ANTHROPOLOGICAL NOTEBOOKS
ISSN / eISSN 1408-032X
Publisher SLOVENE ANTHROPOLOGICAL SOC,
FAK SPORT, GORTANOVA 22,
LJUBLJANA, SLOVENIA, SI-1000
Volume 26-Issue 1-(2026)
http://doi.org/10.65281/703862

OPEN ACCESS

Signal transmission and green development: Does transition climate risk drives green mergers and acquisitions?

Check for updates

Ran He [1] ,Yang Yang[1,], Haifeng Guo[2]*

[1]*Business School, Harbin Institute of Technology, Harbin, Heilongjiang, 150001, China*

[2]*School of Finance, Southwestern University of Finance and Economics, Chengdu, Sichuan, 610074, China*

Ran He:18b910042@stu.hit.edu.cn

[*]***Yang Yang:***corrine0925@126.com

Haifeng Guo:783224745@qq.com

Abstract: In the face of the severe global challenges posed by climate change, green development has become essential for corporate sustainability. Green mergers and acquisitions (M&A) serve as a pivotal strategy in this transformation. Drawing on signaling theory, this study investigates the effect of transition climate risk on green M&A, while also examining the moderating roles of government subsidies and investor attention. Using data from Chinese A-share listed companies over the period from 2013 to 2023, we apply logistic regression for empirical analysis. The results show that transition climate risk significantly drives green M&A activities, with government subsidies and investor attention further amplifying this effect. This study extends the application of signaling theory to the context of transition climate risk and green M&A, offering theoretical insights for both corporate strategy and policy development.

Keywords: Transition climate risk, Green mergers and acquisitions, Government subsidy, Investor attention

1. Introduction

As global concerns over climate change intensify, green development has become a central strategy for achieving corporate sustainability (Lu, 2022). In this context, green mergers and acquisitions (M&A) have garnered significant attention as a pivotal mechanism for driving green transformation (Andriuškevičius & Štreimikienė, 2022; Liang et al., 2022). Green M&A involves acquiring green resources, advanced technologies, and management expertise to meet the increasing demand for sustainable practices (Yang & Chi, 2023). This strategy enables firms to rapidly access critical green assets, enhancing their competitive advantage and fostering innovation, thereby strengthening their position in green markets (Liang et al., 2022). Existing research suggests that green M&A not only accelerates firms' green transformation and market positioning but also contributes to advancing broader sustainability and environmental preservation goals (Lu, 2021; Zhou et al., 2023).

Simultaneously, the escalating risks associated with climate change have made transition climate risk a crucial concern for firms. This risk arises from uncertainties surrounding policy shifts, technological advancements, and evolving market demands as firms adjust to climate-related challenges (Rong et al., 2024). Transition climate risk encompasses both external environmental pressures and the strategic shifts firms must undertake to transition to low-carbon operations (Li & Pan, 2022). These pressures, including compliance costs and carbon taxes, can heighten operational expenses (Reboredo & Ugolini, 2022), prompting firms to explore strategic avenues, such as green M&A, to mitigate these risks. While the importance of green M&A is widely acknowledged, research into the specific drivers of this strategy, particularly in the context of transition climate risk, remains limited. While some studies suggest that transition climate risk increases firms' willingness to bear risks and enhances their legitimacy demands (Xu et al., 2022), the underlying mechanisms and boundary conditions shaping green M&A decisions are underexplored. This study addresses two core research questions: Can transition climate risk drive green M&A? What are the specific mechanisms underlying this relationship?

Government subsidies, as a key policy instrument, also play a vital role in promoting green innovation by alleviating financial constraints and stimulating firms' green capabilities (Fan et al., 2022). These subsidies not only reduce the financial burden associated with green transformation but also guide firms in making strategic investments in sustainability (Shao & Chen, 2022). In the context of green M&A, government subsidies are particularly crucial. They help firms overcome financial obstacles during acquisitions, mitigate associated risks, and enhance motivation for green M&A (Liang et al., 2022). For instance, subsidies provided to new energy vehicle firms facilitate their acquisition of critical technologies and resources, boosting their competitiveness in the renewable energy sector. While the role of government subsidies in fostering green innovation is well-documented, their moderating effect on the relationship between transition climate risk and green M&A remains insufficiently explored. Existing research has primarily focused on subsidies' impact on green innovation and environmental performance, with limited attention to how subsidies influence M&A decisions under the pressures of transition climate risk. Thus, the second research question this study seeks to address is: How do government subsidies moderate the impact of transition climate risk on green M&A?

Investor attention, as a key external governance mechanism, also plays a crucial role in shaping firms' green M&A strategies. Investor attention influences firm behavior, decision-making, and market performance (Yao et al., 2024), with a growing focus on firms that adopt green strategies

and demonstrate strong environmental performance (Schuster et al., 2023). This trend encourages firms to prioritize environmental considerations in their M&A decisions to attract investor support. Investor attention acts as a form of market oversight, impacting market valuations and stock performance (Yin et al., 2023), thus motivating firms to engage in green M&A as a signal of their commitment to sustainability. However, while existing literature has explored the impact of investor attention on firm performance and transparency, its moderating role in the relationship between transition climate risk and green M&A remains largely unexplored. Accordingly, the third research question addressed in this study is: How does investor attention moderate the relationship between transition climate risk and green M&A?

This study empirically tests these hypotheses using a sample of A-share listed companies in China from 2013 to 2023. The results demonstrate that transition climate risk significantly drives firms' green M&A activities. Furthermore, both government subsidies and investor attention positively moderate the relationship between transition climate risk and green M&A. This study contributes to the literature in three important ways. First, it expands research on climate risk by highlighting the strategic role of transition climate risk in driving green M&A decisions, a topic previously underexplored. This offers new insights into how climate risk shapes corporate strategies and provides guidance for responding to climate change. Second, the study identifies transition climate risk as a critical driver of green M&A, broadening the understanding of its role in facilitating firms' green transformations. Finally, drawing on signaling theory, the study uncovers the moderating roles of government subsidies and investor attention in green M&A, enriching the theoretical framework of green M&A research. These findings offer valuable implications for firms, policymakers, and investors, providing a comprehensive foundation for decision-making in green M&A and suggesting new directions for future research.

2. Theory and hypothesis literature review

2.1 Literature Review and theoretical basis

As global awareness of climate change intensifies, governments worldwide have introduced stringent policies to steer firms toward low-carbon and green transformations. These regulatory measures, central to transition climate risk, increase external uncertainty through stricter carbon policies, tighter environmental regulations, and growing public demand for sustainability (Reboredo & Ugolini, 2022). In response, firms face heightened legitimacy pressures, requiring them to demonstrate their commitment to sustainability to key stakeholders—governments, investors, and consumers. Green mergers and acquisitions (M&A), as a prominent form of green investment, have emerged as a strategic tool for firms to signal their environmental commitment (Han et al., 2022). By acquiring green technologies, products, or services, firms can rapidly enter green markets, enhance their environmental reputation, and attract policy support, investment, and market recognition (Lu, 2022).

Signaling theory, widely applied in studies of firm behavior, posits that firm actions convey signals to external stakeholders, shaping their perceptions and influencing decisions (Su et al., 2016). In the context of climate risk, firms are compelled to signal their commitment to green transformation by undertaking initiatives such as green M&A, addressing the growing expectations of stakeholders (Han et al., 2022). These external shifts are interpreted by firms as signals requiring strategic adjustments (BliegeBird & Smith, 2005). For example, as carbon emission regulations tighten, firms recognize the risks of continuing high-carbon production, including increased taxes

and loss of market share. In response, firms seek to transition to low-carbon practices, aligning with evolving market demands. From a risk management perspective, transition climate risk heightens operational uncertainties (Nguyen & Phan, 2020), and green M&A offers a means to mitigate these risks. Not only does green M&A facilitate resource integration and supply chain optimization, but it also strengthens firms' resilience by reducing exposure to risks (Liang et al., 2022). For instance, by acquiring upstream and downstream green firms, firms can create synergies within the supply chain, reducing the impact of climate risks such as disruptions in raw material supply or market demand fluctuations.

