firm age	-0.013 (0.452)	-0.013 (0.452)	-0.013 (0.459)	-0.009 (0.640)	-0.009 (0.640)	-0.008 (0.649)
Leverage	0.109** (0.021)	0.109** (0.021)	0.109** (0.021)	0.121** (0.011)	0.121** (0.011)	0.121** (0.012)
Slack	-0.007* (0.051)	-0.007* (0.051)	-0.007* (0.052)	-0.008** (0.045)	-0.008** (0.045)	-0.008** (0.045)
Cash holdings	0.193*** (0.002)	0.193*** (0.002)	0.193*** (0.002)	0.183*** (0.003)	0.183*** (0.003)	0.182*** (0.003)
Capital expenditure	-0.044** (0.010)	-0.044** (0.010)	-0.045*** (0.010)	-0.046*** (0.009)	-0.046*** (0.009)	-0.046*** (0.009)
Sales growth	-0.032 (0.132)	-0.032 (0.132)	-0.032 (0.139)	-0.030 (0.156)	-0.030 (0.156)	-0.030 (0.164)
Tobin's Q	0.055*** (0.000)	0.055*** (0.000)	0.055*** (0.000)	0.051*** (0.000)	0.051*** (0.000)	0.051*** (0.000)
ROA	-0.348*** (0.001)	-0.348*** (0.001)	-0.349*** (0.001)	-0.348*** (0.001)	-0.348*** (0.001)	-0.348*** (0.001)
R&D expenditure	0.249 (0.391)	0.249 (0.391)	0.249 (0.391)	0.252 (0.379)	0.252 (0.379)	0.253 (0.377)
R&D dummy	-0.075 (0.339)	-0.075 (0.339)	-0.075 (0.337)	-0.078 (0.310)	-0.078 (0.310)	-0.079 (0.310)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	46518	46518	46518	46518	46518	46518
Adjusted R ²	0.091	0.091	0.091	0.092	0.092	0.092

This table presents regression results examining how institutional ownership moderates the relationship between green M&A activity and green innovation. Panel A reports results based on overall institutional ownership, while Panel B disaggregates the effects by financial institutions and foreign investors. All models include industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8**Ownership structure: Family ownership**

Variables	Green Innovation _{t+1}		
	(1)	(2)	(3)
Family ownership	-0.000 (0.232)	-0.000 (0.232)	-0.000 (0.228)
Green M&A dummy	0.306*** (0.000)		
Green M&A dummy $\times$ Family ownership	-0.010*** (0.000)		
(ln) Green M&A count		0.442*** (0.000)	
(ln) Green M&A count $\times$ Family ownership		-0.014*** (0.000)	
(ln) Green M&A value			0.110*** (0.000)
(ln) Green M&A value $\times$ Family ownership			-0.004*** (0.000)
(ln) Firm size	0.142*** (0.000)	0.142*** (0.000)	0.141*** (0.000)
(ln) Firm age	-0.015 (0.433)	-0.015 (0.433)	-0.015 (0.438)
Leverage	0.106** (0.024)	0.106** (0.024)	0.106** (0.024)
Slack	-0.008** (0.045)	-0.008** (0.045)	-0.008** (0.046)
Cash holdings	0.203*** (0.001)	0.203*** (0.001)	0.202*** (0.001)
Capital expenditure	-0.042** (0.014)	-0.042** (0.014)	-0.042** (0.014)
Sales growth	-0.031 (0.149)	-0.031 (0.149)	-0.031 (0.151)
Tobin's Q	0.056*** (0.000)	0.056*** (0.000)	0.056*** (0.000)
ROA	-0.332*** (0.002)	-0.332*** (0.002)	-0.331*** (0.002)
R&D expenditure	0.249 (0.388)	0.249 (0.388)	0.249 (0.389)
R&D dummy	-0.076 (0.331)	-0.076 (0.331)	-0.076 (0.333)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	46518	46518	46518
Adjusted R ²	0.092	0.092	0.092

This table presents regression results examining how family ownership moderates the relationship between green M&A activity and green innovation. All models include industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9

