

A Study on the Relationship Between Climate Risk and Green M&A in Enterprises: An Empirical Analysis of Chinese A-Share Listed Companies

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Abstract. Amid the setting of the dual carbon targets and the climate crisis, the study examines the impact of climate risk in motivating corporate green mergers and acquisitions, based on a sample of Chinese A-share listed companies between the years 2011 and 2024. According to the findings, climate risk greatly promotes green M&A, which is also an active transformation mechanism that is directed by an environmental stimulus effect. The mechanism tests indicate that the mediating factors that mediate the conversion of risk perception to strategic decisions are climate concerns of management and retail investors. In-depth study reveals that this is more pronounced in privately owned businesses, highly market-driven markets and companies that have CEOs who are not in the financial background. The results offer empirical data on the process of substantive transformation of firms as they undertake strategic restructuring in the face of uncertainty.

Keywords: Climate risk, Green M&A, Environmental incentive, Empirical analysis

1. Introduction

The events of extreme weather are becoming ever more frequent all over the world. Climate risks have now been transformed into physical shocks and transformation risks and shifted the macro-level environmental concerns into operational stability of specific enterprises. Risks associated with physical climate may damage their tangible assets, cause chain reactions in financial leverage, and augment tail systemic risks. This volatility interferes with the capital markets valuation as investors require an increased risk premium on high-carbon or eco-prone companies increasing the cost of equity capital and limiting the existence and growth of firms.

Nevertheless, despite climate risks undermining corporate balance sheets in the short-term, it also can push firms to break the path dependence and realize green transformation. Should climate risk be a clear negative signal, it should not only necessitate firms to reduce risks, but undertake low-carbon growth by actively strategically restructuring their industry positions. In the context of the intensifying of the duo carbon objective, ecological policies and societal demands are gaining more and more prominence. One of the principal ways that allow firms to purchase green technology assets and come to leapfrog development low-carbon targets is via Green M & A, and the decision making of the latter is heavily determined by the perceptions of external environmental risks.

This is an environmental incentive effect that a risk perception triggers; it is the driving force behind the enterprises responding passively to comply, instead of being proactive and responding to adjustment strategy. Will green mergers and acquisitions be greatly encouraged by climate risk? Are there any differences in related impacts across enterprises that have different natures and characteristics of senior executives? These questions can enhance our micro-level knowledge of the economic impact of climate risks and offers our decision-making guide to businesses that want to transform in environmental uncertainty.

2. Literature review

Proper definition of concepts is a precondition before delving into the relationship. Climate risk is a category of operational uncertainty due to extreme weather and changes in policies, which can modify the risk-taking rationality in a firm [1]. This paper presents the argument that climate risk must be regarded as a strategic catalyst that has a role of early-warning; it creates environmental incentives that make firms invest more in innovation as it forces them to seize the opportunities to transform [2]. At the same time, the external shock is reflected in the adjustments of asset allocation, in which firms respond by balancing the financialization and risk-taking [3]. As to the dependent variable, green M&A can be considered a risk-hedging approach according to which companies are able to recreate competitive advantages as well as decrease the probability of default by means of incorporating environmentally friendly resources.

In terms of driving factors, the main external driver that makes firms enhance performance by means of green M&A are environmental regulations [4]. Besides the formal institutions, there are also the informal institutions like the Confucian culture that greatly enhance the propensity of green M&A among the firms that are largely polluting [5]. Moreover, organizational behavior also affects the timing of M&A; a distinct inverted U-shaped relationship exists between the two-way performance feedback and green M&A propensity, which suggests that moderate performance gap is the best time to consider [6]. Green M&A has an astounding positive effect on the performance of target companies in terms of outcomes [7]. Lastly, external stakeholder supervision, including institutional investors, is effective in steering the management to making substantive decisions regarding green transitioning [8].