In a dynamic business environment, firms' strategic decisions serve as signals that influence stakeholder perceptions and subsequent actions. In response to climate change and evolving government policies, green M&A has become a primary focus for policy support, including subsidies and tax incentives (Wang et al., 2024). These government subsidies provide critical financial support, easing firms' funding constraints and facilitating the adoption of green initiatives (Wu & Hu, 2022). Such incentives are particularly vital in sectors marked by uncertain returns, where they help mitigate risks related to technological failure and market adoption (Bai et al., 2019). By alleviating these challenges, subsidies enhance firms' willingness to invest in green innovation (Hu et al., 2021). Moreover, government subsidies not only reduce financial risks but also enhance the legitimacy of firms by signaling alignment with broader policy goals. This alignment strengthens firms' competitive positioning, particularly in the green M&A space, as it underscores their commitment to sustainability and policy-driven objectives (Bianchi et al., 2019).

Investor attention, as a form of external governance, plays a pivotal role in shaping firms' green strategies. Investors increasingly focus on firms' environmental performance, encouraging them to adopt sustainable practices (He et al., 2022). By monitoring indicators such as carbon emissions and resource efficiency, investors push firms to prioritize green technologies and emission reduction measures, safeguarding their reputation and market value. As societal concerns over sustainability rise, investors increasingly consider firms' green positioning when making investment decisions. In turn, firms reassess their strategies and intensify investments in green industries to secure investor support (Yao et al., 2024). In the context of signaling theory, investor attention reinforces the signaling effect of green M&A, with high levels of investor focus signaling a firm's commitment to social responsibility and green transformation (Wang et al., 2023). Such attention not only bolsters the firm's reputation but also attracts additional resources for green M&A.

In summary, government subsidies and investor attention—key external forces—play an increasingly crucial role in shaping firms' responses to transition climate risks. As these risks intensify, firms are driven to pursue green M&A to align with the expectations of these stakeholders. Drawing on signaling theory, this study investigates the moderating effects of these external factors on the relationship between transition climate risk and green M&A.

2.2 Research hypothesis

First, transition climate risk drives green M&A by enhancing firms' risk tolerance. The uncertainties associated with transition climate risk destabilize operational conditions, forcing firms to confront increasing volatility in decision-making (Chen et al., 2024). While this heightened uncertainty amplifies perceived risks, it simultaneously increases managers' propensity to embrace risk (Xu et al., 2020). In response, firms recalibrate their strategies, redirecting resources toward green initiatives and scaling up investments in sustainable practices. These growing green

investments enhance their competitive positioning in green markets. However, relying solely on internal resources to achieve green transformation proves insufficient, particularly in areas like technology and market expansion. As such, green M&A emerges as a crucial strategy for acquiring external assets, accelerating the pace of green transformation (Han et al., 2022). With an increased willingness to assume risk, firms are more likely to pursue green M&A opportunities that align with their long-term sustainability objectives. By acquiring external green technologies, market access, and managerial expertise, firms can generate synergies, thereby fast-tracking their green transformation process.

Second, transition climate risk heightens firms' legitimacy demands, further incentivizing green M&A activity. In the face of rising global environmental concerns and more stringent regulations, firms are under growing pressure from stakeholders, including governments, investors, and consumers (Liu et al., 2024). These stakeholders now expect firms to demonstrate proactive environmental responsibility and contribute to sustainable development. To meet these expectations and safeguard their legitimacy, firms are compelled to take significant green actions. In this regard, green M&A plays a critical role. By acquiring firms with established green technologies, products, or market access, companies can rapidly scale their green operations and diversify their sustainability portfolio (Shi & Huang, 2024; Yang & Gu, 2024). Green M&A not only helps firms fulfill legitimacy demands but also enhances their market position, ensuring the long-term viability and growth of their green business. Therefore, we propose the following hypothesis:

H1: Transition climate risks positively drive green M&A.

First, government subsidies mitigate the financial burden on firms, enabling them to increase investments in green initiatives. Transition climate risks elevate the uncertainty firms face, prompting managers to adopt more risk-tolerant strategies and allocate resources to sustainability efforts. In this context, subsidies serve as a critical enabler for investments in areas such as green technology development, product innovation, and green supply chain optimization (Han et al., 2022). For example, subsidies may facilitate the acquisition of advanced green technologies, the establishment of specialized R&D teams, or the enhancement of sustainable infrastructure, thereby improving a firm's competitive positioning in green markets.

Second, government subsidies strengthen a firm's competitive advantage in green M&A by enhancing its capacity to integrate external green resources (Bai et al., 2019). With financial support, firms are better equipped to pursue and execute green acquisitions, accelerating their transition to sustainability. Additionally, subsidies signal strong governmental endorsement of the firm's green initiatives, bolstering its legitimacy and reputation (Han et al., 2024). This not only helps firms meet stakeholder demands for environmental responsibility but also fosters a positive image of green commitment. For instance, firms may use subsidies to fund environmental projects, signaling their dedication to sustainability and strengthening their appeal to investors. This enhanced reputation not only attracts greater consumer loyalty but also garners increased investor interest and support for green M&A.Thus, we propose the following hypothesis:

H2: Government subsidies enhance the positive relationship between transition climate risk and green M&A.

First, investor attention magnifies the positive effect of firms' enhanced risk-taking capacity on green M&A under transition climate risk. As an external governance mechanism, investor scrutiny incentivizes firms to confront the uncertainties posed by transition climate risk more decisively (He

et al., 2022). When managers recognize that their strategic choices are closely monitored by investors, they are more likely to embrace risk, aiming to fulfill investor expectations for effective risk management and sustainable growth. This heightened risk tolerance encourages firms to intensify investments in green initiatives, such as advancing green technology R&D and entering emerging green markets. Such actions not only bolster the firm's competitive position in the green sector but also increase its capacity to pursue green M&A opportunities. Moreover, investor attention serves as a valuable source of market intelligence and potential partnerships (Yao et al., 2024), aiding firms in identifying strategic green M&A targets that align with their objectives, thereby expediting the green M&A process.

Second, investor attention plays a critical role in helping firms meet legitimacy demands and build a strong green image in response to transition climate risk, further driving green M&A. As societal concern for environmental issues intensifies, investors increasingly focus on how firms address environmental responsibilities amid transition climate risk. This increased scrutiny compels firms to more proactively engage with societal and regulatory expectations, reinforcing their legitimacy (He et al., 2022). Consequently, firms are more inclined to intensify investments in green business activities, pursue green innovation, and enhance the transparency of their environmental disclosures (Hu et al., 2021a). By aligning with these legitimacy demands, firms secure stronger investor support, which in turn facilitates successful green M&A transactions. Therefore, we propose the following hypothesis:

H3: Investor attention strengthens the positive relationship between transition climate risk and green M&A.