Firm heterogeneity: Green capabilities of acquiring firm

Variables	Green M&A	Green Innovation _{t+1}		
	(1)	(2)	(3)	(4)
Green underperformer	-0.102*** (0.035)	-0.491*** (0.024)	-0.491*** (0.024)	-0.491*** (0.024)
Green M&A dummy		0.494*** (0.126)		
Green M&A dummy $\times$ Green underperformer		-0.440*** (0.129)		
(ln) Green M&A count			0.713*** (0.181)	
(ln) Green M&A count $\times$ Green underperformer			-0.635*** (0.186)	
(ln) Green M&A value				0.178*** (0.047)
(ln) Green M&A value $\times$ Green underperformer				-0.159*** (0.049)
(ln) Firm size	0.276*** (0.017)	0.116*** (0.008)	0.116*** (0.008)	0.116*** (0.008)
(ln) Firm age	-0.074** (0.034)	-0.015 (0.015)	-0.015 (0.015)	-0.015 (0.015)
Leverage	0.165 (0.119)	0.080** (0.039)	0.080** (0.039)	0.079** (0.039)
Slack	-0.017 (0.015)	-0.007** (0.003)	-0.007** (0.003)	-0.007** (0.003)
Cash holdings	0.156 (0.206)	0.139*** (0.051)	0.139*** (0.051)	0.138*** (0.051)
Capital expenditure	0.224*** (0.067)	-0.032** (0.016)	-0.032** (0.016)	-0.032** (0.016)
Sales growth	0.123 (0.088)	-0.027 (0.020)	-0.027 (0.020)	-0.026 (0.020)
Tobin's Q	0.097*** (0.020)	0.053*** (0.009)	0.053*** (0.009)	0.053*** (0.009)
ROA	0.133 (0.379)	-0.269*** (0.095)	-0.269*** (0.095)	-0.269*** (0.095)
R&D expenditure	0.002 (0.748)	0.275 (0.255)	0.275 (0.255)	0.271 (0.256)
R&D dummy	0.060 (0.271)	-0.082 (0.071)	-0.082 (0.071)	-0.081 (0.071)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	47399	46518	46518	46518
Pseudo/Adjusted R^2	0.133	0.144	0.144	0.144

This table presents regression results examining whether the presence of green underperforming firms moderates the relationship between green M&A activity and green innovation. All models include industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10

Firm heterogeneity: ESG orientation of acquiring firm

Variables	Green M&A	Green Innovation _{t+1}		
	(1)	(2)	(3)	(4)
Green acquirer	0.004*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)
Green M&A dummy		0.081 (0.056)		
Green M&A dummy $\times$ ESG score _{t-1}		0.005* (0.003)		
(ln) Green M&A count			0.117 (0.081)	
(ln) Green M&A count $\times$ ESG score _{t-1}			0.008* (0.004)	
(ln) Green M&A value				0.027 (0.023)
(ln) Green M&A value $\times$ ESG score _{t-1}				0.002* (0.001)
(ln) Firm size	0.244*** (0.020)	0.110*** (0.010)	0.110*** (0.010)	0.110*** (0.010)
(ln) Firm age	-0.024 (0.041)	-0.001 (0.021)	-0.001 (0.021)	-0.001 (0.021)
Leverage	0.283** (0.138)	0.154*** (0.055)	0.154*** (0.055)	0.154*** (0.055)
Slack	-0.000 (0.015)	-0.005 (0.004)	-0.005 (0.004)	-0.005 (0.004)
Cash holdings	0.211 (0.239)	0.204*** (0.071)	0.204*** (0.071)	0.204*** (0.071)
Capital expenditure	0.234*** (0.074)	-0.041** (0.021)	-0.041** (0.021)	-0.041* (0.021)
Sales growth	0.192** (0.096)	-0.027 (0.025)	-0.027 (0.025)	-0.026 (0.025)
Tobin's Q	0.084*** (0.024)	0.039*** (0.012)	0.039*** (0.012)	0.039*** (0.012)
ROA	-0.124 (0.466)	-0.288** (0.124)	-0.288** (0.124)	-0.289** (0.124)
R&D expenditure	1.043 (1.187)	0.189 (0.275)	0.189 (0.275)	0.190 (0.275)
R&D dummy	-0.327 (0.459)	-0.108 (0.088)	-0.108 (0.088)	-0.108 (0.088)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	34304	34291	34291	34291
Pseudo/Adjusted R ²	0.143	0.105	0.105	0.105