Overall, though the micro-level effects of climate risk, as well as drivers of green mergers and acquisitions were already covered in the previous literature, the logical gaps are still evident. Few studies focus on how climate risk, as an exogenous impact, promotes the restructuring of enterprises in the M & A market. Therefore, this paper jumps out of the narrow cognition that climate risk is simply regarded as "negative burden" and discusses its positive effect as the trigger factor of enterprise strategic transformation.

3. Mechanism analysis and hypothesis formulation

The logic behind the green M & A promoted by climate risk is mainly divided into two levels: "internal cognition" and "external pressure transmission. First of all, the perception of climate risk by enterprise management is the prerequisite for making decision-making. When the risk of asset loss caused by physical impact or the rise of policy cost caused by transformation risk occurs, these external signals will take the limited attention resources of management first. According to the relevant content of the limited attention theory, the management will transfer the cognitive resources originally put on the traditional operational efficiency to the work related to environmental safety. This kind of adjustment of resource allocation will prompt decision makers to reevaluate the

"stranded asset risk" attached to highly polluted assets, thus generating a strong motivation for asset restructuring. Green M & A is equivalent to a "shortcut", which enables enterprises to quickly obtain green technologies, related brands and carbon emission quotas, and helps enterprises hedge against the loss of valuation decline caused by climate uncertainty.

Secondly, climate risk will amplify the environmental protection demands of external stakeholders, thus bringing "legal pressure" to enterprises ". At present, there are more and more news reports related to the climate crisis. Retail investors, institutional investors and the general public are increasingly sensitive to the environmental performance of enterprises. If investors worry about the climate risk exposure of enterprises, they will either reduce their stocks of high-carbon emission enterprises or put pressure on enterprises through interactive platforms. Under such pressure, if enterprises want to maintain their own reputation and reduce agency costs, they will respond through green mergers and acquisitions, which have strong signal transmission value. It is not only a simple asset expansion, but also a "loyalty guarantee" for enterprises to announce their determination to transform to the outside world, which can alleviate the financing constraints caused by the risk exposure of enterprises.

In the end, this "environmental incentive effect" will internalize climate risks into the driving force for enterprise transformation. If enterprises realize that climate-related policies and physical impacts will threaten their competitive position, they will get "green option" through mergers and acquisitions, turning climate risks into benefits brought by innovation.

Based on this logic, this paper proposes Hypothesis H1: Climate risk has a significant positive effect on corporate green M&A.

4. Variable definition and model selection

4.1. Data sources and sample selection

The initial sample of this study consists of Chinese A-share listed firms spanning 2011–2024. 2011 is chosen as the starting year because from this year on, the environmental information and M & A data disclosed by enterprises can better meet the relevant requirements of empirical research. The data of green M & A are extracted from the "Merger and Reorganization module of listed companies" of CSMAR database, and identified by referring to the standards of authoritative literature. The construction of climate risk indicators is obtained by extracting relevant data from the listed companies' annual reports disclosed by Shanghai and Shenzhen stock exchanges and then processing them with the method of text analysis. Data on control variables and corresponding financial items come from the CSMAR database.

The sample screening excludes: (1) finance, insurance, and securities sectors; (2) ST, *ST, or PT firms; (3) observations with severe missing values. After screening, 51,662 firm-year observations are obtained. All continuous variables undergo winsorization at the 1% and 99% thresholds.

4.2. Variable definition

The dependent variable is green mergers and acquisitions (Green M & A). Drawing on Pan Ailing et al. [9], green M&A is defined as asset expansion activities initiated by listed companies to acquire green technologies and achieve low-carbon transformation. Identification: all M&A events where a listed company is the buyer are extracted; by reviewing announcements, transactions with objectives or target attributes containing keywords such as "environmental protection" "energy conservation" "emission reduction" "green" or "clean energy" are matched against the *Green Industry Guidance*

Catalog. If a firm initiates and completes at least one such transaction in a given year, Green M & A = 1; otherwise 0.