3. Samples and variables

3.1 Sample

This study uses a sample of listed companies from the Shanghai and Shenzhen A-share markets in China from 2013 to 2023. We chose the 2013 as the starting year due to the increased global attention to climate change and the growing pressures on companies to undergo transformation suring this period. The study examines four core variables, with data on these variables sourced from publicly available databases. First, data on green M&A are drawn from the merger event data in the CSMAR database, which includes basic information on the acquiring and target companies, as well as their financial data. Additional information, such as merger announcements, annual reports, social responsibility reports, and sustainability reports, were collected from company websites and subjected to content analysis and keyword extraction. Second, data on transition climate risk are derived from the text in the corporate annual reports of listed companies, which can be accessed via the CNINFO website (http://www.cninfo.com.cn/new/index). Third, government subsidy data are obtained from the financial statement notes in the CSMAR database. Finally, investor attention data are sourced from the internet search index of listed companies disclosed in the CNRDS database. The control variables for this study are also drawn from the CSMAR and CNRDS databases. In total, the study includes a sample of 31,040 observations from 4,649 companies.

3.2 Variables

3.2.1 Independent variable: Green mergers and acquisitions

Green M&A refers to corporate acquisition activities that incorporate green principles, aiming to acquire green resources, technologies, equipment, while also contributing to energy savings, emission reductions, environmental protection, and sustainable development (Lu, 2022; Sun et al., 2023). Drawing on the works of Han et al. (2022), Yang et al. (2023b), and Zou & Ma (2024), we manually collected M&A announcements, annual reports, and other relevant documents from listed companies. Using text analysis techniques, we extracted green-related keywords such as "environmental protection," "energy-saving and emission reduction," "green technology," and "clean energy" to identify whether an M&A event qualifies as a green M&A. If the M&A information contains these keywords and, after a comprehensive analysis, it is determined that the transaction contributes to the firm's green production or development goals, the event is classified as a green M&A and assigned a value of 1. Otherwise, it is categorized as a non-green M&A and assigned a value of 0.

3.2.2 Dependent variable: Transition climate risk

Transition climate risk refers to the uncertainty and potential financial impacts that companies face during the transition to a low-carbon economy, resulting from changes in policies, technologies, markets, and societal factors (Lee et al., 2023; Arfaoui et al., 2024). This risk primarily stems from government policy adjustments aimed at addressing climate change, industry transformations driven by technological innovation, and challenges stemming from shifts in market demand and societal attitudes. Building on the works of Yang et al. (2024) and Fang (2024), we first analyzed corporate annual reports, government work reports, and other relevant texts to extract keywords related to transition climate risk. The frequency of these keywords was then used to measure the extent of transition climate risk. Subsequently, we employed an open-source Chinese word vector corpus to train these seed words, identifying synonyms, and expand the keyword database. Finally, using tools such as Python, we extracted the occurrence of these keywords in the annual reports of listed companies or government work reports, calculating their proportion relative to the total word count of the reports, which served as an indicator of transition climate risk.

3.2.3 Moderator variable

3.2.3.1 Government subsidies

Government subsidies refer to the financial support provided by governments to firms or other organizations to achieve specific economic, social, and environmental objectives (Yan & Li, 2018; Shao & Wang, 2023). This support can include, but is not limited to, financial grants, tax reductions, interest subsidies, and in-kind contributions. A common approach for measuring government subsidies is to use the natural logarithm of the total amount of subsidies received by a firm (Liu et al., 2019). Building on the work of Wang et al. (2021), Liu et al. (2022), and Shao & Wang (2023), we summed the values listed under "government subsidies" in the financial statement notes and then applied the natural logarithm to quantify the level of government support.

3.2.3.2 Investor attention

Investor attention refers to the level of interest shown by investors in specific events related to the firms in which they invest or firms within the relevant market (Gu, 2024). Most studies use a firm's internet search index as a key indicator to measure the level and fluctuations in investor attention (Hao & Xiong, 2021; Chen & Chen, 2024). Following the methodology of He et al. (2022)

and Zhang & Zhang (2024), we employed the internet search index as a proxy for investor attention in the Chinese market, measured by the natural logarithm of the total number of searches. Specifically, we calculated search frequencies based on keywords such as stock codes, firm abbreviations, and full firm names, then applied the natural logarithm to the sum of these frequencies.

3.2.4 Control variable

In accordance with previous research on green M&A by Sun & Liu (2022) and Zou & Ma (2024), we selected the following variables. Firm characteristics include firm size, listing age, financial leverage, and cash flow ratio. Firm governance characteristics include board size, CEO duality, the proportion of independent directors, and ownership concentration.

Table 1 Variable definitions

Variable	Name	Measure
Green Mergers and Acquisition	GMA	If a firm implements green M&A, it is assigned a value of 1; otherwise, it is assigned a value of 0.
Transition climate risk	TCR	(Total keyword frequency of "Transition Climate Risk" /Total word frequency of Annual Report)*100
Government subsidy	GS	ln(Total government subsidy + 1)
Investor attention	IA	ln(Number of searches with stock code as keyword + 1)
Firm size	Size	ln(Total annual assets + 1)
List age	ListAge	ln(Current year - Listing year + 1)
Financial leverage	Lev	Total liabilities / Total assets
Cash flow ratio	Cash	Net cash flow/Total assets
Board size	Board	ln(Number of board members + 1)
CEO duality	Dual	The board and CEO are the same as 1, otherwise 0
Independent director ratio	Indep	Independent directors divided by the number of directors
Share concentration	Top1	ratio of the largest shareholder

3.3 Empirical model

Based on the results of the Hausman test, we applied a fixed effects logistic regression model (FE_Logit) to test the hypotheses proposed in this study using the collected panel data. To examine the relationship between transition climate risk and green M&A, we specified Model 1as follows:

$$\text{logit}(GMA_{i,t+1}) = \alpha_0 + \alpha_1 TCR_{i,t} + \alpha_2 Controls_{i,t} + \alpha_i \sum Ind_i + \alpha_j \sum Year_j + \varepsilon_{i,t} \quad (1)$$

In equation (1), $GMA_{i,t+1}$ represents the green M&A activity of the firm in year $t+1$, $TCR_{i,t}$ denotes transition climate risk, and $Controls_{i,t}$ includes all control variables. Year effects are captured by $Year_j$, and industry effects are represented by Ind_i. $\varepsilon_{i,t}$ represents the random error term. The explanatory variables are lagged to mitigate potential endogeneity issues arising from reverse causality.

To test the moderating effects of government subsidies and investor attention on the relationship between transition climate risk and green M&A, we constructed Models 2 and 3 as follows:

$$\text{logit}(GMA_{i,t+1}) = \alpha_0 + \alpha_1 TCR_{i,t} + \alpha_2 GS_{i,t} + \alpha_3 TCR_{i,t} * GS_{i,t} + \sum \alpha_4 Controls_{i,t} + \alpha_i \sum Ind_i + \alpha_j \sum Year_j + \varepsilon_{i,t} \quad (2)$$

$$\text{logit}(GMA_{i,t+1}) = \alpha_0 + \alpha_1 TCR_{i,t} + \alpha_2 IA_{i,t} + \alpha_3 TCR_{i,t} * IA_{i,t} + \sum \alpha_4 Controls_{i,t} + \alpha_i \sum Ind_i + \alpha_j \sum Year_j + \varepsilon_{i,t} \quad (3)$$

In equation (2), $GS_{i,t}$ represents government subsidies, and the interaction term $TCR_{i,t} * GS_{i,t}$ captures the moderating effect of government subsidies. In equation (3), $IA_{i,t}$ represents investor attention, and the interaction term, $TCR_{i,t} * IA_{i,t}$ captures the moderating effect of investor attention.

4. Results

4.1 Descriptive statistics and correlation analysis

Table 2 presents the descriptive statistics, including the mean, standard deviation, maximum, minimum, and correlation analysis. The mean value of TCR is 0.189, indicating that firms are facing a relatively high level of transition climate risk. The mean value of GMA is 0.261, suggesting that approximately 26.1% of firms have engaged in green M&A activities. The mean values of GS and IA are 16.078 and 12.229, respectively. Furthermore, the correlation coefficients between most variables are relatively low, suggesting that severe multicollinearity is unlikely to be a concern.