This table presents regression results examining whether the acquiring firms' ESG orientation moderates the relationship between green M&A activity and green innovation. All models include industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 11**Corporate governance**

Panel A. Board independence						
Variables	Green Innovation _{t+1}		Green Innovation _{t+1}		Green Innovation _{t+1}	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Green M&A dummy	0.283*** (0.091)	0.198*** (0.073)				
(ln) Green M&A count			0.409*** (0.132)	0.286*** (0.105)		
(ln) Green M&A value					0.115*** (0.035)	0.066** (0.027)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	20328	26190	20328	26190	20328	26190
Adjusted R ²	0.088	0.095	0.088	0.095	0.089	0.094
Panel B. Board gender diversity						
Variables	Green Innovation _{t+1}		Green Innovation _{t+1}		Green Innovation _{t+1}	
	Yes	No	Yes	No	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Green M&A dummy	0.441*** (0.155)	0.196*** (0.059)				
(ln) Green M&A count			0.637*** (0.223)	0.282*** (0.084)		
(ln) Green M&A value					0.161*** (0.058)	0.073*** (0.022)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	7729	38789	7729	38789	7729	38789
Adjusted R ²	0.123	0.085	0.123	0.085	0.124	0.085

This table presents regression results examining whether the relationship between green M&A activity and green innovation differs across corporate governance characteristics. Panels A and B report results based on board independence and board gender diversity, respectively. All regressions include the full set of control variables used in Table 3 (not reported for brevity), as well as industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 12**Additional analysis: Innovation capacity and external opportunity**

Panel A. Absorptive capacity						
Variables	Green Innovation _{t+1}		Green Innovation _{t+1}		Green Innovation _{t+1}	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Green M&A dummy	0.249*** (0.093)	-0.008 (0.009)				
(ln) Green M&A count			0.360*** (0.134)	-0.012 (0.014)		
(ln) Green M&A value					0.096*** (0.033)	-0.002 (0.004)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	13867	32651	13867	32651	13867	32651
Adjusted R ²	0.064	0.011	0.064	0.011	0.065	0.011
Panel B. Technological opportunity						
Variables	Green Innovation _{t+1}		Green Innovation _{t+1}		Green Innovation _{t+1}	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Green M&A dummy	0.239** (0.094)	0.004 (0.018)				
(ln) Green M&A count			0.345** (0.136)	0.006 (0.027)		
(ln) Green M&A value					0.095*** (0.034)	-0.000 (0.006)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	13311	33207	13311	33207	13311	33207
Adjusted R ²	0.076	0.024	0.076	0.024	0.076	0.024

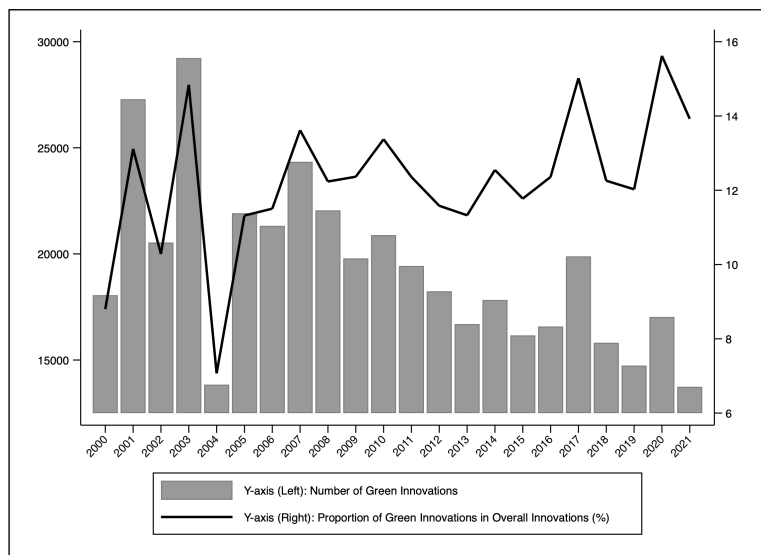
This table presents regression results examining whether the relationship between green M&A activity and green innovation varies with firms' innovation capacity and external technology opportunity. Panel A reports results based on absorptive capacity, while Panel B presents results that focus on technological opportunity. All regressions include the full set of control variables used in Table 3 (not reported for brevity), as well as industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 13