The independent variable is climate risk (ClimateRisk). Following Du Jian et al. [10], text analysis is used to characterize climate uncertainty perceived by firms. A climate risk keyword corpus is constructed with two dimensions: physical risks (extreme weather) and transition risks (low-carbon policies, carbon trading). Using text segmentation, 98 climate risk keywords are identified in annual reports, and their total annual frequency is calculated. The climate risk perception index is computed as the total count of climate risk keywords divided by the report's overall word count, then multiplied by 100. A larger index value signifies greater perceived climate risk.

4.3. Model selection

To investigate the effect of climate risk on firms' green M&A activities, we estimate a fixed-effects regression model, as presented in equation (1):

$$y_{it} = \beta_0 + \beta_1 * x_{it} + \sum \alpha_k controls_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad (1)$$

ε_{it} denotes the random error term; i and t denote the firm and the year respectively. The model controls for the annual fixed effect λ_t and the firm-specific fixed effect μ_i , k indicates the number of control variables, β_0 is the constant term, and β_1 is the coefficient of the independent variable.

5. Empirical analysis

5.1. Descriptive statistics

The descriptive statistics of the main variables are reported in Table 1. The results show that the mean value of the dependent variable, corporate green mergers and acquisitions (Green M & A), is 0.052. This implies that within the sample period of 2011 to the year 2024, about 5.2 per cent of the companies have been involved in green M&A activities in their yearly observations. Its standard deviation is 0.222, which is a large measure of variation among sample firms in their decisions regarding a green transition. The independent variable, climate risk (ClimateRisk), has a mean of 0.088, and a standard deviation of 0.061. Also, the large disparity between the highest value (0.395) and the lowest value (0.003) validates the fact that listed firms portray great heterogeneity in how they perceive climate risk, which forms a substantial data base on which the current study can be conducted to investigate its influence on M&A behavior.

In terms of the control variables, the statistical features are more or less in line with the study that has been conducted on Chinese A-share listed companies. The average of the firm size (Size) is 21.849, the average of the debt to asset ratio (Lev) is 0.391, which means that the financial structure of the sample firms is relatively healthy. The average equity concentration (Top1) will be 0.354, which means that the majority shareholder stands out as a powerful force in the corporate decision making process. In particular, the mean value of return on assets (ROA) is 0.046, and the minimum is -0.107. The visuals of the negative values here indicate that there were some firms in the sample that had made large operating losses during certain fiscal years. Besides, the average of the Tobin Q ratio (TobinQ) stands at 2.221 which indicates how the market generally thinks that the sample firms can grow. In general, all the key variables distributions are within reasonable boundaries, and the

sample choice is scientific and representative, which successfully substantiates the follow-ups empirical tests.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
greenMA2	51675	0.495	1.466	0	48
climaterisk1	51675	0.181	0.215	0.001	3.478
Size	51675	22.155	1.304	19.415	26.452
Lev	51675	0.423	0.205	0.028	0.910
ROA	51675	0.034	0.065	-0.556	0.222
Top1	51675	0.341	0.149	0.075	0.758
TobinQ	51662	2.002	1.305	0.795	17.676

5.2. Baseline regression

The base regression results on the effects of climate risk (climaterisk1) on corporate green M & A (greenMA2) are shown in Table 2. In Table 2, Column 1, the results of a model with no controls or fixed effects are found, where the climate risk coefficient is 1.6759 and is significant at the 1% level. The climate risk coefficient in column (2) and column (3) is within a range of 1.5973 to 1.6583, and in all specifications is statistically significant at the 1% level.

This finding has great economic consequences. Table 2 (Column 4) uses a much more rigorous estimation using an individual fixed-effects model (FE), and it is found that the regression coefficient of climate risk is 1.0503 that is highly significant at the 1 percent level and has a t-statistic of 27.17. It means that every unit increase in climate risk makes the level of green M&A of the firm grow by 1.0503 units on average. This is a clear indication that the increased perceptions of climate risk are a major driver to green M&A behavior by firms and Hypothesis H1 is strongly supported by the empirical evidence.