Table 2 Descriptive statistics and correlation analysis

	Mean	Std	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12
GMA	0.261	0.439	0.000	1.000	1											
TCR	0.189	0.157	0.000	1.757	0.226***	1										
GS	16.078	2.557	0.000	20.234	0.030***	0.143***	1									
IA	12.229	2.841	0.000	14.915	0.043***	0.010*	0.047***	1								
Size	22.266	1.295	19.966	26.314	0.089***	0.246***	0.373***	0.285***	1							
ListAge	2.085	0.941	0.000	3.497	0.063***	0.070***	0.016***	0.453***	0.438***	1						
Lev	0.417	0.208	0.008	1.957	0.156***	0.158***	0.101***	0.199***	0.495***	0.380***	1					
Cash	0.047	0.075	-0.888	0.876	-0.072***	0.038***	0.121***	0.006	0.079***	-0.023***	-0.162***	1				
Board	2.112	0.199	1.099	2.890	0.016***	0.105***	0.099***	0.102***	0.270***	0.160***	0.140***	0.039***	1			
Indep	0.378	0.056	0.143	0.800	-0.011*	-0.052***	-0.005	-0.001	-0.010*	-0.017***	-0.006	-0.002	-0.559***	1		
Dual	0.298	0.457	0.000	1.000	-0.035***	-0.068***	-0.022***	-0.148***	-0.190***	-0.262***	-0.139***	-0.010*	-0.174***	0.100***	1	
Top1	0.338	0.149	0.003	0.900	-0.045***	0.076***	0.074***	-0.009	0.187***	-0.077***	0.034***	0.104***	0.018***	0.039***	-0.053***	1

*Note: ***p < 0.01, **p < 0.05, *p < 0.1.*

4.2 Main regression

Table 3 presents the results of the fixed-effects logistic regression, which tests the hypotheses proposed in this study. First, Model 1 includes only the control variables as a baseline. Next, the regression results in Model 2 show a significantly positive relationship between transition climate risk (TCR) and green mergers and acquisitions (GMA) ($\beta = 2.275$, $p < 0.01$), indicating that as TCR increases, the likelihood of firms engaging in GMA significantly rises, thus supporting H1. Furthermore, the results from Model 3 demonstrate that government subsidies (GS) has a significant positive effect on GMA ($\beta = 0.022$, $p < 0.01$). The interaction term between TCR and GS (TCR*GS) is also significantly positive ($\beta = 0.110$, $p < 0.01$), suggesting that GS enhances the positive effect of TCR on GMA, thereby supporting H2. Finally, the regression results from Model 4 indicate a significant positive effect of investor attention (IA) on GMA ($\beta = 0.019$, $p < 0.01$), and the interaction term between TCR and IA (TCR*IA) is significantly positive ($\beta = 0.118$, $p < 0.01$). This finding implies that IA strengthens the positive influence of TCR on GMA, supporting H3. Model 5, which includes all variables, further corroborates the above results, with the signs and significance of the key variables' coefficients remaining consistent with those in the previous models.

Table 3 The Results of TCR on GMA

Variable	GMA				
	Model1	Model2	Model3	Model4	Model5
Size	0.075***	0.017	-0.007	0.008	-0.014
	(0.014)	(0.015)	(0.016)	(0.015)	(0.017)
ListAge	0.064***	0.079***	0.082***	0.054***	0.058***
	(0.018)	(0.019)	(0.019)	(0.020)	(0.020)
Lev	1.057***	0.999***	1.003***	1.010***	1.013***
	(0.083)	(0.084)	(0.084)	(0.084)	(0.084)
Cash	-1.381***	-1.357***	-1.380***	-1.379***	-1.401***
	(0.195)	(0.197)	(0.197)	(0.197)	(0.197)
Board	-0.172*	-0.178**	-0.180**	-0.177*	-0.179**
	(0.089)	(0.090)	(0.090)	(0.090)	(0.091)
Indep	-0.459	-0.239	-0.241	-0.237	-0.238
	(0.304)	(0.307)	(0.307)	(0.307)	(0.307)
Dual	-0.033	-0.025	-0.023	-0.023	-0.021
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
Top1	-0.979***	-1.055***	-1.061***	-1.051***	-1.058***
	(0.101)	(0.103)	(0.103)	(0.103)	(0.103)
TCR		2.275***	2.233***	2.261***	2.227***
		(0.103)	(0.104)	(0.104)	(0.105)
GS			0.022***		0.021***
			(0.007)		(0.007)
IA				0.019***	0.018***
				(0.006)	(0.006)
TCR*GS			0.110***		0.091**
			(0.042)		(0.042)

TCR*IA				0.118***	0.109***
				(0.035)	(0.035)
Constants	-2.931***	-1.956***	-1.773***	-1.953***	-1.788***
	(0.408)	(0.414)	(0.418)	(0.415)	(0.419)
N	31040	31040	31040	31040	31040
Industry	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.087	0.101	0.102	0.102	0.102

Note: Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

5 Robustness and heterogeneity analysis

5.1 Instrumental Variable

To account for potential endogeneity in the relationship between transition climate risk (TCR) and green mergers and acquisitions (GMA), we introduce an instrumental variable (IV) and apply a two-stage least squares (2SLS) model. This approach mitigates the risk of biased estimates that may arise from unobserved factors influencing both TCR and GMA. Following Yang et al. (2024), we use the Paris Agreement as our instrument, coded as 0 for years prior to its implementation (pre-2016) and 1 for years post-implementation (from 2016 onward). The Paris Agreement serves as a valid instrument for two key reasons: First, its implementation heightens the TCR faced by firms, encouraging greater disclosure of TCR-related information in annual reports (Diaz-Rainey et al., 2021). Second, the signing of the Paris Agreement is an external event independent of firm-level decisions, ensuring its exogeneity and satisfying the necessary condition for a valid instrument. This study primarily conducted tests for identification and weak instruments, and the results confirm the validity of the instrument.

Table 4 presents the regression results using the instrumental variable. In the first stage, with TCR as the dependent variable, the coefficient of the IV is significantly positive ($\beta = 0.038$, $p < 0.01$), indicating that the IV is correlated with the endogenous variable. In the second stage, with GMA as the dependent variable, the coefficient of TCR is significantly positive ($\beta = 1.141$, $p < 0.05$), suggesting that after addressing endogeneity and adjusting for it with the instrumental variable method, TCR continues to have a significant positive effect on GMA, consistent with the earlier findings.

Table 4 Results of instrumental variable regression

Variable	TCR	GMA
	Model1	Model2
TCR		1.141**
		(1.012)
IV	0.038***	
	(0.003)	
Size	0.023***	0.014
	(0.001)	(0.026)
ListAge	-0.004***	0.047***
	(0.001)	(0.012)

Lev	0.029***	0.594***
	(0.004)	(0.056)
Cash	-0.017*	-0.788***
	(0.010)	(0.115)
Board	0.005	-0.101*
	(0.005)	(0.053)
Indep	-0.088***	-0.145
	(0.016)	(0.202)
Dual	-0.003**	-0.017
	(0.002)	(0.019)
Top1	0.026***	-0.598***
	(0.005)	(0.063)
Constants	-0.403***	-1.243***
	(0.021)	(0.459)
N	31,040	31,040
AR		1.26***
Wald		1.27***
Industry	Yes	Yes
Year	Yes	Yes
Adj /Pseudo R^2	0.358	0.101

Note: Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

5.2 Robustness analysis

To further assess the robustness of the empirical results, we conducted three types of robustness checks, with the specific results presented in Table 5. First, we replaced the measurement method for the explanatory variable by using the annual count of green M&A events (NGMA) as a substitute for GMA, following the approach of Yang et al. (2023a). The regression results in Models 1 and 2 show that, after introducing the alternative variable, the results remain highly consistent with those from the previous regressions. Second, we altered the econometric model by replacing the Logit model with the Probit model to revalidate the hypotheses. The results from Models 3 and 4 demonstrate that the findings obtained using the Probit model are consistent with those derived from the Logit model. Finally, we shortened the sample period to exclude data influenced by the COVID-19 pandemic. The sample period was narrowed to 2016-2019, removing data from the pandemic-impacted years. The regression results in Models 5 and 6 continue to align with the original findings. In summary, the main empirical conclusions of this study remain robust across different model specifications and data treatments, thereby strengthening the reliability of the results.