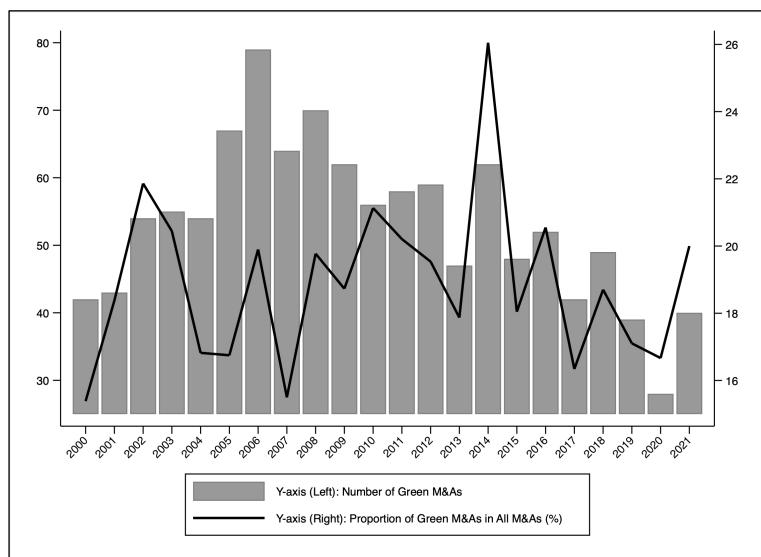
Additional analysis: Market and accounting performance following green M&A activity

Panel A. Market valuation									
Variables	Tobin's Q_{t+1}			Tobin's Q_{t+2}			Tobin's Q_{t+3}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Green M&A dummy	0.112*** (0.029)			0.082*** (0.027)			0.051* (0.028)		
(ln) Green M&A count		0.162*** (0.042)			0.118*** (0.039)			0.074* (0.041)	
(ln) Green M&A value			0.042*** (0.011)			0.032*** (0.010)			0.021** (0.010)
(ln) Green Innovation	0.038*** (0.008)	0.038*** (0.008)	0.038*** (0.008)	0.034*** (0.008)	0.034*** (0.008)	0.034*** (0.008)	0.029*** (0.008)	0.029*** (0.008)	0.029*** (0.008)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	44821	44821	44821	42342	42342	42342	39933	39933	39933
Adjusted R^2	0.367	0.367	0.367	0.338	0.338	0.338	0.310	0.310	0.310
Panel B. Profitability									
Variables	ROA $_{t+1}$			ROA $_{t+2}$			ROA $_{t+3}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Green M&A dummy	-0.004** (0.002)			-0.006*** (0.002)			-0.007*** (0.002)		
(ln) Green M&A count		-0.006** (0.003)			-0.009*** (0.003)			-0.011*** (0.003)	
(ln) Green M&A value			-0.001* (0.001)			-0.002*** (0.001)			-0.002*** (0.001)
(ln) Green Innovation	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	44821	44821	44821	42342	42342	42342	39933	39933	39933
Adjusted R^2	0.192	0.192	0.192	0.143	0.143	0.143	0.110	0.110	0.110