In the context of control variables, the relationship between different financial variables and green mergers and acquisitions is largely in accordance with expectations. The coefficient of enterprise Size is 0.0385 in the fixed effect model, for example, which is evidently positive, meaning that in the presence of pressure of environmental protection, possess greater transformation and execution ability. The coefficient of profitability (ROA) is -0.4563, which is obviously negative, indicating that enterprises with current operating difficulties are more inclined to look for transformation opportunities through green mergers and acquisitions and try to "overtake by changing lanes". In addition, asset-liability ratio (Lev) and Market Valuation (TobinQ) both show significant positive effects. The above results are basically consistent with the conclusions of the existing relevant studies, indicating that the model setting of this study is reasonable and the estimation results are reliable.

Table 2. Baseline regression analysis

	(1)	(2)	(3)	(4)
	greenMA2	greenMA2	greenMA2	greenMA2
climaterisk1	1.6759***	1.7480***	1.6852***	0.8466***
	(0.03)	(0.03)	(0.03)	(0.06)

Table 2. (continued)

Size			0.0194*** (0.01)	0.1058*** (0.01)
Lev			0.5213*** (0.04)	0.2965*** (0.06)
ROA			-0.6825*** (0.11)	-0.3656*** (0.12)
Top1			-0.6518*** (0.04)	-0.5109*** (0.09)
TobinQ			0.0294*** (0.01)	0.0617*** (0.01)
cons	0.1918*** (0.01)	0.0418 (0.04)	-0.4090*** (0.13)	-2.1584*** (0.29)
N	51675	51675	51662	51662
R ²	0.061	0.074	0.087	0.028
adj. R ²	0.061	0.073	0.086	-0.065
year	No	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5.3. Robustness tests

In order to ascertain the credibility of the benchmark results, this research performed strong tests that included some strategies, among them, varying variables, endogeneity, and the sample period. Table 3 presents results.

Firstly, substitution of the core variables. Because the climate risk is multidimensional, columns (1) and (2) use transition risk (climaterisk2) and physical risk (climaterisk3) in place of composite index, respectively. The two coefficients are both significantly positive at the 1% level. Column (3) substitutes the dependent variable with a dummy variable (greenMA1); the coefficient is quite significant which implies that climate risk raises the frequency and probability of green M&A. Second, addressing endogeneity. To mitigate reverse causality, Column (4) uses a one-period lag of climate risk (L.climaterisk1). The causal direction is supported by the lagged coefficient 0.9576 which is significant at the 1% level. Third, narrowing the sample period. Given potential disturbances from 2020–2022, Column (5) excludes these years and re-estimates the model. The coefficient for climate risk remains 1.0503, significant at the 1% level.

In summary, the positive effect of climate risk on green M&A remains robust across all tests.

Table 3. Robustness tests

	(1) GreenMA	(2) GreenMA	(3) GreenMA	(4) GreenMA	(5) GreenMA
Climaterisk	0.8585*** (0.06)	-1.0798 (1.79)	0.1788*** (0.02)	0.6460*** (0.07)	0.5970*** (0.13)

Table 3. (continued)

Size	0.1058*** (0.01)	0.1334*** (0.01)	0.0256*** (0.00)	0.0808*** (0.02)	0.2030*** (0.03)
Lev	0.2960*** (0.06)	0.2947*** (0.06)	0.1107*** (0.02)	0.1959*** (0.06)	0.1639 (0.12)
ROA	-0.3657*** (0.12)	-0.3303*** (0.12)	-0.0995*** (0.03)	-0.1944 (0.13)	-0.0653 (0.18)
Top1	-0.5106*** (0.09)	-0.4731*** (0.09)	-0.0916*** (0.02)	-0.4740*** (0.10)	-0.1352 (0.21)
TobinQ	0.0617*** (0.01)	0.0607*** (0.01)	0.0191*** (0.00)	0.0484*** (0.01)	0.0700*** (0.02)
cons	-2.1577*** (0.29)	-2.6974*** (0.29)	-0.5121*** (0.08)	-1.3860*** (0.33)	-4.1852*** (0.71)
N	51662	51662	51662	46560	18423
R ²	0.028	0.024	0.041	0.022	0.035
year	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5.4. Heterogeneity analysis