Table 5 Robustness check

Variable	NGMA Model1	NGMA Model2	GMA Model3	GMA Model4	GMA Model5	GMA Model6
Size	0.031***	0.018*	0.009	-0.009	0.052***	0.016
	(0.010)	(0.010)	(0.009)	(0.010)	(0.019)	(0.021)
ListAge	0.018*	0.006	0.048***	0.035***	0.042*	0.025

	(0.010)	(0.011)	(0.011)	(0.012)	(0.025)	(0.027)
Lev	0.582***	0.591***	0.588***	0.595***	0.934***	0.948***
	(0.058)	(0.058)	(0.049)	(0.049)	(0.107)	(0.107)
Cash	-0.785***	-0.801***	-0.784***	-0.809***	-1.755***	-1.791***
	(0.122)	(0.122)	(0.114)	(0.114)	(0.250)	(0.251)
Board	-0.301***	-0.302***	-0.102*	-0.103*	-0.366***	-0.370***
	(0.060)	(0.060)	(0.053)	(0.053)	(0.114)	(0.114)
Indep	-0.500**	-0.498**	-0.125	-0.128	-0.679*	-0.684*
	(0.198)	(0.198)	(0.179)	(0.179)	(0.389)	(0.389)
Dual	0.011	0.012	-0.017	-0.015	-0.035	-0.032
	(0.020)	(0.020)	(0.019)	(0.019)	(0.042)	(0.042)
Top1	-0.774***	-0.773***	-0.604***	-0.605***	-1.035***	-1.033***
	(0.059)	(0.059)	(0.060)	(0.060)	(0.130)	(0.130)
TCR	1.610***	1.563***	1.360***	1.333***	2.210***	2.143***
	(0.099)	(0.097)	(0.060)	(0.062)	(0.130)	(0.135)
GS		0.007*		0.012***		0.024***
		(0.004)		(0.004)		(0.009)
IA		0.011***		0.011***		0.027**
		(0.003)		(0.004)		(0.011)
TCR*GS		0.093**		0.057**		0.093*
		(0.040)		(0.025)		(0.053)
TCR*IA		0.132***		0.064***		0.068*
		(0.022)		(0.020)		(0.065)
Constants	0.464*	0.530**	-1.155***	-1.061***	-1.962***	-1.886***
	(0.242)	(0.241)	(0.240)	(0.244)	(0.516)	(0.525)
N	31080	31071	31040	31031	19071	19068
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Adj /Pseudo R^2	0.098	0.100	0.101	0.102	0.098	0.099

Note: Standard errors in parentheses

* *p < 0.10,* ** *p < 0.05,* *** *p < 0.01*

5.3 Heterogeneity analysis

Firms' ownership structures influence their legitimacy demands and resource acquisition strategies, necessitating an examination of how the proposed hypotheses hold across different ownership types. First, with respect to the effect of transition climate risk (TCR) on green mergers and acquisitions (GMA), the results reveal notable differences between state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs). For SOEs, the coefficient of TCR in Model 1 is 2.089 ($p < 0.1$), whereas for non-SOEs in Model 4, the coefficient increases to 2.344 ($p < 0.01$). This suggests that TCR has a stronger positive influence on GMA in non-SOEs than in SOEs. This discrepancy may stem from the heightened competitive pressures faced by non-SOEs, which necessitate continual innovation and the pursuit of new growth opportunities. In the context of TCR, non-SOEs are more inclined to use green M&A as a strategic tool to rapidly acquire green

technologies and resources, thus enhancing their green competitiveness and responsiveness to climate-related risks.

Second, regarding the moderating role of government subsidies (GS), the results indicate that subsidies significantly amplify the effect of TCR on GMA for SOEs. In Model 2, the interaction term (TCR*GS) for SOEs shows a positive and significant coefficient of 0.217 ($p < 0.1$). However, for non-SOEs in Model 5, the interaction term is statistically insignificant ($\beta = 0.01$, $p > 0.1$), suggesting that government subsidies do not exert a notable moderating effect on the relationship between TCR and GMA in non-SOEs. This divergence may be attributed to SOEs' relatively easier access to government resources, which allows them to leverage subsidies more effectively in their green initiatives, whereas non-SOEs face greater barriers in securing such support.

Finally, in terms of the moderating role of investor attention (IA), Model 3 for SOEs reveals an insignificant coefficient of 0.381 ($p > 0.1$) for the interaction term (TCR*IA), indicating that investor attention does not meaningfully influence the TCR-GMA relationship in SOEs. In contrast, Model 6 for non-SOEs shows a positive and significant coefficient of 0.098 ($p < 0.1$), suggesting that investor attention significantly strengthens the relationship between TCR and GMA in non-SOEs. This contrast can be explained by the fact that SOEs are more heavily influenced by government directives, diminishing the role of market signals such as investor attention. In non-SOEs, where market dynamics and investor expectations play a more pivotal role, investor attention becomes a crucial driver of strategic decisions related to green M&A.

Table 6 Analysis of Ownership heterogeneity

	State-owned			Non-state-owned		
	Model1	Model2	Model3	Model4	Model5	Model6
Size	0.108***	0.068***	0.091***	-0.039**	-0.052**	-0.048**
	(0.023)	(0.025)	(0.024)	(0.020)	(0.023)	(0.020)
ListAge	-0.001	0.000	-0.027	0.120***	0.123***	0.098***
	(0.037)	(0.037)	(0.039)	(0.024)	(0.024)	(0.026)
Lev	0.675***	0.689***	0.696***	1.254***	1.255***	1.263***
	(0.139)	(0.140)	(0.140)	(0.109)	(0.109)	(0.109)
Cash	-0.901***	-0.889**	-0.894**	-1.571***	-1.593***	-1.595***
	(0.349)	(0.349)	(0.349)	(0.242)	(0.243)	(0.243)
Board	-0.397***	-0.403***	-0.414***	-0.048	-0.047	-0.046
	(0.143)	(0.144)	(0.143)	(0.123)	(0.123)	(0.123)
Indep	-0.325	-0.374	-0.374	-0.261	-0.241	-0.257
	(0.465)	(0.466)	(0.466)	(0.425)	(0.425)	(0.425)
Dual	0.071	0.075	0.070	-0.045	-0.044	-0.043
	(0.073)	(0.073)	(0.073)	(0.037)	(0.037)	(0.037)
Top1	-0.990***	-0.994***	-0.991***	-1.021***	-1.026***	-1.021***
	(0.172)	(0.172)	(0.173)	(0.136)	(0.136)	(0.136)
TCR	2.089*	1.996*	1.850*	2.344***	2.345***	2.372***
	(0.170)	(0.172)	(0.184)	(0.133)	(0.134)	(0.134)
GS		0.035***			0.011	
		(0.011)			(0.010)	
IA			0.037			0.013**