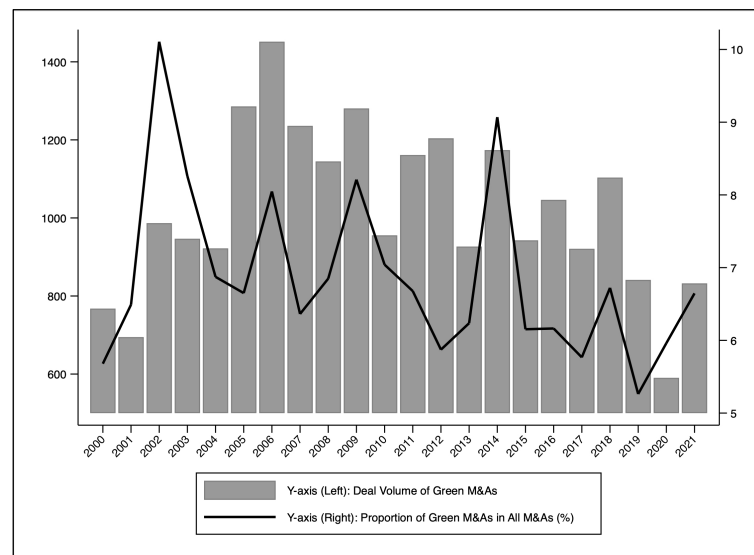
This table presents the results of market and accounting performance following green M&A activity. Panels A and B assess the effect on the market valuation (Tobin's Q) and profitability (ROA), respectively, over the three years following the green M&A activity. Green innovation is included as an additional control variable in both panels. All regressions include the full set of control variables used in Table 3, excluding Tobin's Q or ROA in their respective specifications (not reported for brevity). All regressions include industry and year fixed effects. Standard errors are clustered at the firm level and shown in parentheses. Variable definitions are provided in Appendix A. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.



(a)

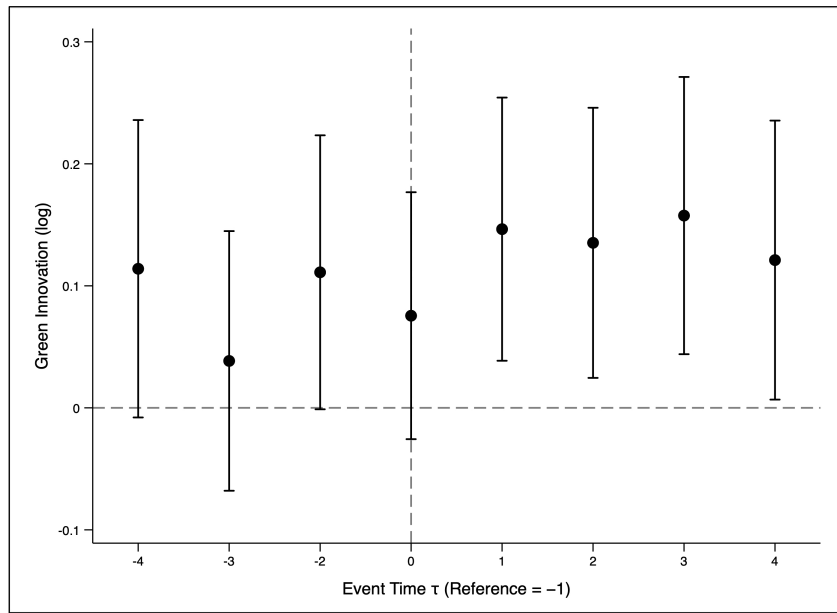


(b)

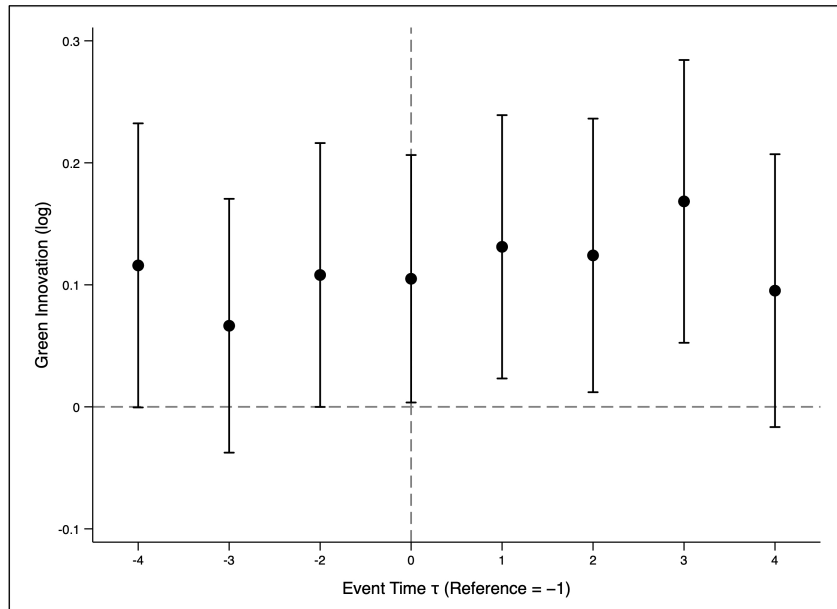


(c)

Fig. 1. Trends in green innovation and green M&As. Figure 1 illustrates the annual trends in (a) the number of green innovations, (b) the number of green M&A transactions, and (c) the total deal volume of green M&As. For each panel, we also plot the proportion relative to the total overall innovations or all M&A activity, respectively.