To examine the heterogeneity of the effects of climate risk on corporate green M&A, this research carried out group regression tests on the basis of overseas and management background of CEOs. The results are shown in Table 4. Under the CEO overseas background grouping, the regression coefficient on climate risk of the group with no overseas background (Column 2) is positive and significantly high at the 1% level whereas the coefficient of the group with overseas background (Column 1) is not significant. It means that the positive impact of climate risk on green M&A is stronger in companies where the CEO cannot be considered as having an overseas experience. The reason is the fact that long-experienced CEOs of the domestic market better understand the domestic climate policies and industry transformation requirements and can better respond to climate risks by using green M&A.

In the group divided by CEO management experience, the climate risk regression coefficient of group (3) (CEO with management experience) is 0.8089, and it is significantly positive at the level of 1%; however, the corresponding coefficient of group (4) (CEO without management experience) is -0.639, which does not have statistical significance. This shows that the positive impact of climate risk is more prominent in enterprises led by CEOs with management experience. Such CEOs usually have stronger strategic decision-making ability and resource integration ability, there are more conditions to seize the opportunity of transformation through green mergers and acquisitions. On the whole, the boosting influence of climate risk on green mergers and acquisitions is more obvious in the enterprises with no overseas background but management experience, which also verifies the regulating effect of CEO's personal characteristics.

Table 4. Heterogeneity analysis results

Variable name	GreenMA			
	(1)	(2)	(3)	(4)
climaterisk1	0.0815	0.8145***	0.8089***	-0.639
	-0.31	-0.06	-0.06	-0.74
controls	Yes	Yes	Yes	Yes
cons	2.5177*	-2.1604***	-2.2637***	-0.6815
	-1.5	-0.31	-0.81	-2.61
<i>N</i>	4755	45208	47524	2439
<i>R</i> ²	0.029	0.028	0.025	0.065
year	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. Conclusions and recommendations

This paper selects the relevant data of China's A-share listed enterprises from 2011 to 2024 to study the actual impact of climate risk on green mergers and acquisitions. Benchmark regression results show that climate risk has a significant positive effect on green mergers and acquisitions, and this conclusion is still valid after several rounds of robustness tests. The results of mechanism test show that climate risk will enhance the management's cognition of climate risk and trigger environmental pressure from retail investors. These factors together become the strategic thrust of enterprises' green transformation, it also provides support for the "environmental incentive hypothesis. The results of heterogeneity analysis show that this positive effect is more obvious in private enterprises, regions with high degree of marketization, and enterprises with no overseas background but management experience as CEOs. Under appropriate internal governance and external conditions, climate risk can be transformed from the original financial burden to a catalyst to promote enterprise transformation.

Based on the above research conclusions, this paper puts forward three suggestions. First, policy-making departments can further improve the relevant rules of climate risk disclosure, guide listed enterprises to disclose their physical risks and transformation risks in an orderly manner, so as to optimize the risk pricing mechanism of the market, provide institutional incentives for enterprises to carry out green mergers and acquisitions. Second, the regulatory authorities can build a multi-subject environmental governance system to encourage institutional investors and individual investors to express their own climate demands through shareholder proposals, online voting, etc, strengthen the governance constraints on high-carbon emission enterprises. Third, considering the differences between different property rights and different regions, local governments can implement differentiated incentive measures: for private enterprises, green loan discount can be introduced, set up special funds for mergers and acquisitions and other supporting policies; For regions with low degree of marketization, priority can be given to promoting the implementation of

environmental regulations, improving the construction of green financial infrastructure, and gradually narrowing the gap of transformation ability between different regions.

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