			(0.023)			(0.007)
TCR*GS		0.217***			0.01	
		(0.061)			(0.060)	
TCR*IA			0.381			0.098***
			(0.118)			(0.037)
Constants	-3.077***	-2.725***	-3.068***	-1.170*	-1.087*	-1.139*
	(0.590)	(0.597)	(0.611)	(0.646)	(0.652)	(0.647)
N	10797	10793	10797	20189	20184	20189
Pseudo R^2	0.098	0.100	0.100	0.114	0.114	0.115
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

The varying levels of pollution result in different environmental pressures and societal expectations, highlighting the need to examine how the research hypotheses function under different pollution intensities. First, concerning the relationship between transition climate risk (TCR) and green mergers and acquisitions (GMA), the regression results reveal contrasting effects for firms with varying pollution levels. For non-heavy-polluting firms, Model 1 yields an insignificant coefficient of 2.440 ($p > 0.1$), while for heavy-polluting firms, Model 4 shows a significant positive coefficient of 1.855 ($p < 0.01$). These findings suggest that the positive impact of TCR on GMA is more pronounced for heavy-polluting firms. This is likely due to the heightened regulatory and societal pressures faced by these firms to reduce carbon emissions and comply with stricter environmental standards. Consequently, in the face of transition climate risk, heavy-polluting firms are more inclined to pursue green M&A as a strategic response to ensure compliance and adaptation to stringent regulations.

Second, regarding the moderating effect of government subsidies (GS), Model 2 for non-heavy-polluting firms shows an insignificant coefficient of 0.078 ($p > 0.1$) for the interaction term (TCR*GS). In contrast, Model 5 for heavy-polluting firms indicates a significant positive coefficient of 0.162 ($p < 0.05$) for the same interaction term. This suggests that government subsidies notably enhance the positive relationship between TCR and GMA for heavy-polluting firms, whereas no such effect is observed in non-heavy-polluting firms. This divergence may stem from the relatively lower pressure on non-heavy-polluting firms to engage in green transformations. Even with subsidies, these firms may prioritize other strategic objectives over green M&A in response to transition climate risks.

Finally, in terms of the moderating role of investor attention (IA), Model 3 for non-heavy-polluting firms shows an insignificant coefficient of 0.124 ($p > 0.1$) for the interaction term (TCR*IA). In contrast, Model 6 for heavy-polluting firms reveals a significant positive coefficient of 0.096 ($p < 0.01$) for the same interaction term. This difference may be attributed to the fact that non-heavy-polluting firms perceive investor attention as primarily focused on financial performance and profitability rather than on green M&A initiatives. For heavy-polluting firms, however, investor attention acts as a crucial signal, motivatng them to adopt proactive green strategies and accelerate their green M&A activities.

Table 7 Analysis of pollution level heterogeneity

	Non-heavy pollution			Heavy pollution		
	Model1	Model2	Model3	Model4	Model5	Model6
Size	-0.021	-0.049**	-0.029	0.095***	0.078***	0.081***
	(0.018)	(0.020)	(0.018)	(0.026)	(0.030)	(0.027)
ListAge	0.088***	0.092***	0.067***	0.050	0.052	0.018
	(0.022)	(0.022)	(0.024)	(0.035)	(0.035)	(0.037)
Lev	1.161***	1.165***	1.167***	0.746***	0.755***	0.765***
	(0.102)	(0.103)	(0.103)	(0.149)	(0.149)	(0.149)
Cash	-1.467***	-1.510***	-1.485***	-1.096***	-1.077***	-1.115***
	(0.234)	(0.235)	(0.234)	(0.366)	(0.366)	(0.366)
Board	-0.059	-0.058	-0.059	-0.420***	-0.430***	-0.414***
	(0.110)	(0.110)	(0.110)	(0.160)	(0.161)	(0.160)
Indep	-0.373	-0.361	-0.370	0.311	0.270	0.316
	(0.366)	(0.366)	(0.367)	(0.569)	(0.570)	(0.569)
Dual	-0.018	-0.016	-0.017	-0.038	-0.037	-0.034
	(0.038)	(0.038)	(0.038)	(0.062)	(0.062)	(0.062)
Top1	-1.217***	-1.235***	-1.217***	-0.689***	-0.675***	-0.673***
	(0.123)	(0.123)	(0.123)	(0.190)	(0.190)	(0.190)
TCR	2.440	2.414	2.441	1.855***	1.789***	1.823***
	(0.126)	(0.128)	(0.127)	(0.181)	(0.183)	(0.183)
GS		0.026			0.008**	
		(0.009)			(0.014)	
IA			0.016*			0.026*
			(0.007)			(0.013)
TCR*GS		0.078			0.162**	
		(0.055)			(0.068)	
TCR*IA			0.124			0.096**
			(0.040)			(0.071)
Constants	-1.324***	-1.132**	-1.338***	-2.847***	-2.555***	-2.820***
	(0.480)	(0.486)	(0.481)	(0.684)	(0.696)	(0.691)
N	21567	21561	21567	9473	9470	9473
pseudo R2	0.111	0.111	0.111	0.081	0.082	0.082
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Discussion and conclusion

As global climate change accelerates, transition climate risk has emerged as a significant challenge for firms, compelling them to adopt green development strategies to navigate the low-carbon transition. Among these strategies, green mergers and acquisitions (M&A) stand out as a crucial means for firms to achieve sustainable development while addressing climate-related risks. Despite substantial research on the economic outcomes and environmental benefits of green M&A,

the driving forces behind such activities remain underexplored. This study, therefore, investigates the relationship between transition climate risk and green M&A, with a particular focus on the influence of external environmental factors.

Based on signaling theory, we examine whether transition climate risk prompts firms to engage in green M&A and explore the underlying mechanisms and boundary conditions. Utilizing a sample of Chinese A-share listed companies, we employ logistic regression to test our hypotheses. The empirical findings yield several key insights. First, transition climate risk significantly accelerates green M&A activity by enhancing firms' risk-taking propensity and increasing their legitimacy demands. Second, both government subsidies and investor attention positively moderate this relationship. While subsidies provide essential financial support and bolster firms' legitimacy, investor attention, as an external governance mechanism, drives firms to proactively address transition climate risk.

Additionally, a heterogeneity analysis reveals that the impact of transition climate risk on green M&A is more pronounced among non-state-owned and heavily polluting firms. This study extends the application of signaling theory in the context of climate transition risk and green M&A, offering novel theoretical contributions and practical implications. Our findings provide valuable guidance for firm-level decision-making on green M&A, the formulation of government subsidy policies, and investor strategies, ultimately advancing the broader agenda of sustainable business practices and green development.

6.1 Theoretical implications

This study advances our understanding of how transition climate risk influences firm-level decision-making, particularly in the context of green strategies. While prior research has predominantly focused on the macroeconomic implications of transition climate risk or its effects on firm performance and capital structure (Chen et al., 2024; Deng et al., 2024), its impact on specific firm behaviors, especially regarding green strategic decisions, has been underexplored. By shifting the focus to the micro-level, this research examines how transition climate risk drives green M&A decisions. It reveals that climate risk enhances firms' risk-taking capacities and elevates their legitimacy demands, which in turn fosters green M&A activity. This study enriches transition climate risk theory by providing a micro-level framework that links climate risk to strategic behavior, thereby deepening our understanding of how firms respond to environmental changes and contribute to advancing research on corporate management in the context of climate transition.