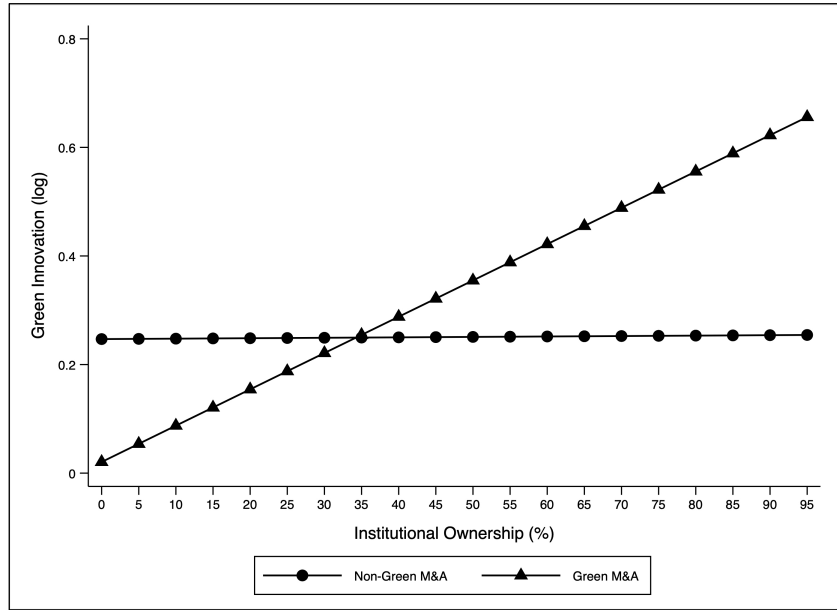


(a)

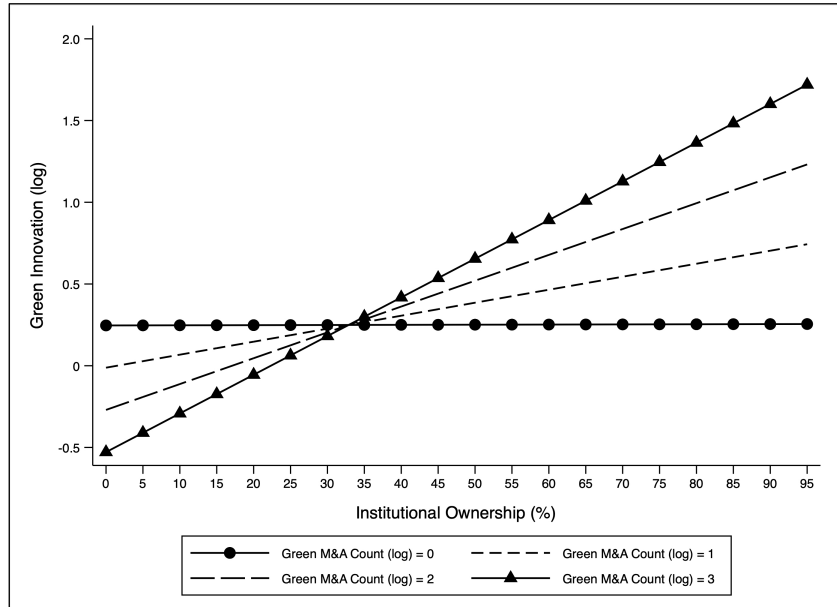


(b)

Fig. 2. Dynamic effects of green M&A activity on green innovation. Figure 2 plots the coefficients estimated for the dynamic effects of green M&A activity on green innovation using (a) the baseline event-study DiD model and (b) the Sun and Abraham (2021) model. The solid lines represent 95% confidence intervals.