Additionally, this study identifies new drivers of green M&A. Existing literature has primarily focused on the economic outcomes, environmental benefits, and policy incentives associated with green M&A (Lu, 2022; Sun et al., 2024; Xu et al., 2024), with limited attention to its antecedents. Notably, the role of external environmental factors, such as transition climate risk, in driving green M&A decisions has been underexplored. This research is the first to explicitly highlight transition climate risk as a key antecedent of green M&A, offering empirical evidence that transition climate risk positively influences firms' green M&A decisions. In this way, it extends the theoretical framework on the drivers of green M&A and provides new insights into the mechanisms that shape corporate green transformation in response to global climate change. These findings offer valuable theoretical guidance for firms in formulating green development strategies and for policymakers crafting relevant regulatory frameworks.

Furthermore, this study applies signaling theory to investigate the moderating roles of government subsidies and investor attention in green M&A decisions. Although signaling theory has been widely used to understand how firms communicate with stakeholders through strategic actions, its application in the context of climate risk has been limited. By integrating signaling theory, this research uncovers the boundary conditions of transition climate risk's influence on corporate green M&A behavior. Specifically, it shows that government subsidies and investor attention amplify the effects of transition climate risk, with subsidies signaling government support for green initiatives and investor attention serving as a market-driven signal of oversight. Both mechanisms enhance the positive impact of transition climate risk on green M&A, providing a deeper understanding of the external drivers that influence firms' green strategies. This work extends the applicability of signaling theory to the field of green management, offering a novel theoretical lens for understanding how stakeholder behavior shapes firms' responses to environmental challenges.

6.2 Management implications

Firms should recognize the external environmental shifts driven by transition climate risk and their profound implications for business operations. To navigate these changes effectively, firms should monitor policy and regulatory developments, market sentiment, and technological advancements, treating them as critical signals. In response, firms should enhance their risk-taking capacity, refine strategic positioning, and reallocate resources toward green initiatives, such as green technology R&D and sustainable production processes. These proactive measures will enhance their competitiveness in green M&A. Rather than viewing green M&A solely as a reactive response to climate risk, firms should leverage it as a strategic tool to accelerate green transformation. In practice, this entails selecting acquisition targets with complementary green technologies, products, or services and integrating these assets to generate synergies and accelerate sustainable growth.

Governments should enhance financial support for firms pursuing green development, particularly those actively engaging in green M&A to address transition climate risk. Subsidies should be designed to reduce the financial barriers to green innovation and M&A, alleviating funding constraints and incentivizing further investments in green transformation. In addition, subsidy programs should be tailored to the specific needs of different industries and firm types, ensuring more efficient resource allocation. By aligning subsidies with strategic green priorities, governments can guide firms toward key areas such as green M&A, promoting broader systemic shifts. Moreover, policymakers should emphasize the signaling function of these subsidies, clearly defining policy priorities to provide direction to the market. Such clarity will not only encourage green development but also enhance firms' reputations and competitiveness in the green sector, attracting additional resources to the industry, fostering the growth of the green M&A market, and accelerating the green upgrading of industries.

Investor attention is an important external signal that should be carefully managed. Firms should prioritize transparency in their environmental disclosures, providing high-quality, detailed reports on their actions to mitigate transition climate risk, their green M&A progress, and the returns on green investments. This transparency will help investors accurately assess a firm's commitment to green development and its potential for long-term sustainable growth, thereby strengthening investor confidence. Investor attention should be seen as a key driver in the green M&A decision-making process. Firms should incorporate investor expectations and feedback into their strategic decisions, adjusting resource allocation in response to shifting investor interests in green sectors.

By aligning their strategies with market trends, firms can capitalize on emerging green industries, expand into new green markets, and meet investor demands for sustainable development, ultimately enhancing their market value and competitive edge.

6.3 Limitations and future research

First, the measurement of transition climate risk and green M&A may be subject to bias. Transition climate risk is assessed using text analysis based on keyword frequency, which may fail to capture the full complexity of the actual risks firms face. Similarly, green M&A transactions that do not include specific keywords may be overlooked, despite being relevant. Future studies could refine these measures by employing more accurate and comprehensive methods.

Second, our analysis focuses solely on external factors influencing green M&A decisions. However, firm-level decisions are shaped by a range of internal factors, such as organizational culture, managerial cognition, and individual attitudes. Future research could incorporate these internal drivers to develop a more holistic model of green M&A decision-making.

Finally, while this study examines a broad sample of listed firms, future research could concentrate on specific sectors, such as energy or manufacturing, to explore how climate risk influences green M&A behavior in these industries. This would allow for a deeper understanding of sector-specific responses to climate risk.

Reference

[1] Andriuškevičius, K., & Štreimikienė, D. (2022). Sustainability framework for assessment of mergers and acquisitions in energy sector. Energies, 15(13), 4557.

[2] Arfaoui, N., Naeem, M. A., Maherzi, T., & Kayani, U. N. (2024). Can green investment funds hedge climate risk?. Finance Research Letters, 60, 104961.

[3] Bai, Y., Song, S., Jiao, J., & Yang, R. (2019). The impacts of government R&D subsidies on green innovation: Evidence from Chinese energy-intensive firms. Journal of Cleaner Production, 233, 819-829.

[4] Bianchi, M., Murtinu, S., & Scalera, V. G. (2019). R&D subsidies as dual signals in technological collaborations. Research Policy, 48(9), 103821.

[5] BliegeBird, R., & Smith, E. (2005). Signaling theory, strategic interaction, and symbolic capital. Current anthropology, 46(2), 221-248.

[6] Chen, T. H., & Chen, K. S. (2024). The effect of investor attention on stock price crash risk. Journal of Empirical Finance, 75, 101456.

[7] Chen, Y., Ren, Y. S., Narayan, S., & Huynh, N. Q. A. (2024). Does climate risk impact firms' ESG performance? Evidence from China. Economic Analysis and Policy, 81, 683-695.

[8] Connelly, B. L., Certo, S. T., Reutzel, C. R., DesJardine, M. R., & Zhou, Y. S. (2024). Signaling theory: state of the theory and its future. Journal of Management, 01492063241268459.

[9] Deng, C., Su, Z., & Feng, Y. (2024). Extreme climate and corporate financialization: Evidence from China. Economic Analysis and Policy, 81, 306-321.

[10] Diaz-Rainey, I., Gehricke, S. A., Roberts, H., & Zhang, R. (2021). Trump vs. Paris: The impact of climate policy on US listed oil and gas firm returns and volatility. International Review of Financial Analysis, 76, 101746.

[11] Fan, R., Wang, Y., Chen, F., Du, K., & Wang, Y. (2022). How do government policies affect the diffusion of green innovation among peer enterprises?-An evolutionary-game model in complex networks. Journal of Cleaner Production, 364, 132711.

[12] Fang, X. (2024). Can climate risk exposure compel companies to undergo a green transformation?. Journal of Cleaner Production, 434, 140310.

[13] Gu, J. (2024). Investor attention and ESG performance: Lessons from China's manufacturing industry. Journal of Environmental Management, 355, 120483.

[14] Han, F., Mao, X., Yu, X., & Yang, L. (2024). Government environmental protection subsidies and corporate green innovation: Evidence from Chinese microenterprises. Journal of Innovation & Knowledge, 9(1), 100458.

[15] Han, Z., Wang, Y., & Pang, J. (2022). Does environmental regulation promote green merger and acquisition? Evidence from the implementation of China's newly revised Environmental Protection Law. Frontiers in Environmental Science, 10, 1042260.

[16] Hao, J., & Xiong, X. (2021). Retail investor attention and firms' idiosyncratic risk: Evidence from China. International Review of Financial Analysis, 74, 101675.

[17] He, F., Yan, Y., Hao, J., & Wu, J. G. (2022). Retail investor attention and corporate green innovation: Evidence from China. Energy Economics, 115, 106308.

[18] Hu, D., Huang, Y., & Zhong, C. (2021a). Does environmental information disclosure affect the sustainable development of enterprises: The role of green innovation. Sustainability, 13(19), 11064.

[19] Hu, D., Qiu, L., She, M., & Wang, Y. (2021b). Sustaining the sustainable development: How do firms turn government green subsidies into financial performance through green innovation?. Business Strategy and the Environment, 30(5), 2271-2292.

[20] Lee, C. C., Wang, C. W., Thinh, B. T., & Xu, Z. T. (2022). Climate risk and bank liquidity creation: International evidence. International Review of Financial Analysis, 82, 102198.

[21] Li, S., & Pan, Z. (2022). Climate transition risk and bank performance: Evidence from China. Journal of Environmental Management, 323, 116275.

[22] Liang, X., Li, S., Luo, P., & Li, Z. (2022). Green mergers and acquisitions and green innovation: An empirical study on heavily polluting enterprises. Environmental Science and Pollution Research, 29(32), 48937-48952.

[23] Liu, M., Liu, L., Xu, S., Du, M., Liu, X., & Zhang, Y. (2019). The influences of government subsidies on performance of new energy firms: A firm heterogeneity perspective. Sustainability, 11(17), 4518.

[24] Liu, Y., Xu, H., & Wang, X. (2022). Government subsidy, asymmetric information and green innovation. Kybernetes, 51(12), 3681-3703.

[25] Liu, Z., He, S., Men, W., & Sun, H. (2024). Impact of climate risk on financial stability: Cross-country evidence. International Review of Financial Analysis, 92, 103096.

[26] Lu, J. (2021). Can the green merger and acquisition strategy improve the environmental protection investment of listed company?. Environmental Impact Assessment Review, 86, 106470.

[27] Lu, J. (2022). Green merger and acquisition and export expansion: Evidence from China's polluting enterprises. Sustainable production and consumption, 30, 204-217.

[28] Nguyen, J. H., & Phan, H. V. (2020). Carbon risk and corporate capital structure. Journal of Corporate Finance, 64, 101713.

[29] Ozkan, A., Temiz, H., & Yildiz, Y. (2023). Climate risk, corporate social responsibility, and firm performance. British Journal of Management, 34(4), 1791-1810.

[30] Reboredo, J. C., & Ugolini, A. (2022). Climate transition risk, profitability and stock prices. International Review of Financial Analysis, 83, 102271.

[31] Rong, X., Chen, H., & Liu, S. (2024). Nonlinear impact of climate risks on renewable energy stocks in China: A moderating effects study. International Review of Financial Analysis, 96, 103613.

[32] Schuster, M., Bornhöft, S. C., Lueg, R., & Bouzzine, Y. D. (2023). Stock price reactions to the climate activism by Fridays for Future: The roles of public attention and environmental performance. Journal of Environmental Management, 344, 118608.

[33] Shao, K., & Wang, X. (2023). Do government subsidies promote enterprise innovation?——Evidence from Chinese listed companies. Journal of Innovation & Knowledge, 8(4), 100436.

[34] Shao, Y., & Chen, Z. (2022). Can government subsidies promote the green technology innovation transformation? Evidence from Chinese listed companies. Economic Analysis and Policy, 74, 716-727.

[35] Shi, P., & Huang, Q. (2024). Green mergers and acquisitions and corporate environmental responsibility: Substantial transformation or strategic arbitrage?. Economic Analysis and Policy, 83, 1023-1040.

[36] Su, W., Peng, M. W., Tan, W., & Cheung, Y. L. (2016). The signaling effect of corporate social responsibility in emerging economies. Journal of Business Ethics, 134, 479-491.

[37] Sun, Y., & Liu, L. (2022). Green credit policy and enterprise green M&As: an empirical test from China. Sustainability, 14(23), 15692.

[38] Sun, Z., Sun, X., Wang, W., & Wang, W. (2023). Source reduction strategy or end-of-pipe solution? The impact of green merger and acquisition on environmental investment strategy of Chinese heavily polluting enterprises. Journal of Cleaner Production, 413, 137530.

[39] Sun, Z., Sun, X., Wang, W., Sun, M., & Wang, W. (2024). Green merger and acquisition decision driven by environmental regulation and its impact on green innovation: evidence from Chinese heavily polluting listed enterprises. Environment, Development and Sustainability, 26(2), 4973-5001.

[40] Wang, D., Wang, Y., & Zhou, M.(2024). Can environmental tax promote green M&A inemerging market firms? Evidence from China's heavypolluters. Business Ethics, the Environment & Responsibility, 00,1–25.

[41] Wang, X., Li, Z., Shaikh, R., Ranjha, A. R., & Batala, L. K. (2021). Do government subsidies promote financial performance? Fresh evidence from China's new energy vehicle industry. Sustainable Production and Consumption, 28, 142-153.

[42] Wang, Z., Zhang, J., & Ullah, H. (2023). Exploring the multidimensional perspective of retail investors' attention: the mediating influence of corporate governance and information disclosure on corporate environmental performance in China. Sustainability, 15(15), 11818.

[43] Wu, H., & Hu, S. (2020). The impact of synergy effect between government subsidies and slack resources on green technology innovation. Journal of Cleaner Production, 274, 122682.

[44] Xu, W., Gao, X., Xu, H., & Li, D. (2022). Does global climate risk encourage companies to take more risks?. Research in International Business and Finance, 61, 101658.

[45] Xu, Y., Wang, W., Gao, H., & Zhu, H. (2024). The Impact of Green Mergers and Acquisitions on Corporate Environmental Performance: Evidence from China's Heavy-Polluting Industries. Sustainability, 16(9), 3796.

[46] Yan, Z., & Li, Y. (2018). Signaling through government subsidy: Certification or endorsement. Finance Research Letters, 25, 90-95.

[47] Yang, J., & Gu, Y. (2024). Peer spillovers of environmental penalties-Evidence from green mergers and acquisitions. Finance Research Letters, 69, 106213.

[48] Yang, L., Liu, L., Yan, K., Cai, C., & Geng, Y. (2023a). "Carrot and stick": Green fiscal policy, upper echelons expertise, and the green mergers and acquisitions. Finance Research Letters, 58, 104650.

[49] Yang, X., Wei, L., Deng, R., Cao, J., & Huang, C. (2023b). Can climate-related risks increase audit fees?–Evidence from China. Finance Research Letters, 57, 104194.

[50] Yang, Y., & Chi, Y. (2023). Path selection for enterprises' green transition: Green innovation and green mergers and acquisitions. Journal of Cleaner Production, 412, 137397.

[51] Yao, S., Li, T., Sensoy, A., Fang, Z., & Cheng, F. (2024). Investor attention and environmental information disclosure quality: evidence from heavy pollution industries in China. International Journal of Finance & Economics, 29(3), 2971-2990.

[52] Yin, Z., Li, X., Si, D., & Li, X. (2023). China stock market liberalization and company ESG performance: The mediating effect of investor attention. Economic Analysis and Policy, 80, 1396-1414.

[53] Zhang, Z., & Zhang, L. (2024). Investor attention and corporate ESG performance. Finance Research Letters, 60, 104887.

[54] Zhou, L., Li, W., Teo, B. S. X., & Yusoff, S. K. M. (2023). The impact of green M&A listed companies' size on the rural ecological environment—Digitalization as moderating effect. Sustainability, 15(7), 6068.

[55] Zou, L., & Ma, J. (2024). Does carbon emission trading scheme improve corporate green mergers and acquisitions? Evidence from Chinese industrial enterprises. Environment, Development and Sustainability, 1-23.