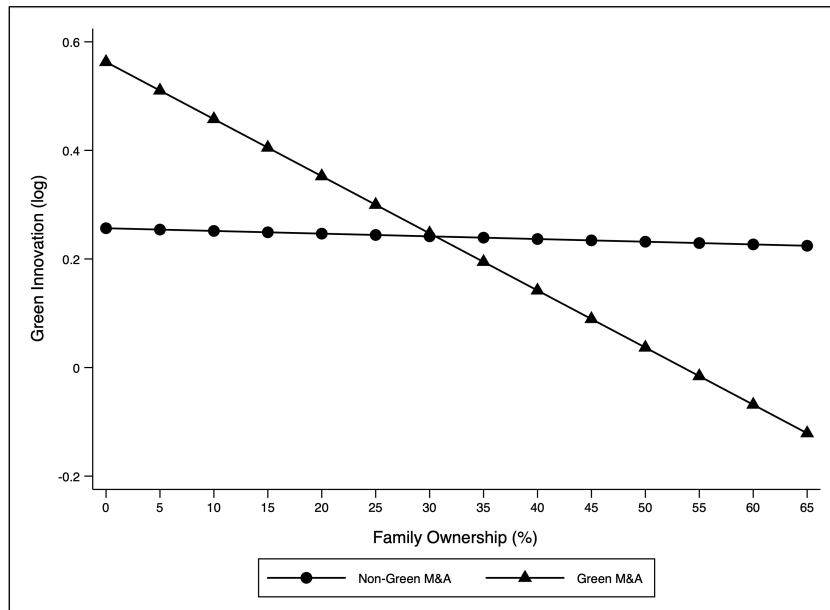


(a)

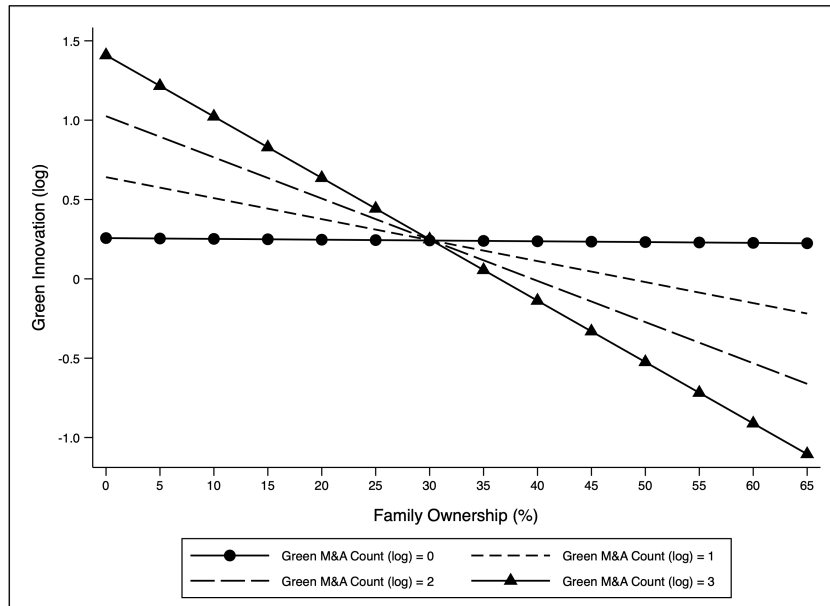


(b)

Fig. 3. Interaction effects of institutional ownership and green M&A activity on green innovation. Figure 3 depicts how institutional ownership moderates the relationship between green M&A activity and green innovation. Panel (a) presents the results based on the presence of green M&A activity (corresponding to Column (1) of Table 7, Panel A), while Panel (b) displays results based on the count of green M&As (Column (2) of Table 7, Panel A). In both panels, the vertical axis represents the natural logarithm of one plus green innovation, and the horizontal axis denotes the levels of institutional ownership.



(a)



(b)

Fig. 4. Interaction effects of family ownership and green M&A activity on green innovation. Figure 4 depicts how family ownership moderates the relationship between green M&A activity and green innovation. Panel (a) presents the results based on the presence of green M&A activity (corresponding to Column (1) of Table 8), while Panel (b) displays results based on the count of green M&As (Column (2) of Table 8). In both panels, the vertical axis represents the natural logarithm of one plus green innovation, and the horizontal axis denotes the levels of family ownership.